

Annex 2: Feasibility Study

**STRENGTHENING CLIMATE RESILIENCE OF VULNERABLE AGRICULTURE LIVELIHOODS IN IRAQ'S RURAL
COMMUNITIES (SRVALI)**

FAO

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I. TABLE OF CONTENTS

I. TABLE OF CONTENTS.....	2
II. LIST OF TABLES.....	5
III. LIST OF FIGURES.....	7
IV. LIST OF ACRONYMS	9
V. DEFINITIONS ACCORDING TO IPCC AND FAO	11
VI. CURRENCY AND CONVERSION FACTORS.....	13
1. PROJECT SUMMARY	14
ABSTRACT:	14
ADAPTATION BENEFITS	15
MITIGATION BENEFITS	16
OTHER EXPECTED CO-BENEFITS.....	16
2. METHODOLOGY AND APPROACH	17
LITERATURE REVIEW	17
ANALYSIS OF DATA FROM EXISTING METEOROLOGICAL STATIONS	17
FAO GEOSPATIAL ANALYSIS:	19
DATA REVIEW WITH INSTITUTIONAL STAKEHOLDERS	19
‘GROUND-TRUTHING’ OF CLIMATE VARIABLES WITH REPRESENTATIVE FOCUS GROUPS DISCUSSIONS AND INTERVIEWS IN TARGET AREAS	19
3. BACKGROUND INFORMATION.....	20
COUNTRY ECONOMIC AND SOCIAL BACKGROUND	20
NATURAL RESOURCES, CLIMATE AND CLIMATE CHANGE	25
Introduction	25
Institutional set-up of the climate change sector.....	27
Climate context and climate scenarios	28
Greenhouse Gas Emissions and mitigation scenarios.....	45
Climate change adaptation and mitigation targets and related policies, strategies and laws	46
SWOT Analysis of the Sector.....	52
Main past, existing and planned projects	53
Lessons learned from past climate change experiences.....	55
WATER, IRRIGATION AND WATER MANAGEMENT	55
Introduction	55
Institutional set-up	56
State of the art	62
Main challenges and CC impact	94
SWOT Analysis of the Sector.....	97
Main Policy framework, strategy, laws	105
Main past, existing and planned projects	109
Lessons learned from past climate change experiences.....	112
THE AGRICULTURE AND CLIMATE RESILIENT AGRICULTURE SECTOR.....	116
Introduction	116
Institutional set-up	117
State of the art	119
Main challenges and CC impact	120
SWOT Analysis of the Sector.....	123
Main Policy framework, strategy, laws	128

Main past, existing and planned projects	129
Lessons learned from past climate change experiences	130
RENEWABLE ENERGY RESOURCES SECTOR.....	132
Introduction	132
Institutional set-up	136
State of the art	138
Main challenges and CC impact	143
SWOT Analysis of the Sector.....	144
Main Policy framework, strategy, laws.	145
Main past, existing and planned projects	147
Lessons learned from past climate change experiences	148
4. PROJECT AREAS AND TARGET GROUP	150
SELECTION CRITERIA FOR PROJECT AREAS:	150
DEMOGRAPHIC AND SOCIO-ECONOMIC PROFILE OF PROJECT AREAS.....	151
CLIMATE, WATER, IRRIGATION AND WATER MANAGEMENT.....	155
THE AGRICULTURE AND CLIMATE RESILIENT AGRICULTURE SECTOR.....	162
5. BENEFICIARIES	164
PROJECT BENEFICIARIES CALCULATION AND ACCOUNTING	164
6. KEY TECHNOLOGIES, PRACTICES AND SECTORIAL APPROACHES IDENTIFIED BY STAKEHOLDERS TO ADDRESS CLIMATE CHANGE ADAPTATION AND CONTRIBUTE TO CLIMATE CHANGE MITIGATION	168
COMPONENT 1: STRENGTHENING RESILIENCE AGAINST CLIMATE INDUCED WATER SCARCITY	168
INVESTMENTS IN IRRIGATION CANALS UPGRADING (SUBCOMPONENT 1.1).....	168
Proposed action, rational, and feasibility	169
Cost assessment	172
Specific Execution Modalities	173
Operation and maintenance	176
Economic, financial, social and environmental sustainability	176
INVESTMENTS IN RENEWABLE ENERGY EFFICIENT SYSTEMS (SUB-COMPONENT 1.2)	177
Proposed action, rational, and feasibility	177
Cost assessment	179
Specific Execution Modalities	179
Operation and maintenance	180
Economic, financial, social and environmental sustainability	180
INVESTMENTS IN KNOWLEDGE TRANSFER, BEHAVIOUR CHANGE AND TRAINING (SUB-COMPONENT 1.3)	182
Proposed action, rational, and feasibility	182
Cost assessment	185
Specific Execution Modalities	185
Operation and maintenance	186
Economic, financial, social and environmental sustainability	186
COMPONENT 2: CLIMATE RESILIENT AGRICULTURE PRODUCTION.....	189
STRENGTHENING ADAPTIVE CAPACITY OF FARMERS (SUB-COMPONENT 2.1)	189
Proposed action, rational, and feasibility	189
Cost assessment	194
Specific Execution Modalities	194
Operation and maintenance	195
Economic, financial, social and environmental sustainability	195
ENHANCING AWARENESS ABOUT ENERGY EFFICIENT SOLUTIONS (SUB-COMPONENT 2.2).....	196
Proposed action, rational, and feasibility	196

Cost assessment	198
Specific Execution Modalities	199
Operation and maintenance	199
Economic, financial, social and environmental sustainability	199
ENHANCING CLIMATE RESILIENCE FOR WOMEN (SUB-COMPONENT 2.3)	199
Proposed action, rational, and feasibility	199
Cost assessment	205
Specific Execution Modalities	206
Operation and maintenance	206
Economic, financial, social and environmental sustainability	206
COMPONENT 3: SCALING UP CLIMATE ADAPTATION THROUGH POLICY FORMULATION AND PLANNING	206
A CLIMATE RESILIENT WATER ALLOCATION STRATEGY AND ITS ACTION/LEGAL/COORDINATION PLAN DEVELOPED (OUTPUT 3.1.1)	207
Proposed action, rational, and feasibility	207
Cost assessment	208
Specific Execution Modalities	209
Operation and maintenance	209
Economic, financial, social and environmental sustainability	209
IMPROVED NATIONAL COMPLIANCE PRACTICES FOR MANAGEMENT OF IRRIGATION WATER SUPPLY (OUTPUT 3.1.2)	210
Proposed action, rational, and feasibility	210
Cost assessment	211
Specific Execution Modalities	211
Operation and maintenance	212
Economic, financial, social and environmental sustainability	212
ENHANCED PLANNING FOR SOLAR RURAL ELECTRIFICATION (OUTPUT 3.2.1)	212
Proposed action, rational, and feasibility	212
Cost assessment	213
Specific Execution Modalities	213
Operation and maintenance	214
Economic, financial, social and environmental sustainability	214
OPTIONS ANALYSIS	214
7. ENVIRONMENTAL AND SOCIAL MANAGEMENT FRAMEWORK	220
Mitigation measures and approach to enhance positive impacts	220
Expected project impacts	220
Mitigation of environmental and social impacts	221
8. IDENTIFIED ACTIONS TO TRANSFER TECHNOLOGIES AND PRACTICES AND TO SCALE UP RESULTS NATIONALLY	225
TRAININGS	225
FIELD CONFERENCES	225
AWARENESS	225
E-KNOWLEDGE DIFFUSION	226
UPDATE OF THE NATIONAL CURRICULA	226
PRIVATE SECTOR INVOLVEMENT	226
CIVIL SOCIETY ORGANIZATIONS INVOLVEMENT	227
CLIMATE WISE WOMEN	227
FARMER FIELD SCHOOLS	227
POLICY DIALOGUE	229
9. PROJECT FEASIBILITY ASSESSMENT	229
10. PROJECT COORDINATION AND COLLABORATION	237

11. PLANNING, M&E AND KNOWLEDGE MANAGEMENT	239
MONITORING AND EVALUATION	241
PROJECT'S BASELINE.....	245
DESCRIPTION OF SELECTED INDICATORS.....	246
MONITORING STRATEGY	246
REPORTING, SUPERVISION AND EVALUATION.....	247
M&E OUTPUTS AND BUDGET	249
LEARNING AND KNOWLEDGE MANAGEMENT.....	249
APPENDICES.....	251
APPENDIX 1. CHRONOLOGY OF MAJOR EVENTS IN THE EUPHRATES–TIGRIS RIVER BASIN.....	251
APPENDIX 2: FUTURE WATER QUALITY & QUANTITY (2035).....	252
APPENDIX 3. WATER RESOURCES OF MAIN AQUIFER ZONES OF IRAQ	253
APPENDIX 4. TOTAL DYNAMIC RESERVES OF WATER IN THREE CATEGORIES	254
APPENDIX 5. GROUNDWATER LEVEL IN IRAQ.....	255
APPENDIX 6: GROUNDWATER SALINITY MAPS OF IRAQ	256
APPENDIX 7: SPATIAL VARIATIONS OF GROUNDWATER SALINITY IN IRAQ	257
APPENDIX 8: RECOMMENDED NEW DAMS IN IRAQ	258
APPENDIX 9: WATER BALANCE IN THE MARSHES UNDER AVERAGE HYDROLOGIC CONDITIONS IN 2035.....	259
APPENDIX 10: NUMBER OF GROUNDWATER WELLS DRILLED IN EACH GOVERNORATE IN IRAQ	260
APPENDIX 11: DETAILS OF IRRIGATION PROJECTS IN IRAQ.....	261
APPENDIX 12: SCHEMATIC OF IRAQ'S WATER STORAGE AND CONTROL SYSTEM	267
APPENDIX 13: AGRO-CLIMATIC ZONES	268
APPENDIX 14: IRAQ CROP YIELDS (2019)	269
APPENDIX 15: TOP 20 IMPORTED AGRICULTURAL PRODUCTS IN IRAQ (2019)	270
APPENDIX 16: TOP 20 EXPORTED AGRICULTURAL PRODUCTS IN IRAQ (2019).....	271
APPENDIX 17: PRELIMINARY DESIGN	272
APPENDIX 18: PRELIMINARY MAINTENANCE PLAN PV PUMPING SYSTEM	277
APPENDIX 19: IRRIGATION EFFICIENCIES FOR CURRENT AND FUTURE SCENARIOS IN THE TARGET GOVERNORATES	281
APPENDIX 20: PRELIMINARY FEASIBILITY AND COST ESTIMATIONS.....	282

II. LIST OF TABLES

Table 1: Location of the weather stations.....	17
Table 2: Iraq soil salinity.....	22
Table 3: Population of target governorates: Karbala, Najaf, and Muthanna	22
Table 4: State of Food Security in project areas	24
Table 5: Poverty and vulnerability	24
Table 6: Labor force participation and employment rates	25
Table 7: Historical (1980-2020) and projected climate change trends in the three governorates and impacts (2020-2060). NSST = No statistical significant trend. NED = Not enough data	39
Table 8: Non Climatic Factors influencing water availability	40
Table 9: Historical trends (1980-2020) and projected trends at the watershed level (2020-2060)	44
Table 10: Project aligned with national policies and strategies related to climate change.....	47
Table 11: SWOT Analysis for natural resources, climate and climate change sector	52
Table 12: Current and past projects in the natural resource management and climate change	53
Table 13: WUA established within and outside Pilot Project.....	59
Table 14: Number of WUA as of January 2016.....	60
Table 15: The area of Tigris and Euphrates basins	65
Table 16: The Tigris River water inflow for the years 1933-2012, (BCM)	66

Table 17: The Euphrates River water inflow for the years 1933-2012 (BCM)	66
Table 18: Surface water entering Iraq (billion m3/year).....	67
Table 19: Rechargeable and exploitable volume	69
Table 20: Effect of Salinity in Irrigation	71
Table 21: Soil Salinity Classification and Crop Responses	71
Table 22: Water withdrawals by sector in 2015	75
Table 23: Total current and future water requirements in Iraq, including evaporation (BCM/year).....	75
Table 24: Water consumption in industrial sector, oil and electricity (BCM/year).....	77
Table 25: Groundwater Usage.....	78
Table 26: Iraq's water balance with the implementation of the SWLRI Strategy	81
Table 27: Reuse of drainage water	83
Table 28: Iraq's dams and their storage capacity and hydropower generation	84
Table 29: Dams of GAP project in Turkey	84
Table 30: Dams of the River Euphrates in Syria	85
Table 31: Iran dams	85
Table 32: Irrigation potential, irrigation-equipped area and recently irrigated area	89
Table 33: SWOT Analysis Water, Irrigation and water management	97
Table 34: Past, existing and planned projects in water	109
Table 35: Selected climate change impacts and needed responses in agriculture sector	121
Table 36: SWOT analysis in the agriculture sector	123
Table 37: Average electricity consumption in target regions and Baghdad	141
Table 38: Projected solar PV capacities in Iraq	146
Table 39: Brief description of selected target areas.....	150
Table 40: Population of target governorates: Karbala, Najaf, and Muthanna	151
Table 41: State of Food Security in project areas	152
Table 42: Illiteracy and completion rates (primary to upper secondary)	153
Table 43: Agricultural households' access to land	154
Table 44: Division of agricultural activities by gender in the targeted governorates	154
Table 45: Female-headed households' ownership of farmland and livestock in targeted governorates.....	155
Table 46: Water Users Associations in Najaf till 2020	157
Table 47: Information of proposed sites for project interventions (Najaf)	157
Table 48: Water Users Associations in Muthanna by end 2020.....	159
Table 49: Information of proposed sites for project interventions (Muthanna)	159
Table 50: Water Users Associations in Karbala by end 2020	160
Table 51: Information of proposed sites for project interventions (Karbala).....	160
Table 52: Length and lining ratio of main, branch and secondary canals (JICA 2016)	161
Table 53:Length and lining ratio of distributary canals	162
Table 54: Beneficiaries calculations and accounting.....	Error! Bookmark not defined.
Table 55: Activities under output 1.1	171
Table 56: Costs under sub-component 1.1.....	173
Table 57: List of canals selected for rehabilitation (upgrade)	174
Table 58: List of canals for solar panels proposed by DoWR	177
Table 59: Activities under output 1.2.....	178
Table 60: Costs under sub-component 1.2.....	179
Table 61: Activities under output 1.3.....	183
Table 62: Activities under output 1.4.....	183
Table 63: Costs under sub-component 1.3.....	185
Table 64: Activities under output 2.1.....	190
Table 65: Activities under output 2.2.....	191
Table 66: Activities under output 2.3.....	193
Table 67: Costs under sub-component 2.1.....	194
Table 68: Results from FAO Aquacrop	196
Table 69: Activities under output 2.4.....	197

Table 70: Costs under sub-component 2.2.....	199
Table 71: Activities under output 2.5.....	200
Table 72: Courses planned under activity 2.5.3	203
Table 73: Activities under output 2.6.....	204
Table 74: Costs under sub-component 2.3.....	205
Table 75: Activities under output 3.1.....	207
Table 76: Costs under output 3.1	208
Table 77: Activities under output 3.2.....	210
Table 78: Costs under output 3.2	211
Table 79: Activities under output 3.3.....	212
Table 80: Costs under output 3.3	213
Table 81: Options Analysis for Irrigation Investments.....	214
Table 82: Options Analysis for Climate Resilient Agriculture Practices	217
Table 83: Options for Scaling-up climate adaptation through policy formulation and planning	219
Table 84: ESS mitigation plan: potential environmental and social impacts, and actions.....	222
Table 85: FFS training curricula.....	228
Table 86: Component 1 main elements of feasibility.....	230
Table 87: Component 2 main elements of feasibility.....	232
Table 88: Component 3 main elements of feasibility.....	234
Table 89: Collaboration and complementarities between GCF Projects in Iraq implemented by FAO and WFP	239
Table 90: Baseline Summary according to LFM	245
Table 91: Project's means of verification	246
Table 92: Project Reporting Framework.....	248
Table 93: Project Reports	248

III. LIST OF FIGURES

Figure 1:Map of Iraq and its surrounding countries	20
Figure 2: Land utilization in Iraq	21
Figure 3: Organigram Ministry of Environment.....	27
Figure 4: Iraq Rainfall map.....	29
Figure 5: Current seasonal variations of the monthly average temperature	31
Figure 6: Current seasonal variations of the monthly accumulated precipitation.....	31
Figure 7:Historical time series of the annual average temperature in the three target governorates	32
Figure 8: Historical time series of the annually accumulated precipitation in the three target governorates	33
Figure 9: Projected time series of the annual average temperature in the three target governorates	34
Figure 10: Projected time series of the annually accumulated precipitation in the three target governorates	35
Figure 11: Annually accumulated precipitation and annual average temperatures - Historical and projected time series and trends in the targeted governorates	37
Figure 12: Location of river basins considered within the project	42
Figure 13: Current spatial distribution of monthly average accumulated precipitation over the Iraqi watershed	43
Figure 14: GHG scenarios are summarized.....	45
Figure 15: Structure of the Ministry of Water Resources	57
Figure 16: Expected water supply sources and quantities in Iraq in the near future	62
Figure 17: Average monthly discharge of Tigris River at Sarai Baghdad station	63
Figure 18: Average monthly discharge of Euphrates River at Hit and Haditha stations	63
Figure 19: Tigris and Euphrates Rivers	64
Figure 20:Total water allocations of the Tigris and Euphrates basins for the water years (1933-2020)	67
Figure 21: Appropriateness of ground water for agricultural purposes in different hydrogeological areas	68
Figure 22: Satellite view of Southern Marshes.....	70
Figure 23: Frequency of occurrence of flooded areas within the Marshlands.....	70
Figure 24: Salinity variation along Tigris River before 1983 and after 1995	72
Figure 25: Salinity variation along Euphrates River since 1996	73

Figure 26: Measured water quality parameters along the Tigris River, 2011	73
Figure 27: Measured water quality parameters along the Euphrates River, 2011	74
Figure 28: Evolution of gross water demand to support oil well reinjection and refineries	77
Figure 29: Water entering at the Iraqi borders (billion m3)	79
Figure 30: Iraq's water balance without the implementation of the SWLRI Strategy	80
Figure 31: Locations of the 142 Irrigation Projects	82
Figure 32: The twenty years investment strategy	83
Figure 33: Fluctuation of the contribution of the primary sector to GDP and variation of GDP growth by year	87
Figure 34: Status of Agriculture in 2035	90
Figure 35: Public expenditure in water resources and agriculture	91
Figure 36: Source of water for the wheat farmers in each agro ecological zone	93
Figure 37: The Economic Impacts of Climate Change-Induced Water Scarcity by World Region, 2050.....	95
Figure 38: Schematic of water management structures in Iraq	96
Figure 39: Ministry of Agriculture at central and directorate level.....	117
Figure 40: Total Energy Supply (TES) by Source, Iraq 199-2018.....	132
Figure 41: Transmission and Distribution Losses in Arab Region, 2015 (percent of Output)	134
Figure 42: Peak demand and maximum power supply from the grid in Iraq, 2014-18	134
Figure 43: AFEX Energy Efficiency assessment of Iraq. Red lines are regional average and blue lines the score of Iraq	136
Figure 44: Organizational structure IME.....	136
Figure 45: Solar Irradiation Iraq.....	138
Figure 46: Solar PV levelized costs relative to oil- and gas-fired generation in Iraq, 2015 – 30.....	139
Figure 47: Total Renewable Energy Capacities in the Arab Region excluding Hydro (2010-2018)	140
Figure 48: Transmission and Distribution losses in Iraq.....	141
Figure 49: Average Load Demand and Covered Electricity Load in 2016	141
Figure 50: Technology options to improve electricity supply by time to complete project type.....	142
Figure 51: AFEX Renewable Energy 2019 of Iraq	147
Figure 52: Cropping pattern in Najaf	157
Figure 53: Cropping pattern in Muthanna.....	158
Figure 54: Cropping pattern in Karbala.....	160
Figure 55: Location of the target governorates and the 19 target canals within the SRVALI project.....	160
Figure 56: Najaf, Muthanna and Karbala water balance	162
Figure 57: Timeframe Scheme of the Planning and Approval phase of the AWPB	240
Figure 58: M&E Unit Composition	243

IV. LIST OF ACRONYMS

AF	Adaptation Fund
AMA	Accreditation Master Agreement
ANAPCD	Aligned National Action Plan to Combat Desertification
AWPB	Annual Working Plan and Budget
AWPBR	Annual Working Plan Budget and Report
BH	Budget Holder
CBM	Cubic Meter
CC	Climate Change
CCA	Climate Change Adaptation
CCF	Climate Change Finance
CIF	Climate Investment Fund
CCM	Climate Change Mitigation
CSO	Civil Society Organization(s)
DOWR	Directorate of Water Resources
EBRD	European Bank for Reconstruction and Development
ECMWF	European Center for Medium-Range Weather Forecasts
EU	European Union
ESA	Environmental and Social Analysis
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Safeguards
FAO-IRQ	Food and Agriculture Organization Representation in Iraq
FAO	Food and Agriculture Organization
FAO-HQ	Food and Agriculture Organization Head Quarter
FAO - RNE	Food and Agriculture Organization Regional Office for Near East and North Africa
FNC	First National Communication
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Green House Gasses
GoI	Government of Iraq
HH	Household
IEA	International Energy Agency
IFAD	International Fund for Agriculture Development
IFI	International Finance Institution
INGO	International Non-Governmental Organization
IME	Iraq Ministry of Electricity
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
INES	Integrated National Energy Strategy
IQD	Iraqi Dinar
LCOE	The Levelized Costs of Electricity
LFM	Logframe Matrix
LPD	Land Productivity Dynamics
M&E	Monitoring and Evaluation
MCM	Million Cubic Meters
MENA	Middle-East and North Africa
MoE	Ministry of Environment
MoA	Ministry of Agriculture
MoWRs	Ministry of Water Resources
NAP	National Adaptation Plan
NDA	National Designated Authority

NDC	Nationally Determined Contribution
NC	National Communication
NCCC	National Centre for Climate Change
NWC	National Water Council
OECD	Economic Cooperation and Development
OP	Operational Partner
PSC	Steering Committee
PNCCC	Permanent National Committee for Climate Change
PMU	Project Management Unit
PPM	Part Per Million
RES	Renewable Energy Sources
RCP	Representative Concentration Pathway
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RRH	Rooftop Rainwater Harvesting
SPIS	Solar Powered Irrigation Systems
SDG	Sustainable Development Goal
SNC	Second National Communication
SRVALI	Strengthening climate Resilience of Vulnerable Agriculture Livelihoods in Iraq
SWLRI	The National Strategy for Water Resources and Land Management for Iraq
TNC	Third National Communication
UN	United Nations
CBD	Convention on Biological Diversity
UNCCD	United Nation Convention to Combat Desertification
UNDP	United Nations Development Program
UNFCCC	United Nation Framework Convention on Climate Change
UNEP	United Nation Environmental Program
UNHCR	United Nation High Commissioner for Refugees
UNISDR	United Nation International Strategy for Disaster Reduction
USD	United State Dollar
USAid	United States Agency for International Development
VET	Vocational Education and training
WB	The World Bank
WWTP	Waste Water Treatment Plant
WUA	Water Users Association

V. DEFINITIONS ACCORDING TO IPCC AND FAO ¹

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.

Adaptive capacity/Readiness The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.

Anthropogenic: Resulting from or produced by human beings.

Baseline/reference: The baseline (or reference) is the state against which change is measured. It might be a 'current baseline,' in which case it represents observable, present-day conditions. It might also be a 'future baseline,' which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.

Climate change: A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Climate projection: A projection of the response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/ concentration/radiative-forcing scenario used, which are based on assumptions concerning, e.g., future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty.

Climate scenario: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate.

Disaster risk reduction (DRR): Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience.

Exposure: The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.

Hazard: The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources.

Land use and land use change: Land use refers to the total of arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g., grazing, timber extraction, and conservation). Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and land use change may have an impact on the surface albedo, evapotranspiration, sources and sinks of greenhouse gases, or other properties of the climate system and may thus have radiative forcing and/or other impacts on climate, locally or globally.

ND-GAIN Index: the Index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. It aims to help governments, businesses and communities better prioritize investments for a more efficient response to the immediate global challenges ahead.

¹ Sources: [IPCC](#) and FAO

Vulnerability: The propensity or predisposition to be adversely affected.

Wadi: The bed or valley of a stream that is usually dry except during the rainy season.

VI. CURRENCY AND CONVERSION FACTORS

United States Dollar = 1.457 Iraqi Dinar (IQD)

1 Dunum= 2,500 m² à 4 dunums = 1 hectare

1 m³ =1,000 liters

1. PROJECT SUMMARY

Abstract:

1. The project '*strengthening climate resilience of vulnerable agriculture livelihoods in Iraq's rural communities*' aims to enhance the climate resilience of rural households through the introduction of climate adaptive infrastructure, technologies and farming practices that will stabilize and possibly increase water availability, water use efficiency and secure the agriculture yields at the farm level. The project will contribute to the implementation of the National Designated Contributions (NDC) by building institutional adaptive capacity and farmers' resilience to climate change and by avoiding 1,344,154 tonnes of CO₂eq emitted over a 20-year lifespan.² The project will also increase water productivity per unit of production and reduce food insecurity.
2. The project will have three interrelated components which will work synergistically to address key barriers and enhance the impact of project investments. The components are designed to tackle the lack of investments in innovation and climate proofing, the inefficient water use practices, the high climate change adaptation deficit and the limited role of women in the agriculture sector, and include: **Component 1** - Strengthening resilience against climate induced water scarcity - will address water and energy availability to ensure increased water supply, reduce water losses and increase water use efficiency; **Component 2** - Climate Resilient Agriculture Production - will address adaptation deficit of farming communities via extension programs, knowledge transfer processes, empowerment of Water User Associations (WUAs), and through e-extension systems or Information Communication Technology for Climate Change (ICT4CC); and **Component 3** - Scaling-up climate solutions into policy formulation and planning - will address the strategic and legal framework for water management and adoption of climate resilient technologies.
3. The project will benefit 1,958,134 people, including 1,044,800 direct beneficiaries, thereby reaching 5 percent of the total population. Total project costs are estimated at USD 38.95 million. The total comprises a GCF grant of USD 29.25 million (75% of total project cost) FAO grant of USD 6.82 million and FAO in-kind USD 0.08 million (18%), and Government of Iraq contribution of USD 2.8 million (7 %). The overall Economic Rate of Return of the project is 29.44 percent and its Net Present Value (NPV) is USD 89.81 million. The financial and economic analyses were calculated at a cut-off rate of 4 percent for the economic analysis (given the Central Bank of Iraq's current policy interest rate) and 7 percent for the financial analysis. The total cropped irrigated areas that will be affected by the project is: 3,662 ha, with an increase of 1,442 ha from the initial 2,220 ha cropped irrigated areas targeted by the project. Cumulative water savings are estimated around 36,958,118 m³ in total in the three governorates.
4. Climate change impacts threaten to erode the food security and well-being of the rural population and further exacerbate the impacts of political conflict and insecurity and the usurping of the water share by the upper riparian states to the detriment of Iraq's most vulnerable communities thereby negatively impacting the country's aspirations regarding its SDGs. Some of the wider benefits of the project are expected to assist in mitigating some of these affects and help in reducing poverty (SDG 1), enhancing food security and reducing hunger (SDG 2), enhancing the role of women and promoting gender equality (SDG 5), investments in innovative pilots to promote green energy and elaborating a road map for solar rural electrification (SDG 7), reduce inequalities through more equitable access to water (SDG

² In this regard the project considers GHG reductions through the implementation of component 1 in the core indicator 1 (-22,536 tCO₂eq over 20 years), while it accounts the impact of the capacity development activities for Climate Resilient Agriculture of component 2 as mitigation co-benefits (-1,321,618 tCO₂eq over 20 years).

10), undertake several key investments for combatting climate action (SDG 13), promote sustainable use of terrestrial ecosystems, combat desertification, and halt and reverse land degradation and biodiversity loss through more appropriate adaptation practices and technologies (SDG 15). In addition, there are several aspects of the investments that will enhance prospects for long-term sustainability in the agriculture sector. These include the introduction of a more favourable policy and regulatory environment with regard to water allocation. Some of the mechanisms developed under the project, such as the water-sharing plan and its enforcement will allow Water User Associations (WUAs) to better manage water resources and strengthen their capacity for improved water governance. Extension programmes, farmer field schools and field days and dissemination through various electronic media and digital technologies will enhance awareness and help to transfer knowledge and best practices generated from the interventions.

5. Total project costs are estimated at USD 38.95 million. The total comprises a GCF grant of USD 29.25 million (75% of total project cost) FAO grant of USD 6.82 million and FAO in-kind USD 0.08 million (18%), and Government of Iraq contribution of USD 2.8 million (7 %). Component 1: Strengthening resilience against climate induced water scarcity, comprises 71.18 percent of total costs; Component 2: Climate resilient agriculture production comprises 20.69 percent; Component 3: Scaling-up climate adaptation through policy formulation and planning is estimated at 3.58 percent of total project costs and Project Management comprises 4.55 percent.
6. There are several areas in which the project is expected to facilitate a paradigm shift in the country. These include transformation of the agriculture food sector through more efficient use of water by conversion of the open-air canals to piped systems, introducing solar powered energy on irrigation channels, transforming agriculture production practices and use of climate resilient technologies and practices, changing the system of water regulation and use and participation of women as key agents of change in the farming sector. The project will mobilize technical assistance and female agricultural outreach workers or extension agents to impart knowledge and establish a cadre of Climate Wise Women (CWW). This network of CWW will help to increase adaptive capacity of women farmers in the face of climate risks and empower them through enhancing their leadership skills and ability to adapt to climate change. Shifting the paradigm from women as victims, to women as powerful agents of change, has shown to be transformative. The current project is expected to have a significant impact in changing perceptions and stereotypes regarding women and their role in communities. The project will design a new climate resilient policy to promote efficient use of water in agriculture at the national level. In addition, the project is expected to elaborate a road map for solar rural electrification. This is expected to enhance the awareness regarding the use of renewable energy and create a demand for this source.

Adaptation Benefits

Project objective	Results	Beneficiaries – health, well-being, food and water security
Enhance the climate resilience of rural households and farmer communities in Muthanna, Karbala, and Najaf	The project will introduce climate adaptive infrastructure, technologies and farming practices that will stabilize and possibly increase water availability, water use efficiency	The project will benefit 1,958,134 people (1,044,800 direct beneficiaries), including 971,909 women.

	and secure the agriculture yields at the farm level	
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Mitigation Benefits

Project objective	Results	Beneficiaries
Reduced GHG emissions through (a) reduction in energy through reduced water pumping needs; (b) installation and use of solar panels on irrigation canals (c) introduction of climate resilient practices such as minimum soil disturbance; (d) change from low carbon input to high carbon input and other good agricultural practices.	It is estimated that 1,344,154 tonnes of CO ₂ eq will be avoided over 20 Years of the project. Preliminary results suggest an annual emission avoidance of about -67,208 tonnes of CO ₂ equivalent per year. (For more details refer to Annex 22). In this regard the project considers GHG reductions through the implementation of component 1 in the GCF core indicator 1 (-22,536 tCO ₂ eq over 20 years), while it accounts the impact of the capacity development activities for Climate Resilient Agriculture of component 2 as mitigation co-benefits (-1,321,618 tCO ₂ eq over 20 years).	The mitigation benefits will be achieved through the implementation of all activities foreseen by the project. Therefore 1,958,134 people (1,044,800 direct beneficiaries), including 971,909 women will benefit from the measures.

Other Expected Co-Benefits

7. The project will have additional beneficial impacts on the environmental, economic, and social spheres – including gender. These can be summarized as follows:

Environment	<p>Climate smart and resilience agricultural practices have positive impacts on soil and water conservation: increase water infiltration, reduce wind and water erosion and increase water crop productivity</p> <p>Solar energy has positive impacts on improved air quality and avoided contamination (as a substitute of fossil energy). When installed on canals the system contributes to a reduction of algae growth and evaporation</p> <p>Canals enable to mitigate erosion with multiple environmental conservation benefits, due to the unobstructed flow of water in the canal</p>
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Social	Increase women's revenue will lead to improvements in children's health and education Greater equity in investments for small-holders, reduction in conflicts over water and more equitable distribution for tail end users.
Economic	Enhance farmers' livelihoods and returns as a result of increased and secured yields due to improved water management and CSA practices.
Gender	Enhanced women's adaptive capacity and self-confidence, and greater acceptance of the role of women by demonstrating to the community the important role that they can play and serve as a role model for other women to emulate in the community.

2. Methodology and approach

Literature Review

8. As mandated by the NDA, FAO as Accredited Entity approached the preparation of the proposed climate investment project by analysing results deriving – among other - from the following main sources:
 - a) Comprehensive literature review and reports of on-going and past projects;
 - b) FAO Geospatial analysis of target areas and related water basins³;
 - c) Data review with the Ministry of Environment, the Ministry of Agriculture and the Ministry of Water and Irrigation;
 - d) Ground-truthing of data in targeted areas via field visits, community consultations, focus groups discussions, in-depth interviews and key informant interviews; and
 - e) Data collected both at national and local levels to determine current exposure of communities and to understand vulnerability to CC. The next chapters will highlight and summarize the main findings at national, local and target areas level.
9. FAO and NDA teams collected and analysed available, project documents and national communications/policy papers. Of these, priority was given to: **(i)** national communications to UNFCCC, UNCCD, CBD and others; **(ii)** national action plans and strategies; **(iii)** national legal frameworks, **(iv)** UN assessments and reports; **(v)** publications from national institutions, academia (national and international) and CSO; and **(vi)** bilateral donors' reports / projects.

Analysis of data from existing meteorological stations

10. Location of the weather stations considered within the project (Table 1):

Table 1: Location of the weather stations

Station	ID	Organization	Governorate	Latitude	Longitude
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³ FAO has developed a new application that allow access to and elaboration of the main international databases on remote sensing and climatic data. Iraq specific information is provided in Annex 16A

<i>Afak</i>	1	Iraqi Ministry of Agriculture	Qadisiyah	32.07°N	45.23°E
<i>Al Borgism</i>	2	Iraqi Ministry of Agriculture	Basra	30.37°N	47.61°E
<i>Razzaza</i>	3	Iraqi Ministry of Agriculture	Karbala	32.59°N	43.88°E
<i>Shatrah</i>	4	Iraqi Ministry of Agriculture	Dhi Qar	31.41°N	46.17°E
<i>Al Khidr</i>	5	Iraqi Ministry of Agriculture	Muthanna	31.23°N	45.53°E
<i>Al Mishkab</i>	6	Iraqi Ministry of Agriculture	Najaf	31.80°N	44.48°E
<i>Abu Ghraib</i>	7	Iraqi Ministry of Agriculture	Baghdad	33.37°N	44.08°E
<i>Daquk</i>	8	Iraqi Ministry of Agriculture	Kirkuk	35.14°N	44.46°E
<i>Bashiqah</i>	9	Iraqi Ministry of Agriculture	Nineveh	36.45°N	43.34°E
<i>Mosul</i>	608	Iraqi Meteorological Organization and Seismology	Nineveh	36.42°N	43.18°E
<i>Kirkuk</i>	621	Iraqi Meteorological Organization and Seismology	Kirkuk	35.48°N	44.37°E
<i>Rutba</i>	642	Iraqi Meteorological Organization and Seismology	Anbar	33.17°N	40.25°E
<i>Baghdad</i>	650	Iraqi Meteorological Organization and Seismology	Baghdad	33.46°N	44.36°E
<i>Al Hay</i>	665	Iraqi Meteorological Organization and Seismology	Wasit	32,20°N	46.04°E
<i>Qadisiyah</i>	672	Iraqi Meteorological Organization and Seismology	Qadisiyah	31.99°N	44.90°E
<i>Nasiriyah</i>	676	Iraqi Meteorological Organization and Seismology	Dhi Qar	31.13°N	46.31°E
<i>Basra</i>	689	Iraqi Meteorological Organization and Seismology	Basra	30.61°N	47.71°E
<i>Nadjaf</i>	670	Iraqi Meteorological Organization and Seismology	Najaf	32.12°N	44.32°E

<i>Muthanna</i>	674	Iraqi Meteorological Organization and Seismology	Muthanna	31.36°N	45.28°E
<i>Karbala</i>	656	Iraqi Meteorological Organization and Seismology	Karbala	32.70°N	44.00°E
<i>Khanaqin</i>	637	Iraqi Meteorological Organization and Seismology	Diyala	34.39°N	45.37°E

Source: Iraqi Ministry of Agriculture and Iraqi Meteorological Organization and Seismology

FAO GeoSpatial Analysis:

11. As part of its mandate to support member countries, FAO developed a set of tools and methodologies to allow rapid and tailored geospatial analysis. One result of such effort is Earth Map, an open-source application that allows for the interpretation of large remote sensing datasets in near real time as an open source. [Earth Map](#) is an innovative tool that facilitates and empowers users in performing historical and current climate-environmental analysis for a given area (regional, inter-regional, national, district, and sub-district) through a graphical interface that has been developed by FAO thanks to its partnership with Google. The tool ensures an objective evidence-based approach not only to support project design but to be accessible in future for monitoring and evaluation activities, as well.
12. FAO deployed Earth Map in Iraq (among other countries) to ensure evidence-based project cycle management and to understand the climate risk and vulnerability of target areas. The application, using available data published from internationally accredited organizations and research institutes⁴, allowed for a clear understanding of Iraqi climatic patterns, trends and anomalies. The tool also allows to look, with high accuracy, at local realities and determine risks and vulnerability of each site or community identified in target areas.

Data review with Institutional stakeholders

13. Data were gathered from the Ministry of Environment, Ministry of Agriculture, Ministry of Water Resources, Ministry of Planning, Iraq Ministry of Electricity, Central Statistical Organization (CSO) and Iraqi Meteorological Organization and Seismology. Data and analysis produced by FAO experts have been verified with the Ministry of Environment (NDA), as well as relevant ministries who participated in the design process.

‘Ground-truthing’ of climate variables with representative focus groups discussions and interviews in target areas

14. To ensure that the project design is responsive, relevant, as well as gender sensitive, community consultations were held in the target governorates of Karbala, Najaf, and Muthanna with the support of the Department of Water Resources, Department of Agriculture and a local service provider, Stars Orbit Consultations and Management. These community consultations are part of the national engagement process and ensure local ownership and community participation in the project. FAO designed activities based on these consultations and aligned with the climate scenario, and validated project’s baselines with representatives of the three governorates via focus group discussions (FGDs), in-depth interviews (IDIs), and key informant interviews (KIIs). In total, nine FGDs were held with women farmers, six participants per group (three in each governorate), three FGDs with men farmers, six participants per group (one in each governorate), nine IDIs with women-headed households (three in each governorate), nine KIIs with women (three in each governorate), and three KIIs with men (one per governorate). Consultations were also organized with locally active CSOs, NGOs and institutions.

⁴ Earth Map uses only peer reviewed and internationally accepted models and algorithms to run queries and process data.

Additionally, FAO hired two Iraqi experts with longstanding working experience with international organizations and the local Ministries of Agriculture and Water Resources.

3. BACKGROUND INFORMATION

Country economic and social Background

15. Kuwait, Iran, Turkey, Syria, Jordan, and Saudi Arabia border Iraq (Figure 1). The country slopes from mountains over 3,000 meters above sea level along the border with Iran and Turkey to the remnants of sea-level marshes in the southeast. Much of the topography is mostly broad plains; reedy marshes along the Iranian border in the south with large flooded areas. The mountains in the northeast are an extension of the alpine system that runs eastward from the Balkans into southern Turkey, northern Iraq, Iran, and Afghanistan, terminating in the Himalayas.

Figure 1: Map of Iraq and its surrounding countries



Source. (Ala H. Elaiwi & al, 2020)

16. Iraq spans 438 320 km², with a population of 39.1 million (30 percent rural) (2020)[[World Bank](#)]. Iraq's economy is dominated by oil production (around 43 percent of its gross domestic product (GDP) in 2019). Agriculture on the other hand contributes for 5.9 percent to Iraq's GDP (2020)⁵ [\[Trading Economics, 2021\]](#) and is targeted to double by 2025. Iraqi GDP amounted 182.3 trillion dinars (USD 125 trillion) in 2015, and is planning to double (a 110 percent increase) by 2025. GDP's growth since 2005 was between 1.6 percent (2005) and -10 percent (2020), with positive growth in 2013 and 2016 around 13 percent and negative trends in 2017 and 2018 around -1.2/1.7 percent [\[World Bank data\]](#). The GDP per capita is between USD 4,900 and 5,900 (constant price – 2010 reference, between 2016 and 2020). Debts amounted 19.1 billion dinars (USD 13 million) (external debt) in 2016 [\[NDP 2018-2022\]](#) and 48.469 trillion dinars (USD 33.2 million) (internal debt).

⁵ Combines contribution of agriculture, fishery and forestry

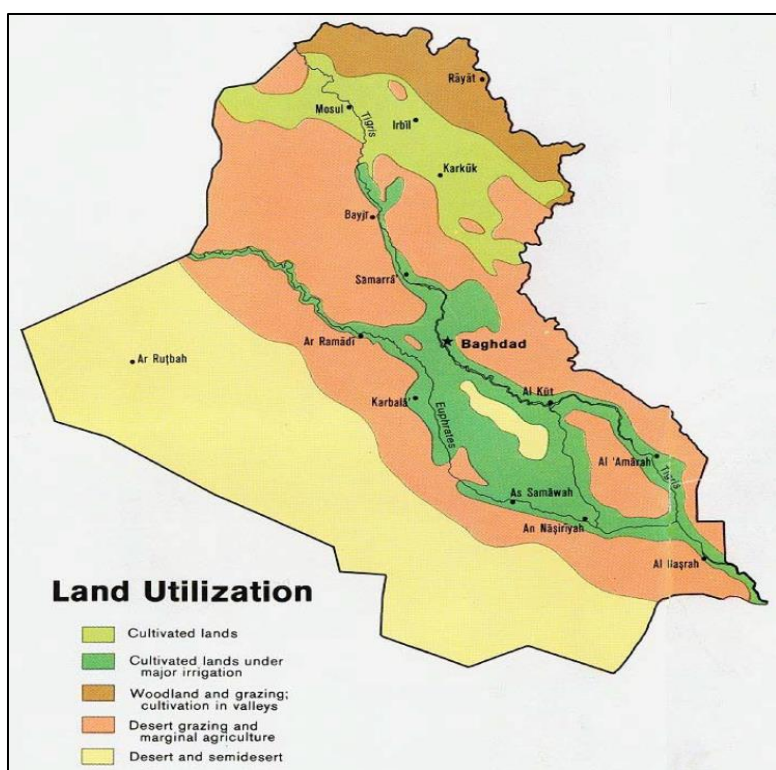
17. According to the International Energy Agency (IEA), Iraq produced 4.7 million barrels per day in 2018 and will add a further 1.3 million barrels a day by 2030, which will make the country the 4th largest producer in the world⁶ and on the 10th position with regards to natural gas reserves.⁷ Crude oil reserves provided 80 percent of foreign exchange earnings in 2016 and more than 90 percent of government revenues (2016). Governmental budgets are highly dependent on oil prices and the global fall in these prices in the year 2020 impacted the functioning of governmental institutions significantly.
18. The total agricultural area of variable quality and potential amounts to 11 million hectares, of which 6 million hectares are actually cultivated with 2.5 million hectares under rainfed in the North and 3.5 million hectares under irrigation in the Center and the South. About 3.3 million hectares are irrigated from surface water and the rest from underground aquifers. Of the total land cultivated, the cereal crop group is preponderant (53.5 percent), and from these wheat (19.4 percent), barley (31.6 percent), and maize (1.1 percent) are the main crops grown. From among these crops, there is a dynamic upward trend in the cultivation of wheat and maize crops and a decrease in barley (Saleem A. & al. 2020 and Abd-El-Mooty & al, 2016).
19. Wheat is the most important staple food crop in Iraq and represents 1.543.316 ha (2019)⁸. Barley is mainly used for animal feed, and covers an area of 897.216 ha (2019). Wheat production has been increasing since 1995 from 2 million tonnes to around 4-6 million tonnes in 2019, whereas barley and rice remained around 1 million tonnes. Overall, stagnation in agricultural productivity has been a characteristic of Iraq's agriculture production system, and has steadily increased dependence on imports to meet domestic food needs and has made Iraq a major importer of agricultural products [FAO, 2012]. Top import categories are wheat flour (over 1.3 million tonnes per year) and rice (over 1.2 million tonnes per year), sugar, maize, tomatoes oils and fats, milk are also relevant. Top export categories in 2019 were dates, beans, potatoes, olives, and wool. Agriculture employs between 20 percent and 25 percent of the population. The agriculture sector provided employment for an estimated 44 percent of the total female workforce and the Women's participation in the sector in terms of employment has increased from 30 to 50 percent between 1980 and 2010 (World Bank), due to migration to urban areas [FAO, 2012]. Additional information on women is provided in Annex 8.
20. Large areas of Iraq are facing serious problems of desertification due to declining water flow, repeated frequency of drought and increasing water salinity. During the Gulf wars, huge number of palm and other kinds of trees that offered a natural protection and barrier against the expansion of desertification were destroyed. At least 75 percent of the area of Iraq has been substantially affected by desertification, see Figure 2 and Table 2. In addition, it is estimated that over 74 percent of the irrigated land is affected by salinity (UNCCD, 2017 and Iraq Energy Institute, 2018).

Figure 2: Land utilization in Iraq

⁶ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

⁷ <https://www.government.nl/binaries/government/documents/publications/2019/02/05/climate-change-profiles/Iraq.pdf>

⁸ Last available data in FAOSTAT.



Source. FAO, 2005. Country Profile: Land Use and Water Resources

Table 2: Iraq soil salinity

Total affected irrigated areas	74%
Severly saline	4%
Mmedium saline	50%
Slightly saline	20%

Source. Iraq Energy Institute, 2018

21. The total population at the national level and at the governorate level is given in Table 3 below:

Table 3: Population of target governorates: Karbala, Najaf, and Muthanna⁹

	Total Population	Share of Female (percent)	Avg. HH Size	Rural	HH	Female
Karbala	1,250,806	49.6	6.3	375,242	59,562	186,120
Muthanna	835,797	49.7	7.6	250,739	32,992	124,617
Najaf	1,510,338	49.9	6.3	453,101	71,921	226,097
National	39,127,889	49.5	6	11,738,367	1,956,395	5,810,492

⁹ Source: Central Statistical Organization (CSO), Ministry of Planning, Government of Iraq, 2019 / Data on Average HH Size is taken from Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, World Food Programme and CSO, Government of Iraq / Data on number of villages taken from Governorate Rural Development Surveys (2017)

Total 3 Governorates	3,596,941	49.7333		1,079,082	164,475	536,834
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Source: Central Statistical Organization (CSO), Ministry of Planning, Government of Iraq, 2019 / Data on Average HH Size is taken from Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, World Food Programme and CSO, Government of Iraq / Data on number of villages taken from Governorate Rural Development Surveys (2017)

22. The population is expected to reach 53.3 million in 2030 [GoI, 2019b]. Population growth trends and increasing urbanization will lead to a rise in water consumption and increased pressure on agriculture water systems across the nation, but mainly in the Central and Southern Governorates where irrigation plays a key role in agricultural production.
23. Iraq has been identified as a country with extreme fragility by the International Fund for Agriculture Development (IFAD), peer organizations and IFIs (World Bank) and international assessments (in the 'high alert' category in the Fund for Peace Index, which forms the basis for OECD's assessment of fragility). Fragility affects rural development significantly, reducing institutional capacity and service delivery. For Iraq, this fragility is complex, subnational and multi-dimensional mainly stemming from weak institutional capacities and structures for good governance. Volatile and transboundary security with associated risks are not very conducive to private sector investment for reconstruction, inclusive economic growth and job creation.
24. Rural poverty in Iraq is a direct consequence of internal conflict and insecurity, rapid population growth, climate change, increasing water scarcity and rapid desertification. The combined effects resulted in reduced prospects for viable rainfed and irrigated agricultural and livestock production, and lack of sustainable income-generating opportunities for rural communities (IFAD-AF, 2018). The population also has poor access to physical infrastructure. On average, villages in the center and southern governorates are located approximately five kilometers from a paved road, 19 km from input markets, 20 km from fruit and vegetable markets, and 32 km from wholesale grain markets. Farms vary in size between two and twelve hectares (10-50 donums) (WB, 2019a). Approximately 30 percent of Iraq's population lives in rural areas. Iraq's rural population lives in more than 10,000 villages with an average population of 465 persons with about 48 households per village.
25. Poverty is prevalent in rural areas, with 1.6 million of the chronically poor (25 percent of the total) living in the countryside and per capita incomes in rural households averaging less than half the MDG Target 1 of \$1 a day (source: FAO Database). These income levels are far below average GDP per capita levels, which are in excess of \$900 per head, a startling indicator of Iraq's failure to devise an agricultural economic system, which shares the benefits of oil income equitably with its rural population. Unemployment and underemployment are pervasive, and all indicators of human and social development are worse for rural areas than for towns. A recent study estimated that more than half of Iraq's poor farm households would directly benefit from improvements in the irrigation economy, and international experience confirms that irrigation development can have a high local multiplier effect and a significant impact on the poor (IFAD, 2017).
26. Iraq's rural population are usually more vulnerable to food insecurity than urban households are. According to the 2016 Comprehensive Food Security and Vulnerability Analysis (CFSVA), 80 percent of the poorest quintile in rural areas were classified as either food insecure or vulnerable to food insecurity compared to 67 percent of those in the poorest quintile in urban areas.
27. Based on a poverty mapping study [WB, 2015], Muthanna is the poorest governorate in Iraq, and proportion of poor Iraqis in Muthanna is nearly triple that of Iraq's national average (6.4 percent versus

2.1 percent).¹⁰ Although the proportion of food insecure households in Karbala and Najaf is lower than Muthanna, the share of households vulnerable to food insecurity is alarmingly high in all three governorates—65 percent in Karbala, 67 percent in Muthanna, and 87 percent in Najaf (Table 4).¹¹

Table 4: State of Food Security in project areas

	Food Security Zone	Food Secure HHs (percent)	Marginally Food Secure HHs / Vulnerable to Food Insecurity (percent)	Food Insecure HHs (percent)
Karbala	Food Deficit Semi-Arid Rangelands	28.9	65.2	5.9
Muthanna	Drought Prone Desert Area	22	66.7	11.3
Najaf	Drought Prone Desert Area	10.3	87.3	2.5
National	--	44.3	53.2	2.5

Source: CFSVA 2016, WFP, FAO and Government of Iraq / Data on Food Security Zones taken from Iraq Socio-Economic Atlas, WFP (2019)

28. In addition, an overwhelming majority of households in the three governorates receive Public Distribution System (PDS) Ration Cards, see Table 5.¹² After the outbreak of the COVID-19 pandemic, overall poverty has increased by 11.7 percent, making the poverty rate 31.7 percent compared to 20.0 percent in 2017-2018.¹³ This translates to 4.5 million additional of poor because of the crises, adding to the 6.9 million already living in poverty before the crisis.¹⁴

Table 5: Poverty and vulnerability

	Multi-dimensional Vulnerability Index ¹⁵ (MVI)	Share of Poor (percent) based on MVI	HHs Receiving Public Distribution System Ration Cards (percent)
Karbala	0.143	2.9	98.1
Muthanna	0.258	3.1	98.8
Najaf	0.145	3.6	99.3
National	0.173	--	94.7

Source: COVID-19 Impact on Poverty and Vulnerability (2020) / Data on PDS Ration Cards is taken from CFSVA 2016, WFP and CSO, Government of Iraq

29. Muthanna has one of the highest unemployment rates, 14.5 percent, among the three governorates. The unemployment rate is roughly 9.5 percent in Najaf and 7.1 percent in Karbala. Within the three governorates, women's unemployment is highest in Najaf, 31.4 percent, which is significantly greater than the national average of 22 percent. In comparison to 81 percent at the national level, nearly 90

¹⁰ Where are Iraq's Poor: Mapping Poverty in Iraq (2015) <https://documents1.worldbank.org/curated/en/889801468189231974/pdf/97644-WP-P148989-Box391477B-PUBLIC-Iraq-Poverty-Map-6-23-15-web.pdf>

¹¹ CFSVA 2016, WFP, FAO, CSO Government of Iraq

¹² Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016

¹³ Assessment of COVID-19 Impact on Poverty and Vulnerability in Iraq (July, 2020), World Bank, UNICEF, Government of Iraq

¹⁴ [https://www.unicef.org/iraq/media/1181/file/Assessment percent20of percent20COVID-19 percent20Impact percent20on percent20Poverty percent20and percent20Vulnerability percent20in percent20Iraq.pdf](https://www.unicef.org/iraq/media/1181/file/Assessment%20of%20COVID-19%20Impact%20on%20Poverty%20and%20Vulnerability%20in%20Iraq.pdf)

¹⁵ *ibid*

¹⁶ A multidimensional index tailored to measure social deprivation in dimensions affected by the crisis. The index includes four dimensions measured at household level, namely education and health dimensions capturing access to services, and living conditions and financial security dimensions capturing household living standards and resilience to cope with shocks.

percent of women, excluding internally displaced persons (IDPs), are out of the labour force in Muthanna, 79 percent in Najaf, and 76 percent in Karbala; women's labour force participation is markedly low in the target governorates and unemployment is a significant national issue. The unemployment rate for young women is twice the rate for men, see Table 6. In 2017, about 56 percent of young women were unemployed compared to 29 percent for young men¹⁶.

Table 6: Labor force participation and employment rates

	Unemployment Rate (percent)			Labor Participation Rate (percent) (residents / excluding IDPs)			Out of Labor Force (percent) (residents / excluding IDPs)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Karbala	4.5	27.8	7.1	78	16	70	21	76	27
Muthanna	14.0	18.6	14.5	70	10	63	25	90	32
Najaf	6.5	31.4	9.5	80	19	74	18	79	25
National	8.5	22.2	10.8	81	16	74	17	81	24

Source: Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, WFP and Government of Iraq

Natural Resources, climate and climate change

Introduction

30. Iraq has natural rich ecosystems in biodiversity [\[NDC, 2021\]](#) that are however very exposed to environmental risks due to its geolocation (desertification phenomenon) and to climate change, e.g. temperature and precipitation variabilities as well as the increased frequency of extreme weather events (e.g. dust storms, fires). These environmental phenomena combined with climate change led to a reduction in the spread of many endemic plant species and extinction of wild animals. Natural resources are mainly affected by resource depletion and overexploitation, soil and water pollution [\[CBD, 2014\]](#). The unsustainable exploitation of natural resources, development pressures (e.g. building infrastructure), climate change and habitat degradation led to biodiversity loss and changing of species conservation status [\[6th CBD, 2018\]](#). Iraq also suffers from a lack of specific legislation on threatened species and a weak environmental legislation's enforcement.
31. The country can be divided into four different geographic zones [\[ICARDA, draft 2021\]](#):
 - Rocky and sandy desert - west and south-west regions;
 - Mountains, hills, and steppes - north and north-east regions;
 - Hills and plains – along the Turkish and Iranian borders; and
 - Marshy lowlands – the delta of the Tigris and Euphrates
32. Desertification of lands is a serious problem in the country and the affected areas in Iraq amount to 66,946 Km², and the total area without vegetation represents 79.8 percent of the total Iraqi territory (excluding the Kurdistan region) [\[6th CBD, 2018\]](#). Desert areas represent more than 30 percent of Iraq's surface [\[UN, fact sheet\]](#). Total forests (including natural and artificial) amount to 2,382,841 dunum which represent 1.4 percent of the land area [\[6th CBD, 2018\]](#), including 658 dunum in the Najaf governorate. Forest covers has been decreasing since the 1980's, due to excessive cutting for fuel or by fires, overgrazing, salinization and soil erosion caused by river basin flooding and conflicts.

¹⁶ World Bank Group, Iraq Economic Monitor from War to Reconstruction and Economic Recovery, Spring 2018.

33. Arable lands stand for 44.46 million dunum, out of which 22.86 million are available for irrigation (National Communication). Only 58 percent of these available areas are irrigated. Field crops occupy ten million dunum. Based on 5th Report of the Convention on Biological diversity, the quantity of plant nutrients used per unit of arable land was evaluated above the global average between 2004 and 2010 [CBD, 2014], great amounts of fertilizers are used in Iraq and exceed the legislative limitations. Most pollutants are persistent and end up in soil and water, and damage soil and water quality.
34. The red list of the International Union for the Conservation of Nature registered 417 species of bird, out of which 18 are subject to durability issues [INC, 2016]. 4,500 plants are recorded, including 195 endemic plants.
35. The major water source comes from surface water, while underground water only represents 7.44 percent of the total Iraqi water resources (National Communication). Two main rivers cross the country: the Tigris¹⁷ (1,418 kilometres in Iraq) and the Euphrates (1,213 kilometres, 40 percent of the total basin area is located in Iraq) [ICARDA, draft 2021; INC, 2016], that merge together in the Persian Gulf through the Shatt'a al-Arab river. Population increased from 12 million inhabitants in 1977 to almost 40 million in 2020 [INC, 2016; World Bank], with an average annual growth rate of around 3 percent, which pressure even more on water resources. Other non-climatic drivers have been causing pressure on water resources, such as the increasing construction of dams and reservoirs built in neighbouring countries (Turkey, Syria and Iran), as Iraq is a downstream country and depends for 80 percent on its neighbouring countries. This has already caused adverse impacts in the fishing sector and accelerated as well environmental problems (such as water quality, drying rivers) in the country (National Communication).
36. The first NDC, 2021, stated that high level of acidity of water, as well as seawater temperature are key issues in Iraq, and could be exacerbated in the future due to climate change, and threaten biodiversity of the marine environment and coral reefs in Iraqi waters. Salinity is a serious problem in Iraq, especially in the Central and South of Iraq, with around 60 percent of the total land that has been affected by salinity [6th CBD, 2018] and around 70 percent of the irrigated area [LDN, 2019]. As for example, between 2004 and 2009, salinity in Abu Ghraib increased from 2900mg/L to 4000mg/L, while it increased from 4500 to 6900mg/L in Nasiriya in the 2010-2012 period (National Communication).
37. A threat assessment was led in the framework of the Nature Iraq work and key biodiversity areas, 11 types of threats were assessed (Convention on Biological Diversity 2014) and include: Agricultural expansion & intensification, Residential & commercial development, Energy production & mining, Transportation & service corridors, Overexploitation, persecution & control, Human intrusions & disturbance, Natural system modifications, Invasive & other problematic species & genes, Pollution, Geological events, Climate change & severe weather. Nonetheless, Iraq has no capacity to assess climate change impacts on biodiversity and have no adequate information to assess global warming threats, desertification and increased dust storm events.
38. Marine Ecosystems: Iraq has approximately 105 km of coastline and waters of the Arabian Gulf are high in salts as a result of too high temperatures, low precipitations, and high evaporation (5th CBD, 2014). Coral reefs in the region are considered under threat, and fisheries underwent a major decline due to the drainage of the marshlands of southern Iraq. Several marine species were classified endangered e.g. Loggerhead Sea Turtle (*Caretta caretta*); Green Turtle (*Chelonia mydas*); Hawksbill Turtle subspecies (*Eretmochelys imbricata bissa*); Olive Ridley (*Lepidochelys olivacea*); and Leatherback Sea Turtle subspecies (*Dermochelys coriacea schlegelii*), Beaked sea snake/Hook-nosed sea snake (*Enhydrina*

¹⁷ The Tigris river has many tributaries, out of which one is in Iraq: Al Edhaim (National Communication)

schistosa) and Graceful Small-headed Sea Snake/Slender Sea Snake (*Microcephalophis gracilis*), Bull Shark (*Carcharhinus leucas*); Hilsa shad (*Tenualosa ilisha*); and Yellow-finned seabream (*Acanthopagrus latus*).

39. Iraq suffers from an environmental deficit due to low biological capacity of the entire land footprint [NDP, 2018]. Key steps should be followed:

- Launch continuous awareness-raising campaigns to help understand the environmental footprint concept and its calculation methods and the data it requires;
- Identify, use and maintain renewable and clean energy sources, particularly solar energy, in order to reduce demand on oil and gas sources, to reduce carbon emissions, to raise environmental awareness, and thereby limit resource depletion;
- Reduce the random growth of informal settlements and trespassing on agricultural lands;
- Protect the marine environment and ensure sustainable management of fishing areas which form part of the biological capacities;
- Promote the optimal use of water resources and adopt modern irrigation methods to increase cultivated areas; ensure sustainable management of resources in agriculture; and support agricultural production to reduce imports.

40. Iraq suffers from water shortage and it will remain below the water poverty line for the next 15 years. Water resources management systems in Iraq should be improved and water loss should be reduced through use of the “virtual water” footprint [NDP, 2018]. The scarcity of freshwater resources is due to climate change and factors in the neighbouring countries.

- Hot and dry climate and limited rainfall lead to green water’s scarcity
- Weak environmental legislations and protection of rivers from daily pollution led to the abundance of grey water
- The water footprint cannot be calculated accurately due to the many factors affecting its value¹⁸

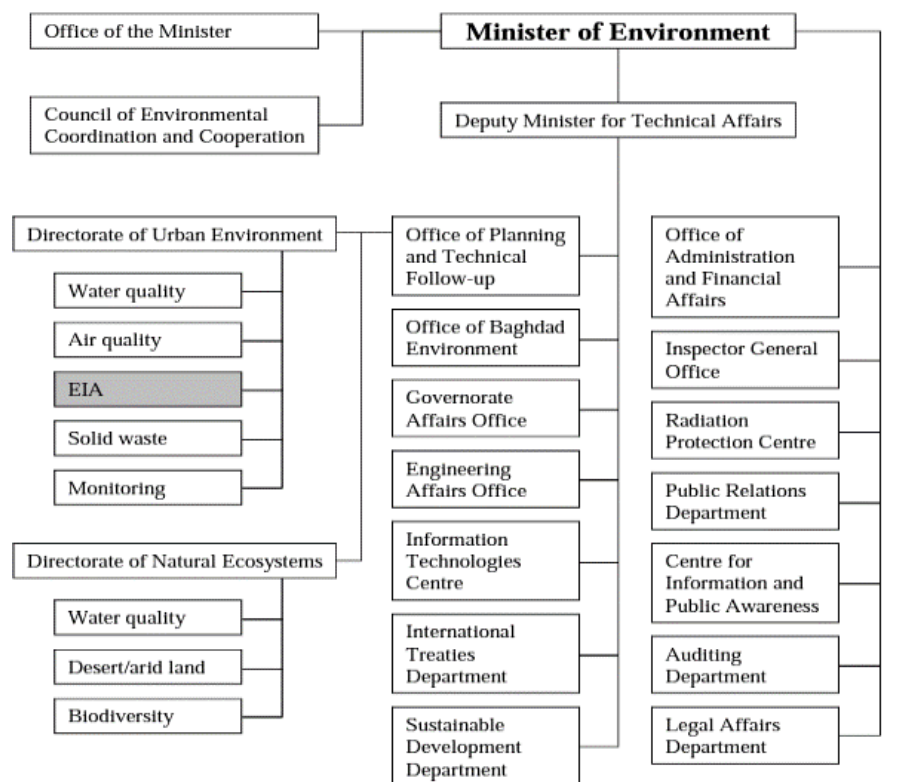
41. All these environmental challenges combined to climate change led to a decrease of quality and quantity of natural vegetation, the removal of topsoil, and a decline in land productivity and food production in Iraq [LDN,2019].

Institutional set-up of the climate change sector

42. **The Ministry of Environment (MoE)** - the Ministry of Environment was established in Iraq in 2003 to implement state policy that protects and improves the quality of the environment (Climate Change Profile: Iraq, 2018). The MoE also serves as a participant in international environmental agreements and leads the development of the National Communications, as well as relations with the UNFCCC. The MoE is the National Designated Authority for GCF activities. The MoE is the national liaison actor, in cooperation with the Ministry of Water Resources, the Ministry of Agriculture and other relevant ministries and departments that has taken several actions to protect Iraq’s environment, especially its water resources.

Figure 3: Organigram Ministry of Environment

¹⁸ However, approximate values can be reached so that decision makers, companies and institutions engaged in reducing water consumption and improving water efficiency identify the best measures to be taken to reduce water waste and provide safe and healthy fresh water. See https://planipolis.iiep.unesco.org/sites/default/files/ressources/iraq_national_development_plan_2018-2022_english.pdf



Source: ([JICA, 2011](#))

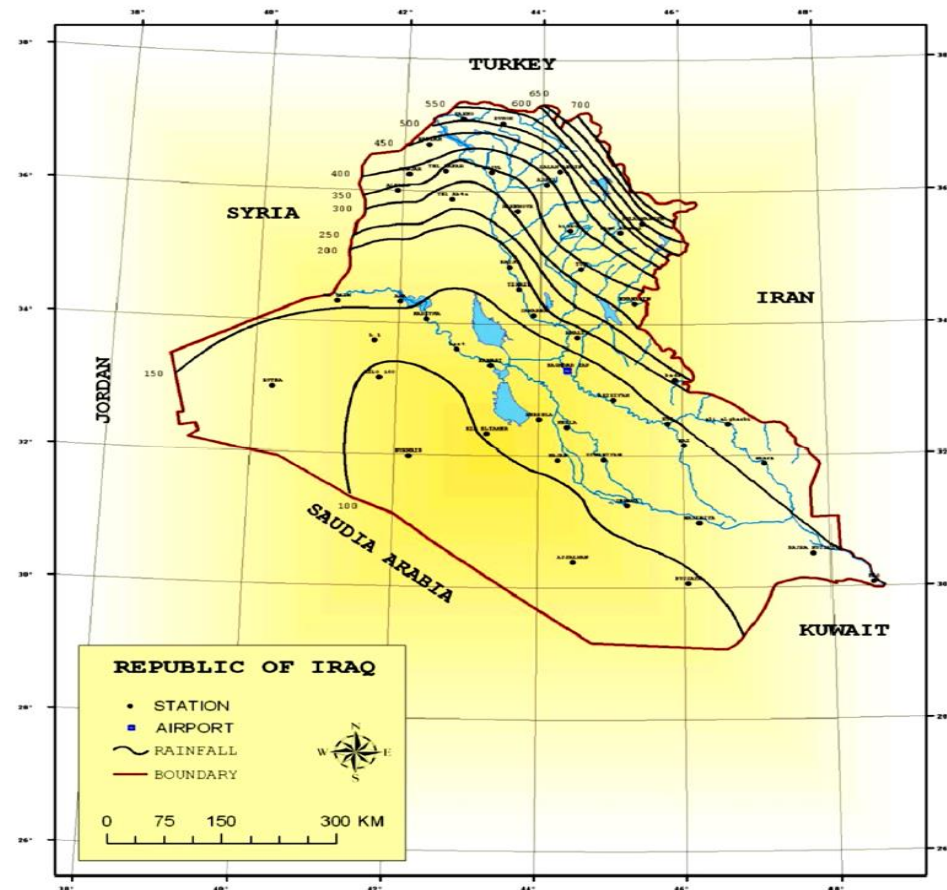
43. **The Ministry of Planning (MoP)** – responsible for developing an institutional framework to follow up the Iraq Vision 2030 implementation in relation to the Sustainable Development Goals on the federal and local levels, and translate the outputs of the follow-up, evaluation and monitoring reports in the national and sectoral strategies and plans and the implementation policies in all state institutions ([Iraqi Vision 2030](#)). The MoP also chairs the National Committee of Sustainable Development.
44. **Ministry of Water Resources-** [please refer to Water, irrigation and water management sector section below.](#)
45. **Ministry of Agriculture-** [please refer to the agriculture and climate resilient agriculture sector section below.](#)

Climate context and climate scenarios

46. Iraq is one of the most vulnerable countries of the Middle East to climate change, as a result of its hydrological limitations and downstream access to water (expert workgroup report, [2018](#)), as well as geographic location. Climate is mostly arid with mild winters and dry and hot summers. As per [National Communication](#) (2015), the country has three main climatic zones:
 - Mediterranean climate: mountainous areas in the northeast, with a cold winter and snowfall on the mountain top;
 - Step climate: transitional climate between the mountainous areas and the warm desert climate in the south.
 - Warm desert climate: representing 70 percent of the area, sedimentary plain and western plateau, from North Baghdad to the Saudi Arabia and Jordanian borders. Extreme temperatures and less than 200mm of annual precipitations.

47. The three project targeted governorates are located in the tropical desert climate zone, as part of the warm desert climate. A fourth agro-climatic zone could be added: the irrigated area between the Tigris and Euphrates rivers (ICARDA, draft 2021).
48. The climate in most of Iraq is subtropical and semi-arid. Rainfall distribution is temporally and spatially uneven. The wettest season in Iraq is winter, which receives about 42-56 percent of the total annual rainfall. Spring and autumn contribute about 27-32 percent and 15-27 percent of the total annual rainfall in the country, respectively. Average annual rainfall is estimated at 154 mm, but ranges from less than 100 mm in the south (60 percent of the country) to 1,200 mm in the north-eastern mountainous region, see Figure 4. The mountainous region of northern Iraq receives appreciably more precipitation than the central or southern desert region. Rainfall occurs between October and May with the highest precipitation levels between December and February. While the winters are cool, summers are hot resulting in a high rate of evaporation in the Southern plains (10 to 17 mm per day in the summer) (USAID, 2017 and WB, 2021b). Summer temperatures are above 35°C on average for most of the country, and frequently exceed 48°C. Winter temperatures have an average maximum around 15 to 16 °C. The high evapotranspiration rates due to relatively high temperatures diminish the value of the precipitated water that is available. Therefore, getting the economic benefit from precipitation is mainly limited to the northern regions of Iraq.

Figure 4: Iraq Rainfall map



Source. MoWR

49. According to the [ND-Gain](#), Iraq is the 115th most vulnerable country (out of 182 countries) for climate vulnerabilities, with a great need for investment and innovations to improve readiness and a great urgency for action. The high vulnerability score and low readiness score of Iraq places it in the upper-left quadrant of the ND-GAIN Matrix. Iraq is placed on 101st of the vulnerability ranking and on the 151st position of the readiness ranking. Since 2006, its vulnerability has been slightly decreasing thanks to a decreasing vulnerability in food production reaching 0.456, and a slight improvement in terms of fresh water with a water score of 0.358. In terms of readiness, governance and social readiness has been very low due to critical scores of control of corruption, education and innovation (0.107, 0.112, 0.078 respectively).
50. Iraq is reportedly already experiencing the adverse impacts of climate change leading to increased soil salinity (salinity in rivers increased by +50 percent in 2006 compared to 2002), loss of biodiversity, decreased agricultural yields and increased desertification [[Gol, 2016](#)]. This combination of factors, together with obsolete farming practices and mismanagement of water resources contributes to desertification¹⁹ [[WFP, 2019](#)] and to a decrease in levels of groundwater, springs and aquifers [[GoN, 2018](#); [ESCWA, et al 2017](#)]. All these impacts have already significant implications for the efficiency and sustainability of agricultural practices but have so far not been sufficiently addressed within corresponding educational curricula.
51. Coherently, the INC [UNFCCC, 2017] reports a sharp increase in the dryness of the soil and depletion of ground water resources. The reported decrease of rainfall has resulted in the decline of the main rivers, decreased groundwater level, especially in desert areas, as well as a decrease in other water resources, such as springs and aquifers [GoN, 2018; RICCAR, 2017]. Significant reduction in the annual amount of Climatic Water Availability (CWA) at a rate between –1 and –13 mm/year was observed at 0.05 level of significance in most of Iraq, including in the three-targeted governorates (except in the northern parts of Iraq), hence the increased need for irrigation for crop production ([Salman et al., 2020](#)). The Euphrates and Tigris River basins will have to gradually face more challenges related to reduced precipitation (snow and rainfall) and increasing demographic pressures (71.3 million of people in 2050), upstream hydro-infrastructure developments, water-quality concerns and a real threat of growing conflicts. Likewise, the average yearly inflow of the Euphrates declined from 30.26 BCM (1933-1972) to about 16.90 BCM (average of 1990-2012) (decrease of 44.1 percent), while the inflow of the Tigris declined from 49.22 BCM (1933-1998) to 32.64 BCM (1999-2012), due to a mix of overexploitation, dams building, and climate change [Ahmed A., 2019].
52. Described and projected changes in rainfall and temperatures and other extreme weather events (e.g floods, storms etc), increased evaporation, increased salinization and high desertification risks are the main determinants of climate change hazards in Iraq. The impact of these will result in reduced availability of surface water and groundwater reserves as well as lower agriculture productivity due to increased salinization and the limited tolerance of crops, increased water requirements and water variability, especially in rainfed production.
53. The historical trends of key climatic variables such as temperatures (MIN and MAX), rainfall (annual and monthly distribution) show that climate has changed and that observed trends will further worsen. In the Initial National Communication [INC, 2016], eight local meteorological stations²⁰ were selected to analyse recorded rainfalls and temperatures trends between 1941 and 2009, regression coefficients of

¹⁹ Presently, 39 percent of the country's surface is estimated to have been affected by desertification, with an additional 54 percent under serious threat [Sissakian, 2013]

²⁰ Bagdad, Al-Rutba, Al-Hay, Diwaniya, Nasriya, and Basra are located in the desert zones, Mosul and Kirkuk are in the tropical/semi-dry climate zones.

average annual temperature and rainfalls²¹ had positive trends in temperatures and negative trends in precipitations²². In addition, the Al-Edhaim basin²³ (arid basin in the Northeast Iraq) recorded the following trends: between 1952 and 2009, average air temperatures increased by +1.5°C (19.75°C – 21.25°C approximately); and in the same period²⁴, annual accumulated rainfall decreased by 50 mm approximately (from 325 mm to 275 mm approximately). In addition, the country is reportedly also facing increasingly erratic rainfall patterns [World Bank, 2021; Gol, 2018b]. The FAO analysis (2021) of local meteorological data (Annex 16-A) confirms the rising annual average temperatures (1980-2020) [Annex 16-A, page 8] and the increased rainfall variability [Annex 16-A, page 61], while trends in annual average precipitation could not be detected [Annex 16-A, page 47]. Figures 2 and 3 are showing the current seasonal variation of the monthly average temperature and monthly accumulated precipitation, respectively.

Figure 5: Current seasonal variations of the monthly average temperature

Data averaged over the 1990-2020 period. **In red:** average value over all the available weather stations located in the governorate of Muthanna. **In blue:** likewise, for the governorate of Karbala. **In green:** likewise, for the governorate of Najaf. **In black dashed line:** likewise, but for all Iraq. Data source: Iraqi Ministry of Agriculture and Iraqi Meteorological Organization and Seismology.

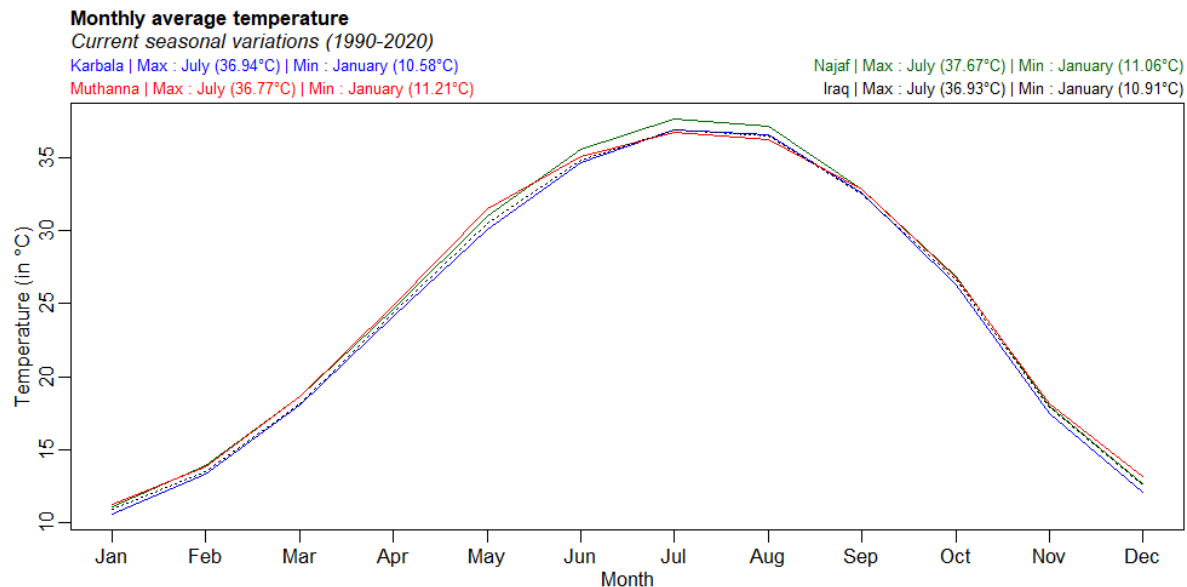


Figure 6: Current seasonal variations of the monthly accumulated precipitation

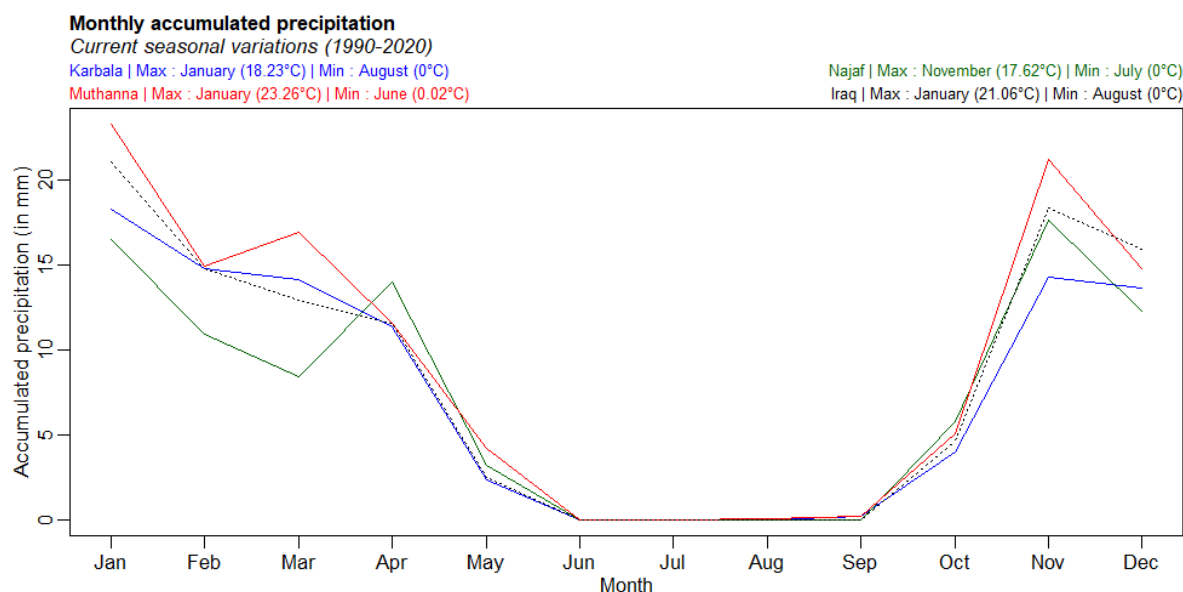
Data averaged over the 2008-2020 period. **In red:** average value over all the available weather stations located in the governorate of Muthanna. **In blue:** likewise, for the governorate of Karbala. **In green:** likewise, for the governorate of Najaf. **In black, dotted line:** likewise, but for all Iraq. Data source: Iraqi Ministry of Agriculture and Iraqi Meteorological Organization and Seismology.

²¹ No exact value on temperature increases and precipitation decreases was shared in the INC, only regression coefficients.

²² Regression coefficients showed a positive trend between +0.01°C and +0.05°C (per year) in annual temperatures²². Between 1938 and 2009, total annual rainfalls decreased in most stations, with a regression coefficient between -0.31 mm and -1.35 mm per year (except in Nasiriya that recorded positive trends with +0.16 mm between 1941 and 2009, and in Al-Rutba with +0.19 mm between 1941 and 2002) [UNFCCC, 2017].

²³ The basin was taken as reference for climate observations, as this area represents many parts of Iraq affected by climate change (INC, 2017)

²⁴ Between 1953 and 2008



54. Based on FAO's findings (2021) [Annex 16-A], annual average temperatures increased between by 1.48°C on average in the 1980-2020 period, while precipitation remain highly variable (between 17 mm/year and 185 mm/year) without presenting any statistically significant trend. The data also shows that in the selected project governorates of Karbala, Muthanna and Najaf, in the 1980-2020 period, average temperatures have increased between +0.22°C and +0.56°C per decade in the target governorates (Karbala represent the lowest temperature and Najaf the highest) and by +0.37°C per decade on a national level since 1980 (Figure 4). Temperature and precipitation trends in the target areas are shown in Figures 4 and 5 respectively [Annex 16-A, pages 13; page 51].

Figure 7: Historical time series of the annual average temperature in the three target governorates

Time series over the 1980-2020 period. **In red:** average value over all the available weather stations located in the governorate of Muthanna. **In blue:** likewise, for the governorate of Karbala. **In green:** likewise, for the governorate of Najaf. **In black, dotted line:** likewise, but for all Iraq. Data source: Iraqi Ministry of Agriculture and Iraqi Meteorological Organization and Seismology.

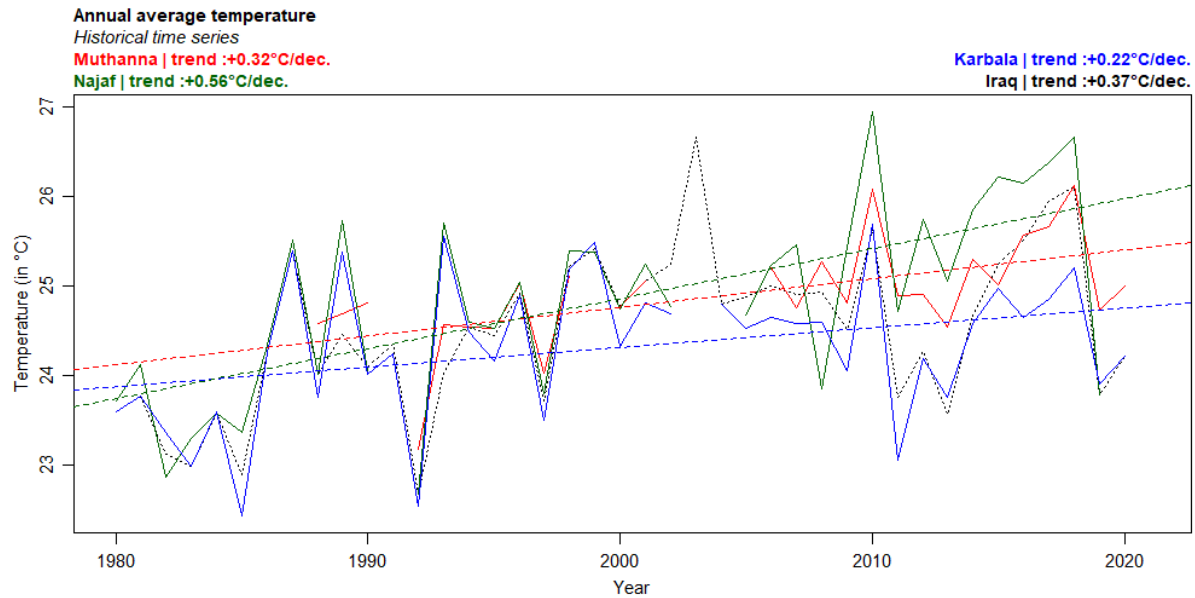
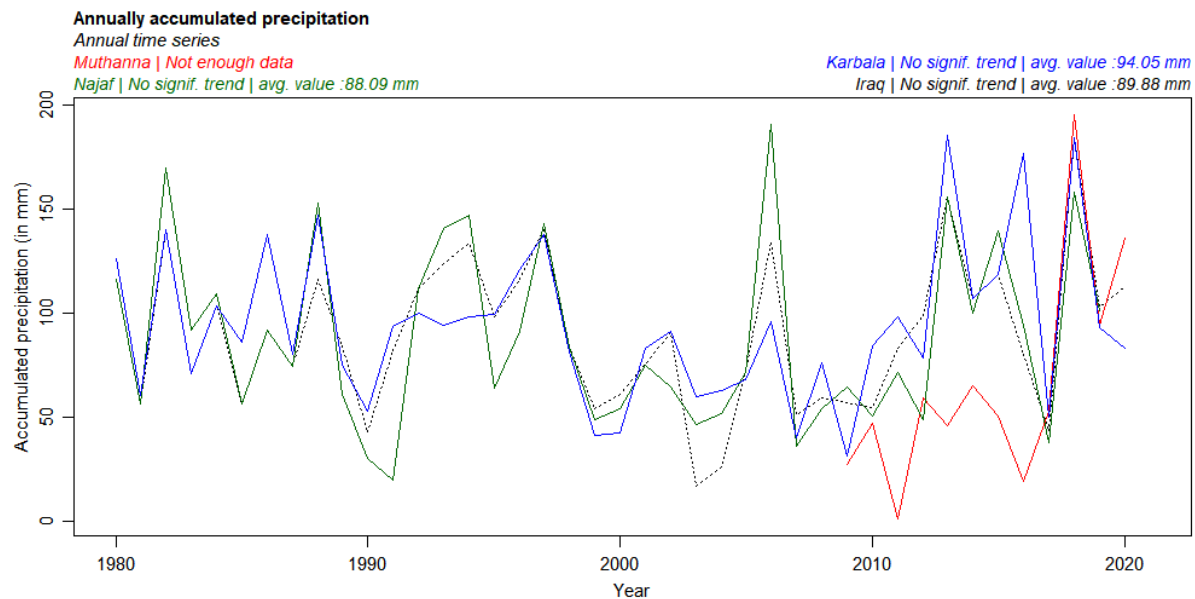


Figure 8: Historical time series of the annually accumulated precipitation in the three target governorates

Time series over the 1980-2020 period. **In red:** average value over all the available weather stations located in the governorate of Muthanna. **In blue:** likewise, for the governorate of Karbala. **In green:** likewise, for the governorate of Najaf. **In black, dotted line:** likewise, but for all Iraq. Data source: Iraqi Ministry of Agriculture and Iraqi Meteorological Organization and Seismology.



55. Historical trends toward warmer temperatures will continue in the future with mean annual temperature rising by +1°C in 2011-2040 (RCP 4.5 scenario) compared to the 1981-2011 reference period [Levi and Mann, 2020]. Based on the IPCC, 2013, RICCAR [2017] reported that IPCC AR5 findings²⁵ show an increase by +2°C in the Arabic Peninsula by 2081-2100 compared to 1986-2005 period (RCP 4.5 scenario) or +2-3°C in 2050²⁶ (RCP 8.5

²⁵ Temperature and precipitation projections are based on a global synthesis output from around 40 Global Climate Models (GCM) and Coupled Model Intercomparison Project Phase 5 (CMIP5) simulations. See https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter14_FINAL.pdf

²⁶ Around 2.53°C (1.62°C to 3.86°C) in 2040-2059 (RCP 8.5, Ensemble) [WB,2020; RICCAR, 2017]. The referenceReference period used is 1986-2005 in the projection presented in the World Bank Climate Change Knowledge Portal and cited by USAID and RICCAR. http://sdwebx.worldbank.org/climateportal/countryprofile/home.cfm?page=country_profile&CCCode=IRQ&ThisTab=ClimateFuture

scenario)²⁷. Based on the CORDEX MENA model, temperatures could increase by +2.25-2.75°C in winter and +2.75/3.25°C in summer in 2081-2100 (RCP 4.5 scenario), with peak increase of +6/6.25°C in summer under the RCP 8.5 scenario [Lelieveld, 2016]. Annual rainfall will decrease by -3.50mm (-60.17mm to -63.69mm) in 2040-2059 (RCP 8.5, Ensemble) [WB, 2020], and decrease by -10 percent end of century compared to the 1986-2005 period (RCP 8.5 scenario) [RICCAR, 2017, based on the IPCC findings]. FAO's analysis in 2021 of local meteorological data of the targeted governorates²⁸ reports that annual mean (average) temperatures will increase between +0.33°C per decade (RCP 4.5 scenario) and +0.61°C pre decade (RCP 8.5 scenario) in the 2020-2060 period [Annex 16-A, page 19], while annually accumulated precipitations will decrease between -1.64 mm per decade in Muthanna to -2.64mm per decade (RCP 4.5 scenario) in Karbala, while under scenario 8.5 the annual accumulated precipitation did not show significant variation [Annex 16-A, page 59], (Figures 6 and 7 below respectively). Precipitation variability is expected to decrease in Karbala and Muthanna under RCP 4.5 scenario, while there is no significant trend in Najaf and at the national level in the 2020-2060 period. In RCP 8.5 scenario, there is an increasing variability of precipitation in Karbala, Najaf and the national level, and no significant trend in Muthanna, for the same projected period [Annex 16-A, page 61].

56. Based on the climate projections, temperature and precipitation changes are likely to continue and will lead to a higher loss of cultivable land to desertification and declining agriculture [Adamo et al, 2018]. There are hence growing concerns that most of the agricultural land in Iraq will be converted to desert areas²⁹. The compounded effects of decreasing land productivity, reducing yields, food security and incomes threaten the livelihoods of most of the rural populations, reducing food provisions and increasing migration to cities. In particular, in the three target governorates, increased temperatures and precipitation fluctuations (Figures 6 and 7 respectively) are expected to increase heat stress on crops, increase evapotranspiration, reduce soil moisture and increase soil salinization, and increase water crop requirements. These will increase crop failure risk and the dependence of crop production on irrigation water use, for all types of production systems in the three target governorates. Simulations carried out with the CROPWAT³⁰ model, using local meteorological data as a baseline and projected climatic data from the NASA Earth Exchange - Global Daily Downscaled Climate Projections (NEX – GDDP) dataset, estimated that in the RCP 8.5 scenario the potential evapotranspiration in the project-selected areas would increase by 2.5 percent by 2040, compared to the baseline year scenario (2019). In practice, this will mean an increase of 45 mm/year that will undoubtedly increase the demand for water resources for crop irrigation.

Figure 9: Projected time series of the annual average temperature in the three target governorates

Time series over the 2020-2060 period. In yellow (dotted line): value for each projected model under the RCP4.5. In orange (full line): median value calculated over all projected models under the RCP4.5. In light green (dotted line): value for each projected model under the RCP8.5. In dark green (full line): median value calculated over all projected models under the RCP8.5. In grey (dotted line): median value calculated over all projected models under the RCP4.5 scenario within Iraq, for comparison. In black (dotted line): median value calculated over all projected models under the RCP8.5 scenario within Iraq, for comparison. Data source: NASA Earth Exchange - Global Daily Downscaled Climate Projections (NEX – GDDP) (Thrasher et al., 2012).

²⁷ These projections are also aligned with the CORDEX MENA model, mentioned in the RICCA report 2017. The CORDEX-MENA model is a hybrid of different simulations, from different Regional Climate Models. According to this model, temperatures could increase by +1.5/2°C in winter and +2/2.5°C in summer, 2046-2056 period (RCP 4.5 scenario), and by +2.25-2.75°C in winter and +2.75/3.25°C in summer in 2081-2100 (using 1986–2005 as a baseline period). Under the RCP 8.5 scenario, temperatures are projected to increase by +2.25/2.75°C in winter and by +4.5/5°C in summer at mid-century, using the same baseline period. By the end of century, temperatures could increase by +3.25/3.75°C in winter and +6/6.25°C in summer (Lelieveld, 2016), using the same baseline period.

²⁸ FAO. 2021-Annex 16-A. Atlas of the climate in the Governorates of Karbala, Najaf & Muthanna in the Republic of Iraq.

²⁹ Sissakian et al. Sand and dust storm events in Iraq. *Natural Science*, Vol.5 No.10, 2013.

³⁰ CROPWAT 8.0 for Windows is a computer program for the calculation of crop water requirements and irrigation requirements based on soil, climate, and crop data, developed by the Land and Water Development Division of FAO.

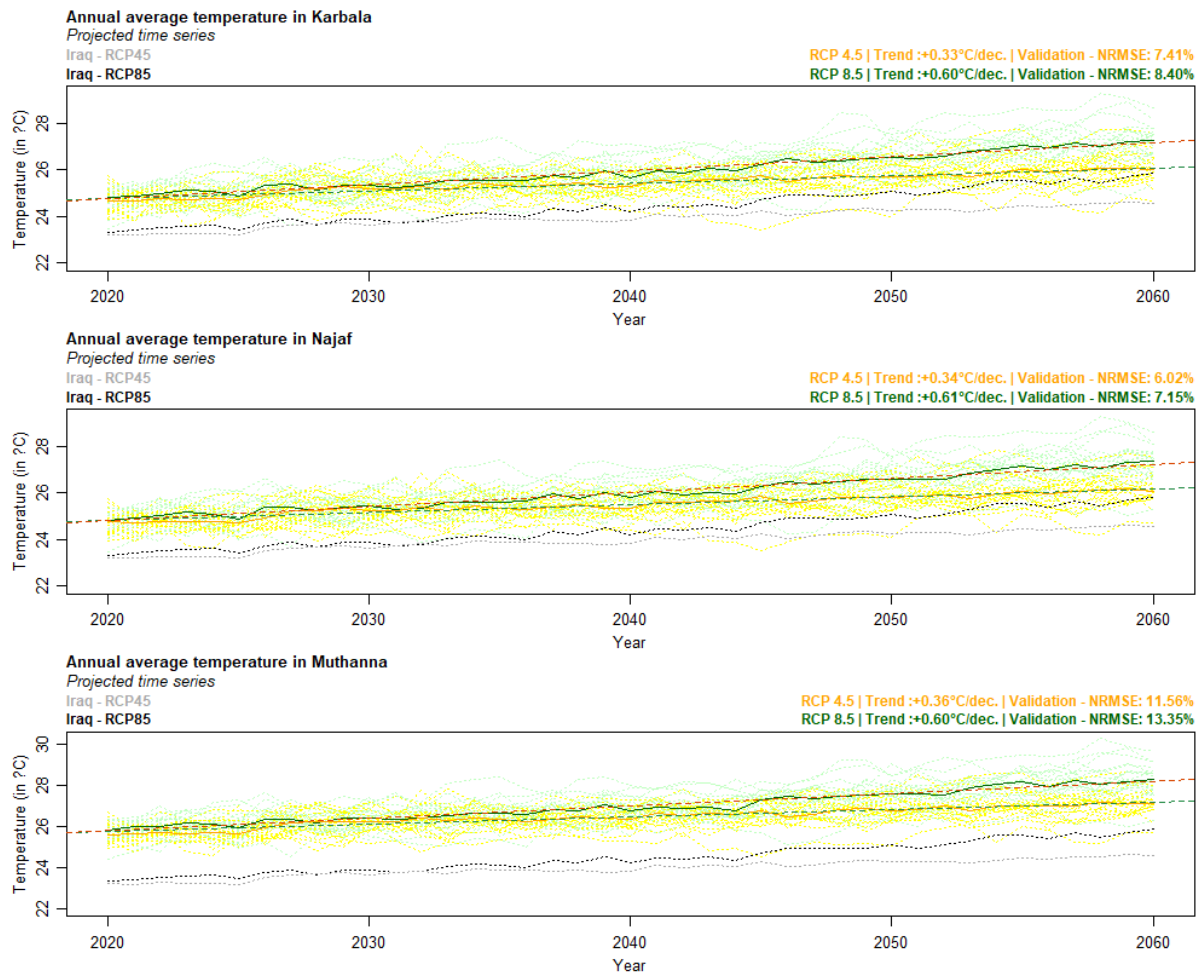
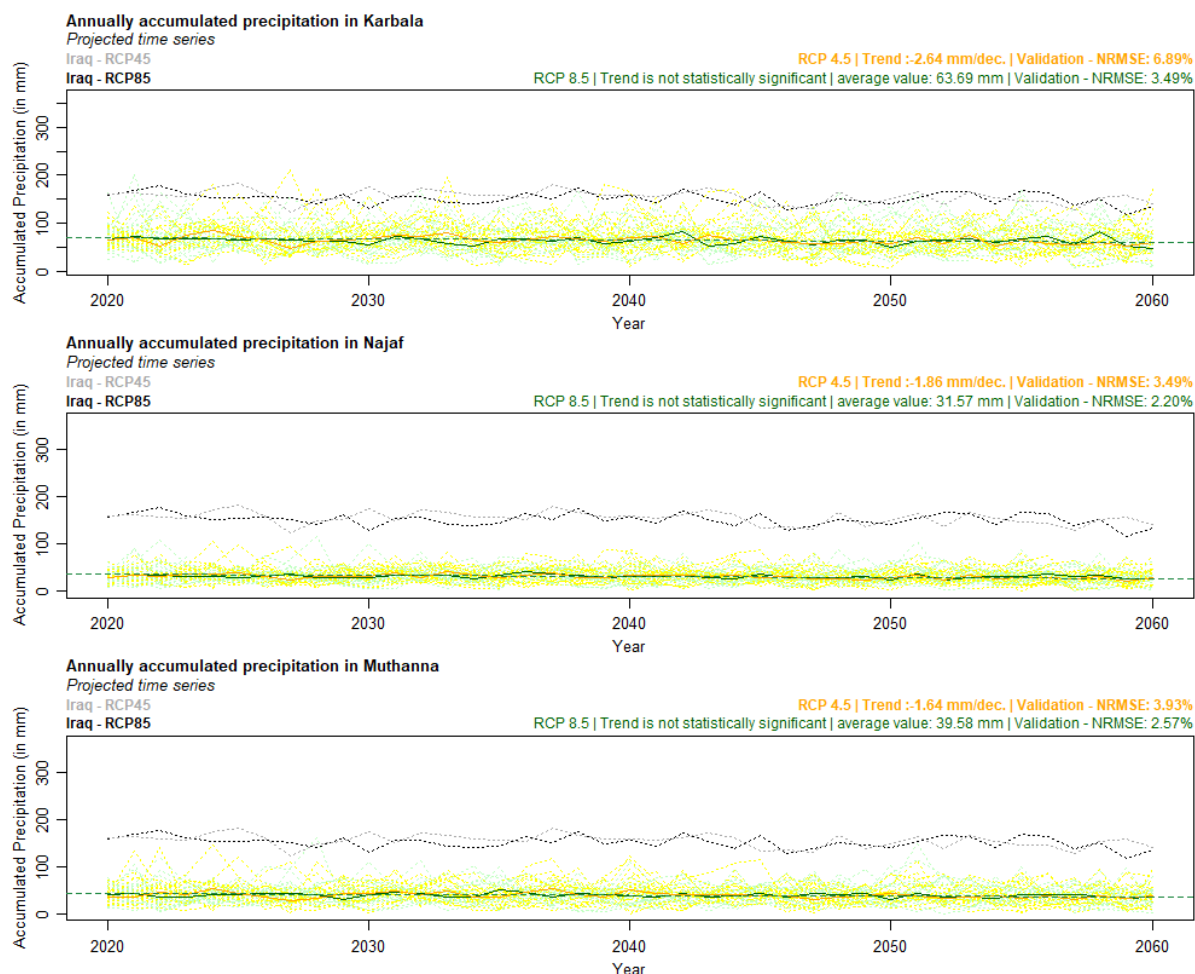


Figure 10: Projected time series of the annually accumulated precipitation in the three target governorates

Time series over the 2020-2060 period. **In yellow (dotted line):** value for each projected model under the RCP4.5. **In orange (full line):** median value calculated over all projected models under the RCP4.5. **In light green (dotted line):** value for each projected model under the RCP8.5. **In dark green (full line):** median value calculated over all projected models under the RCP8.5. **In grey (dotted line):** median value calculated over all projected models under the RCP4.5 scenario within Iraq, for comparison. **In black (dotted line):** median value calculated over all projected models under the RCP8.5 scenario within Iraq, for comparison. Data source: NASA Earth Exchange - Global Daily Downscaled Climate Projections (NEX – GDDP) (Thrasher et al., 2012).

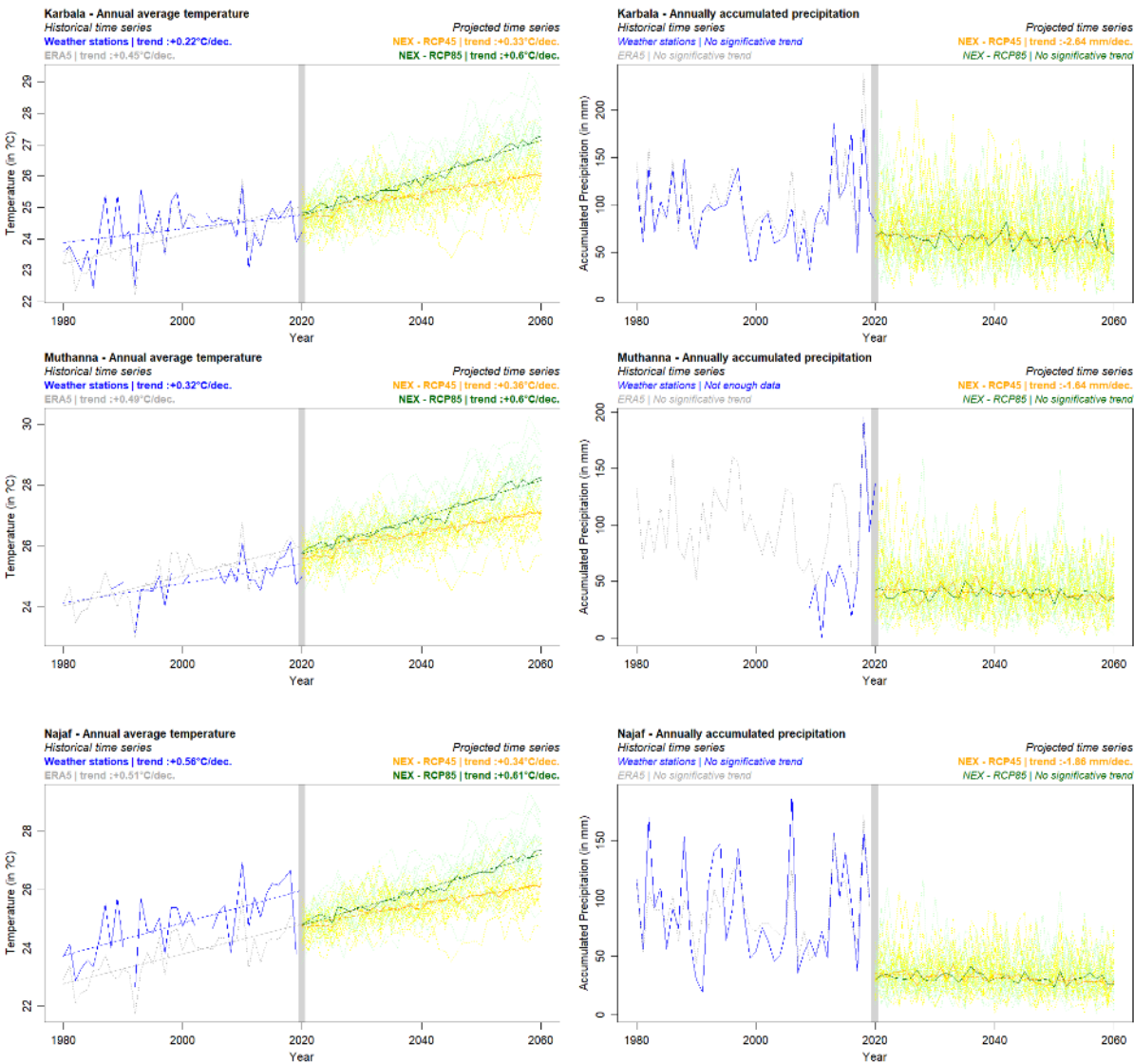


57. Looking at it from the perspective of four decades it provides similar results, in the 1980-2020 period (40 years), annual average temperatures increased between $+0.88^{\circ}\text{C}$ ($+0.22^{\circ}\text{C}$ per decade in Karbala) and $+2.24^{\circ}\text{C}$ ($+0.56^{\circ}\text{C}$ per decade in Najaf)), reaching a temperature close to 25°C on average: monthly average temperatures increased between $+0.46^{\circ}\text{C}$ (September) and $+0.97^{\circ}\text{C}$ (March) per decade in Muthanna, between $+0.38^{\circ}\text{C}$ (July and September) and $+0.51^{\circ}\text{C}$ (August) per decade in Karbala, between $+0.47^{\circ}\text{C}$ (April) and $+1.04^{\circ}\text{C}$ (August) in Najaf. In the same period, precipitations have been highly variable (varying between 17 mm/year and 185 mm/year) without presenting any significant trend as shown above.
58. Similarly, looking at projected trends from the perspective of four decades, the climate projections at the governorate level reported in Figure 8 below, annual average temperatures will increase between by $+1.44^{\circ}\text{C}$ ($+0.36^{\circ}\text{C}$ per decade under the RCP 4.5 scenario) and $+2.4^{\circ}\text{C}$ ($+0.60^{\circ}\text{C}$ per decade under the RCP 8.5 scenario) in Muthanna, by $+1.36^{\circ}\text{C}$ ($+0.34^{\circ}\text{C}$ per decade under the RCP 4.5 scenario) and $+2.44^{\circ}\text{C}$ ($+0.61^{\circ}\text{C}$ per decade under the RCP 8.5 scenario) in Najaf, and between $+1.32^{\circ}\text{C}$ ($+0.33^{\circ}\text{C}$ per decade under the RCP 4.5 scenario) and $+2.4^{\circ}\text{C}$ ($+0.60^{\circ}\text{C}$ per decade under the RCP 8.5 scenario) in Karbala. Projected precipitations will range below 50 mm in Muthanna and Najaf and will be around 50-100mm in Karbala. During the 2020-2060 period and under the RCP4.5 scenario, precipitations are expected to decrease by -4.92 mm (-1.64 mm per decade) in Muthanna, by -7.44 mm (-1.86 mm per decade) in Najaf, and by -10.56 mm (-2.64 mm per decade) in Karbala. No statistically significant trends could be decerned under the RCP8.5 scenario for none of the target governorates. A summary of the most important results of the analysis of is demonstrated in table 4. For more details refer to Annex 16-A, pages 8-61.

59. Historical and projected trends in the three targeted governorates are summarized as follows:

Figure 11: Annually accumulated precipitation and annual average temperatures - Historical and projected time series and trends in the targeted governorates

Historical time series over the 1980-2020 period and projected time series over the 2020-2060 period of annually accumulated precipitation and annual average temperature, by targeted governorates. **Left:** annual average temperature. **Right:** annually accumulated precipitation. **In blue:** historical local weather station data. **In grey:** historical ERA5 data (modeled). **In dark green:** NEX projected data, under the RCP8.5 scenario (median model). **In Orange:** NEX projected data, under the RCP4.5 scenario (median model). **In light green:** NEX projected data, under the RCP8.5 scenario (distinct models). **In Yellow:** NEX projected data, under the RCP4.5 scenario (distinct models). Data source: Iraqi Ministry of Agriculture and Iraqi Meteorological Organization and Seismology, ERA5 - ECMWF / Copernicus Climate Change Service (Muñoz Sabater, 2019), and NASA Earth Exchange - Global Daily Downscaled Climate Projections (NEX – GDDP) (Thrasher et al., 2012)



60. FAO’s analysis of local meteorological data of the target governorates in 2021 indicates that annual average temperatures and Potential Evapotranspiration (PET) will increase in the 2020-2060 period in the RCP 4.5 and RCP 8.5 scenarios (Table 4), while no trends related to minimum temperature and precipitations could be

confirmed³¹. A summary of the most important results of the analysis of the target areas is indicated in table 7. For more details refer to Annex 16-A, pages 62-67.

Table 7: Historical (1980-2020) and projected climate change trends in the three governorates and impacts (2020-2060). NSST = No statistical significant trend. NED = Not enough data

Factor	Variable	Climate change historical trends (1980-2020) and Projected trends (2020-2060) under RCP 4.5 and 8.5 scenarios, per decade				Detailed information Page in Atlas (Annex 16-A)	Impact on water availability
		National	Karbala	Najaf	Muthanna		
Temperature	MEAN T °C	Historical: +0.37°C Projected: RCP4.5: +0.33°C RCP8.5: +0.60°C	Historical: +0.22°C Projected: RCP4.5: +0.33°C RCP8.5: +0.60°C	Historical: +0.56°C Projected: RCP4.5: +0.34°C RCP8.5: +0.61°C	Historical: +0.32°C Projected: RCP4.5: +0.36°C RCP8.5: +0.60°C	Historical: page 13 Projected: page 19	Increase in temperature signifies increase in evaporation from surface water.
	MIN T °C	Historical: -0.38°C NSST Projected: RCP4.5: +0.23°C RCP8.5: +0.32°C	Historical: -0.64°C Projected: RCP4.5: +0.21°C RCP8.5: +0.29°C	Historical: -0.41°C NSST Projected: RCP4.5: +0.22°C RCP8.5: +0.30°C	Historical: +4.08°C Projected: RCP4.5: +0.26°C RCP8.5: +0.37°C	Historical: page 26 Projected: page 32	
	MAX T °C	Historical: +0.42°C NSST Projected: RCP4.5: +0.44°C RCP8.5: +0.74°C	Historical: +0.29°C NSST Projected: RCP4.5: +0.42°C RCP8.5: +0.76°C	Historical: -0.72°C Projected: RCP4.5: +0.43°C RCP8.5: +0.73°C	Historical: +1.37°C NSST Projected: RCP4.5: +0.45°C RCP8.5: +0.73°C	Historical: page 39 Projected: page 45	
Precipitation	AVERAGE ANNUAL PRECIPITATIONS	Historical: +1.59 mm NSST Projected: RCP4.5: -4.39 mm RCP8.5: -3.10 mm NSST	Historical: +1.48 mm NSST Projected: RCP4.5: -2.64 mm RCP8.5: -1.21 mm	Historical: -1.03 mm NSST Projected: RCP4.5: -1.86 mm RCP8.5: -1.22 mm NSST	Historical: NED Projected: RCP4.5: -1.64 mm RCP8.5: -0.78 mm NSST	Historical: page 52 Projected: page 59	Decrease in precipitation is foreseen in an RCP 4.5 scenario that would lead to obvious reductions in water availability. Reportedly, climate change has mainly led to a decrease in snow precipitation in the source areas of the two rivers within the riparian countries [Sensoy et Al., 2023 ; Sengül, 2022 ; FAO, 2011].
	Standard deviation of annually accumulated precipitation ³²	Historical: +4.52 mm Projected: RCP8.5: +1.78 mm	Historical: +5.06 mm Projected: RCP4.5: - 0.76 mm RCP8.5: + 1.43 mm	Historical: NED Projected: RCP8.5: +0.29 mm	Projected: RCP4.5: -1 mm	Historical: page 53 Projected: page 61	

³² Expressed as standard deviation of the last 6 years (moving window) of annually accumulated precipitation

							rivers in Iraq, soil loss and increasing salinization of the Shatt al-Arab and groundwater in the south.
Evaporation	ANNUAL POTENTIAL EVAPOTRANSPIRATION (PET)	NA	Historical: NED Projected: RCP4.5: +19.22 mm RCP8.5: +33.88 mm	Historical: NED Projected: RCP4.5: +19.79 mm RCP8.5: +35.02 mm	Historical: NED Projected: RCP4.5: +20.85 mm RCP8.5: +36.22 mm	Projected: page 68	Evaporation from surface waters is already responsible for 14% of overall water consumption. Further increase in PET is foreseen in all future scenarios in all target areas leading to higher losses of surface water through evaporation.
Drought	Standard precipitation index (SPI) 24	Historical: -0.000461	Historical: -0.000011	Historical: -0.000177	NA	Page 71	A significant increase in exposure in long term hydrological drought for 24 months on a national level can be detected. This shows negative impacts of droughts on the replenishment of reservoir and groundwater.

Table 8: Non Climatic Factors influencing water availability

Factor				
	Current status	Future trends	Detailed information Annex 2	Impact on water availability
Transboundary water abstraction	The average yearly inflow of the Euphrates reportedly declined from 30.26 BCM (1933-1972) to about 16.90 BCM (average of 1990-2012) (decrease of 44%), while the inflow of the Tigris declined from 49.22 BCM (1933-1998) to 32.64 BCM (1999-2012) due to over use by the upper riparian countries.	Available surface water in the next 20 years is estimated to decrease by 17.64 BCM, i.e., a decrease of 24.5%. Of which decrease in the water amount due to increase in water demand outside Iraq is 15.21 BCM (Mukhalad A. & al, 2019).	Page 76	In the worst-case scenario, assuming that the current approach to water and land management in Iraq continues, the water deficit would increase in this scenario to reach about 10.94 BCM/year by the year 2035. Policies based on securing municipal and industrial needs would be adopted, accepting hence the possibility of a water deficit in meeting the irrigation needs. In such scenario all efforts have to be directed towards increasing efficiency of water utilization and productivity in the agricultural sector.
Irrigation technology and practices Cropping intensity	Current efficiency is low due to obsolete technology and practices: 30-40%	It is the aim to raise the total irrigation efficiency to 60% using modern irrigation methods (sprinkler irrigation, drip irrigation), piped irrigation conveyance and canal lining.	Page 73, 88	
	Current cropping intensity: 85%	Future projected cropping intensity: 115%		

Drainage system	Only one quarter of the irrigated area is equipped with drainage system and infrastructure is often obsolete and inefficient. Drainage water corresponds in the year 2015 to 3.781 BCM	Heavy investments are needed to bring drainage water to 4.556, as foreseen in the National water strategy by 2035.	Page 88	Drainage systems give a significant contribution to the water balance. Major efforts need to be implemented to safeguard high quantity and quality contributions by the drainage systems.
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61. **Climate Change Impact on watershed level³³**. The river basin of the Tigris and Euphrates covers numerous countries (see Figures 8 and 9). The evaluations carried out with the ERA5 model³⁴ for historical data and NEX³⁵ for projected future conditions brought the following results: between 1980 – 2020 maximum and average temperatures increased by 0.5°C/dec and 0.6°C/dec respectively, while no significant historical trend could be detected related to minimum temperature and accumulated annual precipitation (Table 5). Projected minimum, maximum and average temperatures (2020 – 2060) show significant increases in both RCP 4.5 and RCP 8.5 scenarios and range from +0.26°C to 0.38°C (MIN), +0.45°C to 0.74°C (MAX) and +0.34°C to 0.6°C (AVG) per decade respectively. Precipitation is expected to decrease in the same period by -5,05 mm/dec in RCP 4.5 and by -5.83 mm/dec in RCP 8.5 (Table 5). Furthermore, Figure 9 shows that most of the precipitation of the watershed occurs on the mountain range within few months (from November until April) confirming the need to increase the efficiency of water management practices and techniques in view of an increasingly reduced water flow. In particular in the target areas, this action becomes even more urgent since irrigation practices are dependent on the rivers. A summary of the most important results of the analysis of watershed is indicated in table 5. For more details refer to Annex 16-A, pages 71-96.

Figure 12: Location of river basins considered within the project

Overlayed on a topographical map and a permanent water map. Data sources: NASA / USGS / JPL-Caltech (Farr et al., 2007), WWF HydroSHEDS (Lehner et al., 2008; Grill et al., 2019) and JRC Yearly Water Classification History (Pekel et al., 2016).

³³ The analysis of climate data in Iraq used local data from meteorological stations. Due to lack of data or their accessibility, the analysis of the regional watershed used remote sensing data.

³⁴ ERA5 is the fifth generation ECMWF (European Centre for Medium-Range Weather Forecasts) atmospheric reanalysis of the global climate.

³⁵ NEX is the NASA Earth Exchange (NEX) - Global Daily Downscaled Climate Projections (GDDP) dataset.

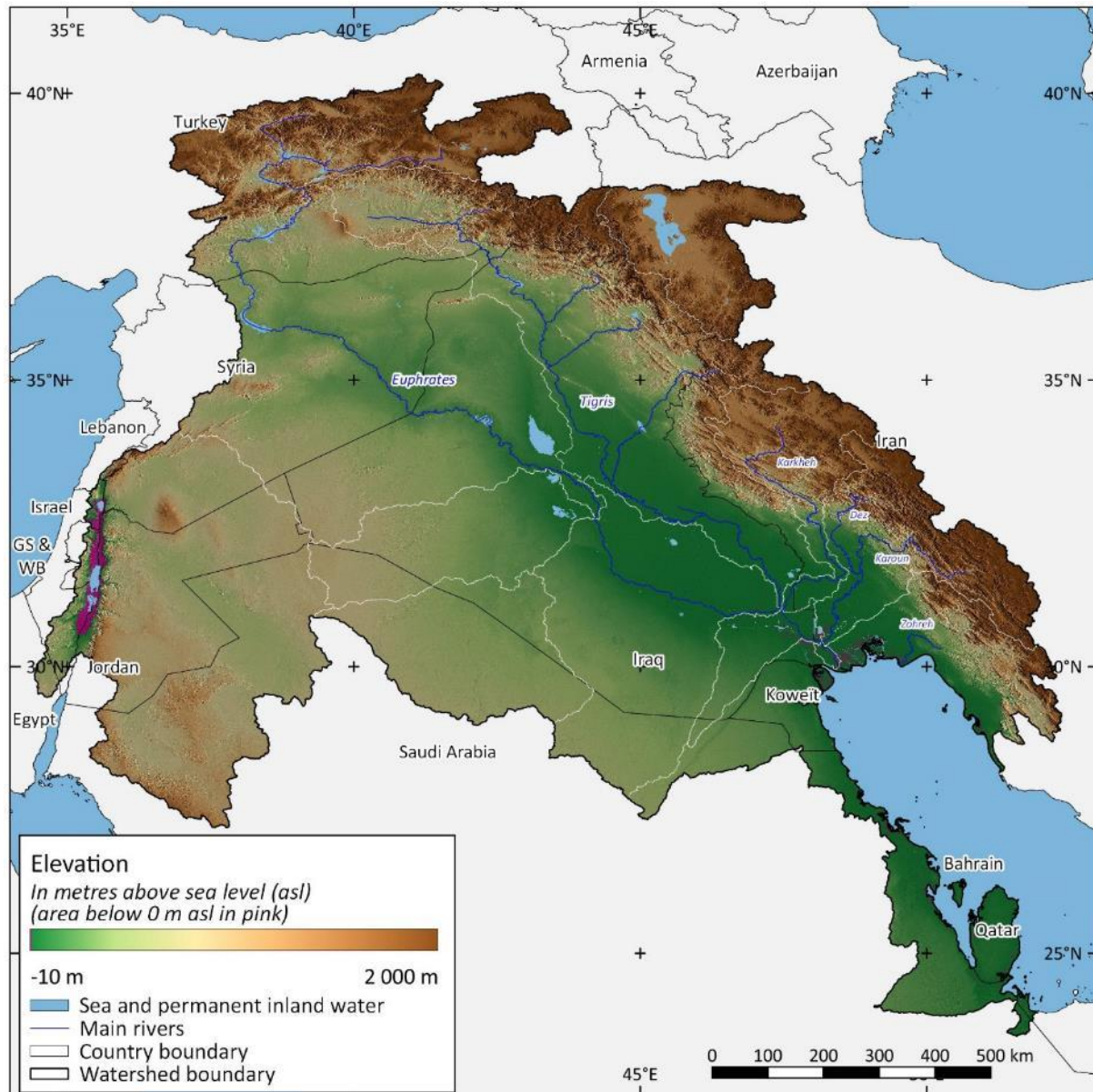


Figure 13: Current spatial distribution of monthly average accumulated precipitation over the Iraqi watershed
Data averaged over the 1990-2019 period. Data source: ERA5 - ECMWF / Copernicus Climate Change Service (Muñoz Sabater, 2019).

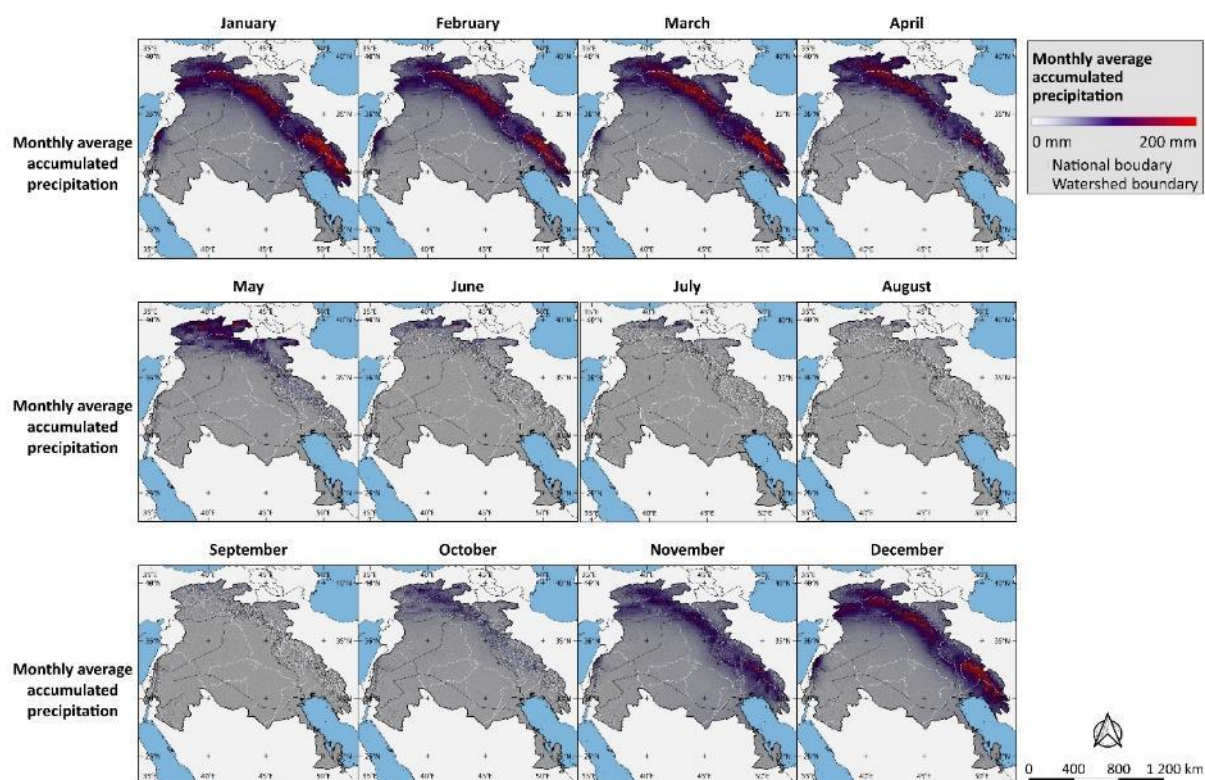


Table 9: Historical trends (1980-2020) and projected trends at the watershed level (2020-2060)

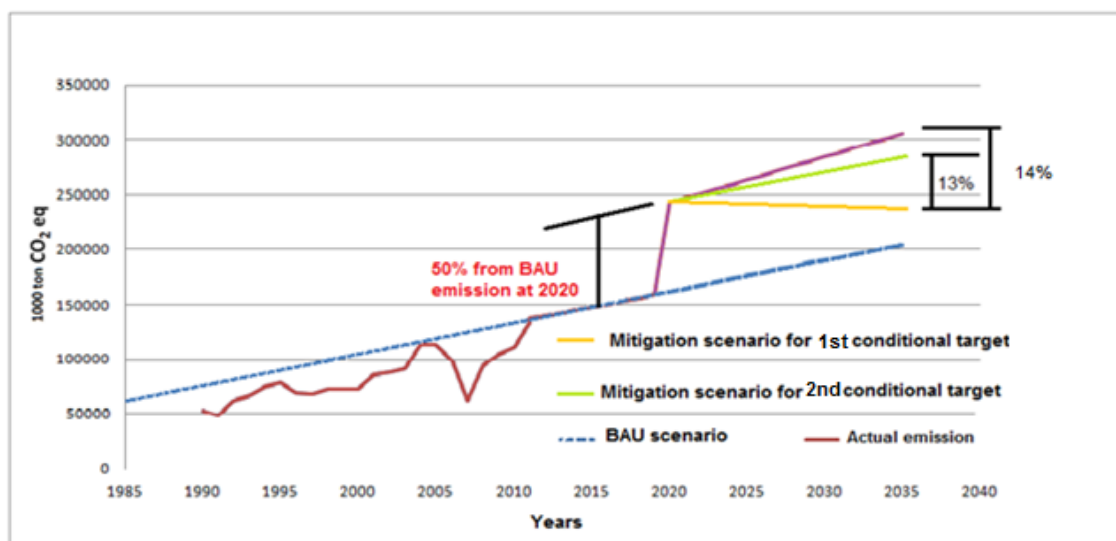
Variable	Climate change historical trends (1980-2020) and Projected trends (2020-2060) under RCP 4.5 and 8.5 scenarios, <u>per decade</u> AT RIVER BASIN LEVEL		
	<i>National</i>	<i>Watershed</i>	<i>Detailed information Page in Atlas (Annex 16-A)</i>
MEAN T °C	Historical: +0.57°C Projected: RCP4.5: +0.33°C RCP8.5: +0.60°C	Historical: +0.6°C Projected: RCP4.5: +0.34°C RCP8.5: +0.60°C	Historical: page 80 Projected: page 86
MIN T °C	Historical: NSST Projected: RCP4.5: +0.23°C RCP8.5: +0.32°C	Historical: NSST Projected: RCP4.5: +0.26°C RCP8.5: +0.38°C	Historical: page 80 Projected: page 86
MAX T °C	Historical: +0.42°C Projected: RCP4.5: +0.44°C RCP8.5: +0.74°C	Historical: +0.5°C Projected: RCP4.5: +0.45°C RCP8.5: +0.74°C	Historical: page 80 Projected: page 86
AVERAGE ANNUAL PRECIPITATIONS	Historical: NSST Projected: RCP4.5: -4.39 mm RCP8.5: NSST	Historical: NSST Projected: RCP4.5: -5.05 mm RCP8.5: -5.83 mm	Historical: page 91 Projected: page 95

NSST: No statistically significant trend

Greenhouse Gas Emissions and mitigation scenarios

62. Iraq's GHG emissions corresponded in the year 2018 to 216,19Mt CO₂eq, representing a 216 percent increase compared to 1990 [Climate Watch Data]. Of these emissions, the energy sector accounted for 186,56Mt CO₂eq, while agriculture represented 7,39Mt CO₂eq (3 percent of the total GHG emissions). The energy sector increased by 216 percent its GHG emissions compared to the 1990 levels, while the agriculture did not show any significant variations. Iraq has abundant fossil fuel resources and these are also responsible for the high share of GHG emissions of the energy sector. The importance of these resources is also reflected by the fact that Iraq's economy is dominated by oil production (around 55 percent of the GDP, 2015 data). Agriculture on the other hand contributes to the national 5.9 percent to Iraq's GDP (2020)³⁶.
63. The INDC sets the targets to reduce greenhouse gas (GHG) by 14 percent below business-as-usual (BAU) emissions between 2020 and 2035. 13 percent of these reductions are conditional on receiving international support and 1 percent is unconditional (financed from Iraq's own resources). In the INDCs there is no detailed information included allowing to quantify the Business-as-usual situation in the year 2035; scientific estimations³⁷ calculated that BAU emissions could reach 462 Mt CO₂eq. Consequently, with the non-conditional reductions, a level of 458 Mt CO₂eq could be achieved, while with the conditional ones the CO₂ eq emissions would correspond to 408 Mt (Figure 11).

Figure 14: GHG scenarios are summarized



Source: INC, 2016

64. Based on the NDC, 2016, specific mitigation measures were listed in the different sectors based on the different mitigation scenario, including electricity and agriculture: shift to combined cycle power plants; improve the performance of electricity system to maintain sustainability and stability with high reliability; and develop a system to protect, maintain and increase natural forests. Subject to additional support from the international community, Iraq committed to increasing investment in combined cycle power plants, initiating energy conservation and efficiency programs; using clean, new and renewable

³⁶ Combines contribution of agriculture, fishery and forestry

³⁷ The estimations come from ISIPedia -ISIPedia is an online portal for national-level, cross-sectoral climate-impact assessments, based on state-of-the-art climate-impacts simulations, hosted by the Potsdam Institute for Climate Change impacts

energies; reducing the technical loss in power transmission and distribution; and developing hydroelectric plants in Kurdistan Region, which will increase the hydroelectric power contribution to total generation to 3.3 percent by 2035, supposing that the Mosul Dam will have been rehabilitated. Additionally, in the agriculture sector, Iraq committed to Land management; improving rice farming technologies and natural fertilizer management to reduce CH₄ emissions; increasing the use of Nitrogen fertilizers to reduce N₂O emissions; and improving the quality of crops.

Climate change adaptation and mitigation targets and related policies, strategies and laws

65. **National regulations of permissible limits of air pollutants in ambient air No.2 of 2018** (updated recently) related to the pollutants emitted from any activity such as, solid waste incinerators, hazardous and medical waste incinerators, sources of hydrocarbon combustion, including (SO₂, NO₂, CO, O₃, TDS, Pb, dioxins and furans).
66. **National regulations for the use of treated sewage water in agricultural irrigation No. 3 of 2012:** includes several conditions related to the use of treated wastewater in agricultural irrigation and the standards of treated wastewater used for agricultural irrigation to prevent surface and groundwater pollution.
67. **Regulation on ambient air protection from pollution No.4 of 2012.** It identifies the role of the MoE in reducing pollution, including establishing the national monitoring program, air pollutants guidelines and measuring methods, instructions for reducing pollutants and details the mandate of the Environment Observer.
68. **Protected Areas Law No 2 of 2014.** It establishes the creation of protected areas in Iraq and the creation of a National Committee of the Natural Protected Areas.
69. **Iraqi Law of Protection and Improvement of the Environment, No. 27 of 2009.** This Law aims to improve and to protect the environment by handling the damages, protecting the public health and the natural resources. The Law establishes a Council for the protection and improvement of the environment referring to the Ministry of Environment and cooperating with other Ministries. It also defines its duties and responsibilities³⁸.
70. **Law No. 17 of 2010 on the Protection of Wild Animals.** This Law aims to protect wild animals and to organize the hunting grounds by regulating hunting licences and determining animal species that could be hunted. Natural reserves should also be created to protect endangered species of wild animals³⁹.
71. **Act of Natural Pastures No. 2 of 1983.** This Law aims to manage and develop the pasture by identifying the areas of rough grazing, planning the grazing according to scientific bases, protecting the natural vegetation, conserving water resources and organizing their use, and conducting studies and researches for the protection of rough grazing⁴⁰.
72. **National Environmental Strategy and Action Plan (NESAP) (2013-2017⁴¹).** The objective of this Strategy and Action Plan is to improve the quality of life and livelihood of the population through the protection

³⁸ See https://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=89060

³⁹ See <https://www.ecolex.org/fr/details/legislation/law-no-17-of-2010-on-the-protection-of-wild-animals-lex-faoc100093/>

⁴⁰ See <https://www.ecolex.org/details/legislation/law-no-2-of-1983-on-pasture-lex-faoc100316/>

⁴¹ Currently being updated.

of natural resources and support to sustainable practices. It provides an analysis of key and priority environmental issues in the country, and identifies ten Strategic Objectives which include, among others, protecting and improving water quality, controlling land degradation and combating desertification, and developing the institutional and legal framework of the environment sector. The implementation of this Strategy is presented in its Action Plan.

73. In the [Iraq Vision 2030](#), the promotion of RES is indicated as one of the most important measures to achieve Goal (5-1): “Reduce environment pollution and greenhouse emissions”. The Integrated National Energy Strategy also acknowledges the great importance of developing Renewable energy infrastructures. Solar energy is a key source in the short term for supplying energy to remote off-grid locations. In the medium- to long-term, solar and wind power capacity will be developed for connection with the grid, and the potential for hydro-power development will be further examined. The INES expects that by 2030 renewable capacity will exceed 2 GW, approximately 4-5 percent of total system capacity.

74. The project is aligned with the current national documents, strategies as per the table below:

Table 10: Project aligned with national policies and strategies related to climate change

#	Policy/Strategy	Addressed Priority	Contribution	Sub-Comp.
1	(Intended) National Determined Contributions - 2015	Upgrading the water use efficiency in distribution networks and water consumption meters; water monitoring, reuse of drainage water in green belts against desertification; switch to non-conventional irrigation methods; increase irrigation efficiency, use of drought and saline tolerant crop varieties and climate smart agricultural practices	68 kms of canals shifted from open to closed system One km of water canals covered with solar panels, providing 1,000 kWp of renewable energy Improved national compliance practices for management of irrigation water supply 121,965 hectares of farming area will be brought under climate-resilient management practices	1.1, 1.2, 3.1
2	National Communication 2016	Raise the irrigation efficiency in irrigated agriculture and use of efficient irrigation technologies. Increase the efficiency of field irrigation Design and promotion of alternative crops of less water consumption. Establishment of water users' associations.	68 kms of canals shifted from open to closed system 500 technical staff trained in design, installation and maintenance of irrigation, drainage and energy technologies 400 Extension Staff trained on climate resilient agricultural practices and technologies	1.1, 1.3, 2.1, 2.2, 3.2, 3.1, 3.2

		<p>Improve management of rain-fed agriculture</p> <p>Follow modern efficient irrigation systems (drip, sprinkler irrigation), raise awareness of farmers to adopt them, and support the establishment of water users' associations.</p>	<p>Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture</p> <p>15 WUAs supported in developing and adopting more efficient and climate sensitive water-distribution plans.</p> <p>Improved national compliance practices for management of irrigation water supply</p> <p>121,965 hectares of farming area will be brought under climate-resilient management practices</p>	
3	National Development Plan (NDP) 2018-2022	<p>Increasing the agricultural sector share in GDP</p> <p>Achieving sustainable food security</p> <p>Securing the annual demand for water for sustainable uses in the (agricultural, industrial, municipal) fields and achieving water balance (by reducing the annual demand for water 500 million m3)</p> <p>Working on providing sustainable water resources</p> <p>Protecting the environment from contamination and handling environmental problems resulting from oil and gas activity of existing facilities and reducing CO2 emissions</p> <p>Improved electrical system efficiency</p>	<p>One km of water canals covered with solar panels, providing 1,000 kWp of renewable energy</p> <p>400 Extension Staff trained on climate resilient agricultural practices and technologies</p> <p>Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture</p> <p>Technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events</p> <p>Enhanced planning for solar rural electrification</p>	1.2, 2.1, 2.2, 2.3
4	Iraq Vision 2030	<p>Sustainable Environment</p> <p>- Goal (5-1): Reduce environment pollution and greenhouse emissions</p> <p>- Goal (5-2): Efficient use of water resources</p>	<p>One km of water canals covered with solar panels, providing 1,000 kWp of renewable energy</p> <p>500 technical staff trained in design, installation and maintenance of irrigation, drainage and energy technologies</p>	1.2, 1.3, 3.1

		<p>- Goal (5-3): Environmental conservation</p> <p>- Goal (5-4): Develop the consumption and production patterns to achieve environmental sustainability</p> <p>- Goal (5-5): Protect biodiversity and revive the Mesopotamian marshes</p>	A climate resilient water allocation strategy and its action/legal/coordination plan developed	
5	Strategy on Water and Land Resources (SWLRI) (2013)	Optimal use of water resources, and the integrated water resources management using modern technologies and advanced planning tools, in order to ensure the requirements of water security, food, energy and environmental preservation	<p>68 kms of canals shifted from open to closed system</p> <p>500 technical staff trained in design, installation and maintenance of irrigation, drainage and energy technologies</p> <p>400 Extension Staff trained on climate resilient agricultural practices and technologies</p> <p>Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture</p> <p>A climate resilient water allocation strategy and its action/legal/coordination plan developed</p>	1.1, 1.3, 2.1, 3.1
6	Land Degradation Neutrality Target Setting National Report - 2017	4) Reduce salinization rate by improving productivity and SOC stocks in cropland and plantation lands 10,000 ha by 2035 as compared to 2017	<p>Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture</p> <p>Technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events</p>	2.1, 2.3
7	Strategic Plan of the Ministry of Agriculture 2015-2025	(i) Expand the use of conservation agriculture; (ii) Spread the use of modern irrigation methods (iii) Use of supplemental irrigation in the rainy areas to create a state of stability in production, increase the unit area and reduce costs; (iv)	One km of water canals covered with solar panels, providing 1,000 kWp of renewable energy	1.2, 2.1, 2.2, 2.3

		<p>Development, propagation and use of high-yielding varieties suitable for environmental conditions; (v) Raise the percentage of organic matter in the soil through organic and green fertilization, (vi) Regulate irrigation provided to crops in terms of quantity and timing, and (vii) Increasing the water use efficiency</p> <p>The strategy is based on 4 axes:</p> <p>First: Implementation of new irrigation projects and networks through.</p> <ol style="list-style-type: none"> 1. Investing in surface water and wastewater after treatment. 2. Digging wells to exploit renewable groundwater. 3. Rainwater harvesting projects to stop and reduce decertified areas. <p>Second: Increasing the water use efficiency.</p> <ol style="list-style-type: none"> 1. Expanding the use of modern irrigation technologies. 2. Lining the irrigation canals. 3. Expansion of the closed irrigation system. 4. Establishing a pricing system for the quantities of water used to reduce waste. <p>Third: Increasing the planting density.</p> <ol style="list-style-type: none"> 1. Development and dissemination of short-lived varieties, such as the rice variety Bohouth. 2. Expansion of intercropping 3. Early cultivation by using breeding in nurseries. 4. Implementation of appropriate agricultural rotations for a high agricultural density. <p>Fourth: Expansion of supplemental irrigation.</p> <ol style="list-style-type: none"> 1. Expanding the use of modern irrigation technologies in the irrigated areas, depending on groundwater and water harvesting. 	<p>400 Extension Staff trained on climate resilient agricultural practices and technologies</p> <p>Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture</p> <p>Technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events</p>	
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		2. Expanding the construction of small dams in water harvesting areas.		
8	Integrated Energy Strategy (2012)	Develop renewable energy capacity Priority is to develop gas-based industries, achieve energy security, diversify the economy and create jobs	One km of water canals covered with solar panels, providing 1,000 kWp of renewable energy Enhanced planning for solar rural electrification	1.2, 2.2
9	(draft) National Adaptation Plan (2021)	Enabling environment, policies and institutional coordination, environmental awareness and education and finance - intersectoral priorities yet to be defined	15 WUAs supported in developing and adopting more efficient and climate sensitive water-distribution plans. Technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events Enhanced planning for solar rural electrification A climate resilient water allocation strategy and its action/legal/coordination plan developed	1.3, 2.1, 2.2, 2.3, 3.1
10	Strategy for the reduction of poverty in Iraq (2018-2022)	Adoption of the SDGs, including poverty reduction of 25 percent by 2022. (1) sustainable income for the poor from work; (2) improved health status of the poor; (3) improved education for the poor; (4) suitable housing and environment responsive to challenges; (5) effective social protection; and (6) emergency response activities	400 Extension Staff trained on climate resilient agricultural practices and technologies Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture Technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events A cadre of Climate Wise Women (CWW) trained as change agents for climate adaptation.	2.1, 2.2, 2.3

75. In its [INC](#), Iraq developed a series of adaptation measures for the agriculture sector - crop production and the water sector (rain-fed and irrigated fields) and the water sector – irrigation facilities:

1) Agriculture sector

- Raise the irrigation efficiency in irrigated agriculture through development of field irrigation and use of efficient irrigation technologies (e.g. drip irrigation, sprinkler irrigation).
- Promotion of alternative crops of less water consumption.
- Establishment of water users' associations.
- Protection and restoration of desert oases as a source of ground water, grazing area, and useful plant resources.
- Establishment agro-meteorological stations to provide relevant information and analysis of weather data (also for climate change assessment), including early warning systems.
- Establishment of an effective monitoring system of weather/crop production and natural pastures conditions, including early warning systems for drought, floods, and desertification.
- Design research and development of crop species and varieties (especially for wheat) resistant to drought, salinity.
- Improve management of rain-fed agriculture, by digging water wells and applying complementary irrigation.
- Strengthening the strategic crops storage conditions for crops like wheat and barley to address potential drought seasons.

2) Water sector

- Use modern methodologies for an integrated management planning of water resources in Iraq.
- Establish hydrological stations to monitor water resources in terms of quality and quantity.
- Use groundwater storage in a sustainable manner, especially the renewed for agriculture to compensate for the shortfall in surface water imports.
- Continue establishing small dams in desert and non-desert areas for drinking, agriculture and livestock requirements.
- Follow modern efficient irrigation systems (drip, sprinkler irrigation), raise awareness of farmers to adopt them, and support the establishment of water users' associations.
- Assess the performance of the irrigation and drainage infrastructure, and research and development programs to prevent water pollution and losses.
- Increase the efficiency of field irrigation, through the adoption of close irrigation methods and lining field channels to reduce water losses.
- Support research and promote the use salt and sewage water in irrigation without damaging soils.
- Find different patterns of agriculture, on the basis of availability of water, such as covered agriculture and hydroponics, to rationalize water consumption and dispose of prevailing salinity in soil.
- Apply and expand water harvesting techniques in desert areas to take advantage of rains
- Build institutional and technical capacity on climate modelling, hydrological modelling, and mainstreaming adaptation measures into water management.

SWOT Analysis of the Sector

76. Strengths, Weaknesses, Opportunities and Threats were developed based on the review of national documents and strategies related to environment and climate change.

Table 11: SWOT Analysis for natural resources, climate and climate change sector

Strengths	Weaknesses
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<p>Existence of national academic and other institutions across the country</p> <p>Government support to the agricultural sector as one of the priority sectors to achieve food security and sustainable development;</p> <p>Existence of agricultural lands to be farmed and included into agricultural investment</p> <p>Existence of protected areas</p> <p>Climate is suitable for cultivation of all crops</p> <p>Existing national documents and strategies on climate change, including NAP, NDC, National Communications</p> <p>Establishment of national programs for combating desertification and sand and dust storms, and drought risk management</p>	<p>Lack of knowledge on biodiversity value and ecosystem services especially at the local level</p> <p>Low unit area productivity</p> <p>Reliance on traditional methods of agriculture</p> <p>Dependence on imported agricultural products</p> <p>Low coordination between government institutions</p> <p>Low water use efficiency and water mismanagement</p> <p>Use of traditional irrigation methods</p> <p>Absence of studies on the impact of the pollutants on the natural ecosystems in Iraq</p> <p>Limited capacity of the ministries</p> <p>Unsustainable land management and over-exploitation of the soil through the unsustainable use of chemical fertilizers and pesticides.</p>
<p>Opportunities</p> <p>Possibility of horizontal and vertical expansion of crop cultivation to increase production and productivity;</p> <p>Variety of climate zones</p> <p>Environmental standards</p> <p>Possibility of expanding the use of modern agricultural irrigation methods</p> <p>Possibility of close linkages between the agricultural and industrial sectors</p> <p>Possibility of high planning of securing the requirements of agricultural production.</p>	<p>Threats</p> <p>Deteriorating security situation;</p> <p>Continuous deterioration in water quality and agriculture land</p> <p>Weak urban planning and fragmentation of agricultural sector</p> <p>High prices of agricultural production inputs (seeds, fertilizers, fighting materials and fuel.)</p> <p>Uncontrolled imports of agricultural products;</p> <p>Limited profit margins in agricultural sector; • Climate fluctuations and exposure to extreme weather events</p> <p>Lack of financing in the state budget due to economic crisis.</p>

Main past, existing and planned projects

77. The following projects in the natural resource management and climate change were identified:

Table 12: Current and past projects in the natural resource management and climate change

Initiative	Source of Funding	Implementation period
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IFAD	<i>Smallholder Agriculture Revitalization Project and the Building Resilience of the Agricultural Sector to Climate Change</i> USD 31.84 million: IFAD and domestic funding ⁴²	2017 – 2025
WFP	Green Climate Fund (still under development): <i>Promoting Climate Resilient Livelihoods of Food Insecure People in Southern Iraq</i> USD 10 million	4 years
UN Environment	Green Climate Fund: National Adaptation Plan USD 2.5 million	2019-2022, 3 years
FAO	2018-2022 Country Programming Framework (CPF) ⁴³ - Resilience and restoration of agricultural livelihoods in regained areas of the country - Restoration of degraded agricultural land and higher productivity of water resources - Increased, sustainable agricultural productivity by smallholders for higher food security and nutrition levels FAO Restoration of agriculture and water systems sub-programme 2018–2020 ⁴⁴	2018-2022 USD 90 million/2018-2020
JICA	Project for Sustainable Irrigation Water Management through Water Users Associations Irrigation Sector Loan Capacity Development Project for Agriculture Research and Extension	2017-2020 Since 2018 2019-2023

⁴² The project is part of a larger IFAD programme named “The Smallholder Agriculture Revitalization Project and Building Resilience of Agriculture to Climate Change in Iraq”. Significant delays have been experienced and limited progress achieved so far. IFAD expects that bottlenecks for the ongoing investment will be resolved through the reconfiguration of responsibilities in a way that responds and resolves challenges of Government execution. In this regard, IFAD is exploring with FAO the possibility to implement the farmer training and on-farm investment support. Government will instead play a monitoring role, while its capacity will be built by the UN partners, including FAO, that will assume direct execution responsibilities on behalf of Government. A project mid-term review is planned for May 2023 to conclude these arrangements. Given this background, FAO through the GCF has an opportunity to align the project while also executing the IFAD AP livelihoods component.

⁴³ See <http://www.fao.org/3/a-au080e.pdf>

⁴⁴ See <http://www.fao.org/3/ca1511en/CA1511EN.pdf>

GEF - Sustainable Land Management for Improved Livelihoods in Degraded Areas of Iraq	USD 24 million	Approved in 2019 48 months
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Lessons learned from past climate change experiences

- 78. Climate risks vulnerabilities were not fully assessed** in the first National Communication and Intended National Determined Contributions. In the first National Communication, it was acknowledged the need to develop climate change studies to assess climate change impacts and vulnerabilities in the different economic sectors. In this regard, the updated NDC and National Communications are working on filling these gaps.
- 79. Tools on the GHG emissions inventory and a transparent Monitoring, Reporting and Verification system are missing.** There were weak mitigation scenarios – mainly based on conditionality, which prevent Iraq from taking adequate mitigation measures in the different sectors. The updated NDC should include priorities and measures towards developing a transparent MRV system to help with the assessment of the GHG emissions.
- 80. Integrated and participatory approach is necessary for planning in agriculture and other:** When designing policy strategies and subsidies programs for Solar Powered Irrigation Systems (SPIS) it is necessary to adapt an integrated water-energy-food nexus approach to prevent unsustainable water use, in particular related to groundwater. Appropriate design of SPIS however allows for the implementation of a variety of irrigation techniques and can also integrate fertigation and filtration. In addition, international organizations have been using a multi-stakeholder approach for the consultation and development process, engaging relevant ministries, private sector, academia and NGOs.
- 81. The empowerment of women is needed to tackle climate change and adapt.** A major weakness of on-going projects is the marginal role that women have had in the on-going initiatives. The current project recognizes that women are impacted by climate change and can be an important agent of change in the agriculture sector and will put in place a cadre of women agents of change at the community level to empower women to deal with climate risks. Under the Project for Sustainable Irrigation Water Management through Water Users Associations (WUA) in the Republic of Iraq, 2017-2021, JICA, it was assessed that (i) gender training can help to create space for women's inclusion and (ii) indirect representation of women through nominating a small committee among women relatives of the WUA members does not constitute meaningful participation of women and completely excludes women-headed households. Discussions with project staff showed that it is possible for women farmers to have direct representation and for women-headed households to be included in the decision-making body in a culturally sensitive manner with appropriate planning
- 82. Irrigation systems powered by solar energy are a climate-friendly and cost-effective technology** for provision of irrigation water, especially in rural and remote areas with unreliable energy access. The systems have relatively high investments costs, but once installed, comparably low maintenance and no running costs for fuels.

Water, Irrigation and water management

Introduction

- 83.** In the midst of the immediate concern over political stability, security, and structural reform of the economy, climate change looms as a major impediment to long-term growth and development in Iraq.

Climate change affects and will continue to impact rainfall patterns and temperatures, increasing the country's vulnerability to drought and environmental challenges. Recent work for long-term predictions of temperature and rainfall indicated that the former would be increasing in Iraq while the latter would be decreasing. Population growth trends and increasing urbanization will lead to a rise in water consumption and increased pressure on agriculture water systems across the nation, but mainly in the Centrale and Southern Governorates where irrigation plays a key role in agricultural production.

84. Iraq's agriculture faces current constraints in terms of water resource availability and is projected to face serious shortages in the future as well. These constraints stem from both the physical scarcity of water and the lack of financial resources to meet capital improvement needs, known as "economic scarcity" of water. Water scarcity problem are due to various factors. Some of these factors like global climatic change and water policies by riparian countries cannot be solved independently or in short-term actions or planning. Other issues of water scarcity can be solved independently within relatively short periods. These are those which are related to mismanagement of water resources inside Iraq, such as water losses in the distribution networks, overuse of water by inefficient irrigation systems, deterioration of water quality from return flows from agricultural drainage and sewage, increased water salinity, etc.
85. The critical importance of improving water productivity for essential economic development and ecosystem services will only increase in the coming decades. As competing demands increase, the potential for tensions will heighten, placing current cooperative relationships at risk and raising the possibility of conflicts over water rights, allocations, and use. It is therefore paramount for the country to figure out how to best use its finite but renewable water resources for meeting human, economic, and environmental needs while protecting the quality of this precious resource. Climate change will exacerbate these challenges and will affect water use in agricultural production as some regions become drier.
86. Improving water use in agriculture involves supporting efforts to improve agricultural productivity by emphasizing irrigation system efficiency, working with public and private extension services to increase the adoption of improved production technologies and systems, appropriate crops for specific environments by farmers, and, where appropriate, promoting the reuse of drainage water for agriculture. Moreover, investments in policy and legal reforms, and strengthening water resources planning, management, and governance yield more lasting change and strengthen investments in infrastructure. In addition, interventions that strengthen the capacity of water authorities and related institutions have positive repercussions, including building the capacity of local governments, strengthening decentralized institutions, and empowering women to take leadership roles in community life. It is also crucial to assess water and energy investments in tandem and consider the impacts that pricing, subsidies, and other factors of one sector can have on the other.

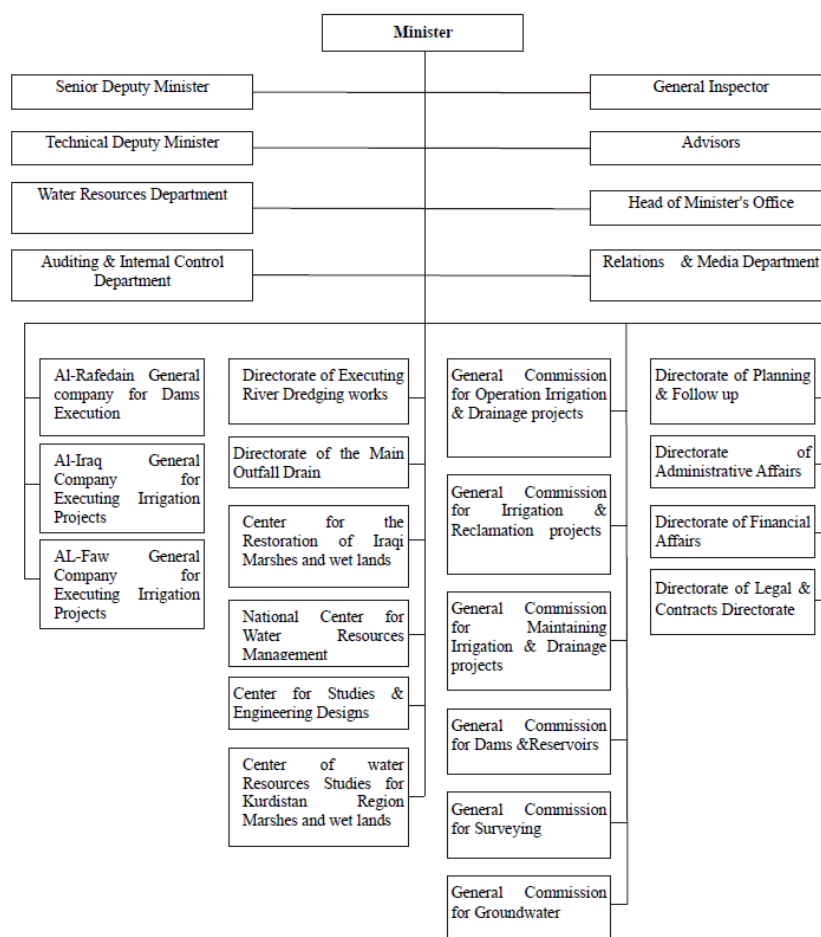
Institutional set-up

87. **Ministry of Water Resources.** The Ministry of Water Resources (MoWR) is responsible for water management (previously former Ministry of Irrigation). The responsibilities of MoWR include water planning, water allocation, the construction, operation and maintenance of facilities for bulk water supply, flood prediction and mitigation. MoWR operates dams, reservoirs, hydropower stations, irrigation and drainage pumping stations, barrages and regulators. MoWR is responsible for irrigation management through its offices at the districts and sub-districts. At the level of distributary canals, typically commanding 900-1250 ha (3600-5000 dunums), an official, called the "irrigation foreman", is responsible for water distribution.

88. MoWR has established a Water Resources Management Center to control dams and regulate water intake at intake structures under the Water Control Center. Further, monitoring water quality is being conducted by experiment section (Laboratory Department), while planning section (Planning Department) manages budget and human resource development. The National Groundwater Centre, which is a part of the Commission for Integrated Water Resources Management, is responsible for quantitative and qualitative groundwater resources assessment and for developing the hydrogeological database. MoWR has divided Iraq into ten groundwater zones and is carrying out hydrogeological surveys for each of them.
89. Each governorate has Directorate of Water Resources⁴⁵. There are sections for planning, design, implementation, accounting, legal matters, and a section for WUAs. In addition, local unit office has been established to oversee matters at the district level. The Directorate of Water Resources of each governorate based on irrigated area, unit water demand and environmental discharge estimates monthly water requirement. These data are used to control and regulate dam discharge and intake structures. Environmental discharge is indexed based on required discharge in rivers, water in wetlands and salinity control. Flow regulation is carried out on a daily basis. However, unit water demand is different between the north and the south. The estimated value for upland irrigation is 5,000 dunums/m³/sec (0.8 l/s/ha) and 2,000 dunums/m³/sec (2 l/s/ha) for rice cultivation.
90. Cooperation is weak between MoWR as the supplier of water and the user agencies, such as Ministry of Agriculture, Iraq Ministry of Electricity, Ministry of Municipalities and Public Works, and the Ministry of Environment. To put things into perspective, the size of MoWR's budget, which is ten times that of MoA, underlines the relative status of these two agencies (JICA, 2016a). The MoWR is structured as follows (Figure 12):

Figure 15: Structure of the Ministry of Water Resources

⁴⁵ Some governorates have more than one Directorate of Water Resources



Source: JICA, 2016

91. **Ministry of Agriculture.** Following the 1958 revolution, successive land reforms brought the government closely into the organization of the rural economy and society, and the resources from oil enabled the state to become a major investor in the provision of both water and agricultural services. The role of the state was expanded for the political expediency of centralized control, which continued to increase over the years. Thus, by the new millennium, Iraqi government was and still is controlling and directing agricultural production.
92. The Ministry of Agriculture (MoA) is responsible for assigning cropping patterns to the farmers to produce “strategic crops”, for distributing input rations at subsidized prices, and for marketing outputs at controlled prices. The MoA exercised control through Agricultural Directorates in each province. Actually, the ministry is comprised of nine technical departments and two state companies responsible for overseeing irrigation technology and seed certification. The Directorate of Agriculture (technical sector) is placed under the technical permanent secretary. Directorate of Agriculture (for administrative, financial, legal sector, etc.) and central departments for internal auditing and monitoring, finance, clerical, legal matters come under the administrative permanent secretary. It is to be noted that Planning and Follow-up Department, Agricultural Research Department, Agricultural Extension & Training Department, and Sanharib Company implement water saving irrigation methods are at field level.

93. For further details, please refer to section [institutional set up of the agriculture and climate resilient agriculture sector](#).

94. **Water User Associations.** The authority of traditional farmer organization has eroded by the events of last century. The lineage groups, which traditionally farmed tribal lands with cooperation, were marginalized first by the actions of sheikhs in the 1920s who registered tribal lands as private estates. Then, succeeding land reforms initiatives fragmented and individualized the lands. Finally, the redistribution and tenure reform accompanying modern irrigation development further weakened the lineage groups. It is doubtful, therefore, if the traditional institutions have any vitality left to be useful now (IPCS, 2019). Current farmer institutions, in all likelihood, lack social capital because they were formed as an extension of former ruling party. Although about 43 percent of Iraqi farmers are reported to be members of cooperatives or village associations (JICA, 2016a), these institutions are unlikely to enjoy the confidence of farmers for representing issues of mutual interest. One of the fundamental solution lays within the efficient and sustainable management of irrigation water by farmers (WUAs). The fourth amendment to law 12 of 1995 (in its article 1, item III, paragraph C) stipulates that the beneficiaries of a common water source must establish an association for its management, operation and maintenance. Also, paragraph D of the same article, mention that WUA shall aim to achieve the following:

- Raise the efficiency of water use and reduce waste,
- Contribute to resolving the dispute between the beneficiaries, and
- Maintenance of irrigation facilities.

95. Instructions No 1 of 2014 for WUA provides more details on the roles and responsibilities of WUA. The initiative of Water Users Association (WUA) had been introduced by JICA's cooperation projects, "Capacity Development for Agriculture & Rural development for Iraq (as known as Karbala Project)", and "Project for Spreading Water Users Associations for the Efficient Use of Irrigation Water (phase 1)". As shown in Table 9, by the end of the phase 1 of the project, the total number of directly established WUA by the pilot project and those outside the project reached to 47. By January 2016, the number of WUA has increased to 70 by Iraqi governmental efforts that had supported their establishments (Table 10).

Table 13: WUA established within and outside Pilot Project

Phase	Established WUA		Total
	By pilot project	Outside pilot project	
Phase 1 (5 PMTs)	4 (Kirkuk 2, Najaf, Salah ad-Din)	15 (Kirkuk 13, Wasit 2)	19
Phase 2 (6 PMTs)	4 (Babil, Dhi-Qar, Ishaque, Diyala)	5 (Mabain Al Nahrain)	9
Phase 3 (6 PMTs)	7 (Karbala 2, Baghdad, Misan, Muthana, Nineveh, Basra)	10 (Baghdad 4, Basrah 5, Misan)	17
Total (17 PMTs)	15	30	45
Others		0 2 (Musayab)	2
Total	15	32	47

Source: JICA, 2016; JICA, 2021

Table 14: Number of WUA as of January 2016

Governorate (PMTs)	Number of WUAs	WUA in pilot project site
Nineveh	1	Established (1 WUA)
Kirkuk	15	Established (2 WUAs in 1 pilot site)
Diyala	2	Established (1 WUA)
Anbar	0	Not Established
Baghdad	14	Established (1 WUA)
Isahqi	1	Established (1 WUA)
Mabain Al Nahrain	7	Established (2 WUAs in 1 pilot site)
Musaib	3	PMT were added after pilot project
Babi	1	Established (1 WUA)
Karbala	3	Established (2 WUAs)
Wasit	8	Established (3 WUAs in 1 pilot site)
Salah ad-Din	1	Established (1 WUA)
Najaf	1	Established (1 WUA)
Qadisiyah	0	Not Established
Muthana	1	Established (1 WUA)
Dhi-Qar	1	Established (1 WUA)
Misan	2	Established (1 WUA)
Basrah	9	Established (1 WUA)
Total	70	

Source: (JICA, 2016a) and (JICA, 2021)

96. The number of established WUAs has increased to 169 by the end of February 2021. In Iraq, it was a big challenge to strengthen the capacities of WUAs after their establishments due to the lack of detailed guideline or manual for it. Therefore, the JICA project (Project for Sustainable Irrigation Water Management through Water Users Association) which is a technical cooperation between JICA, MoWR and MoA (project closed in March 2021) aimed at developing the Water Management Model by WUA (in two model sites) with the intent to expand the model to the whole of Iraq. The model is defined as a cycle of improvement of irrigation water management by WUA with support of WMT (within the MoWR and MoA). The action plans named the Participatory Irrigation Development Plan (PIDP), and necessary manuals were developed in addition to capacity development of trainers for nationwide expansion of the model.
97. At the central government level, MoWR has a WUA Department, which is in charge of WUA operations. The Water Management Section under MoA's Planning and Follow-Up Office and Extension and Training Office has been reorganized into the Section of On-farm Water Management and WUA. This created a section within MoA that officially handles WUA. Regarding the governorate level, 18 WMTs have been created, and each WMT is organized by 4 to 5 DoWR staff and 4 to 5 DoA staff, for a total of 8 to 10 staff. However, except for one member who belongs to the WUA section of DoWR, WMT members also have other duties, and they are doing the work related to WUA promotion while doing the original duty. In Iraq, MoWR supervises DoWR, while DoA is not necessarily subject to MoA supervision due to the progress of decentralization. However, cooperation between MoA and DoA is important. The policy paper prepared by the JICA project recommends further strengthening the organizational structure of governorates (DoWR / DoA), and it is important to issue a letter from the Ministries and follow up on this to realize it.

98. WUA has a short history in Iraq, and to establish WUA as an Iraqi system, in addition to the on-site activities of expansion of the water management model, it is necessary to develop policies and systems that appropriately support it. A WUA policy paper was drafted by JICA project and signed by the Director Generals of MoWR and MoA in January 2021 and is in the process of being submitted to the Ministry Council.
99. International agreements. Existing international laws are inadequate for arid regions like the Middle East. Legal principle exists in these laws, but there is no legally binding international obligations for countries to share their water. Accordingly, agreements depend upon the goodwill of the riparian in any particular drainage basin. The Euphrates–Tigris River Basin is a transboundary basin distributed between Iraq, Turkey, the Islamic Republic of Iran, the Syrian Arab Republic, Saudi Arabia and Jordan. The Islamic Republic of Iran is riparian only to the Tigris, and Jordan and Saudi Arabia are riparian only to the Euphrates. Both the Euphrates and the Tigris rise in the mountains of eastern Turkey and the basin has high mountains to the north and west and extensive lowlands to the south and east. Two-thirds of their courses go through the highlands of eastern Anatolia in Turkey and the valleys of the Syrian and Iraqi plateaus before descending into the arid plain of Mesopotamia.
100. During the 20th century, various bilateral attempts at cooperation were made within the Euphrates–Tigris Basin. In 1920, the French and British governments, as the mandatory powers in Mesopotamia, signed a treaty regarding utilization of the water of the Euphrates and Tigris. The Turco–French Protocol, signed in 1930, committed the Turkish and French governments to coordinate any plans to use the water of the Euphrates. The principle of mutual-cooperation over water development was extended in a Protocol annexed to the 1946 Treaty of Friendship and Good Neighbourly Relations between Turkey and Iraq. The agreement encompassed both rivers and their tributaries, and both countries agreed that the control and management of the Euphrates and Tigris rivers depended to a large extent on the regulation of flow in the Turkish source areas. At that time, Turkey and Iraq agreed to share related data and consult with each other in order to accommodate both countries’ interests. The 1946 Treaty mandated a committee to implement these agreements. However, none of this occurred because of different conflicts among the riparian countries.
101. In April 2008, Turkey, the Syrian Arab Republic and Iraq decided to cooperate on water issues by establishing a water institute that will consist of 18 water experts from each country to work towards solving water-related problems among the three countries. This institute will conduct its studies at the facilities of the Ataturk Dam, the dam with the largest reservoir capacity in Turkey, and plans to develop projects for the fair and effective use of transboundary water resources (FAO, 2009) (see appendix 1).
102. There have been a number of attempts to find a common ground on water issues between the main three riparian countries (Iraq, Syria and Turkey) since 1920 but no agreement signed yet (Nadhir Al-Ansari, 2016). In July 2019, Turkey announced that a joint action plan had been drafted and a ‘fair agreement’ reached with Iraq, seeming to signal something of a rapprochement over the issue of water⁴⁶. Yet long-term solutions to these challenges are less clear. Any sustainable long-term agreement would likely need to include a binding legal framework. Currently, the only international law applicable - United Nations’ Convention on the Law of the Non-navigational Uses of International Watercourses (1997) - is vague and remains unenforced.

⁴⁶ <https://globalriskinsights.com/2019/11/water-shortage-and-unrest-in-iraq/>

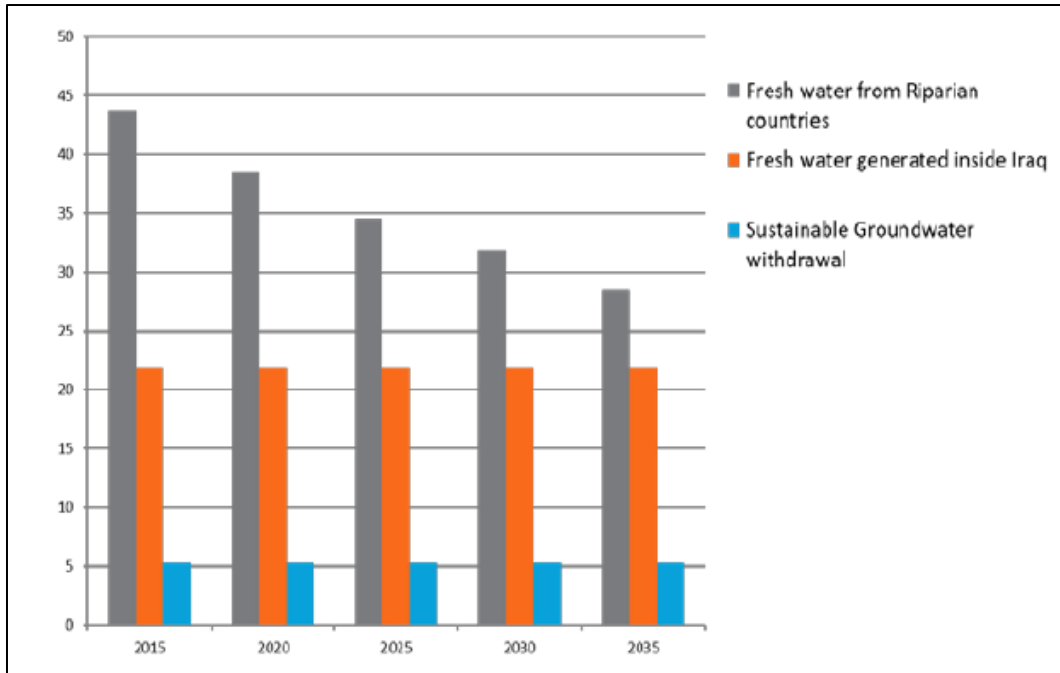
State of the art

Water availability

103. As is the case of many countries in the region, Iraq depends on sustainable fresh water of sufficient quantity and quality to provide for society's needs, sustain economic growth, and maintain ecosystems upon which all life depends. The impacts of changing weather patterns have already made themselves felt in recent years, with a higher frequency and intensity of extreme weather events and rising environmental degradation throughout the country. Climate variability is one of Iraq's main challenges is adapting to the increasing variability of the country's climate, especially in terms of water supply. For instance, two years of severe drought between 2007 and 2009 were followed by several months of sudden heavy rainfalls and storms during which some parts of central and southern Iraq experienced rainfall amount about 200 percent of normal values. The impact of increased variability in weather patterns includes inability to store water during "flash" rainfall events, abandonment of agricultural land during drought (resulting in a lack of preparedness for better rainy seasons), declining discharge rates in rivers in Iraq, the alarming trend of shrinking of the Marshlands, soil loss and increasing salinization of the Shatt al-Arab and groundwater in the south. As demographic growth puts further strain on natural resources that are themselves scarcer, the Government's capacity to devise and implement the necessary adaptation and mitigation policies is undermined by a daunting context of post-conflict reconstruction. Iraq relies on precipitation falling outside its borders for more than half of its water. This high dependency rate makes it vulnerable to climate change and storage projects in Turkey, Syria, and Iran.
104. Discharge rates in the Tigris and Euphrates Rivers, Iraq's primary sources of surface water, have already fallen to less than a third of normal capacity and are expected to drop further in coming years (Figure 17) . Available water resources are calculated as the total of the inflow from the upstream countries, water in the tributary watersheds within the boundary and return flows of agriculture, domestic and industrial uses. Available surface water in the next 20 years is estimated to decrease by 17.64 BCM, i.e., a decrease of 24.5 percent. Of which decrease in the water amount due to increase in water demand outside Iraq is 15.21 BCM⁴⁷ (Figure 16). In addition, with the necessary agricultural drainage facilities installed, the amount of non-reusable water for irrigation is estimated to be 2.43 BCM, from the viewpoint of water quality conservation. This also seems to be a cause of decline in available water.

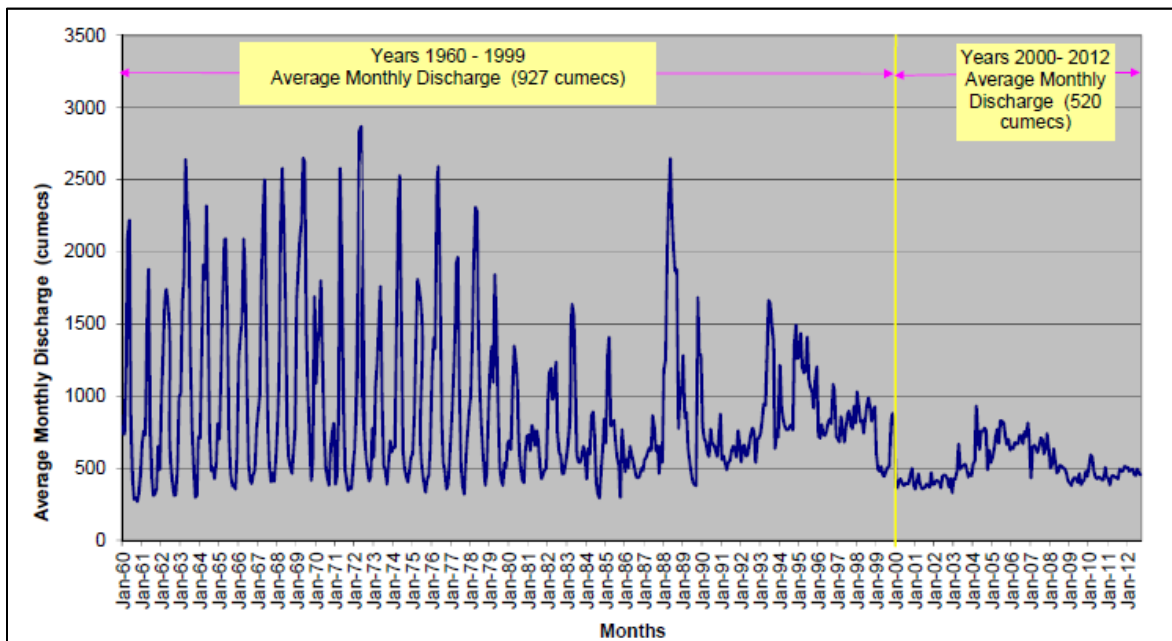
Figure 16: Expected water supply sources and quantities in Iraq in the near future

⁴⁷ Mukhalad A. & al, 2019. Article published online in ResearchGate. Water resources projects in Iraq, Irrigation. (<https://www.researchgate.net/publication/337317793>)



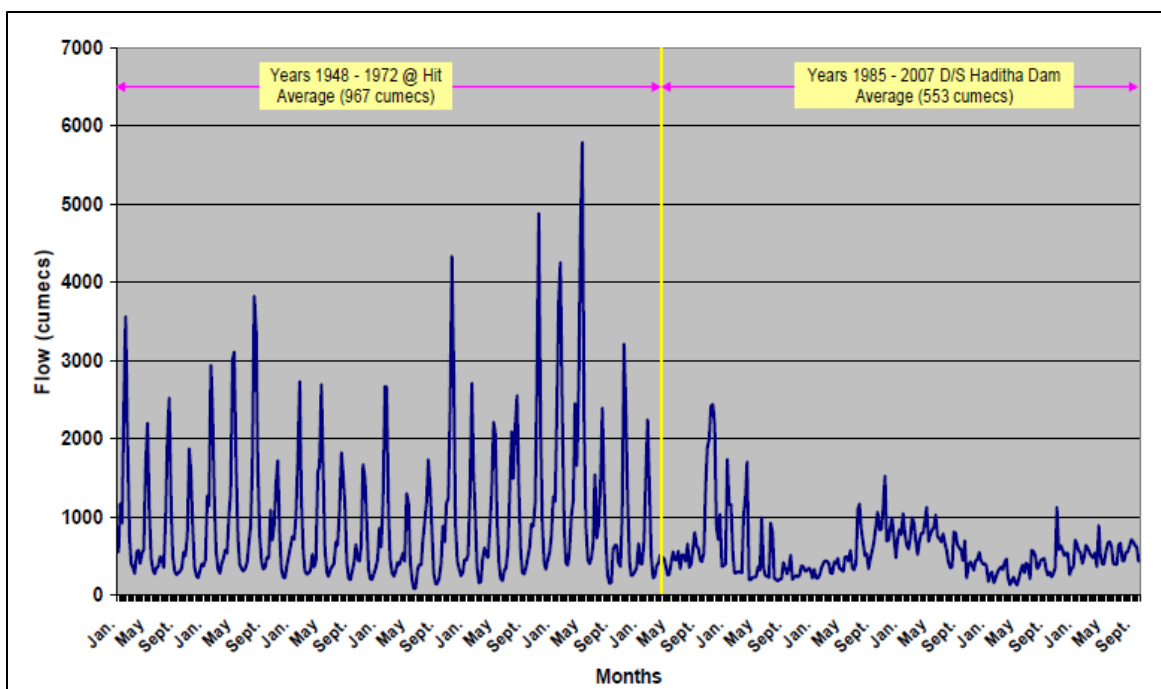
Source: Iraq Energy Institute, 2018

Figure 17: Average monthly discharge of Tigris River at Sarai Baghdad station



Source; Nadhir Al-Ansari, 2015

Figure 18: Average monthly discharge of Euphrates River at Hit and Haditha stations

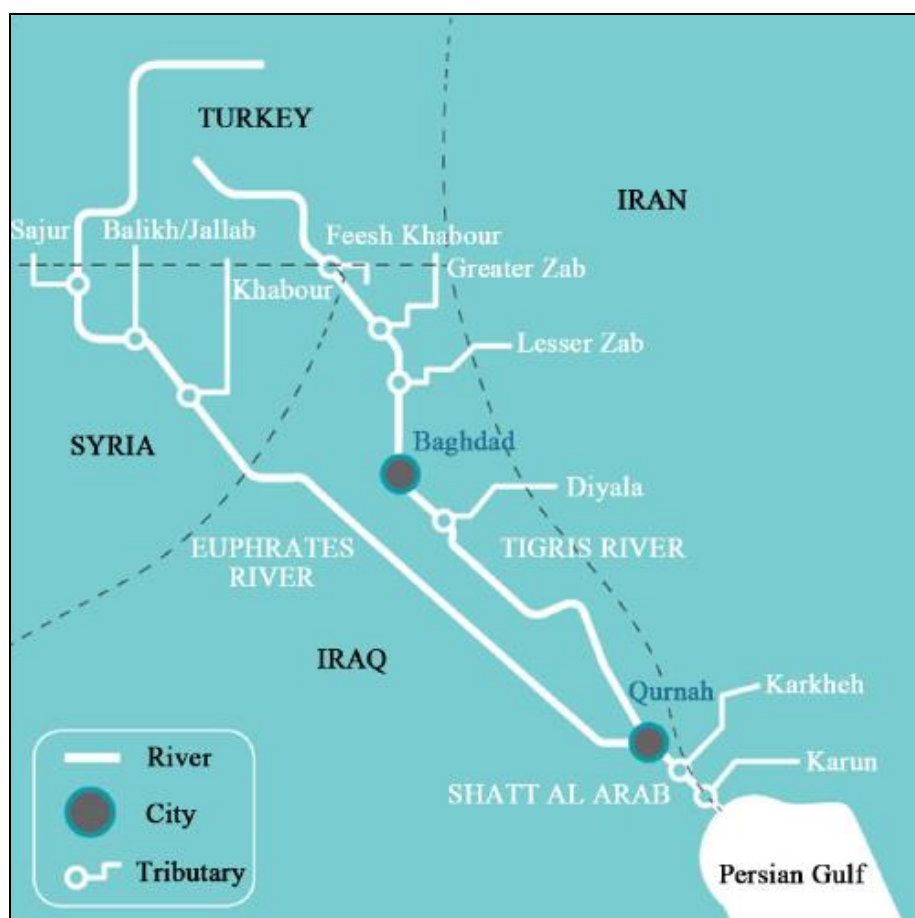


Source: Nadhir Al-Ansari, 2015

Surface water availability

105. The Tigris and Euphrates rivers provide Iraq with its surface water resources. Both rivers originate in the eastern mountains of Turkey and enter Iraq along its northwestern border with Turkey and Syria. The two rivers transcend the country, the Euphrates flows for about 1,000 km and the Tigris for 1,300 km, and they confluence just north of Basra. Downstream from their confluence, the river is known as Shatt al-Arab, a tidal channel, which flows 190 km before joining the Arab Gulf. Iraq's hydrologic network is illustrated in Figure 18 below. Compared with the neighbouring countries, water resources in Iraq, were abundant in the 1970s. Since the 1970s, due to dam constructions and irrigation development both in Turkey and the Syrian Arab Republic, the discharge of the Euphrates River within Iraq had decreased, resulting in poor water quality (see Appendix 2 and Figure 17 above). This phenomenon has affected Iraq's water resource security and accordingly its water strategy.

Figure 19: Tigris and Euphrates Rivers



Source : UN-ESCWA-BGR, 2013

Table 15: The area of Tigris and Euphrates basins

Countries	Tigris River		Euphrates River	
	Catchment area (km ²)	Catchment area (%)	Catchment area (km ²)	Catchment area (%)
Turkey	57,614	12.2	125,000	28.2
Syria	834	0.2	76,000	17.1
Iraq	253,000	58	177,000	39.9
Iran	140,180	29.6	-	-
Saudi Arabia	-	-	66,000	14.9
Total	473,103	100	444,000	100

Source: Nadhir Al-Ansari, 2016

106. Most of the water from these rivers comes from Turkey (78 percent) followed by Iran (6.9 percent) and Syria (4 percent). The remainder, only 8 percent, is from internal sources. Euphrates River does not have tributaries inside Iraq. The average annual flow of the Euphrates and Tigris is estimated to be about 30 BCM (which might fluctuate from 10 to 40 BCM) for the former and 21.2 BCM for the latter when entering Iraq. Tigris River tributaries in Iraq contribute 24.78 BCM of water and there are

about 7.0 BCM of water brought by small wadies from Iran, which drains directly towards the marshes area⁴⁸.

107. The average yearly inflow of the Euphrates declined from 30.26 BCM for the period 1933-1972 to 23.59 BCM for the period 1973-1989. In the recent years it has decreased to about 16.90 BCM (average of 1990-2012), or a decrease of 44.1 percent (Table 21). For the Tigris, the inflow declined from 49.22 BCM for the period 1933-1998 to 32.64 BCM for the period 1999-2012 (Table 20). The decline in the inflow is due to over exploitation, climate change that clearly affects the region in general and Iraq in particular, and the Ataturk Dam in Turkey⁴⁹.

Table 16: The Tigris River water inflow for the years 1933-2012, (BCM)

Year	Inflow	Year	Inflow	Year	Inflow	Year	Inflow	Year	Inflow	Year	Inflow
1933	33.81	1947	35.69	1961	32.90	1975	38.06	1989	26.74	2003	57.38
1934	34.94	1948	47.29	1962	39.55	1976	62.28	1990	38.80	2004	44.42
1935	34.78	1949	55.42	1963	75.09	1977	40.76	1991	30.87	2005	37.08
1936	41.52	1950	57.20	1964	53.50	1978	50.71	1992	62.72	2006	41.85
1937	43.57	1951	31.20	1965	41.48	1979	39.60	1993	66.36	2007	37.09
1938	53.30	1952	55.60	1966	44.32	1980	51.99	1994	45.19	2008	18.00
1939	54.38	1953	57.46	1967	55.84	1981	52.93	1995	66.34	2009	22.99
1940	58.94	1954	79.96	1968	67.76	1982	54.40	1996	39.37	2010	37.68
1941	57.02	1955	31.09	1969	96.58	1983	41.27	1997	42.73	2011	32.90
1942	50.75	1956	51.27	1970	39.49	1984	34.00	1998	49.95	2012	28.60
1943	54.09	1957	57.09	1971	39.52	1985	54.96	1999	18.60		
1944	40.28	1958	37.97	1972	62.31	1986	32.46	2000	20.10		
1945	40.48	1959	34.32	1973	35.77	1987	58.54	2001	20.90		
1946	68.32	1960	33.08	1974	53.36	1988	96.09	2002	42.24		

Source: Ahmed A., 2019

Table 17: The Euphrates River water inflow for the years 1933-2012 (BCM)

⁴⁸ Nadhir Al-Ansari, 2016. Article published online in SciRes. Hydro-Politics of the Tigris and Euphrates Basins. (<http://dx.doi.org/10.4236/eng.2016.83015>)

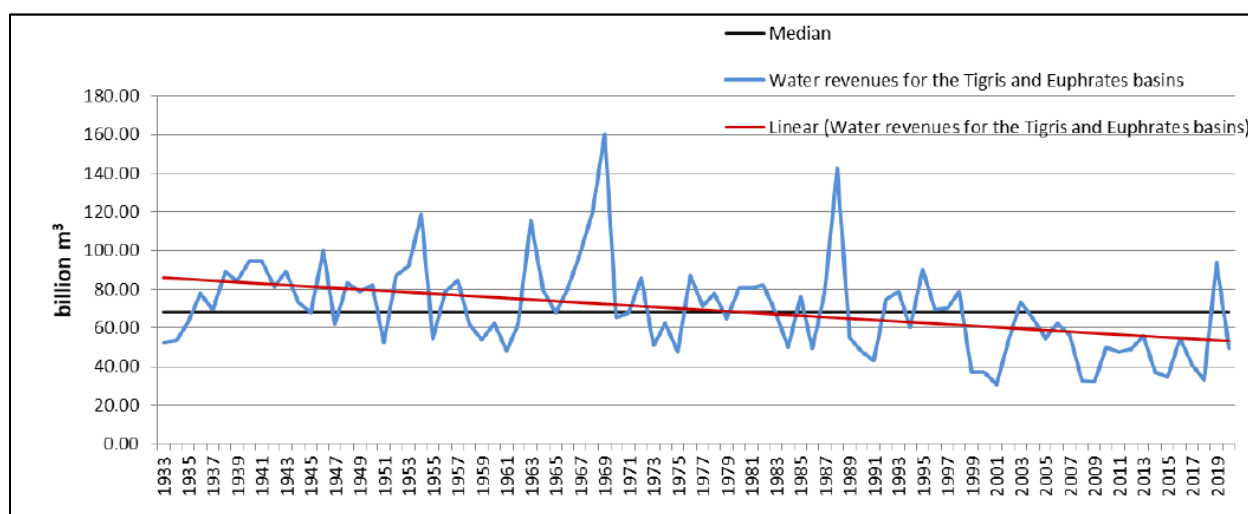
⁴⁹ Ahmed A., 2019. PhD. Thesis, Arizona State University: Optimization Models for Iraq's Water Allocation System

Year	Inflow	Year	Inflow	Year	Inflow	Year	Inflow	Year	Inflow	Year	Inflow
1933	15.60	1947	26.20	1961	15.24	1975	9.42	1989	28.13	2003	15.71
1934	18.30	1948	35.80	1962	23.03	1976	24.76	1990	8.99	2004	20.54
1935	28.00	1949	23.20	1963	40.32	1977	30.47	1991	12.40	2005	17.57
1936	36.20	1950	24.90	1964	25.67	1978	26.9	1992	12.15	2006	20.64
1937	25.80	1951	21.00	1965	26.34	1979	25.37	1993	12.37	2007	19.33
1938	35.70	1952	31.40	1966	35.51	1980	28.87	1994	15.29	2008	14.70
1939	29.60	1953	34.60	1967	42.33	1981	27.92	1995	23.90	2009	9.30
1940	35.50	1954	39.10	1968	51.71	1982	27.92	1996	30.01	2010	12.45
1941	37.50	1955	23.40	1969	63.31	1983	26.47	1997	27.64	2011	14.64
1942	30.60	1956	27.70	1970	26.06	1984	15.82	1998	28.95	2012	20.47
1943	35.30	1957	27.60	1971	28.51	1985	21.08	1999	18.61		
1944	33.20	1958	24.00	1972	23.20	1986	17.21	2000	17.23		
1945	27.60	1959	19.67	1973	15.31	1987	19.60	2001	9.59		
1946	32.00	1960	29.46	1974	9.02	1988	46.73	2002	10.67		

Source: Ahmed A., 2019

108. Due to dams built in neighbouring countries, and a lack of common management practices, peak flows in Iraq do not coincide with the country's water needs, while the peaks are too late for winter crops and too early for summer crops. This problem will become worse with time as demand increases due to increasing population, the unpredictable effects of climate change and extreme weather events.

Figure 20: Total water allocations of the Tigris and Euphrates basins for the water years (1933-2020)



Source: Zeinab H. & al, 2021⁵⁰

Table 18: Surface water entering Iraq (billion m3/year)

⁵⁰ Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWLRI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

River	Before development	2014	2035*
Euphrates	31.19	18.93**	10
Tigris	17.3	16.56	9.82
Greater zab	3.48	3.43	3.29
Lesser zab	2.34	2.32	2.18
Diyala	5.06	4.01	3.19
Eastern tributaries	2.01	1.63	1.28
Karkha	8.35	1.93	1.19
Karon	24.66	3.56	3.56
Summation (except karon)	69.73	48.81	30.95
Summation (except karon, Karkha and Eastern tributaries)	59.37	45.25	28.48

*In case of complete development in Turkey (1093 thousand hectares on the Euphrates), and development in Syria (480 thousand hectares on the Euphrates). In case of full development in Turkey (1093 thousand hectares on the Euphrates) and Syria (618 thousand hectares on the Euphrates) the total would be 25.70 BCM / ** the rate after filling the Ataturk Dam (source. MoWR)

Groundwater availability

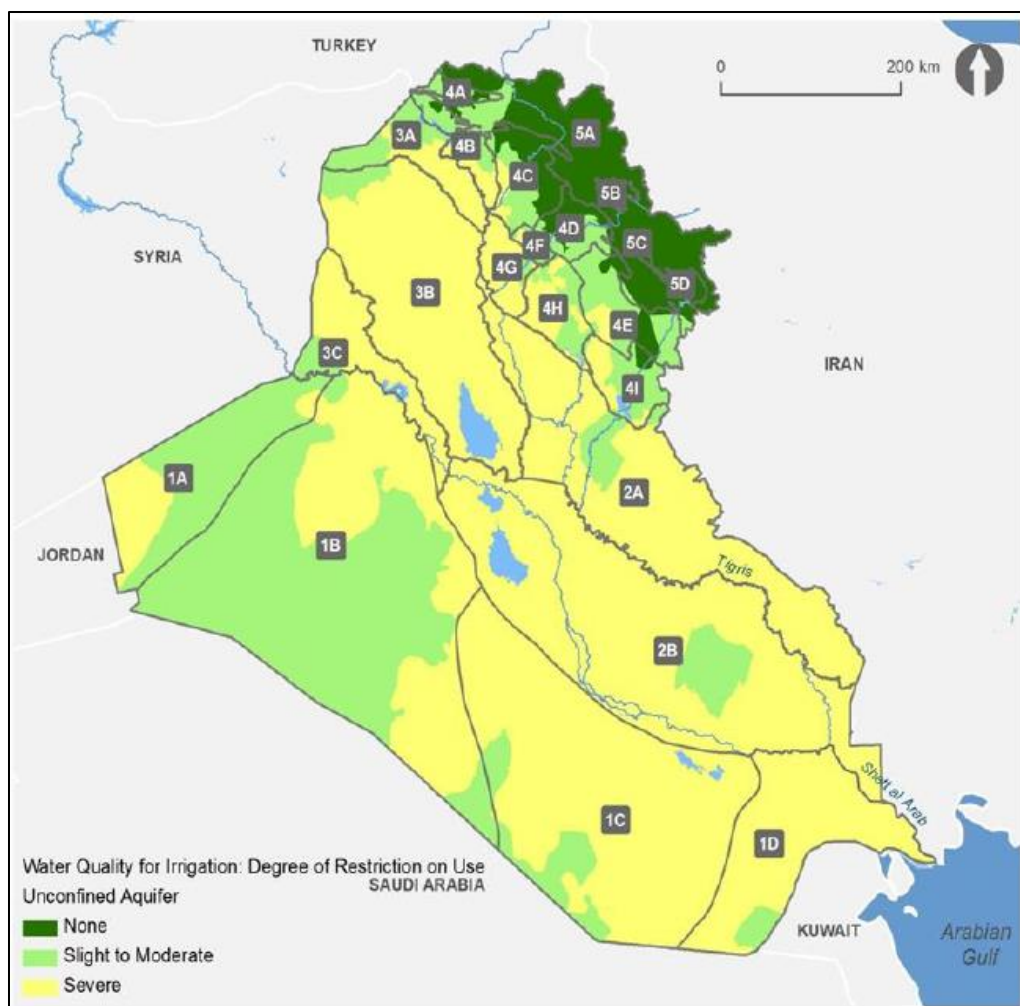
109. Groundwater forms the second major source of water, which is represented by non-renewable aquifers. In general, groundwater does not satisfy the standards of drinking water except in northern Iraq and the west desert⁵¹. Good quality groundwater exists in the foothills of the mountains in the northeast of the country and in the area along the right bank of the Euphrates (see appendixes 3 to 5). The safe yield of these aquifers is estimated at about 1.2 BCM annually, about 2 percent of the nation's annual water budget⁵². Some of the groundwater resource remains to be developed. Elsewhere in the country, groundwater exists but salinity is far too high for agriculture.

110. Groundwater, depending on storage condition and underground flow, can be classified into five physiographic categories: mountains, highlands, Al-Jazeera (Upper Mesopotamia), the desert area and alluvial plain (Lower Mesopotamia).

Figure 21: Appropriateness of ground water for agricultural purposes in different hydrogeological areas

⁵¹ Ahmed A., 2019. PhD. Thesis, Arizona State University: Optimization Models for Iraq's Water Allocation System

⁵² Ali A. & al, 2016. Article published in International journal of water resources development. Groundwater use and policy options for sustainable management in Southern Iraq. (<http://dx.doi.org/10.1080/07900627.2016.1213705>)



Source: Zeinab H. & al, 2021

111. Except for the alluvial plains, rechargeable and/or exploitable groundwater volume has been investigated as follows in Table 18.

Table 19: Rechargeable and exploitable volume

Zone	Area (km ²)	Rechargeable (BCM/year)	Storage Capacity (BCM/year)	Exploitable volume (BCM/year)
Highland and mountains	42,962	2.633	1.087	3.720
Al Jazeera (upper mesopotamia)	22,125	0.453	0.392	0.845
Desert area	168,000	0.930	1.590	2.520
Total	233,087	4.016	3.069	7.085

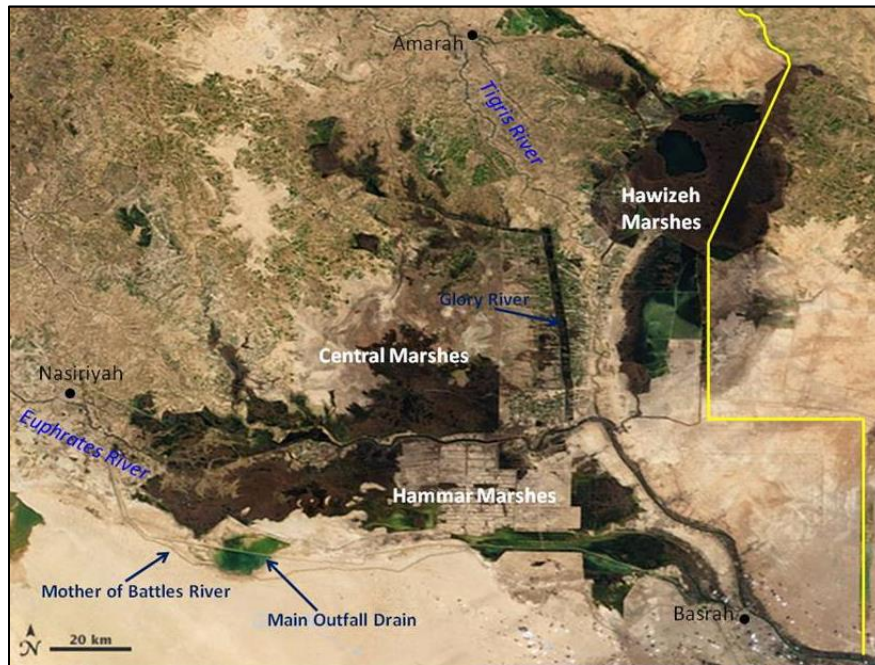
Source: National Development Plan (2013-2017)

Marshlands

112. The marshes are one of the most prominent geographical features of the sedimentary plain. The Iraqi marshes cover an area 15,000 - 20,000 km². The area varies widely between the drought seasons and flood seasons due to the high rate of evaporation and the low depths. There are three major marshes containing smaller marshes inside (figure 22). Hawizeh are the largest marshes, they are in the province of Maysan on the left Tigris River, they are also a joint marsh with the Iranian side, and the major feeder of Hawizeh Marshes is Karkheh River, which originates from the Iranian side. Hawizeh marshes area varies between (1250-2500) km² between Iraq and Iran. Central marshes, also called

Qurnah marshes, are located within the provinces of Maysan, Basra and Dhi qar between the Euphrates and Tigris Rivers. Central marshes mainly connected with some branches of Tigris River on the right. The area of the Central marshes varies from (250-2350) km². Hammar Marshes located on the left of Euphrates River; connect with several branches downstream the city of Suq Al-Shuyukh. The surface area varies between (1650-595) km². The end of the Hammar Marshes is linked to the Shatt Al-Arab in Grmat Ali, which is the ancient course of the Euphrates River.

Figure 22: Satellite view of Southern Marshes

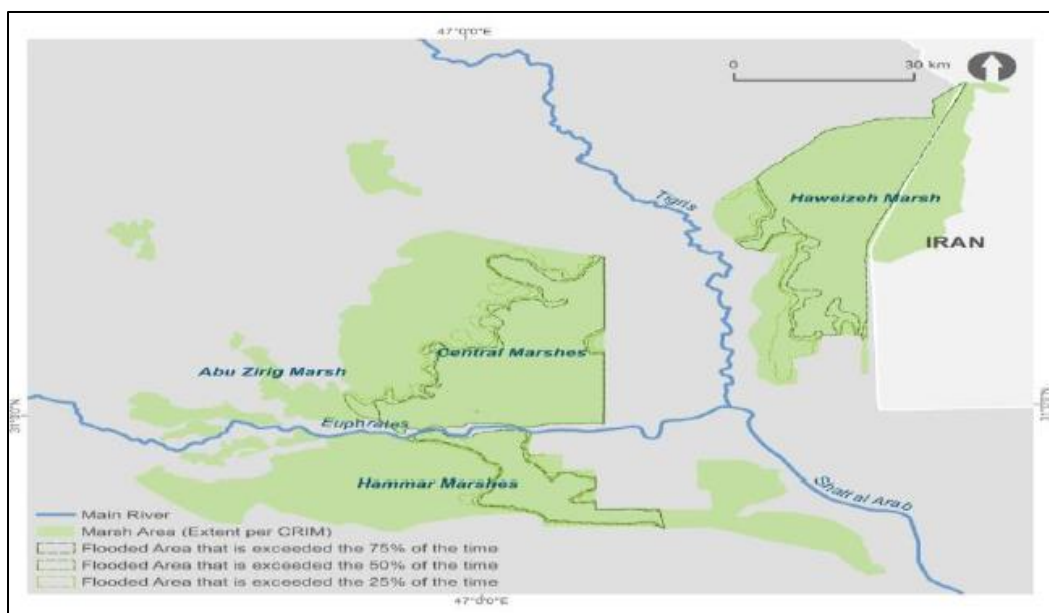


Source: Mukhalad A. & al, 2020a

113. Sixty percent of the fish consumed in Iraq comes from the marshes. The marshlands at the confluence of the Tigris and the Euphrates, famed as the cradle of civilization and unique ecology, is a vestige of its former glory. By the year 2000, less than 10 percent of the area remained. After 2003, the policy of the Ministry of Water Resources changed to re-flood the marshes for livestock development, tourism, and environmental purposes. To restore 70 – 75 percent of the marshes, 13 cubic kilometers of water are required⁵³.

Figure 23: Frequency of occurrence of flooded areas within the Marshlands

⁵³ Mukhalad A. & al, 2020a. Article published in Journal of earth sciences and geotechnical engineering. Irrigation projects in Iraq. (<https://doi.org/10.47260/jesge/1123>)



Source: Zeinab H. & al, 2021

Water Quality

114. As mentioned above, the decrease in discharge in both the Tigris and Euphrates rivers has a huge consequence on the water quality. The quality of irrigation water is deteriorating in terms of salinity and chemical contaminants. Ministry of Environment reported that severe water salinization of over 2,000 mg/l has already been observed at the downstream areas. Salinity guidelines for irrigation by FAO indicates that EC 0.7-3.0 dS/m (700-3,000 μ S/cm), or TDS 450-2,000 mg/l will have low to moderate effects on crops.

Table 20: Effect of Salinity in Irrigation

Salinity	Unit	Effect		
		None	Low to moderate	High
ECw (Electric conductivity)	dS/m	<0.7	0.7-3.0	>3.0
TDS (Total dissolved solids)	mg/l	<450	450-2000	>2000

Source: Guidelines for interpretation of Water Quality for Irrigation, FAO

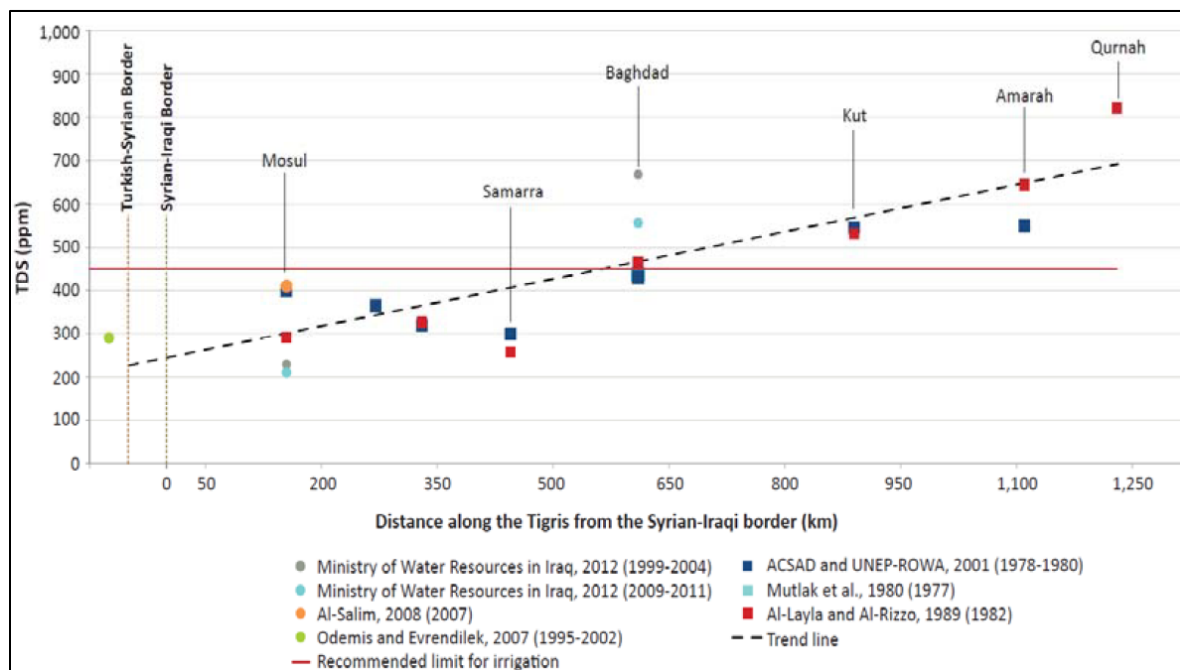
Table 21: Soil Salinity Classification and Crop Responses

Salinity Class	Salinity range (ECe, dS/m)	Crop responses
Non saline (S0)	0-2	Salinity effects on yield negligible
Slightly saline (S1)	2-4	Yield of very sensitive crops reduced
Moderately saline (S2)	4-8	Yield of many crops reduced
Highly saline (S3)	8-16	Only tolerant crops yield satisfactorily
Severly saline (S4)	16-32	Halophytes and a few tolerant crops yield satisfactorily
Extremely saline (S5)	>32	Often bare. Only very salt-tolerant halophytes grow

Source: Managing Salinity in Iraq's Agriculture. Iraq Salinity Assessment. International Center for Agricultural Research in the Dry Areas (ICARDA)

115. TDS 1,500-2,000 mg/l is classified as moderately saline (S2) and will lead to some decrease in yields. For wheat and barley, salinity of classification S2 will not result in much yield reduction, indicating that it is effective to cultivate these crops in the rainy season when evapotranspiration is small and making measures such as water-saving irrigation is viable. The data monitored by MoE showed that the water salinity varies seasonally. The salinity level or Total Dissolved Solids (TDS) in Euphrates River at the Syrian-Iraqi borders is 600 mg/l, which is already higher than the recommended level for irrigation and it increases to more than 1,200 mg/l (minimum) downstream at Samawah. Tigris River is in a better situation relative to the Euphrates River. TDS values of the Tigris water at the Turkish Iraqi border are 280-275 mg/l and it reaches more than 1,800 mg/l in Basra. The situation might be worse on the tributaries where TDS values in the Diyala River reaches 3,705 mg/l⁵⁴.
116. Inside Iraq, the source of most of the back irrigation water is from irrigation projects (1.5 million ha) that are in the central and southern parts of the country. Back irrigation water from these projects is directed to the main outfall drain, which drains to the gulf to reduce the soil salinity. Even with these drainage measures, the salinity increases along the courses of the two rivers in conjunction with decreases in their discharges. Which represents overstress for the agricultural sector especially in the southern part of Iraq. Significant increase in Tigris River's salinity starts from Baghdad downward due to the negative effect of the feedback from Tharthar depression toward Tigris River. Recent estimates indicate that 4 percent of irrigated areas are severely saline, 50 percent are of medium salinity and 20 percent are slightly saline⁵⁵⁵⁶.

Figure 24: Salinity variation along Tigris River before 1983 and after 1995



Source: ESCWA, 2013⁵⁷

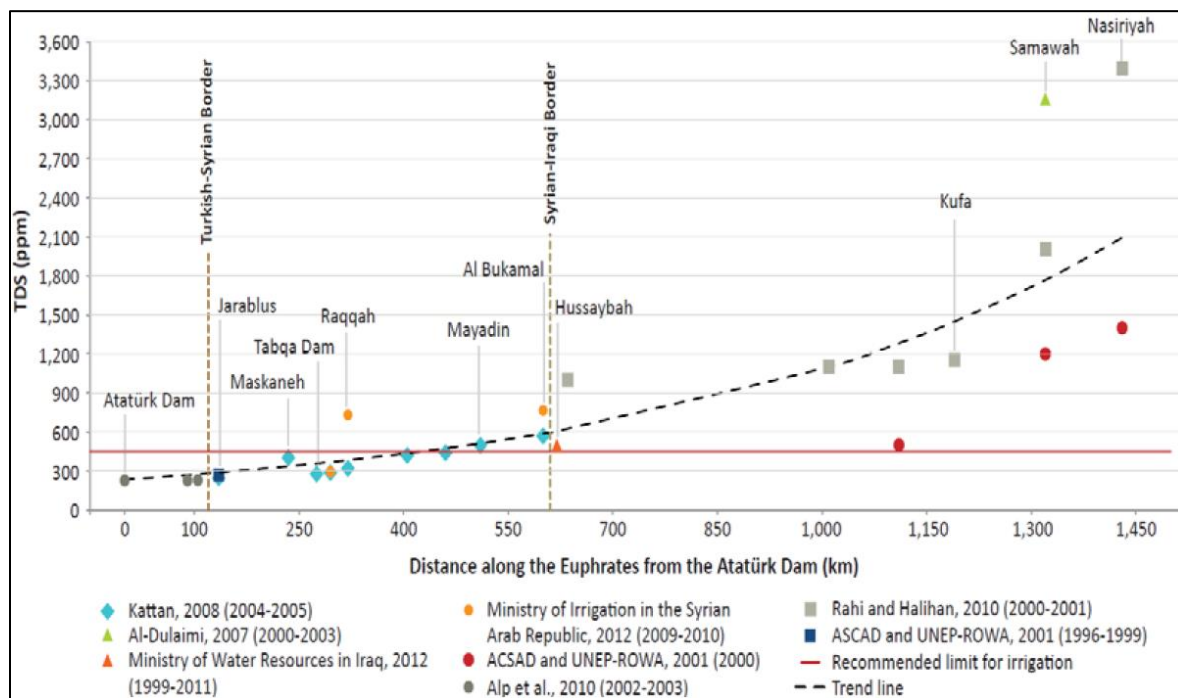
⁵⁴ Nadhir Al-Ansari, 2015. Conference paper published online in ResearchGate. Iraq water resources planning perspectives and prognoses. (<https://www.researchgate.net/publication/272160643>)

⁵⁵ ESCWA & al. 2017. Arab Climate Change Assessment Report – Main Report. Beirut, E/ESCWA/SDPD/2017/RICCAR/Report

⁵⁶ Iraq Energy Institute, 2018. Towards Sustainable Water Resources Management in Iraq

⁵⁷ ESCWA-BGR, 2013. Inventory of Shared Water Resources in Western Asia, United Nations Economic and Social Commission for Western Asia, Beirut.

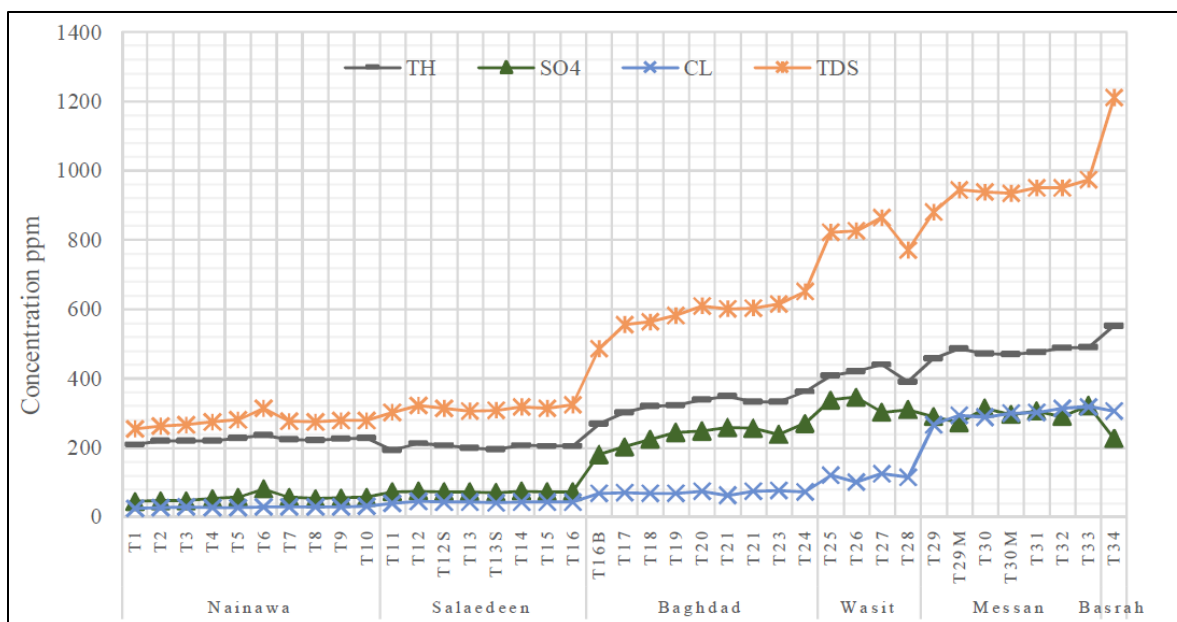
Figure 25: Salinity variation along Euphrates River since 1996



Source: ESCWA, 2013

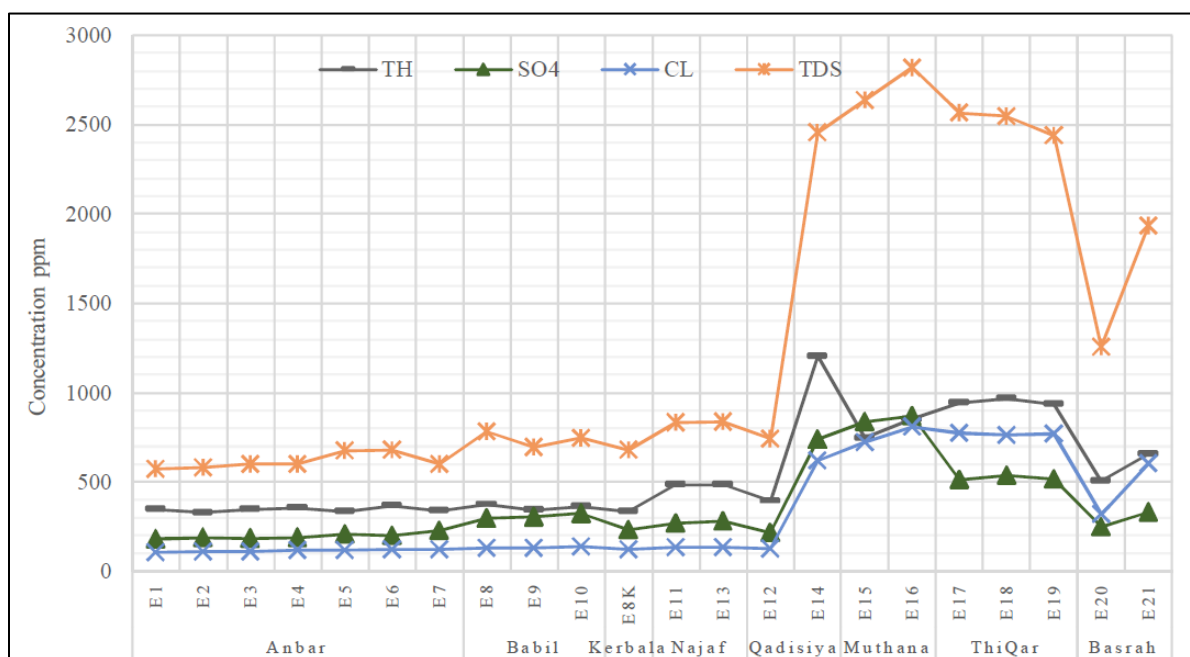
117. The return flows from irrigation inside Iraq along with the low-quality treated wastewater discharges has deteriorated water quality in both the Euphrates and the Tigris Rivers, especially downstream the big cities. Furthermore, both quantity and quality of transboundary water flows from Iran into the southern region of Iraq are unknown, which mainly have been impacted by irrigation return flow and other activities formed in Iran. Consequently, the environment of the Iraqi southern cities and marshlands have been influenced accordingly.

Figure 26: Measured water quality parameters along the Tigris River, 2011



Source: MoE

Figure 27: Measured water quality parameters along the Euphrates River, 2011



Source: MoE

118. For groundwater resources, the salinity varies with depth where it is of the order of 3,500 ppm at depths less than 20 m while it reaches 20,000 ppm at greater depths⁵⁸ (see appendix 6). In restricted areas, fresh water of very good quality can be found overlying saline groundwater. The quantity of ground water with salinities of 1-3 and 5-10 g/l that can be used for irrigation and watering livestock about 3.8 and 2.25 BCM/year respectively. The quantity of more saline groundwater (10 g/l) that can

⁵⁸ Ahmed A., 2019. PhD. Thesis, Arizona State University: Optimization Models for Iraq's Water Allocation System

be used for industrial purposes is about 1.54 BCM/year⁵⁹. In general, investment and optimal use of groundwater in Iraq is still at the beginning stage and does not exceed 5 percent.

Water withdrawals and uses

119. Water needs for hydropower generation, managing sustainable ecosystems, agriculture, domestic and industrial uses were around 42.8 BCM in 1990 and reached 75.9 BCM in 2015. Current estimates indicate that water supply to urban areas provides 73 percent coverage. In rural areas, this falls to 40-45 percent. The biggest user of raw water however is agriculture. Irrigated agricultural land accounts for about 65 percent of water use, a figure that undeniably has a huge impact on current water shortages. Domestic water and industry accounts for 8 percent, inland fisheries and animal husbandry accounts for less than 1 percent, wetland control for 7 percent, evaporation from rivers and reservoirs for 14 percent and discharge into the Persian Gulf for 5 percent (Table 21).

Table 22: Water withdrawals by sector in 2015

	Water Use (BCM)	Ratio
Total Water Withdrawals	75.893	100.0%
Municipal & Industrial	6.041	8.0%
Agriculture	49.589	65.3%
Fish Farms and Livestock	0.329	0.4%
Marshlands	5.388	7.1%
Flow to the Gulf via Shatt Al Arab River	3.934	5.2%
Evaporation from Rivers & Reservoirs	10.612	14.0%

Source: Compiled by author

120. Reduction in available surface water is significantly dependent on the reduction in water use in the agricultural sector. This is founded on the fact that by reviewing cropping plan in the agro-climatic zones, reducing conveyance loss and reducing irrigation demand by increasing on-farm irrigation efficiency, necessary agricultural water amount will decrease to 34 BCM by 2035 (a reduction of 31.3 percent of that of 2015)⁶⁰. Water withdrawals are expected to go down to 56.764 BCM by 2035 (Table 23).

Table 23: Total current and future water requirements in Iraq, including evaporation (BCM/year)

	2015	2020	2025	2030	2035
Total Water Withdrawals	75.893	68.723	63.251	60.189	56.764
Municipal & Industrial	6.041	6.471	7.000	7.521	7.904
Agriculture	49.589	42.748	38.129	35.215	34.069
Fish Farms and Livestock	0.329	0.329	0.329	0.329	0.329
Marshlands	5.388	7.037	6.554	6.395	5.825
Flow to the Gulf via Shatt Al Arab River	3.934	4.691	4.514	4.402	3.391
Evaporation from Rivers & Reservoirs	10.612	7.447	6.725	6.327	5.246

Source: Compiled by author

Allocated water for Agriculture

⁵⁹ Ahmed A., 2019. PhD. Thesis, Arizona State University: Optimization Models for Iraq's Water Allocation System

⁶⁰ idem

121. Irrigation consumptive use reached 39 BCM in 1991 and it was 22 BCM in 2003/2004, equivalents to 44 BCM of water derived, assuming 50 percent irrigation efficiency. Real efficiency might be 25-35 percent. The amount of surface water supplied for irrigation will be reduced in 2035 by about 13.75 BCM, or about 31 percent compared to the present time (from 49 to 34 BCM) despite the increase in the irrigated area by 17 percent⁶¹, because of taking the following measures:
- Planting new crop composition that consume less water and according to their suitability for AEZ (Agro Ecological Zoning), with the reduction of the area planted with rice in 2020 (from 348 thousand dunum to 232 thousand dunum).
 - Raising cropping intensity from 85 percent to 115 percent.
 - Raising the total irrigation efficiency from 30-40 percent now to 60 percent using modern irrigation methods (sprinkler irrigation, drip irrigation), piped irrigation conveyance and canal lining.
122. The amount of water allocated to livestock and fisheries remains the same (strict procedures regarding unlicensed fishponds and a gradual convert towards developing fish in cages with a slight increase in the number of livestock).

Use of water for municipal purposes

123. Potable water usage in Iraq is about 350 litres/capita/day for the urban areas and the coverage rate used to be 100 percent and 54 percent respectively in the urban and rural areas in 1991. Currently 86 percent of the urban population and 62 percent of the rural population have access to improved water through the network. Losses in the drinking water distribution system reaches 40 percent in some governorates due to leaking, old pipes and unauthorized withdrawal. The situation deteriorated in both quantity and quality afterwards and 33 percent of the population do not have access to water and sanitation⁶².
124. The water supply for municipal and industrial purposes represents about 8 percent of the total water consumption. The strategic plan is based on reducing waste in municipal and industrial water supplies by replacing or rehabilitating existing water distribution networks to achieve a steady reduction in water losses in the network.
125. With regard to municipal wastewater treatment, 30 percent of the Iraqi population is currently covered by the sewage system service (78 percent of Baghdad governorate is served by the sewage network, while this percent decreases in the rest of the governorates reaching in some parts to less than 30 percent, and in the other part to less than 10 percent. The strategic plan is built based on expanding the number of sewage treatment plants, so that the amount of municipal and industrial water treated annually increases from 0.55 to 2.08 BCM⁶³.

Use of water for industrial sector, oil and electricity

126. Iraq's vision for energy in the context of the strategic planning is to create an independent energy strategy that includes renewable energy and expand its delivery to citizens, and the adoption of hydropower energy to secure a part of the electric energy. Future energy production can be enhanced by establishing a system of dams that will be dedicated to producing hydroelectric energy. Hydropower

⁶¹ Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWLRI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

⁶² JICA, 2015. REPORT ON DATA COLLECTION SURVEY ON WATER SECTOR IN SOUTHERN IRAQ

⁶³ Ahmed A., 2019. PhD. Thesis, Arizona State University: Optimization Models for Iraq's Water Allocation System

use including the evaporation from reservoirs reaches around 10 BCM /year. Iraq will develop hydroelectric power stations to contribute 3.3 percent of the total power generation in Iraq by 2035⁶⁴ (building 23 dams for the purposes of hydropower generating) (see appendix 7).

Table 24: Water consumption in industrial sector, oil and electricity (BCM/year)

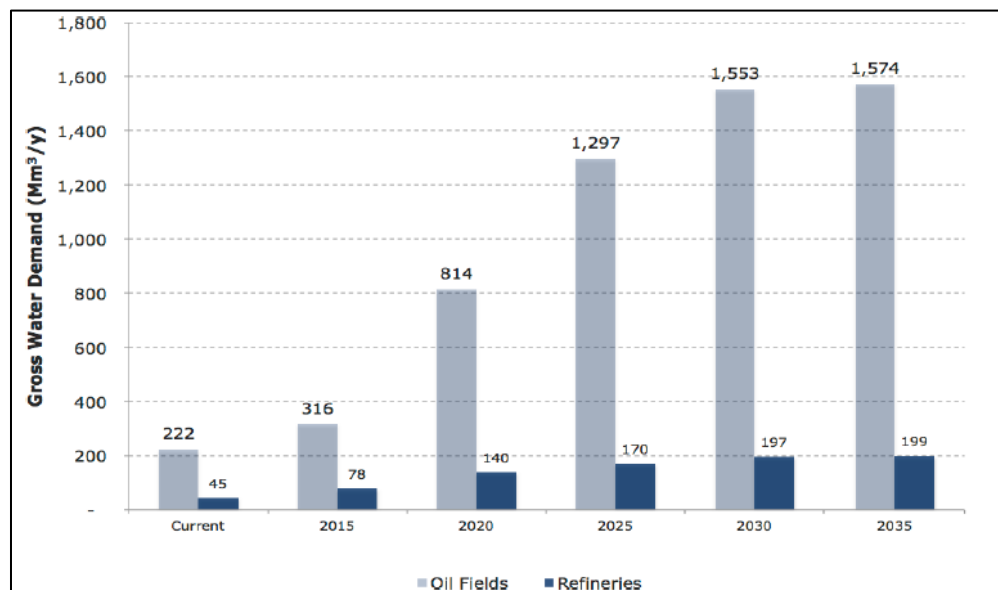
Consumption in BCM/Year		
Type of use	2014	2035
Industry	0.190	0.598*
Refiners	0.045	0.200
Oil fields	0.220	1.570**
Electric power plants	0.190	0.420

Source: Zeinab H. & al, 2021

* The strategic plan is built based on reaching up to 25 percent of the consumed water in the industry sector is reused **About 69 percent of it is from drainage water and the sea (0.55 BCM/year from drainage and 0.53 BCM/year from the sea)

127. Oil projects need 1.773 billion cubic meters of water annually by 2035. Around 69 percent of these needs are from drainage and seawater⁶⁵.

Figure 28: Evolution of gross water demand to support oil well reinjection and refineries



Source: Zeinab H. & al, 2021

Allocated water to revive the marshes

128. Iraq's vision of the environment within the context of long- term planning for water and land resources includes⁶⁶:

- Finding and using effective approaches to manage water quality,
- Revive the marshlands and reaping the benefits of this investment,

⁶⁴Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWLRI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

⁶⁵ Iraq Energy Institute, 2018. Towards Sustainable Water Resources Management in Iraq

⁶⁶ GoI, 2013. The National Environmental Strategy and Action Plan for Iraq 2013-2017

- Ensuring the Minimum Environmental Flow in the Shatt al- Arab,
- Ensuring biodiversity and preserving the ecosystem in the marshlands.

129. In an average hydrological year, the marshes in southern Iraq will only be partially revived, which requires that Turkey and Iran contribute to provide certain flows to achieve the required submerging rates to ensure their biological system. The rehabilitation of the marshes provides a range of direct and indirect economic and social benefits that produce a higher economic return than agriculture in the three southern governorates. The strategic plan aimed to divert 5.82 BCM/year of fresh water to marshlands of which 2,064 BCM/year to al-Hammar marsh (in addition to 2.45 BCM/year to be transferred to al-Hammar marsh from the MOD) to submerge an area of 2,850 km² under average hydrologic conditions in 2035⁶⁷. As per the strategic plan, the salts in the waters of the lower part of the MOD in 2035 will range between 1500-3800 parts per million and the transfer to the Hammar marsh will stop if the salinity exceeds 4000 parts per million (see appendix 8).

Groundwater use

130. The use of ground water in Iraq is low and ranges between 2 percent to 9 percent of water in Iraq. Ministry of water resources has divided Iraq into ten groundwater zones and is carrying out hydrogeological surveys for each of them. In the desert blocks, surveys are largely completed. Thousands of wells were developed in different parts of Iraq for various purposes, especially in the 1980s when many wells were drilled for agricultural purposes. The total number of wells were estimated to be 8,752 in 1990 of which 1200 were used for agricultural purposes. The government was responsible for developing these wells. The number of wells developed by the private sector reached 400 (appendix 9). After the war between Iraq and Kuwait in 1990, no records are available about the number of wells. It is believed that many wells drilled during the 1990s when the government encouraged the private sector to raise agricultural productivity because of UN sanction⁶⁸.

131. Despite the large number of groundwater wells that exists now, ground water utilization in Iraq forms a minor percent (2 percent-9 percent) of the water resources of the country. The quantity of the currently- used groundwater is 3.77 BCM/year (88,000 wells). The quantity of sustainable groundwater is estimated at 5.24 BCM/year, and it represents 8.8 percent of the freshwater resources in Iraq for the future years⁶⁹. However, more studies are needed in order to assess the suitability of aquifers for sustainable withdrawals.

Table 25. Groundwater Usage

	2015	2020	2025	2030	2035
Municipal & Industrial	0.272	0.304	0.337	0.369	0.400
Agriculture	3.499	2.659	1.835	1.837	1.882
From Springs	0.099	0.089	0.095	0.097	0.103
From Wells serving official irrigation projects	0.251	0.256	0.261	0.261	0.300
From wells serving areas outside official irrigation projects	3.149	2.314	1.479	1.479	1.479
Total Groundwater Consumption	3.771	2.963	2.172	2.206	2.282

Source: Compiled by author

⁶⁷ Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWLRI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

⁶⁸ Ahmed A., 2019. PhD. Thesis, Arizona State University: Optimization Models for Iraq's Water Allocation System

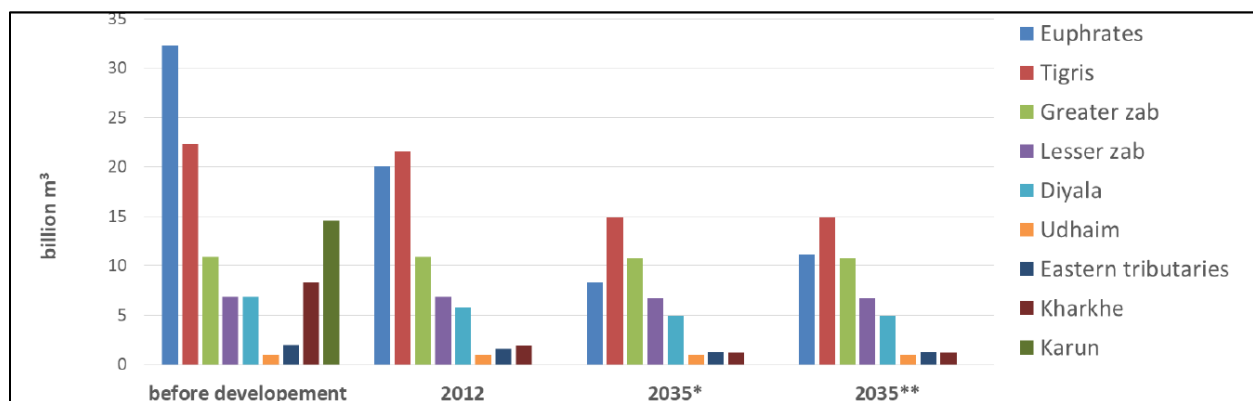
⁶⁹ Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWLRI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

132. Groundwater is considered the only source of water in the western desert. It represents 70 percent of water consumed by villages in north Iraq. There are also increasing problems regarding the allocation of water from surface irrigation projects and the water service delivery from these irrigation schemes. These problems have led many farmers to drill their private wells to supplement their quotas from surface water and gain more flexibility in managing the irrigation at their farms.

Water balance: main issues related to water management

133. Water resource management poses a very complex development challenge in Iraq. While the quantity is diminishing, the quality of water is also rapidly deteriorating. Increasing water scarcity and reduced water availability are dominant economic and environmental challenges in Iraq. Current water use for all purposes far exceeds renewable supplies. Surface and groundwater resources have come under enormous pressure from withdrawals, diversions, and pollution. There is a high demand on water resources from different sectors.
134. Iraq's water demand is increasing; this will lead to an estimated water deficit of 37 percent by 2030. On the account of water availability versus demand, studies suggest that Iraq has crossed the threshold limit, starting in 2015, and will face difficult challenge to balance the competing needs of water for drinking, irrigation, industry, and hydropower production, while meeting environmental requirements, including the restoration of the Marshlands. Estimates indicated that available water in Iraq reached 75 BCM in 2020 (2,200 m³ per person per year) which is more than neighboring countries with the exception of Turkey⁷⁰.

Figure 29: Water entering at the Iraqi borders (billion m3)



Source: Zeinab H. & al, 2021

135. The most important factor in securing the quality and quantity of water in the Tigris and Euphrates rivers is through securing the agreement with Turkey and Syria. SWRLI discussions were built around two scenarios: the first assumes a 100 percent development in Turkey and Syria in the next 20 years, which will result in 24.5 percent of flow decrease compared to 2015 baseline. The second scenario assumes 75 percent development in Turkey and Syria in the next 20 years, which will result in 20.9 percent of flow decrease compared to 2015 baseline. Iraqi Government assumes that they can secure water resources in the latter scenario⁷¹. Besides, balancing the shares of surface and

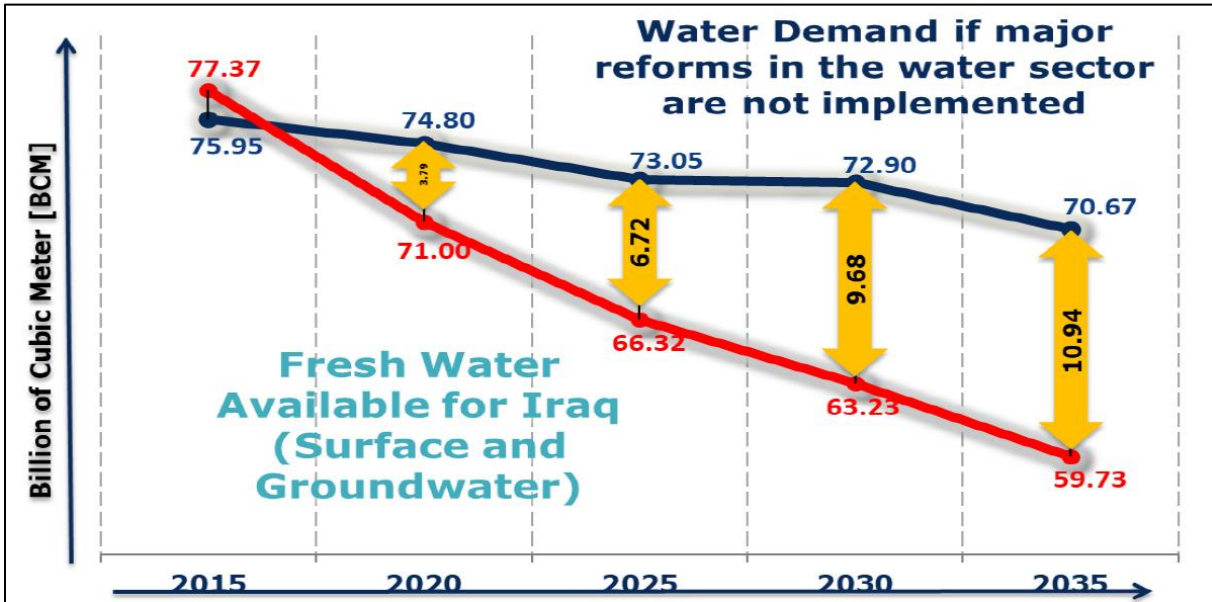
⁷⁰ Nadhir Al-Ansari, 2015. Conference paper published online in ResearchGate. Iraq water resources planning perspectives and prognoses. (<https://www.researchgate.net/publication/272160643>)

⁷¹ Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWRLI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

groundwater is at the heart of the strategy as well as management of water demand between the sectors.

136. In case the riparian countries implemented their entire development plans under the conditions that the sectors that use water in Iraq are unchanged and the current approach to water and land management in Iraq continues, then the water deficit in Iraq will increase to reach about 10.94 BCM/year by the year 2035, as shown in the following figure.

Figure 30: Iraq's water balance without the implementation of the SWLRI Strategy



Source: Zeinab H. & al, 2021

137. A significant challenge would be to identify projects that not only optimize water and land use but also meet the needs for food, energy security and sustain the environment. The sectors of water, food, energy and the environment are closely related and the impact on one of them will have unavoidable repercussions on all the others. Hence the need for a delicate balance between competing uses of water, which the Ministry of Water Resources strives to achieve through its Strategic Plan. The strategic planning process concluded that to achieve water security, Iraq needs to pursue two parallel paths as follows:

- Planning for the worst, assuming the implementation of 100 percent of the planned development projects in Turkey, Syria, Iran, and preparing the strategic plan for integrated water management across Iraq based on received water flows. The plan recommended the implementation of drastic measures and extensive reforms in the system and method of managing water and land resources to adapt to the expected decline in water availability and allocation.
- Continuing efforts to reach agreements with the riparian states for the two basins through negotiation based on comprehensive knowledge of water resources information and development plans for the two basins. Search for cooperation opportunities with the riparian countries with the aim of determining a permanent share of water based on fair and reasonable use without causing significant harm to any country in accordance with the rules of international law.

138. The drought management strategy calls for adopting an operating policy based on securing all municipal and industrial needs throughout the years. Hence, accepting the possibility of a deficit in meeting the irrigation requirements of 20 percent of the years of operation (two out of ten years) and should not exceed the probability of facing a deficit of 25 percent of the quantity required for irrigation.

Table 26: Iraq's water balance with the implementation of the SWLRI Strategy⁷²

	2015	2020	2025	2030	2035
Total Available Water (FW + GW + DW)	81.146	75.427	71.140	67.894	64.281
Available Surface Water	72.122	65.761	61.080	57.984	54.482
Sustainable Groundwater Withdrawals	5.243	5.243	5.243	5.243	5.243
Drainage Water	3.781	4.423	4.817	4.667	4.556
Total Water Consumption (FW + GW + DW)	79.674	73.146	68.068	64.857	61.320
Total Freshwater Consumption	72.122	65.760	61.079	57.983	54.482
Municipal & Industrial	5.769	6.167	6.663	7.152	7.504
Agriculture(*)	46.09	40.089	36.294	33.378	32.187
Fish Farms and Livestock	0.329	0.329	0.329	0.329	0.329
Total Marshlands Consumption	5.388	7.037	6.554	6.395	5.825
Flow to the Gulf via Shatt Al Arab River	3.934	4.691	4.514	4.402	3.391
Evaporation from Rivers	0.959	0.959	0.959	0.959	0.959
Evaporation from Reservoirs	9.653	6.488	5.766	5.368	4.287
Total Groundwater Consumption	3.771	2.963	2.172	2.206	2.282
Municipal & Industrial	0.272	0.304	0.337	0.369	0.4
Agriculture	3.499	2.659	1.835	1.837	1.882
Total Drainage Water Consumption	3.781	4.423	4.817	4.668	4.556
Oil Sector	0.162	0.211	0.338	0.521	0.55
Hammar Marsh (via MOD) + Shatt Al Arab (via ETD)	3.306	3.899	4.166	3.834	3.693
Green Belts	0.313	0.313	0.313	0.313	0.313
Water Balance	1.472	2.281	3.072	3.037	2.961

Source: Compiled by author

139. Iraq has developed vast off-river storage to hold floodwaters. Major water hydraulic infrastructure consists of a series of dams and barrages for a cumulative retention capacity of 70 BCM. The seasonality of the river flows; its damaging floods and the arrival of flood peaks at inopportune times in the agricultural calendar have driven the long history of water impoundment behind barrages in Iraq. Climate change impacts threaten the structural integrity and service sustainability of water supply infrastructure in Iraq.

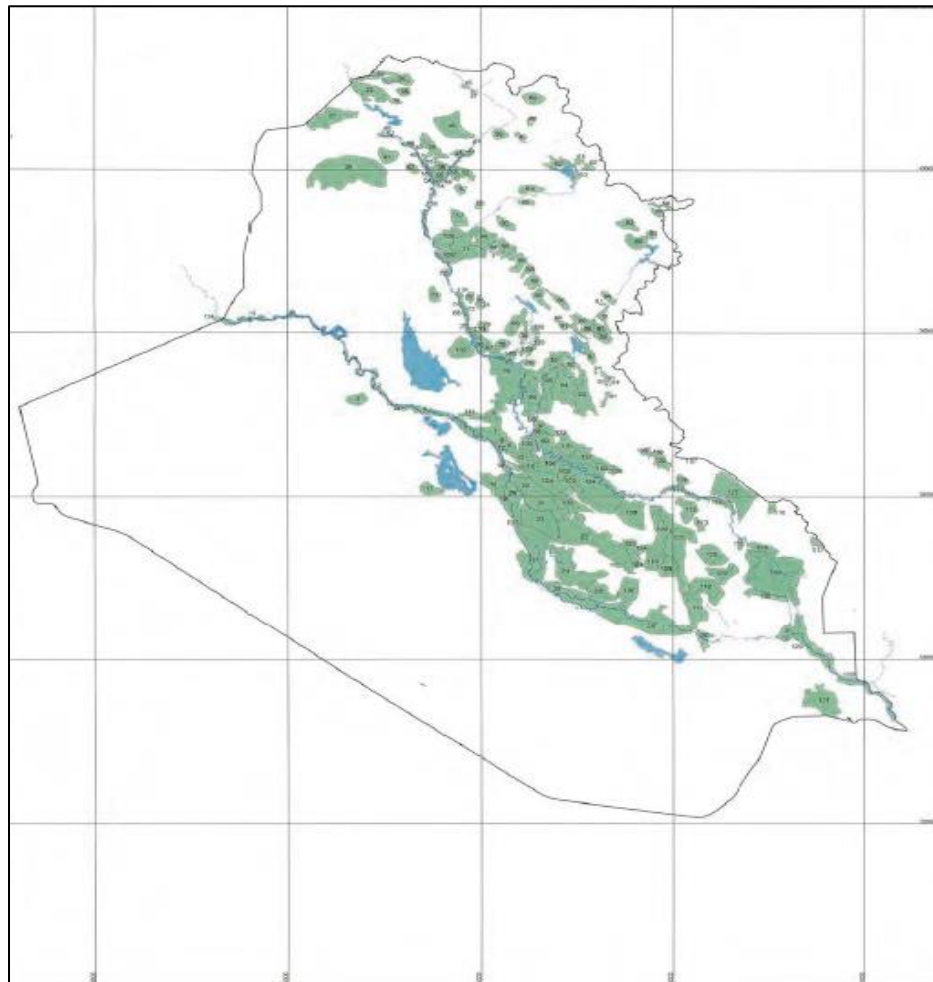
140. The current water distribution network includes 45 main regulators to regulate the main irrigation channels and divert water to branch canals. There are about 45,000 km of water conveyance systems and 85,000 km of drainage canals plus 27,000 kilometres of canals for water distribution.

⁷² if Turkey, Syria, and Iran fully implemented Development Projects

141. The rehabilitation and (re-)building of Iraq's water infrastructures is of utmost importance; in particular, the irrigation and drainage systems need to be modernized and better maintained. Well-functioning infrastructures are also a precondition for implementing approaches that are more sophisticated, policies and strategies. Water infrastructures need to be linked with broader benefits for the population, i.e. improved supply services.

142. The Ministry of Water Resources formulated the future long-term irrigation development plan with the target year of 2035. The plan consisted of surface irrigation schemes, ground water irrigation schemes, and rain-fed sites for which irrigation system was under consideration for a total target of 3.23 million ha. Until 2013, MoWR has developed 1.22 million hectares in total, comprising 1.21 million hectares for the surface irrigation scheme and 0.01 million hectares (less than 1 percent) for the ground water irrigation schemes. Figure 31 and the table in appendix 10 show the details of all 142 irrigation projects in Iraq with the number and area of planned irrigation schemes as well as the developed area and progress rate.

Figure 31: Locations of the 142 Irrigation Projects



Source: JICA, 2016a

143. In implementing farmland development or improvement works in Iraq, drainage facilities are constructed prior to provision of irrigation facility with the aim to protect salinity accumulation in the surface soil layer. Up to 2013, MoWR had almost completed drainage schemes included in its drainage

development plan. Moreover, the strategic plan aimed at completing drainage networks and linking them gradually from 45 large irrigation projects to Main Outfall Drain or evaporation lakes⁷³. It was planned to reuse some of the drainage water as shown in Table 26. Some of the drainage water from the MOD could also be reused for irrigation in those parts of the country where the topographic conditions are convenient. Additionally, it is planned to pump up water (0.408 BCM annually) from the eastern Tigris drainage into the Shatt al-Arab near Abu Flus (behind the city of Basra) and the salinity of its water in 2035 is expected to range between 1300-3000 ppm⁷⁴.

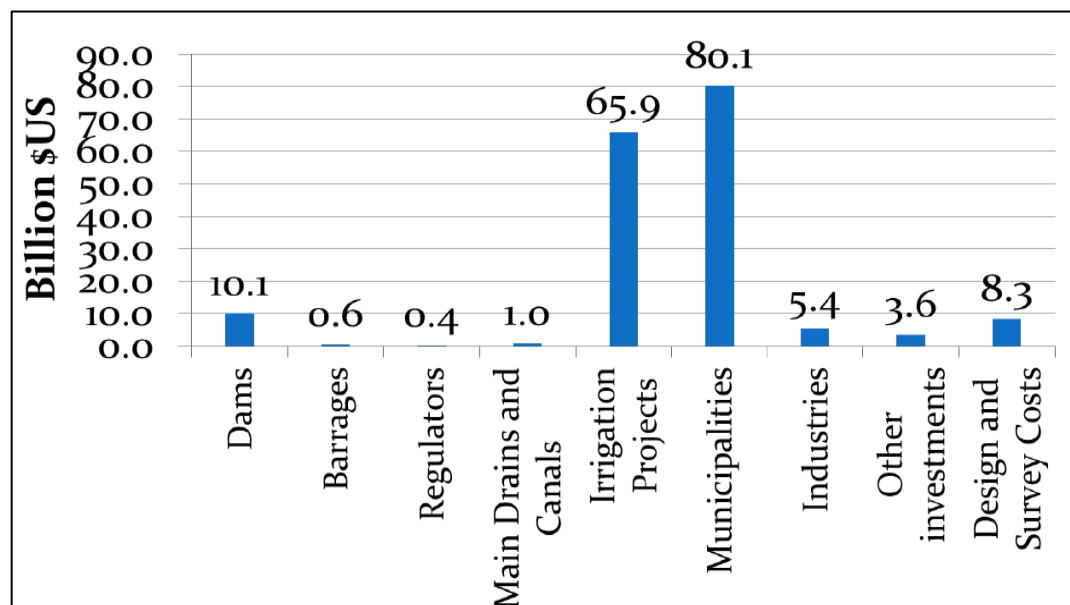
Table 27: Reuse of drainage water

Sector	Quantity (billion m ³ /year)
Hammar Marsh	2.45
Oil fields	0.55
Green belts	0.31

Source: Zeinab H. & al, 2021

144. To ensure the requirements of water security and other requirements related to water policy, the provision for investments under the water strategy amounts to about 175 billion dollars as shown in the figure below.

Figure 32: The twenty years investment strategy



Source: Zeinab H. & al, 2021

145. Major reservoir dams are located on both rivers and on the tributaries of the Tigris (Table 27). The big dams are multi-purpose (hydroelectric, irrigation, flood control). Smaller dams have been built to supply water to cities and irrigation schemes. The resulting hydraulic infrastructure is a complex, capital-intensive system demanding high maintenance expenditure and highly skilled management

⁷³ JICA, 2016a. DATA COLLECTION SURVEY ON WATER RESOURCE MANAGEMENT AND AGRICULTURE IRRIGATION IN THE REPUBLIC OF IRAQ. Final Report. <https://openjicareport.jica.go.jp/pdf/12253860.pdf>

⁷⁴ Zeinab H. & al, 2021. Strategic Study for Water and Land Resources in Iraq (SWLRI): Water-Food-Energy-Environment. Paper presented at first Baghdad International Water Conference

capacity. The appendix 11 presents a schematic of Iraq intricate water storage and control system from the upstream riparian countries to the Gulf of Arabia.

Table 28: Iraq's dams and their storage capacity and hydropower generation

Name	Watershed	Water use (BCM)	Hydropower (Mega watts)	Year completed
Mosul dam	Tigris	11.110	750 main dam 60 regulatory dam 200 pump storage	1986
Dukan dam	Lesser Zab	6.800	400	1959
Darbandikhan dam	Diyala	3.000	240	1961
Hemrin dam	Diyala	2.450	50	1981
Haditha dam	Euphrates	8.280	660	1986
Duhok dam	Duhok	0.047	0	1988
Adhaim dam	Adhaim	1.500	27	1999
Tharthar dam	Tigris	85.390*		1957
Habbaniyah reservoir	Euphrates	3.310		
Total		36.497		

* Gross capacity (of which 35.81 BCM is sediment capacity) / Source: NDP 2013-2017

146. Dams are a contentious issue in the Middle East. Yet the question of dams and their impact on downstream regions is also a vital one. Iraq already faces water scarcity as a major threat to its population; beyond recent drinking water crises in regions of southern Iraq around Basra, the country is facing reduced water access due to upstream damming in Iran, Syria, and Turkey. The increasing effects of climate change and desertification have further aggravated water shortages across the country: the UN Environment Program reported in 2017 that Iraq was losing around 25,000 hectares of arable land annually⁷⁵.

147. **Turkey:** The idea of utilizing the water of Tigris and Euphrates Rivers started in the 1930s due to the need of electrical energy. Since then, a number of studies and investigations have been carried out. In 1977, the overall picture of the project was set and referred to as the Southeastern Anatolia Project (GAP), which included 22 dams and 19 power plants (Iraq Energy Institute, 2018). Some of the dams have been constructed while others are either under construction or to be constructed at a later stage (Table 28). The Turkish Government considers GAP as a multi integrated regional development project. Turkey, now roughly fifty years into its GAP dam-building project has just begun power production from its newly constructed Ilisu Dam.

Table 29: Dams of GAP project in Turkey

⁷⁵ UNEP, 2017. Environmental Issues in Areas Retaken by ISIL Mosul, Iraq. Technical Note. [postconflict.unep.ch/publications/Iraq/Iraq percent20Technical percent20Note_September2017.pdf](https://postconflict.unep.ch/publications/Iraq/Iraq%20Technical%20Note_September2017.pdf)

River Basin	Name of the Dam	Year of completion	River Basin	Name of the Dam	Year of completion
Euphrates	Ataturk	1992	Tigris	Batman	1998
	Birecik	2000		Dicle	1997
	Camgazi	1998		Kralkizi	1997
	Hancagrz	1988		Cizre	Suggested
	Karakaya	1987		Garzan	Suggested
	Karkamis	1999		Kayser	Suggested
	Buykcay	Suggested		Ilsu	Under construction
	Catallepe	Suggested		Silvan	Suggested
	Gomikan	Suggested			
	Kahta	Suggested			
	Kayacik	Suggested			
	Kemlin	Suggested			
	Koeali	Suggested			
	Sirmtas	Suggested			

Source: Nadhir A. Al-Ansari, 2013

148. **Syria:** Until year 1999, three main dams have been constructed on the Euphrates in Syria as shown in Table 29. The construction of these dams is for the purpose of both irrigation and electricity generation⁷⁶.

Table 30: Dams of the River Euphrates in Syria

DAM	RIVER	HEIGHT (M)	PURPOSE	COMPLETION DATE
<i>BAATH</i>	<i>Euphrates</i>	14	P/I/F	1988
<i>TABAQA</i>	<i>Euphrates</i>	60	P/I	1975
<i>TISHRINE</i>	<i>Euphrates</i>	40	P	1999
<i>UPPER KHABOUR</i>	<i>Khabour</i>		I	1992
<i>F: FLOOD CONTROL, I: IRRIGATION, M: MILITARY, P: POWER, W: WATER SUPPLY</i>				

Source: Iraq Energy Institute, 2018

149. **Iran:** after rising in the northwestern reaches of the Zagros Mountains, the Sirwan and Little Zab Rivers flow into the Kurdistan region. The Little Zab meets the Tigris at the town of El Zab in the Kirkuk Governorate, while the Sirwan turns south, running through Iraq's Diyala Governorate before its confluence with the Tigris just south of Baghdad. Both rivers support significant irrigation projects along the way, notably the canal system on the Sirwan following the Diyala Weir near Sinsil and the still incomplete Kirkuk Irrigation Project on the Little Zab. Together, the two tributaries contribute roughly a quarter of the Tigris's annual flow in Iraq. The decrease in the two rivers' flows into Iraq directly corresponds with the completion of new irrigation projects in Iran. In the last three decades, the Iranian government has contracted for the construction of 600 dams nationwide. Of those dams, notable projects like the Daryan Dam have been built on the upper tributaries of the Sirwan and Little Zab, mostly to transfer Iraq-bound water back into Iran⁷⁷.

Table 31: Iran dams

⁷⁶ Iraq Energy Institute, 2018. Towards Sustainable Water Resources Management in Iraq

⁷⁷ IPCS, 2019. Water Scarcity in Iraq: From Inter-Tribal Conflict to International Disputes. Special report #203

DAM	RIVER	HEIGHT (M)	PURPOSE	COMPLETION DATE
DEZ	Shatt Al-Arab/Karun	203	I/P	1963
SHAHID ABBASPOUR (KARUN 1)	Shatt Al-Arab/Karun	200	P	1976
MASJED SULAAYMAN (KARUN 2)	Shatt Al-Arab/Karun	164	P	1976
KARUN 3	Shatt Al-Arab/Karun	205	I/P/F	2002
KARUN 4	Shatt Al-Arab/Karun	230	I/P/F	2010
GARAN	Tigris/Diyala/Sirwan	62	I	2005
DARAYAN	Tigris/Diyala/Sirwan	169	I/P	2010
UPPER GOTVAND	Shatt Al-Arab/Karun	180	P	2012
LOWER GOTVAND	Shatt Al-Arab/Karun	22	P	1977
KARKHA	Shatt Al-Arab/Karun	127	I/P	2001
SEIMARE	Shatt Al-Arab/Karun	180	P	2013
KHERSAN 3	Shatt Al-Arab/Karun/Karkha	195	P/F	2015

F: FLOOD CONTROL, I: IRRIGATION, M: MILITARY, P: POWER, W: WATER SUPPLY

Source: Iraq Energy Institute, 2018

Irrigation sector performance

150. Iraqi agriculture sector employs roughly 20 percent of the country's workforce and is the second largest contributor to the gross domestic product (GDP) after the oil sector, accounting for 5 percent of the GDP⁷⁸. Thus, agriculture development is critical to allow Iraq to achieve their vision of a more diversified economy, in addition to generating employment and boosting private sector engagement. Public policy has focused on the short-term challenges of food security while market inefficiencies have remained unaddressed. As a result, sector performance is well below potential and food imports make up 30 percent (or US\$9.38 billion in 2018) of the total imports⁷⁹. Despite the government's commitment to revive the sector, agriculture has been affected by distortionary and ineffective policies, mismanagement, and conflict-related destruction. Iraq's stagnating agricultural sector has made the country heavily reliant on food imports. This trade imbalance burdens not only the country's finances, but also hinders its food security and distorts the production supply chain⁸⁰.

151. The water crisis is accentuating the burden on incomes, living standards and health status of the Iraqi people. Furthermore, increased soil salinity, prolonged droughts, flooding incidences and siltation have decreased the efficiency of existing irrigation systems. Erratic irrigation services, waterlogging, and salinization affect crops and aggravate the poverty of farm households. Rural employment has plummeted and 30 percent of farmers are reported to have abandoned farming^{81,82}. As of February 2019, 7,074 families originally from the governorates of Missan, Muthanna, Thi-Qar,

⁷⁸ FAO, 2021. Agricultural value chain study in Iraq – Dates, grapes, tomatoes and wheat. Bagdad. <https://doi.org/10.4060/cb2132en>

⁷⁹ Idem

⁸⁰ WB, 2019a. Enabling the Business of Agriculture 2019. Washington, D.C: World Bank. Doi: 978-1-4648-1387-0. License: Creative Commons Attribution CC BY 3.0 IGO. <https://eba.worldbank.org/en/reports>.

⁸¹ IOM, 2019a. ASSESSING WATER SHORTAGE-INDUCED DISPLACEMENT IN MISSAN, MUTHANNA, THI-QAR AND BASRA

⁸² IOM, 2019b. ASSESSING WATER SHORTAGE-INDUCED DISPLACEMENT IN QADISSIYA, NAJAF, BABYLON, WASSIT AND KARBALA

Basra. Qadissiya, Wassit, Najaf, Babylon and Kerbala were displaced due to water shortage in their locations⁸³⁸⁴. Conflict and displacement of entire communities, together with lack of access to knowledge and inputs, has led to decreased agricultural productivity. MoA estimates that Iraq has lost approximately 40 percent of its agricultural production⁸⁵.

152. As major military operations against the Islamic State in Iraq and Levant (ISIL) concluded in late 2017, the situation in Iraq entered a new stage. National and regional authorities, as well as UN agencies and their partners, began focusing on rebuilding the economy and destroyed infrastructure to facilitate return of internally displaced persons (IDPs) to their areas of origin. Households affected by the conflict still face significant obstacles to resume agricultural livelihoods and improve their quality of life. The reconstruction of infrastructure, i.e., irrigation systems, storage and processing facilities, roads, and markets, have begun, but requires time. Although over 4.7 million Iraqis have returned home as of April 2020, 1.39 million Iraqis are still internally displaced⁸⁶ and significant challenges remain. They cannot return and rebuild their farming and animal husbandry businesses without considerable assistance to make the land safe and productive again. Rebuilding infrastructure and supporting livelihoods are key priorities for both national and international actors. This is particularly true in the most conflict-affected governorates and districts, many of which were core agricultural areas before the conflict.

153. The agricultural goals of the NDP 2013-2017 included: increase the agricultural sector GDP contribution, increase plant and animal agricultural production coverage for Iraq's food basket (food security), and secure Iraq's need for water resources. Only 100,000 out of 2.5 million donums were reclaimed during the NDP period. The GDP contribution of the agricultural sector decreased from 4.2 percent in 2013 to 3.1 percent in 2016. Furthermore, GDP growth slowed to 1.1 percent in 2017, a marked decline compared to the previous two years as domestic consumption and investment fell because of civil violence and a sluggish oil market (Figure 33). The volume of water storage decreased from 157 to nearly 50 BCM in 2015, and 2017 is marked by a significant deterioration in storage volume due to low rainfall and the small amounts of flows received from riparian countries. In 2018, the GDP further declined by 1 percent. In 2019, the GDP grew at 4.8 percent in the first half of 2019, reversing the contraction of 2017-18. Growth is mainly attributed to a rise in crude oil production (up 6.3 percent) and a rebound in non-oil economic activity (+5.6 percent) (WB, 2020).

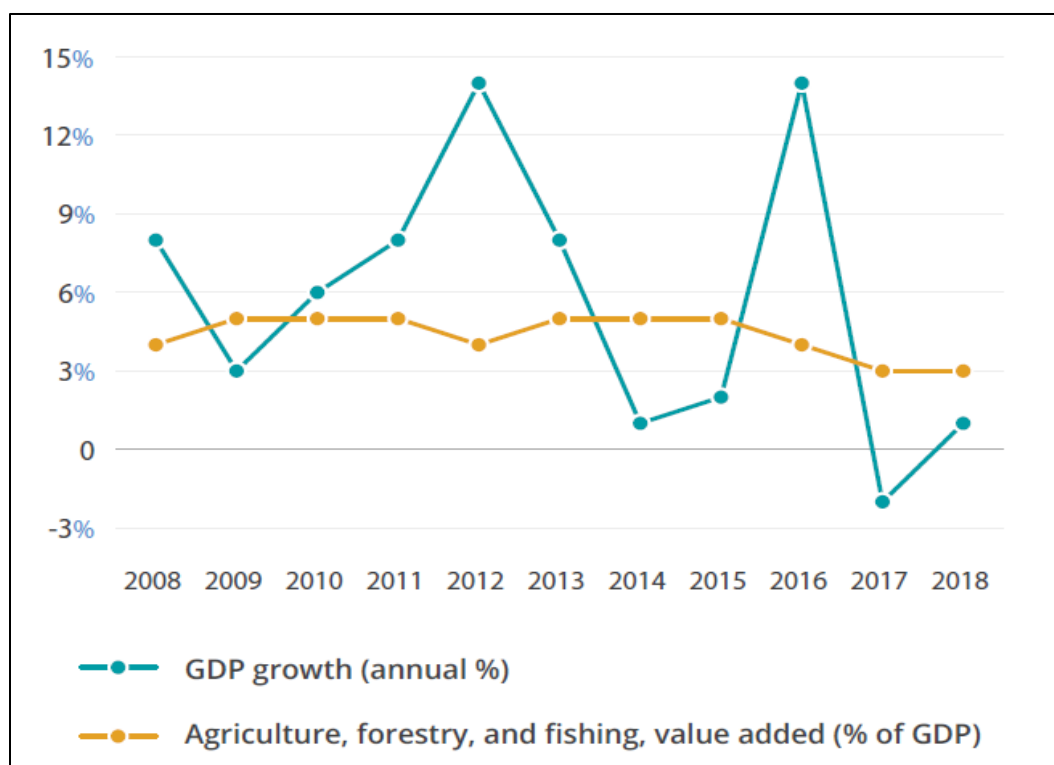
Figure 33: Fluctuation of the contribution of the primary sector to GDP and variation of GDP growth by year

⁸³ IOM, 2019a. ASSESSING WATER SHORTAGE-INDUCED DISPLACEMENT IN MISSAN, MUTHANNA, THI-QAR AND BASRA

⁸⁴ IOM, 2019b. ASSESSING WATER SHORTAGE-INDUCED DISPLACEMENT IN QADISSIYA, NAJAF, BABYLON, WASSIT AND KARBALA

⁸⁵ FAO, 2021. Agricultural value chain study in Iraq – Dates, grapes, tomatoes and wheat. Bagdad. <https://doi.org/10.4060/cb2132en>

⁸⁶ IOM, 2020. Water Quantity and Water Quality in Central and South Iraq: A Preliminary Assessment in the Context of Displacement Risk



Source: FAO, 2021

Irrigated agriculture

154. Agriculture in Iraq is practiced from North to South in eight agro-climatic zones (ACZs) (appendix 12). Most of the country's irrigated agriculture is found in the central and southern governorates and is dependent on the Tigris and Euphrates rivers for most of its water source. In very general terms, the Tigris basin has better quality water, while Euphrates basin has better quality land. The area of Iraq covers 43.7 million hectares, of which about 7 million hectares (16.1 percent) are arable land. Cultivated lands amount to 3.64 million hectares (52 percent of arable land), and there are large agricultural areas (about 1-1.25 million hectares) affected by dunes⁸⁷. Of the latter, 150,000 hectares have been reclaimed.

155. The irrigable lands are largely on the riverine plains. These plains receive small rainfall and agriculture depends almost entirely on water diverted from the rivers. About 64 percent of cultivated land is irrigated, of which 3.4 million hectares are under surface irrigation (i.e., 2.5 million hectares within "government projects" and 900,000 hectares are "non-government"), 426,000 hectares under groundwater irrigation (i.e., 20,000 hectares under government projects and 400,000 hectares are non-government inclusive of 7,000 hectares that are irrigated by springs)⁸⁸. The rainfed area is about 2.175 million hectares. From these figures, most of the irrigated lands are under 142 government projects. In the plains, where most of the population lives, there is very little rainfall and agriculture is dependent on irrigation. A rural population of about 10 million depends on irrigated agriculture⁸⁹.

156. Small-scale farming systems dominate the sector. Small-scale farmers with a holding size ranging from 2.5 to 7.5 hectares account for 35 percent of total number of farmers with subsistence

⁸⁷ UNCCD, 2017. Land Degradation Neutrality Target Setting National Report

⁸⁸ JICA, 2016b. Special assistance for project implementation for "irrigation sector loan" the republic of Iraq. Final report

⁸⁹ IFAD, 2017. Smallholder Agriculture Revitalization Project. Final project design report

cereal crops accounting for 58 percent of their cultivated area. Medium size farmers account for 34 percent with a holding size ranging between 7.6 and 12.5 hectares⁹⁰.

Table 32: Irrigation potential, irrigation-equipped area and recently irrigated area

Source of water	Numbre of projects	Develloped area (ha)	Net Area (ha)
Euphrates	26.0	932,725.0	818,100.0
Tigris	31.0	974,925.0	854,600.0
Diyala	9.0	103,850.0	87,450.0
Lesser Zab	5.0	219,000.0	192,125.0
Greater Zab	4.0	18,125.0	15,900.0
Eastern tributaries	3.0	1,250.0	1,100.0
Udhaim	1.0	40,000.0	35,087.5
GW-Wells	12.0	32,500.0	28,500.0
GW-Springs	10.0	10,500.0	9,250.0
Drainage water	30.0	820,500.0	719,775.0
Rainfed	11.0	127,750.0	-
Total irrigation projects	142.0	3,281,125.0	2,761,887.5

Source: Compiled by author

157. Of the area equipped for irrigation, 67 percent is in the Tigris basin, 30 percent in the Euphrates, and 3 percent in the Shatt Al- Arab basin (WB, 2014).

158. About two thirds of the irrigable land in the Tigris basin is equipped for irrigation, and about half in the Euphrates. Overall, Iraq has developed about 60 percent of its irrigable land. This level of development is consistent with achievements by other countries in the MENA region (regional average is 62 percent) and with other countries having strong irrigation economies (India 64 percent, China 70 percent). Exceeding this level of irrigation development is likely to increase costs and decrease soil capability, rendering investment less viable⁹¹.

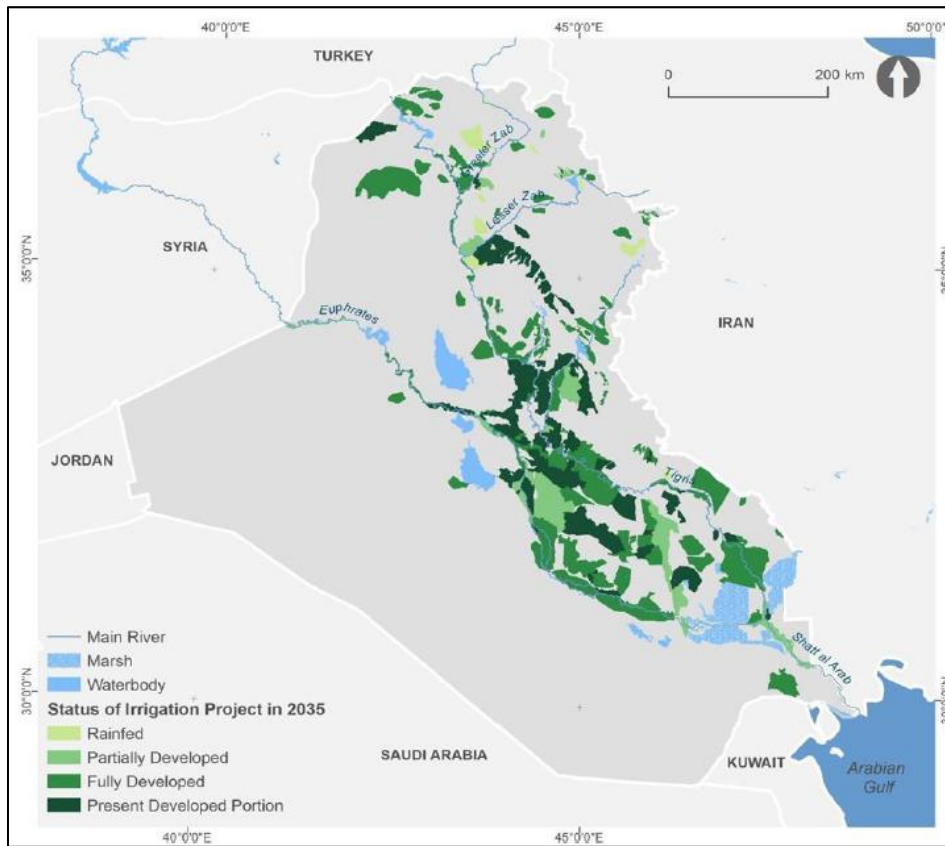
159. In the irrigated system, in addition to cereals, winter and summer vegetables, corn, rice and fruit trees with predominantly date palm are grown. The rainfed farming system is crop/small ruminant based. Both systems are characterized by traditional methods and minimal capital investments, resulting in low productivity. There is also limited social capital and positive outcomes from group interactions, causing poor integration along the supply chain. Iraq's vision for food security in the context of long-term planning for water and land resources is to achieve the biggest part of stable food security through:

- Agricultural development for fertile lands,
- Employment of skilled workers,
- Use of appropriate equipment,
- Effective management of irrigated fields.

⁹⁰ IFAD-AF, 2018. Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC). Project proposal. www.adaptation-fund.org/project/building-resilience-agriculture-sector-climate-change-iraq-brac-2/

⁹¹ Kanaan A. & al, 2021. Article published online in ResearchGate. Land reclamation in Iraq. (<https://www.researchgate.net/publication/345895955>)

Figure 34: Status of Agriculture in 2035



Source: Zeinab H. & al, 2021

Irrigation technology and performance

161. Irrigated agriculture is the largest consumer of water, but use is inefficient. Irrigated agricultural land accounts for about 64 percent of water use, a figure that undeniably has a huge impact on current water shortages. Except for about 3.5 BCM groundwater, the irrigation water is abstracted by diversion from rivers and distributed through an extensive system of barrages, irrigation canals, and on-farm channels, and approximately half of the diverted water is lost in conveyance⁹².

162. Water supply/irrigation infrastructure including small pumps and wells, large pumping stations, canals, water reservoirs, electrical control systems, control gates, bridges, and pivotal/linear sprinklers were damaged or looted. From 2014 to the present day, farmers have reported a significant decrease in water supply due to the poor state of irrigation infrastructure⁹³. There is a clear decline in incoming water resources whether from Tigris and Euphrates rivers outside Iraqi borders, or from feeding rivers inside Iraq, whose water resources, in turn, have declined due to drought conditions. These conditions have negatively affected the tributaries, groundwater, storage levels in dams and reservoirs. In addition, many vital facilities, such as Ramadi and Fallujah Barrages, Warwar and Taqsim regulatory dams, and some other important secondary facilities, were destroyed or damaged⁹⁴. This has affected rural livelihoods with decreasing agricultural production, which leads to insufficient funds to buy agricultural

⁹² Mukhalad A. & al, 2020a. Article published in Journal of earth sciences and geotechnical engineering. Irrigation projects in Iraq. (<https://doi.org/10.47260/jesge/1123>)

⁹³ Nadhir Al-Ansari, 2015. Conference paper published online in ResearchGate. Iraq water resources planning perspectives and prognoses. (<https://www.researchgate.net/publication/272160643>)

⁹⁴ Mukhalad A. & al, 2019. Article published online in ResearchGate. Water resources projects in Iraq, Irrigation. (<https://www.researchgate.net/publication/337317793>)

inputs and fuel, which is further exacerbated by increased prices for fuel and electricity to power the water pumps.

Off farm and conveyance structures

163. The irrigation system in Iraq, diverting water mainly from the Tigris and Euphrates rivers, comprises 25 dams and weirs and 275 pumping stations, with a total network of about 27,000 km of canals. Besides the large-scale dams, smaller dams constructed in the Western Desert, Eastern and Kurdistan Regions for urban water supply, animal and agriculture use.

164. Prior to control by the Islamic State of Iraq and the Levant (ISIL), the Government's Strategy for Water and Land Resources in Iraq (SWRLI) estimated irrigation efficiency at between 30 and 40 percent. Nearly a quarter of main, branch and secondary canals had concrete linings while the percent for tertiary canals is much higher at 42 percent. A further 2 percent of canals were pipelined⁹⁵. The low efficiency can be attributed to water losses along the conveyance and distribution structures. SWRLI points out that water is also lost due to improper gate operation at the weirs and intakes. Some farmers arbitrarily pump water up to their own lands in cases of open channels. Furthermore, the policy allowing farmers to pump water freely into their respective fields with no irrigation service fee naturally enhances the habit of water wastage and thus results in low water use efficiency.

165. The infrastructure has broken down on a wide scale. Headworks have operated for a long time without maintenance or proper management plans. Most pumping stations were built in early 1970's - only three are relatively new. An estimated US\$1.5 billion was spent under the Oil-for-Food program to replace worn-out components but recent reports point out that many large irrigation and drainage pumping stations are in a bad state⁹⁶. Most are severely run down, and some can no longer be repaired. The primary, secondary and tertiary canal networks are also degraded due to lack of maintenance. Deterioration of canal linings, outgrowth of weeds and sedimentation has reduced conveyance capacity significantly. Heavy equipment for canal cleaning was procured but these were inadequate to stop the deterioration of the system. The war of 2003 and the breakdown in civil law and order in its aftermath further contributed to the destruction of many of the sector's existing assets.

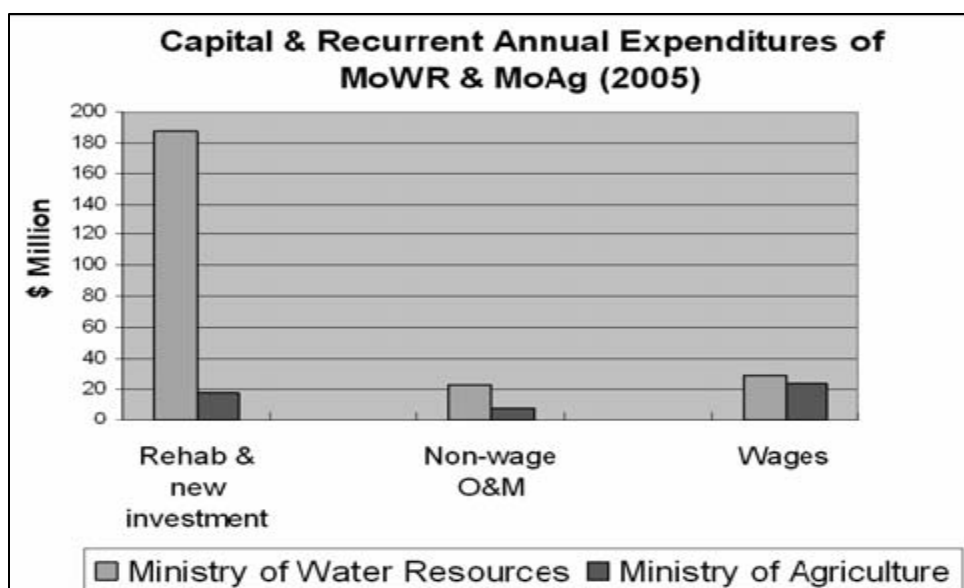
166. MoWR's budget allocation is predominantly for capital expenditure and financing for operation and maintenance is limited. MoWR's budget for 2005 was \$225 million, about half- percent of its GDP (Figure 35). The budget allocation demonstrates a major emphasis on investments for rehabilitation and new structures (80 percent), with only 10 percent of the budget allocated to wages and another 10 percent to operation and maintenance. In fact, the operation and maintenance expenditures, including wages, amount to about \$13/ha, which is low by the standards of systems of comparable management complexity⁹⁷.

Figure 35: Public expenditure in water resources and agriculture

⁹⁵ JICA, 2016a. DATA COLLECTION SURVEY ON WATER RESOURCE MANAGEMENT AND AGRICULTURE IRRIGATION IN THE REPUBLIC OF IRAQ. Final Report. <https://openjicareport.jica.go.jp/pdf/12253860.pdf>

⁹⁶ Mukhalad A. & al, 2020a. Article published in Journal of earth sciences and geotechnical engineering. Irrigation projects in Iraq. (<https://doi.org/10.47260/jesge/1123>)

⁹⁷ JICA, 2016a. DATA COLLECTION SURVEY ON WATER RESOURCE MANAGEMENT AND AGRICULTURE IRRIGATION IN THE REPUBLIC OF IRAQ. Final Report. <https://openjicareport.jica.go.jp/pdf/12253860.pdf>



Source: MoWR

Drainage and land reclamation

167. Most of Iraq's terrain is very flat, which makes the plains susceptible to flooding and hinders drainage. Low permeability is predominant in the upper soil horizons, and the groundwater table is typically near the surface due to restricted natural drainage outflow. The problem has arisen from the combination of over-irrigation and poor drainage. The increasing salinity of irrigation water is exacerbating the problems. Traditionally farmers managed the accumulation of salt by leaving land fallow every alternate year, which allowed the water table to drop, and rainfall to leach out salts. However, with greater water availability from irrigation schemes development, and fragmentation of large estates into smaller parcels, farmers abandoned the alternate year fallows, resulting in accumulation of salts.

168. The drainage system is still incomplete. It is estimated that open drains and collectors serve about 500,000 hectares and about 375,000 hectares are equipped with in-field sub-surface drainage⁹⁸. Thus, less than one quarter of Iraq's area developed for irrigation is equipped for drainage. In addition, the functioning of the drainage system has deteriorated considerably. Many drains are blocked, and many of the drainage pumps used for lifting effluents into the outfalls have broken down. The incomplete state of the drainage system and the breakdown of its management, combined with increases in the salt load from upstream effluents, have led to soil salinity and waterlogging now affecting three quarters of the irrigated area.⁹⁹ Salinization and waterlogging have reportedly contributed to the abandonment of about 1.5 million hectares, which is around 40 percent of the area developed for irrigation¹⁰⁰. The worst affected areas are the plains between the Tigris and Euphrates in the centre and south, including the governorates of Wassit, Missan, Kabala, Babylon, Baghdad, Diyala, Najaf, Thi-Qar and Basra. The salinity in the downstream stretches of Tigris and particularly in the Euphrates River is very high during the summer. This is proving particularly an impediment to rice cultivation.

⁹⁸ ICARDA, 2015. A National Framework for Salinity Management. The Case of Iraq Agriculture. Final report: Soil salinity management central and southern Iraq

⁹⁹ Recent estimates are that 4 percent of the irrigated area is severely saline, 50 percent medium saline, and 20 percent moderately saline.

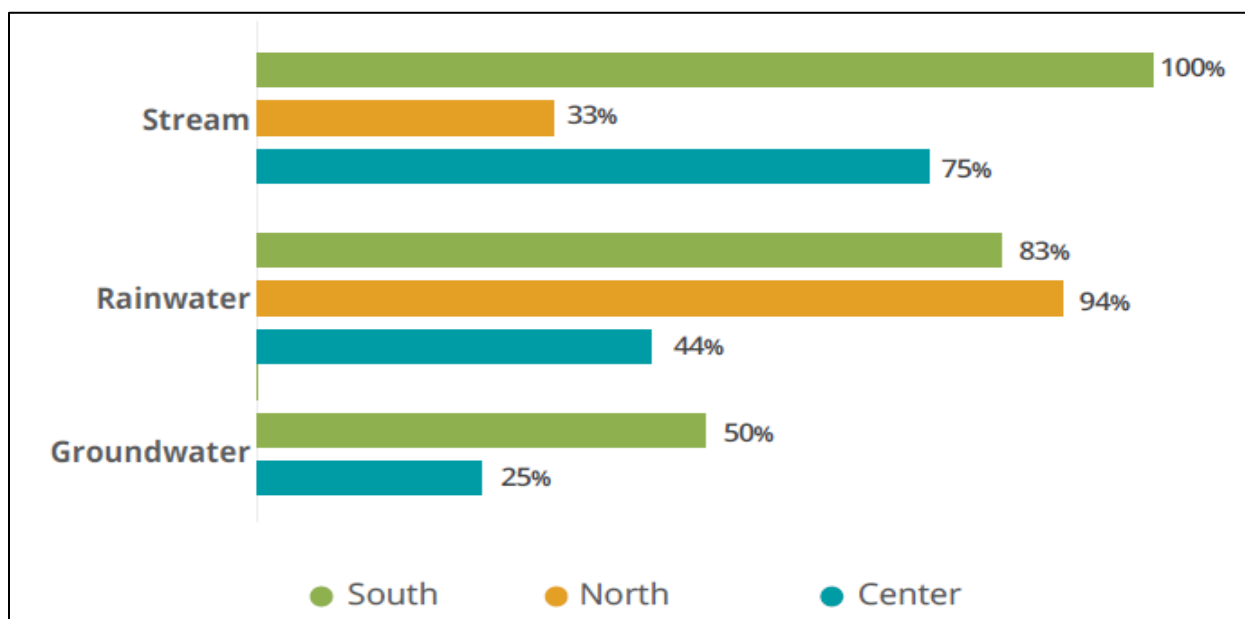
¹⁰⁰ ICARDA, 2015. A National Framework for Salinity Management. The Case of Iraq Agriculture. Final report: Soil salinity management central and southern Iraq

On-farm infrastructure and water management

169. The traditional irrigation method in Iraq of flooding the land with water is an extensive method that overcomes problems of unevenness of the land and does not require costly furrowing or grading. The disadvantages are waterlogging, salinization and low efficiency. Surface irrigation system is practiced in 95 percent of irrigated areas and crop intensity does not exceed 85 percent of cultivated land. On average only 40 percent of the water applied is beneficially used by the plant in evapo-transpiration¹⁰¹. The land reclamation projects undertaken in the 1980s helped improve on-farm irrigation efficiency with land planning and land levelling. However, these actions did not have long lasting impacts and on-farm water use efficiency is still low.

170. In the past, water supply was stable and sufficient, albeit highly dependent on the Euphrates and Tigris Rivers; however, upstream dam construction, increased salinity, reduced precipitation, limited groundwater recharge and decreased river discharge has resulted in water scarcity challenges¹⁰². Thus, water resources in Iraq need to be managed more efficiently, particularly in the agricultural sector. The introduction of efficient irrigation technologies should be a priority. For example, wheat has a significant impact on water resources; up to 70 percent of the total production depends upon irrigated water, placing stress on the environment¹⁰³. Farmers in the north are dependent on groundwater for wheat irrigation, resulting in over-abstraction and causing salinization issues.

Figure 36: Source of water for the wheat farmers in each agro ecological zone



Source: FAO, 2021

171. A water footprint study of wheat in Iraq identified opportunities to optimize water usage, such as shifting production to more appropriate agro-ecological zones, adopting improved growing techniques (i.e., water-efficient irrigation)¹⁰⁴. 58 percent of the wheat farmers still use surface irrigation, while 23 percent use sprinkler irrigation, 6 percent manual, and 2 percent of localized and drip irrigation. The use of the surface irrigation is less efficient than other modern techniques. Only 10 percent of

¹⁰¹ Kanaan A. & al, 2021. Article published online in ResearchGate. Land reclamation in Iraq. (<https://www.researchgate.net/publication/345895955>)

¹⁰² Salam H. & al, 2019b. Article published in Water. Water Footprint of Wheat in Iraq. (www.mdpi.com/journal/water)

¹⁰³ Idem

¹⁰⁴ Idem

farmers stock water (mostly artificial ponds), and diesel and electrical are the most common sources of energy for pumping water. Besides, water authority-enforced restrictions on drilling wells are still weak and poses a serious concern¹⁰⁵.

172. Climate change and changes in agro-climatic conditions will certainly have their impact on production. Improved water use efficiency and water productivity could offset some negative impacts. Growing scarcity of water and risks of climate change set a tough challenge for agriculture in the region for the coming years: more production and more income with less water. This picture of diminishing and vulnerable supply and increasing competition from other sectors drives the challenge of scarcity for agriculture. Inevitably in the coming years, agriculture will have less, not more, water. In such a dry region, water is essential to the agricultural growth needed for the rural economy to prosper and contribute more to GDP, for rural incomes to be maintained or increased, and for more food to be produced. Agriculture must become ever more water-efficient, offsetting scarcity by improved water use efficiency and water productivity¹⁰⁶.

173. Improving water use in agriculture involves supporting efforts to improve agricultural productivity by emphasizing irrigation system efficiency, working with public and private extension services to increase the adoption of improved production technologies and systems, appropriate crops for specific environments by farmers, and, where appropriate, promoting the reuse of drainage water for agriculture. Moreover, investments in policy and legal reforms, and strengthening water resources planning, management, and governance yield more lasting change and strengthen investments in infrastructure. In addition, interventions that strengthen the capacity of water authorities and related institutions have positive repercussions, including building the capacity of local governments, strengthening decentralized institutions, and empowering women to take leadership roles in community life. It is also crucial to assess water and energy investments in tandem and consider the impacts that pricing, subsidies, and other factors of one sector can have on the other.

Main challenges and CC impact

174. Iraq has witnessed disastrous decades in water, as in every other aspect of its national life. Political, military, and economic events have undermined the progress previously achieved, weakening the infrastructure and causing widespread poverty. Iraq's water sector and the services derived from it are in crisis. The water flows in rivers at the frontier have reduced. Moreover, neglecting the regional water-diplomacy has significantly increased the risks posed by Iraq's dependence on transboundary resources. Water is on the frontlines of climate change.

175. Climate change also exacerbates the decline in the inflow of water, in combination to over exploitation, because of increased temperatures and precipitation variabilities. Climate change will keep affecting water resources situation in Iraq negatively and will lead to severe variations in incoming water from Tigris and Euphrates Rivers, causing floods or drought. The effects of water scarcity will vary by region, with some regions suffering more from recurrent droughts and water shortages. As much as 31 percent of Iraq's surface is desert. Years of inappropriate farming practices and mismanagement of water resources have exacerbated the effects of an already dry climate and contributed to increasing rates of desertification. Declining fertility, high soil salinity, erosion and the extension of sand dunes are pervasive problems. Moreover, the mapping of climate and environmental risks in the southern and central governorates¹⁰⁷ shows that key hazards are as follow:

¹⁰⁵ FAO, 2021. Agricultural value chain study in Iraq – Dates, grapes, tomatoes and wheat. Bagdad. <https://doi.org/10.4060/cb2132en>

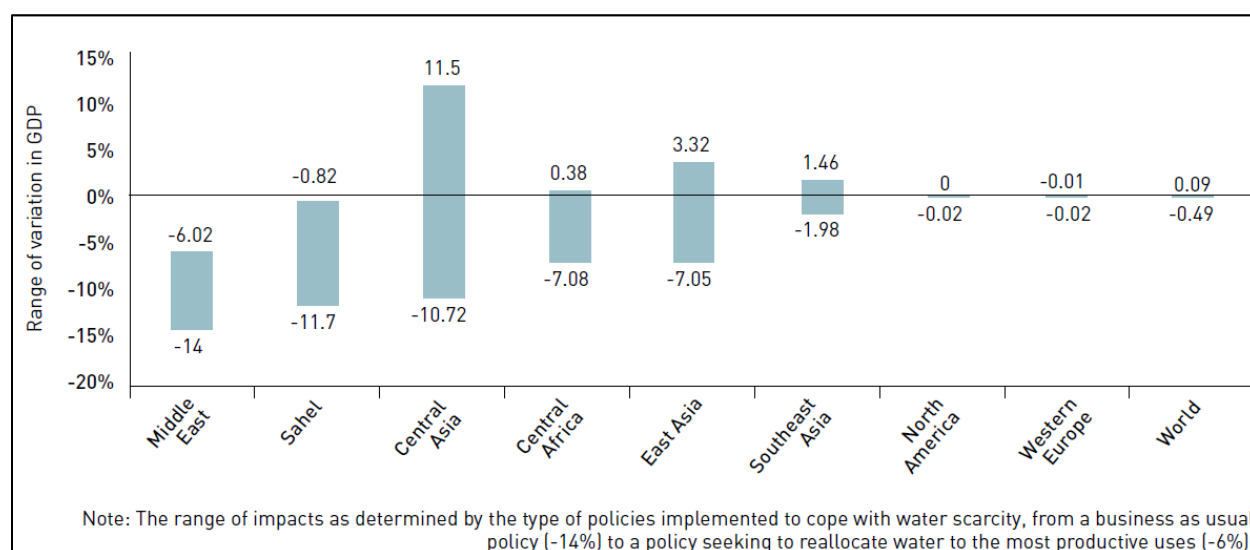
¹⁰⁶ FAO, 2015. Towards a Regional Collaborative Strategy on Sustainable Water Management and Food Security in the Near East and North Africa Region. Cairo.

¹⁰⁷ ICARDA, 2015. A National Framework for Salinity Management. The Case of Iraq Agriculture. Final report: Soil salinity management central and southern Iraq

- Water scarcity (drought / low precipitation and unreliable, declining supplies from riparian countries),
- Saltwater contamination of rivers (sea level rise and excess pumping),
- Water pollution (upstream human activity, and run-off of pesticides and other contaminants),
- Soil salinity,
- High temperatures and heatwaves,
- Insufficient rainfall, particularly in the summer months,
- Erratic heavy rains and flooding,
- Persistent drought.

176. Climate change impacts threaten the structural integrity and service sustainability of water supply infrastructure in Iraq. Direct changes in precipitation patterns and indirect changes in land use within the catchment negatively affect surface water and groundwater availability, which create major risks for agriculture. Water availability is the key determinant of agricultural potential and climate change affects this availability, largely negatively. Soil moisture is likely to decrease, and rivers arising within the region are and will likely experience decreased flows. All water storage is likely to suffer increased evaporation due to higher temperatures. Higher temperatures will also increase crop water requirements, leading to increased agricultural water demands. These changes in agro-climatic conditions will certainly have their impact on production. Improved water use efficiency and water productivity could offset some negative impacts. Growing scarcity of water and risks of climate change set a tough challenge for agriculture in the region for the coming years: more production and more income with less water. This picture of diminishing and vulnerable supply and increasing competition from other sectors drives the challenge of scarcity for agriculture. Inevitably in the coming years, agriculture will have less, not more, water. In such a dry region, water is essential to the agricultural growth needed for the rural economy to prosper and contribute more to GDP, for rural incomes to be maintained or increased, and for more food to be produced. Agriculture must become ever more water-efficient, offsetting scarcity by improved water use efficiency and water productivity (FAO, 2015).

Figure 37: The Economic Impacts of Climate Change-Induced Water Scarcity by World Region, 2050



Source: World Bank 2016.

177. Evaporation losses from surface water reservoirs increase as temperatures increases, thereby reducing yields and increasing storage losses. Shifts in river morphology from increased erosive capacity of river during storm events affect water withdrawal. Flooding, landslides and high sediment loads in water sources frequently damage water infrastructure leading to loss of service. This places a heavy

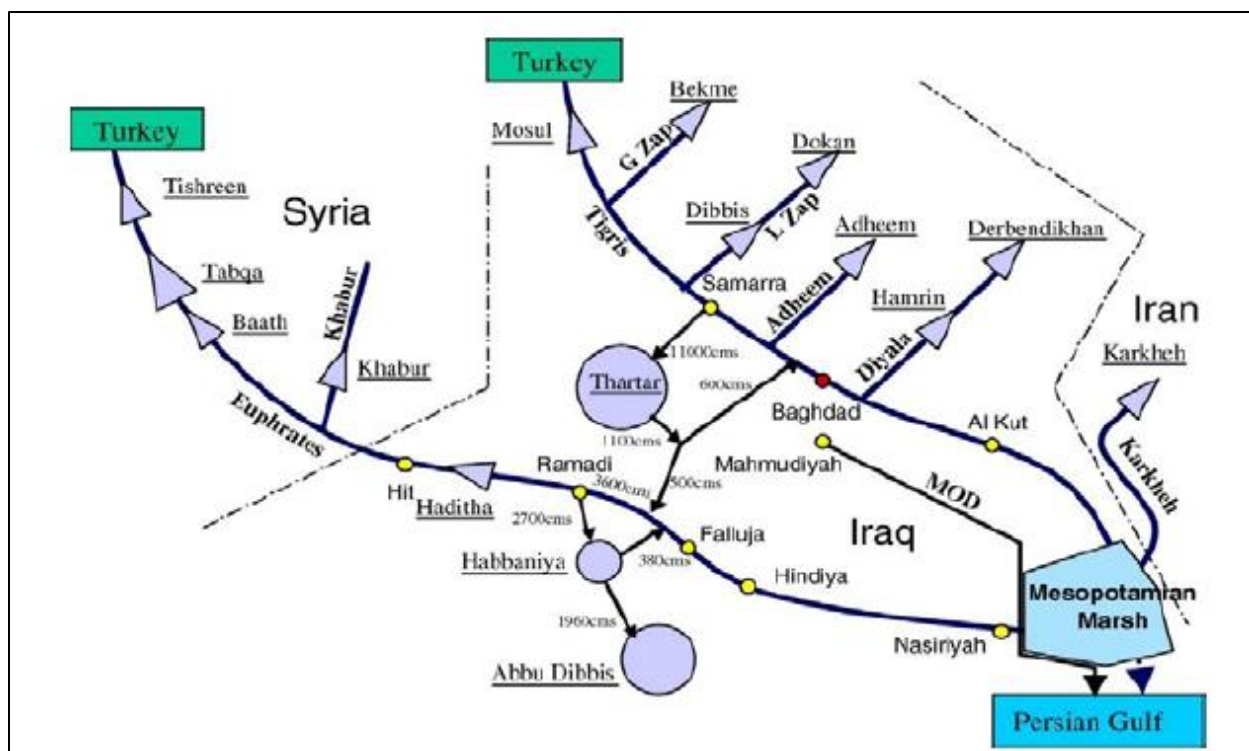
financial burden for repair costs. These natural hazards are combined with ageing water infrastructure and a low level of investment in replacement and rehabilitation in many cases.

178. A more comprehensive approach to risk management for water infrastructure is needed, ensuring that new and replacement infrastructure is resilient to natural hazards. Risk assessment of water infrastructure based on historical information and climate change projections is key. Development of adaptation plans setting out the priorities for infrastructure upgrades encompassing all the actions in response to actual or projected climate change impacts to reduce risks, vulnerability, and related future costs. Examples of climate change adaptation options for water supply infrastructure include:

- assess flexibility to switch between different water sources,
- link seasonal water resources operational activities with medium term weather forecasting in order to improve early action and contingency planning for drought events,
- increase maintenance budget for cleaning/clearing debris at intakes, increase budget for dredging, river training following storm events,
- conduct regular aerial assessments to monitor changing river morphology, and
- stabilize landslide-prone areas by planting trees.

179. Policy failures to address competition over scarce water resources can act as a risk multiplier in already fragile contexts. Water security in Iraq and the region as a whole requires going beyond increasing immediate water supplies to a focus on ensuring sustainable resource management, and efficient and affordable service delivery. Such a balanced approach fortifies the ability to withstand shocks and protracted crisis, such as drought, conflict, or a refugee influx, while also addressing immediate needs such as food security. A regional collaborative approach is necessary, as water resources often cross-national borders (FAO, 2018a).

Figure 38: Schematic of water management structures in Iraq



Source. (Iraq Energy Institute, 2018)

180. The in-country supply losses are now just little short than half the flows received from neighbouring countries¹⁰⁸. Besides, the quality of water has been deteriorating, contaminated by saline return flows and sewage. The hydropower gap contributes to the overall shortfall in electricity (Hydropower generation is often as low as one-third the capacity). Therefore, about 40 percent of the traditionally irrigated area is out of production, three quarters of lands are degraded by salt, and yields and production are at levels below those in 1960s¹⁰⁹¹¹⁰.

SWOT Analysis of the Sector

181. The agricultural sector faces several problems and challenges. Successive years of drought, fluctuation in rainfall, environmental changes, and various risks, in addition to the loss of key cycles in agricultural marketing. This has led to losses in agricultural production from harvesting to consumers and the lack of agricultural insurance companies and associations specialized in agricultural mechanization, marketing, and transport, etc. Such matters are compounded by structural factors that include limited rural financing, weak research and extension capacities, low-level technologies, the increasing impact of climate change and the construction of dams in neighbouring countries, which is related to a reduction in water inflows and increased salinity.

Table 33: SWOT Analysis Water, Irrigation and water management

¹⁰⁸ Nadhir Al-Ansari, 2015. Conference paper published online in ResearchGate. Iraq water resources planning perspectives and prognoses. (<https://www.researchgate.net/publication/272160643>)

¹⁰⁹ Gol, 2019a. First National Voluntary Review on Sustainable Development Goals.

¹¹⁰ Ala H. & al, 2020. Paper published in IOP conference series: Materials science engineering. Management of natural Iraqi water resources aims and challenges. (doi:10.1088/1757-899X/881/1/012181)



Strengths

182. **Irrigation, once it is rehabilitated, has the potential to increase yields.** The total managed irrigated area is estimated at two thirds of the total cultivated area, all of it equipped for full or partial control irrigation. The agriculture sector is the main consumer of water with around 65 percent of the total, yet water efficiency is low due to the weakness of water management institutions, weak monitoring and regulatory capacity. Following years of destruction during the conflict, the irrigation system is in serious disrepair. Currently, only 20 percent of farmers have access to full irrigation compared to 65 percent before the conflict. Because of the poor state of repair of irrigation and drainage schemes, salinization of Iraq's agricultural lands has become a severe issue. Around 60 percent of cultivated land has been seriously affected by salinity, causing yield losses of 30 to 60 percent¹¹¹. The situation is especially severe in central and southern Iraq where irrigation has been most extensive. Rapid rehabilitation of irrigation and drainage systems can contribute to rapidly raise agriculture productivity levels in the country and reduce food imports and would have very high social and economic returns.

¹¹¹ UNCCD, 2017. Land Degradation Neutrality Target Setting National Report

183. **Legally established Water User Associations (WUAs).** Law 11 of 2012 (fourth amendment to law 12 of 1995 under the legislation on maintenance of irrigation and drainage systems) gives control of the distribution of inland waters to beneficiaries' associations, which must be established by users of common source of water. Beneficiaries' associations are responsible for increasing the efficiency of water use and reducing waste; achieve a fair distribution of water amongst them; contribute to the resolution of the conflicts between them as well as maintain the facilities of irrigation and drainage projects. Farmers are expected to comply with rules of the agricultural projects, avoiding waste or illegal activities such as establishing fishponds or quarries in the reclaimed land. The legislation is linked with the law on the maintenance of systems for irrigation and drainage (No. 12 of 1995).
184. **National policies and development plans on water resources.** MoWR oversees water management—assessment, water allocation per sector, monitoring, supply, and supervision of irrigation and drainage projects. Iraq's 2008 Water Law № 50 is the legislation on water management and use. In Iraq, water is a publicly owned good that can be exploited through procurement of a license. The Water Authority defines the amount of time and duration of use rights. The law sets the order of priority for water exploitation and defines the pathways to define, develop, grow, and utilize the country's water resources. The law also lists other aspects of water regulation, including ownership, management responsibilities, licensing, resource preservation from pollution, and trans-boundary water resource management. GoI has developed the Iraq Reconstruction and Development Framework (IRFD), which contributes to the Iraq Vision 2030. Iraq's National Development Plan (NDP) is the overarching development plan for the country. The NDP lays out the goals for the water sector, including on agriculture and irrigation, and the means to achieve them. GoI formulated a 2018-2022 NDP version designed to enable the Iraqi economy to take off and shift from an oil-dependent economy to expand to other key sectors such as agriculture and increase income distribution and gender equality. NDP defines the roles of the public and private sectors and civil society in achieving development, economic, human resources, and environmental goals. NDP's targeted growth rate for the agriculture sector is 8.4 percent in the period 2018-2022 with a 3.4 percent investment to achieve this goal¹¹².
185. **National Strategy on Water and Land resources in Iraq (SWLRI).** MoWR began reforming the national water sector in 2010 - The formulation process of the National Strategy on Water Resources and Land Management of Iraq (SWLRI) involved 14 pertinent ministries, making it a comprehensive strategy for water and land resources. SWLRI was spurred by the realization that there is a steady decreasing trend in meeting water demand until 2015 and prediction of critical shortage by early 2020. The Government's "Strategy for Water and Land Resources in Iraq" reviewed and updated to match assessed availability of water resources, measured against needs for human, animal and irrigated farming use (with a focus on retaken areas of central Iraq), including action plans for more efficient use of irrigated water. The Government of Iraq is predicting that the river flows in the middle and downstream areas of both rivers will not decrease because it anticipates a large extension of its water-saving policy for the irrigated agriculture sub-sector (SWRLI). The Government also has high expectations for irrigation projects through the promotion of the water-saving technologies. The comprehensive plan to develop water and land resources in Iraq until 2035 is based on the optimal use of those resources, and the integrated water resources management using modern technologies and advanced planning tools, in order to ensure the requirements of water security, food, energy and environmental preservation. It also aims to determine the priorities for infrastructure development for projects of major sectors engaged with water use that meet the requirements of sustainable development.

¹¹² GoI, 2018b. National Development Plan 2018-2022. Ministry of Planning of Iraq. https://www.iraq-jccme.jp/pdf/archives/nationaldevelopmentplan2018_2022.pdf

Weaknesses

186. **Increasing water scarcity.** Iraq was considered rich in its water resources compared to other countries in the region; however, current water use for all purposes far exceeds renewable supplies. Construction of dams on the Tigris and Euphrates and their tributaries outside the border of Iraq, and the growing demand for water in Turkey and Syria has significantly reduced inflows from Tigris and Euphrates Rivers. The decline in the inflow of water is further exacerbated by various reasons including over exploitation and climate change. Climate change would affect water resources situation in Iraq negatively. This will lead to severe variations in incoming water from Tigris and Euphrates Rivers, causing floods or drought. Furthermore, rainfall in Iraq has decreased compared to past decades, which expanded desertification. The supply will be reduced from 43 to 17.61 BCM between 2015 and 2025 while current demand is estimated to go from 66.8 to 77 BCM¹¹³. The annual share of renewable freshwater resources per capita in Iraq declined from 4,587 m³ in 1964 to 998 m³ in 2014¹¹⁴.
187. **Weakness of government structures.** The Government of Iraq (GoI) has limited institutional capacity of advisory and technical services. The capacity of the MoA and MoWR and other government institutions to provide services to the agriculture sector has drastically deteriorated over the past 20 years mainly through budget cuts reducing the number and quality of human resources. Many agriculture research assets including buildings, labs and farms have been damaged. Iraq lacks an extension and training strategy with an adequately operating budget involving effective decentralization, privatization, gender empowerment, farmer participation, use of modern information systems, as well as links with research institutions such as universities, the private sector and support to women and youth. In addition, GoI has a slow recovery capacity and there is a need to address the significant sector specific data gaps, which hinder the development of targeted agricultural policies and their adequate implementation.
188. **Eroded authority of traditional farmer organizations.** The authority of traditional farmer organizations (WUAs, Cooperatives, farmer associations, etc.) has weakened due to the unrest of the last two decades, and the various land reforms that fragmented ownership including tenure reform associated with irrigation development. A JICA project to support the establishment of WUAs reports that the project faced various challenges such as limitations of putting into practice what WUAs had learned and thus necessitating further trainings¹¹⁵. Revision and consolidation of WUA-related laws and regulation were also challenging. Political decisions stopped the collection of water fees and becoming part of WUAs is arbitrary. These factors have eroded the authority and incentives for WUA participation and for fair and equitable water resources distribution.
189. **Deteriorated irrigation and drainage infrastructure.** Existing water facilities have not been updated or adequately maintained, and the functionality of the water system has decreased significantly. Most of the conveyance canals is in state of disrepair because of poor maintenance and most of the drainage canals are non-functional due their lack of cleaning. Water losses in irrigation schemes, all over Iraq, are substantial. Water is conveyed to farmers' fields through very poorly maintained distribution systems made of earth canals and ditches, which suffer significant water losses because of infiltration, seepage, or leakage. The afore-mentioned issues are amplified due to budget constraints and delays to improve the systems. For example, MoWR's budget was cut drastically from

¹¹³ IFAD-AF, 2018. Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC). Project proposal. www.adaptation-fund.org/project/building-resilience-agriculture-sector-climate-change-iraq-brac-2/

¹¹⁴ IFAD-AF, 2018. Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC). Project proposal. www.adaptation-fund.org/project/building-resilience-agriculture-sector-climate-change-iraq-brac-2/

¹¹⁵ JICA, 2021. Project for Sustainable Irrigation Water Management through Water Users Associations in the Republic of Iraq. Final Report

USD 1.7 billion in 2013 to USD 50 million in 2017¹¹⁶. Largely, financial constraints prevent the Iraqi government from repairing facilities and implementing comprehensive approaches in line with SWLRI.

190. **Irrigation water supply management is inefficient.** Iraq's water facilities have been deteriorating over the last decades due to poor maintenance, poor water management and the impact of conflict and war. Iraq's water supply is inefficiently managed across the irrigation system due to a lack of water budgeting and poor delivery mechanisms. Current irrigation efficiency is estimated at 30 ~40 percent where approximately 20-24 percent of these systems have concrete lining¹¹⁷. Insufficient levelling within plots also results in water loss, in particular flood irrigation. Water is also lost due to improper gate operation at the weirs and intakes. Some farmers arbitrarily pump water up to their own lands where there are open channels. The policy allowing farmers to pump water freely into their respective fields with no Irrigation Service Fee (ISF) does not block farmers from wasting water. The conventional thinking that "water is free" also causes inefficient use of water - irrigation water has not been priced properly. Low farming technologies, improper practice of intermittent irrigation and lack of agricultural inputs are some of the other reasons. Additionally, Iraqi farmers have had a longstanding reliance on flood irrigation, using techniques that are water intensive. Much water is wasted either directly to the Gulf or through evaporation due to a lack of irrigation planning and water harvesting¹¹⁸.
191. **Policy, Governance and Institutional Issues.** Iraq is in the middle of a triple political, security and socio-economic transition. The overall constraints relate to inadequate policies and weak institutions for good political and socio-economic governance. According to a 2014 report by the Centre for strategic and International Studies (CSIS) on Iraq's economic and governance crisis, fundamental political and economic reforms are required to achieve any meaningful form of unity and stability and to overcome the sectarian and ethnic divisions in the country¹¹⁹. Similarly, a recent World Bank report enabling business of agriculture assessment (2019) reveals weak policy and regulatory framework in key agricultural markets in Iraq relative to other countries. Iraq scored 22.62 out of a maximum score of 100 in the Enabling the Business of Agriculture 2019 ranking. Iraq scored low in other report rankings – it scored zero out of a maximum of 10 in the securing water category. Iraq had the lowest average score in the Middle East and North Africa (MENA) region¹²⁰. The deficient policies and governance have led to the disrepair of rural economic infrastructure namely roads and irrigation networks.
192. **Limited access to rural financial services.** 27 percent of firms identified access to finance as a major impediment to develop their operations. For small firms, this was in effect the top constraint (WB, 2019a). Access to finance remains an issue given the poor depth of the banking system and the underdevelopment of non-banking financial institutions especially micro-credit and other schemes. Over the past few years, Microfinance Institutions (MFIs) in Iraq have emerged as credible sources of financing for low-income households and entrepreneurs, both underserved by conventional banks. Microfinance services in Iraq, however, are still nascent and far from meeting their full potential. Similar to many countries in the MENA region, MFIs in Iraq were set up as non-governmental organizations (NGOs) supported by a steady influx of donor funding. While these NGOs were initially able to grow through donor support, they are now struggling to meet increasing client demand as donor resources have dwindled, preventing them from making the necessary investments in capital and infrastructure

¹¹⁶ Von Lossow, T. 2018. More than infrastructures: water challenges in Iraq. Planetary Security Initiative of the Clingendael Institute. The Netherlands. www.clingendael.org/sites/default/files/2018-07/PB_PSI_water_challenges_Iraq.pdf.

¹¹⁷ JICA, 2016b. SPECIAL ASSISTANCE FOR PROJECT IMPLEMENTATION FOR "IRRIGATION SECTOR LOAN" THE REPUBLIC OF IRAQ. FINAL REPORT

¹¹⁸ Price, R.A, 2018. Environmental risks in Iraq. K4D Helpdesk Report. Brighton, UK: Institute of Development Studies. www.gov.uk/research-for-development-outputs/environmental-risks-in-iraq.

¹¹⁹ IFAD-AF, 2018. Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC). Project proposal. www.adaptation-fund.org/project/building-resilience-agriculture-sector-climate-change-iraq-brac-2/

¹²⁰ WB, 2019a. Enabling the Business of Agriculture 2019. Washington, D.C: World Bank. Doi: 978-1-4648-1387-0. License: Creative Commons Attribution CC BY 3.0 IGO. <https://eba.worldbank.org/en/reports>.

to meet growing client demand¹²¹. The lack of financial resources constrains adaptation action in that it limits the ability of farmers to purchase climate-proofing inputs and equipment (e.g. greenhouses, field covers and irrigation system), impedes shift to water-efficient crops and prevents farmers from engaging in non-agricultural livelihoods in districts that are worse hit by the water crisis (e.g. small business)¹²².

Opportunities

193. **Application of integrated water resources management principles in policy making.** Gol has shown political commitment to ensuring adequate supply and appropriate water quality both for human consumption and for economic development. The creation of the MoWR focuses on strategic directions aiming at utilization of sustainable use of water and land conservation as opposed to the traditional role of the suppliers of water, abundant and unlimited, which promotes the management of water resources among all the relevant sectors and institutions. Iraq's SWLRI is another demonstration of political will to develop sustainable integrated natural resources management. Gol has adhered to major Multilateral Environmental Agreements (MEAs). The Law of Environmental Protection and Improvement Nº 27 of 2009 has organized the technical and legal framework of the Ministry of Environment (MoE), by including provisions for the protection of human, environment and biodiversity from water, air, and soil pollution. There are other provisions related to organizing environmental control, sanctions for polluting activities and compensation for damages. MHE is seeking through the Centre of Climate Change to develop a national strategy for adaptation to climate change impacts. Gol ratified the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol and it became a member of the United Nations Convention to Combat Desertification (UNCCD) in 2009 (first national report submitted in 2014). The framework of the National Strategic Plan for Combating Desertification (NSPCD) and the National Biodiversity Strategy and Action Plan (NBSAP) have established a national coordination mechanism, supported by the MHE, MoWR and MoA.

194. **Opportunity for saving water through off farm and on farm interventions.** Iraq's SWRLI states that irrigation efficiency can be increased from the current 30-40 percent to 60 percent by 2035 by using modern irrigation methods (pipe, sprinkler, and drip irrigation) and canal lining. Conveyance efficiency of lined canal can be increased to 0.9 (90 percent) and operation efficiency to 0.95 (95 percent). The intention is to incorporate about 850,000 ha of land from outside of government projects, or 14.2 percent of the total irrigated area, in irrigation development. SWRLI also aims to increase the current cropping ratio of 85 percent to 115 percent¹²³. MoWR manages off-farm interventions by constructing and operating water conveyance structures. On-farm operations are under Iraq's Ministry of Agriculture (MoA), which is piloting new practices aimed at productivity enhancement and efficient use of natural resources and adaptation to climate change. These include:

- the national programme for the use of on-farm modern irrigation systems;
- the national programme for the improvement of wheat production;
- the national programme for the development of drought and salinity tolerant crops;
- the program for the establishment of an agricultural meteorology network;
- the programme for the genetic improvement of local animal breeds; and
- the conservation agriculture project.

¹²¹ WB, 2014b. The Legal and Regulatory Framework for Microfinance in Iraq. Report

¹²² WB, 2014b. The Legal and Regulatory Framework for Microfinance in Iraq. Report

¹²³ JICA, 2016a. Data collection survey on water resource management and agriculture irrigation in the republic of iraq. Final Report. <https://openjicareport.jica.go.jp/pdf/12253860.pdf>

195. **Climate-smart agricultural practices.** There is evidence of a growing interest for climate-resilient production infrastructure (e.g., greenhouses) and modern irrigation systems (e.g., drip) as farmers seek to optimize water use on farms, enhance crop diversification, and improve soil management practices. For instance, greenhouse farming is practiced by small-scale vegetables producers in Al-Zubair (Al-Basrah), where water salinity is relatively low, and farmers have access to alternative water sources (shallow wells). Yet, uptake remains limited due to, inter alia, constrained access to and high costs of equipment¹²⁴.
196. **Large agricultural growth opportunities.** Iraq has great agricultural growth potential if it rebuilds key irrigation and transport infrastructure. Iraq's agriculture and agribusiness have large opportunities for development, in the short to medium-term through import substitution and export on regional markets, and, in the long term, by integrating into global agri-business value chains. According to the World Bank, the base for improvement exists, besides dates and cereals, there are several fruits and vegetables with significant volume of production and that exports are already taking place (World Bank, 2019b). Iraqi farmers have a comparative advantage in production of irrigated fruits and vegetables, and irrigation is readily available in the southern part of the country. Iraq's domestic market offers an immediate consumer base to sustain expansion of production.
197. **Iraq is strategically positioned to derive a competitive advantage through trade.** Iraq is strategically positioned to have a competitive advantage through trade. With road and other logistics investments, in the short-to-medium term, the country has the potential to export to markets in close geographic proximity. In the longer term, it could even develop the capacity to export to other markets that are currently out of reach (South and Central Asia, and Europe) should Iraq overcome infrastructure, capacity building and other barriers mentioned above¹²⁵.

Threats

198. **Policy and market drivers.** Inefficient price and subsidy policies manifested by depressed producer prices and non-transparent markets because of the heavy subsidy for imported food items. Limited access of smallholder farmers to remunerative market prices, rural financial services, and affordable investment loans, performing extension services and incentives for the adoption of new technologies. High input prices - seed, fertilizer, pesticides, fuel, farm machinery and labour. The volatility of oil prices and the impact of the pandemic have both amplified Iraq's economic afflictions, reversing two years of steady recovery. These twin shocks have also deepened existing economic and social fragilities, adding to public grievances that existed pre-COVID-19. Gol's ability to provide a stimulus package for an economy highly dependent on oil exports for growth and revenue has been limited by this absence of fiscal space. As a result, the country has experienced the largest contraction of its economy since 2003¹²⁶.
199. **Unsustainable environmental and natural resource management.** Iraq's environmental conditions have suffered greatly from the impact of poor policies on pollution and resource management. The years of conflict left chemical pollution affecting the livelihoods and safety of an estimated 1.6 million Iraqis¹²⁷. The natural resources for agriculture use, namely land, water, forest and pasture have been unsustainably managed with underground water resources overly exploited beyond their recharge capacity. The percentage of dried Mesopotamian marshlands is now 90 percent. This

¹²⁴ IOM, 2020. Water Quantity and Water Quality in Central and South Iraq: A Preliminary Assessment in the Context of Displacement Risk

¹²⁵ WB, 2019b. Turning the Corner: Sustaining Growth and Creating Opportunities for Iraq's Youth. Iraq Economic Monitor. World Bank. Washington, D.C. www.worldbank.org/en/country/iraq/publication/iraq-economic-monitor---fall-2019

¹²⁶ WB, 2021a. The World Bank in Iraq. Overview. World Bank. Washington, D.C. [Visited on: July 9, 2021]. www.worldbank.org/en/country/iraq/overview

¹²⁷ IFAD-AF, 2018. Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC). Project proposal. www.adaptation-fund.org/project/building-resilience-agriculture-sector-climate-change-iraq-brac-2/

resulted in increasing threats of land degradation, desertification, water shortage, increased soil and water salinity, low irrigation efficiency, reduced soil fertility and low forest cover of 4.0 percent.

200. **Salinization.** Irrigated areas are confronted with salinization problems, which significantly depress yields. As water shortages are projected to worsen with climate change, salinization problems will worsen even more without deliberate strategies to adapt. FAO estimates that approximately 60 percent of cultivated land is negatively affected by salinity, and 20-30 percent has been abandoned. Furthermore, about 75 percent of the irrigated area of the Mesopotamian plain (more than 2 million ha) is moderately saline and another 25 percent has levels of salinity that have converted once productive lands into salt-affected wastelands. Over 39 percent of Iraq's agricultural land suffered a reduction in cropland between 2007 and 2009. Farmers of saline soils are using 30 percent of their land for cropping; they are 50 percent of the expected yields causing cropping systems to shift from high-value to lower-value crops¹²⁸. If this is not corrected, salinization is bound to lead to land degradation phenomena in central and southern Iraq and will continue to result in sluggish productivity growth in agriculture.
201. **Desertification.** As much as 31 percent of Iraq's surface is desert¹²⁹. Years of inappropriate farming practices and mismanagement of water resources have exacerbated the effects of an already dry climate and contributed to increasing rates of desertification. Declining fertility, high soil salinity, erosion and the extension of sand dunes are pervasive problems. The Government of Iraq reports that 28 percent of the country's land is arable, of which an average of 100,000 donums is lost each year to degradation. Meanwhile 39 percent of the country's surface is estimated to have been affected by desertification, with an additional 54 percent under threat. Because of declining soil moisture and lack of vegetative cover, recent years have witnessed an increase in the frequency of vast dust and sandstorms, often originating in the western parts of Iraq¹³⁰.
202. **Transboundary water issues.** Iraq is heavily dependent on the Euphrates and Tigris River basin, which provide nearly all the country's water supply. The transboundary Twin Rivers originate in Turkey, which has introduced water infrastructure thus reducing water flows and quality into Iraq. The first conflicts over distribution and utilization of these shared resources occurred when Turkey, Syria and Iraq began to unilaterally develop large water infrastructure projects in the 1970s: Iraq's Tharthar Canal Project, Syria's Euphrates Valley Project, and Turkey's Southeastern Anatolia Development Project. Iraq does not have formal water cooperation treaties with its neighbouring riparian states. Lack of agreements about water resources allocation between riparian states and neighbouring countries is a big threat to the economic development of the country. Iranian projects, as well as diverting the stream of some rivers inside Iran and discharging the drainage water towards Iraqi rivers, have also affected the Iraqi joint rivers with Iran. Therefore, the projects of these three states would create two main challenges by 2035, as the following:
- Decline of Iraqi water resources by 1 billion m³ annually will lower water resources at the borders from 43.7 billion m³ in 2015 to 28.5 billion m³ by 2035, in addition to water losses that lower irrigation efficiency to less than 50 percent.
 - Increase in saline concentrations from 320 PPM to 500 PPM in Tigris River, and from 540 PPM to 930 PPM in Euphrates River.
203. **Climate change impacts.** Climate change will exacerbate Iraq's water scarcity calling for urgent action. Climate change will significantly affect rainfall patterns and temperature in Iraq, increasing the

¹²⁸ IFAD-AF, 2018. Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC). Project proposal. www.adaptation-fund.org/project/building-resilience-agriculture-sector-climate-change-iraq-brac-2/

¹²⁹ Ministry of Environment Annual Report 2010

¹³⁰ Gol. 2014. Fifth National Report to the Convention on Biological Diversity Iraq. Ministry of Environment of Iraq.

country's vulnerability to drought and environmental challenges. The flow of the Tigris and the Euphrates is expected to decrease further by 2025, with the Euphrates declining by more than 50 percent and the Tigris by more than 25 percent¹³¹.

204. **Slow institutional transformation.** Iraq's centralized, control-oriented institutional arrangements have resulted in weak accountability to users, no pricing strategy, and a dependency on government financing with limited attention to service standards, all at the expense of a modern, robust hydrological infrastructure. The country's archaic water collection, storage, and distribution infrastructure led to significant losses through evaporation, wastage, and leakage. Complex political conditions have led to uncertainty surrounding water policies – some policies are contradictory on roles and responsibilities between the central government and governorates. Iraq's slow transformation is also linked with corruption. Transparency International (TI) states that in Iraq political corruption remains a challenge depriving its people of their basic rights, including access to safe drinking water, health care, uninterrupted electricity, employment opportunities and an adequate infrastructure. TI's Corruption Perception Index gave Iraq a low score (21 out of 100 the latter number being the "cleanest") meaning that Iraq ranks high in corruption practices¹³². The recovery of the government capacity services is very slow, and there is a need for solid analysis and data to help identify needed interventions to identify policy needs and increase competitiveness of the agriculture sector and enhance its contribution to rural development and poverty alleviation.

Main Policy framework, strategy, laws

205. Iraq's water resources development and management plans initially evolved between the 1960s and 1980s. In 2005, USAID assisted the MoWR in developing a National Water Plan. The National Development Strategy (2007-2010) included regulations on integrated water management. In addition, UNDP developed a strategic framework of assistance towards integrated water management and institutional development¹³³. More recently (2015), MoWR completed the Strategic Water and Land Resources for Iraq (SWLRI) plan that used Iraqi experts along with international experts to develop tools that were then used to compile plans under various scenarios of water supply and development of land in Iraq and the riparian countries. The plan included recommendations for infrastructure developments to impact water saving projects. However, the war with ISIL as well as the financial crisis from reduced income due to low oil prices has resulted in no project implementation. This makes the situation even more difficult for Iraq and the current situation is not sustainable. Iraq has to revise its strategy now in view of changing conditions since the plan was completed.

Regional water-diplomacy

206. Iraq's most important riparian neighbour, arguably, is Turkey. The country is home to the sources of both the Euphrates and the Tigris. Through its southeastern Anatolia Project, Ankara has constructed various dams on both rivers. This has allowed it to regulate the downstream flow to Iraq (and Syria on the Euphrates). Water policymaking in Ankara thus has repercussion for communities across Iraq. More specifically, a reduction in the flow of the Tigris has especially adverse effects for the northern, central, and finally the southeastern areas of Iraq. Reduced discharge of the Euphrates negatively affects the Anbar governorate and the adjoining provinces further south. Iraq has also two other upstream neighbours, Iran and Syria, whose impact has often been overshadowed by the debate on Turkey's infrastructure projects. While the Tigris originates in Turkey, tributaries coming from Iran

¹³¹ UN, 2013. Water in Iraq: Factsheet. United Nations Joint Analysis and Policy Unit. <https://reliefweb.int/sites/reliefweb.int/files/resources/Water-Factsheet.pdf>.

¹³² Transparency International, 2021. Corruption Perception Index Iraq. Transparency International. <https://www.transparency.org/en/cpi/2020/index/irq#>.

¹³³ UNDP, 2016b. Strengthening Iraq's Capacity for Sustainable Water Resources Management. Final Project Report

have been estimated to contribute at least one-fifth of the river's flow. Further south cross-border streams from Iran also account for around 40 per cent of the Shatt al-Arab.

207. These three states have already encroached the rivers running towards Iraq and are likely to further monopolize them in the future. Both Iran and Syria have been facing unrest and conflict that has been linked to issues of water availability. With this resource in decline, both Tehran and Damascus may further restrict the downstream discharge. While Turkey has been relatively less prone to water scarcity compared to its southern neighbours, when water resources do become strained, Turkish authorities prioritize their own supply over that of the neighbouring countries. Moreover, there is also the precedent of Ankara manipulating river flows for political purposes¹³⁴. The issue of dam construction on the Tigris and Euphrates and their tributaries, while tied to economic and industrial strategy in Turkey and Iran, cannot be separated from regional politics and political leverage.
208. There is no global agreement between Iraq, Syria, and Turkey for allocating water resources from the Euphrates and Tigris. Despite a long history of contacts on the Euphrates, existing water sharing arrangements between the three parties are the subject only of bilateral protocols. The upstream riparian control much of the upstream water. A multilateral pollution abatement agreement was signed in 1978 but it has never been implemented¹³⁵. The lack of cooperation between the three riparian has prevented the development of an integrated water management plan for the entire basin. It also creates particular risk for Iraq as the downstream riparian of a diminishing and increasingly uncertain flow.
209. While this is not a new crisis, the Ilisu dam began filling in June 2018, causing the Tigris to briefly empty, causing an outpouring of concern in Iraq and leading to emergency talks between Baghdad and Ankara. On June 7, 2018, Turkish Ambassador for Iraq announced that after talks with the Iraqi Ministry of Water Resources (MoWR) Turkey had re-opened the gates of the new dam and that filling would recommence on July 1, 2018. However, the crisis is far from over. Going forward, it will require a renewed focus within Iraq, Turkey, in the region and within the international community to find an amicable resolution to a complex transboundary water dispute¹³⁶.
210. The National Development Plan (NDP). The recent policy directions in Iraq's development give significant priority to the agriculture sector. Government of Iraq has developed the Iraq Reconstruction and Development Framework (IRFD), which contributes to the Iraq Vision 2030 and National Development Plan (2018–2022). Guided by IRFD, Iraq's United Nations Country Team (UNCT) formulated the Recovery and Resilience Programme (RRP), which prioritizes three (out of nine) components to be implemented in the retaken areas with high priority: (i) preventing violent extremism; (ii) restoring communities; and (iii) restoring agriculture and water systems.
211. The National Development Plan is the overarching supreme development plan for the nation. In the NDP, the goals for water resources sector, including agriculture and irrigation, are specified, and means for achieving them are also set. The National Development Plan (NDP) 2018-2022 is the most significant step forward in Iraq's sustainable development journey¹³⁷. The common vision for agricultural and water resources sector calls for "agriculture to meet the demands of the national food basket as well as to contribute to the rights to security and to sustain the diversified economic foundation". To realize such vision, strategic objectives and quantitative goals are set and various

¹³⁴ IPCS, 2019. Water Scarcity in Iraq: From Inter-Tribal Conflict to International Disputes. Special report #203

¹³⁵ FAO, 2009. Transboundary River Basin Overview – Euphrates-Tigris. Aquastat report

¹³⁶ Iraq Energy Institute, 2018. Towards Sustainable Water Resources Management in Iraq

¹³⁷ GoI, 2018b. National Development Plan 2018-2022. Ministry of Planning of Iraq. https://www.iraq-jccme.jp/pdf/archives/nationaldevelopmentplan2018_2022.pdf

measures to achieve the strategic and quantitative goals are described. NDP 2018-2022 takes as a frame of reference the national goals of the sectoral strategies, national documents, and international Sustainable Development Goals 2015-2030 – in order to ensure that the identification of goals and priorities address the Iraq Vision 2030. Therefore, this NDP will be the first of three NDPs covering the period 2018-2030.

212. The Plan recognizes several challenges for agricultural development. These include limited capital investment, outdated laws and legislations, irrigation wastewater, environmental degradation, and climate change, etc. This has led to the decrease in local agricultural production and heavy reliance on imports. Therefore, the National Development Plan aims to achieve high yields for cereals – especially wheat – as well as for fruits and vegetables, improve competitiveness of the agriculture sector, agricultural diversification, improvements in production and post-harvest technologies, extension services and rural infrastructure and facilitate growth in areas such as food processing and strengthening value chains.
213. The National Strategy for Water Resources and Land Management for Iraq (SWLRI), Led by MoWR, strategic documents on water resources and land resources development (Strategy for Water & Land Resources in Iraq: SWLRI) has been formulated. The formulation process involved 14 pertinent ministries, making it a comprehensive strategy for water and land resources. SWLRI was spurred by the realization that there is a steady decreasing trend in meeting water demand until 2015 and prediction of critical shortage by early 2020. The Government’s “Strategy for Water and Land Resources in Iraq” reviewed and updated to match assessed availability of water resources, measured against needs for human, animal, and irrigated farming use (with a focus on retaken areas of central Iraq), including action plans for more efficient use of irrigated water. The Government of Iraq is predicting that the river flows in the middle and downstream areas of both rivers will not decrease because it anticipates a large extension of its water-saving policy for the irrigated agriculture sub-sector (SWRLI). The Government also has high expectations for irrigation projects through the promotion of the water-saving technologies. The comprehensive plan to develop water and land resources in Iraq until 2035 is based on the optimal use of those resources, and the integrated water resources management using modern technologies and advanced planning tools, to ensure the requirements of water security, food, energy and environmental preservation. It also aims to determine the priorities for infrastructure development for projects of major sectors engaged with water use that meet the requirements of sustainable development.
214. The Iraq Vision 2030. The Iraqi vision 2030 is a road map and an action plan, which all ministries and local governments should adhere to ensure the vision realization. The vision embraces a new social contract between the state and its citizens to enhance their trust in the government and provide opportunities for self-development, work and generating income. The state seeks to develop the economic activities and pave the way of reforms, which tackle the past challenges and provide the needed development strategies in light of the external and internal challenges and the national capacities particularly a diverse people, natural resources and a strategic location. The Iraq Vision involves five sections which express Iraq’s national goals (man building, good governance, a diversified economy, safe society, and sustainable environment) and meet the UN sustainable development pillars: people, prosperity, planet earth, peace, and partnerships¹³⁸.

¹³⁸ GoI, 2019b. Iraq vision for Sustainable Development 2030

215. National Water Council Law. Laws and regulations related to National Water Council (NWC) were adopted in February 2015. The National Water Council¹³⁹ has two supreme committees, one for international water resources, and the other for domestic water resources. The former oversees international rivers and watersheds, implement groundwater strategies, negotiate with neighbouring countries in matters pertaining to economic and technical aspects of international water resources, technical aspects related to the water rights, implement legal investigation, and participate in international conference and forum related to Iraq's rights. The latter, in the areas related to the water and land resources, makes strategic proposals based on water allocation plan proposed by MoWR and policy direction of the federal Government in survey of effective use. It is also stipulated that the committee proposes and makes decision on strategies on effective utilization of water resources, agriculture and environment. In addition, the NWC organizes academicians and experts, and has the ability to conduct studies on water resources, agriculture and environment.
216. Law relative to maintenance of systems for irrigation and drainage (No. 12 of 1995). This Act qualifies irrigation networks; provides for the management and maintenance of irrigation and drainage networks, including natural rivers and water basins; provides for the establishment of a public body called the General Body for the Operation of Irrigation Projects; and defines duties of farmers in relation with the management and exploitation of agricultural lands and the use of water.
217. Law No.11 of 2012 - Fourth Amendment of Law No. 12 of 1995. Main objective of this Amendment consisting of five articles is giving the control of the distribution of inland waters to beneficiaries' associations. These associations have to be established by users of common source of water. Other tasks of the beneficiaries' associations are raising the efficiency of water use and reduce waste; achieve a fair distribution of water among the beneficiaries; contribute to the resolution of the conflicts between the beneficiaries; maintaining the facilities of irrigation and drainage.
218. Law No. 2 of 2001 on Conservation of Water Resources. This Law, consisting of 18 articles divided in 4 Chapters, regulates the utilization of water for purposes other than domestic use. The four Chapters are: Definitions and Applications (1); Provisions on the discharge of wastes into the public waters (2); Plans of public waters protection (3); and General Provisions (4). Purpose of this Law is to establish rules on management, utilization and preservation of Iraq's water resources.
219. Ministry of Water Resources Law No. 50 of 2008. This Law, consisting of 16 articles divided in 4 Chapters, aims at establishing the Ministry of Water Resources and creating the legal and technical framework for institutionalization of water resources management in the country. Main tasks of the Ministry are: to plan for the investment in water resources in Iraq; to regulate utilization of ground and surface water to achieve the perfect use of water resources; to develop water resources; and to determine water sources and uses.
220. Irrigation Law No.83 of 2017. Repeals Irrigation Law No. 6 of 1962. This Law consisting of 16 articles aims at preserving the work of water resources and preventing damage to them together with preventing overflow of water quotas and to up-to-date, the fines imposed on offenders. It establishes among others that the Ministry of Water Resources is committed to carry out the work of public water resources (restoration, maintenance and supervision) and establish, maintain or improve rivers, bridges, dams, buildings, reservoirs and banks.

¹³⁹ NWC is constituted by the Prime Minister (Chairman), Deputy Prime Minister, Ministry of Foreign Affairs (MoFA), Ministry of Water Resources (MoWR), Ministry of Agriculture (MoA), Ministry of Power (MoP), Ministry of Industry (Mol), Ministry of Public Works (MoPW), Ministry of Environment (MoE), Ministry of Local Governments (MoLG), the National Security Advisor (NSA), and the ministers of the agriculture and water resources provincial office in the Kurdish district

221. WUA instructions. WUA instructions, translated literally from official Arabic title: "The instruction No.1 on implementing laws and regulation 2014 regarding water sharing among Water resource users." Based on a preceding Article 5 paragraph 3 c of the "Law No. 12 of 1995 on the maintenance of the irrigation and drainage network", it was enacted in April 2014 to define the establishment procedures as well as the rights and obligations of WUAs.

222. Water fee law. Bill relating to resuming water fee collection has been submitted to the Iraqi parliament in the second half of 2014. According to the Bill, water fees are set at 5,000 IQD/dunum for each cropping season. In cases where cropping is done twice, winter and summer, in a year, the fees will be 10,000 IQD/dunum. In each Directorate of Water Resources, Water Resources Bureau has stationed staff to collect water fees. Fine is imposed on default and measure for repeated/continued defaults is spelled out. Weak law enforceability remains a challenge.

Main past, existing and planned projects

223. The following projects in the water sector and water management were identified (Table 32):

Table 34: Past, existing and planned projects in water

Project	Targeted governorate	Budget (USD)	Timeframe	Purpose
IFAD/AF, 2019. Building Resilience of the Agriculture Sector to Climate Change in Iraq	Muthanna, Qadisiya, Missan and Thi Qar	10 million	2019-2025	To strengthen the agro-ecological and social resilience to climate change in the four target governorates, by enhancing water availability and use efficiency, and promoting adaptive agriculture production systems and technologies for improved livelihoods and food security of rural households.
IFAD, 2017. Smallholder Revitalization Project	Muthanna, Qadisiya, Missan and Thi Qar	31.84 million	2017-2025	To enable poor smallholder farmers to improve crop and livestock productivity, resilience to climate change and diversify incomes. The project would assist 20,000 rural households improve their livelihoods, incomes and food security through investments in productive infrastructure, adoption of improved crop practices and varieties better adapted to the conditions in the project area, improved livestock management practices, asset creation, and skill development.

WFP/GCF, 2019. Promoting Climate Resilient Livelihoods of Food Insecure People in Southern Iraq	Qadisiya, Thi-Qar and Basra.	10 million	2019-2023	To introduce practices that build the resilience of vulnerable households whose livelihoods are at risk from climate change. This will be achieved through: increased irrigation efficiency and water availability; enhanced agricultural productivity through the promotion of stress tolerant seed varieties; fostering multi-level efforts for mentoring and capacity strengthening; improved climate decision-support tools and services; as well as livelihood diversification through provision of climate-resilient economic assets.
IOM, 2020. Water Quantity and Water Quality in Central and South Iraq: A Preliminary Assessment in the Context of Displacement Risk. International Organization for Migration.	Qadisiya, Najaf, Babylon, Wassit, Kerbala, Missan, Muthanna, Thi-Qar and Basra	Not available	2019-2020	Study to assess water shortage induced displacement in Central and South Iraq:
JICA, 2020. Irrigation Sector Loan (II)	Several governorates	146 million	2018-2026	To construct and rehabilitate irrigation and drainage system mainly in the basin of Tigris and Euphrates River. Provision of irrigation drainage pumps, and equipment and materials for maintaining the operation of irrigation channels in the areas where agriculture is important including the Governorate of Al-Muthanna. (phase II)
JICA, 2017. Sustainable Irrigation Water Management through Water Users Associations	15 governorates	Not available	2017-2021	To develop sustainable water management system under WUA and its dissemination. The project purpose is to develop the capacity of the relevant agencies on irrigated agriculture to develop the capacity of WUAs for irrigation water management in the pilot project sites

JICA, 2016. Irrigation Sector Loan (I)	Several governorates	86 million	2008-2018	To improve and upgrade the existing irrigation systems by the rehabilitation of pumps and related facilities and provision of necessary equipment and machineries for the operations and maintenance (O&M), thereby contributing to increasing agricultural production, creating medium-term and long-term job opportunities, and accelerating regional development.
JICA, 2014. Spreading Water Users Associations for Efficient Use of Irrigation Water.	15 governorates	Not available	2012-2015	To disseminate established water users association and spread water saving methods. The construction/rehabilitation of irrigation facilities and capacity development of the relevant persons are included.
UNDP, 2016. Strengthening Iraq's Capacity for Sustainable Water Resources Management.	Baghdad	2.45 million	2013-2015	To address water quantity and quality, this project was anchored with the Prime Minister's Advisory Commission (PMAC) to make an institutional response that will enable Iraq to ensure effective leadership for judicious and sustainable water governance and for ensuring riparian rights in the transboundary river context.
UNDP, 2014. Water resources decision support system for the MoWR o Iraq	Baghdad	2.65 million	2009-2014	To increase and improve management capacity of water resources in Iraq through provision of technical support, strengthening institutional capacity and public awareness, knowledge sharing and management.
WB, 2014. Emergency Community Infrastructure Rehabilitation Project	Al Muthanna, Al Amara, Nasiriya, and Sulaymaniyah	46 million ¹⁴⁰	2005-2016	The objective of the project is to generate near-term employment while addressing urgent rural irrigation, drainage and water infrastructure rehabilitation needs.
ICARDA, 2017. Iraq Salinity Project: Rehabilitation of irrigation and	Wasit and Babylon	Not available	2017-2018	Study to review and document the current state of irrigation and drainage infrastructure in two selected projects and assess the factors influencing irrigation delivery, irrigation management, and disposal of the

¹⁴⁰It is the total cost of the Emergency Infrastructure and Rehabilitation Project.

drainage infrastructure in Iraq				drainage effluent. It also aimed at highlighting the key deficiencies in the system that contributes to soil salinization and low land and water productivity. This information is finally used to draw investment plans for the pilot scale development of irrigation and drainage infrastructure.
FAO-GEF, 2020. Sustainable Land Management for Improved Livelihoods in Degraded Areas of Iraq (FSP)	Several governorates	3.55 million	2020-2024	Reverse land degradation processes, conserve and sustainably manage land and water resources in degraded marshland ecosystems in Southern Iraq for greater access to services from resilient ecosystems and improved livelihoods.
FAO, 2018. Restoring the Water Supply for Food Production and Livelihoods in post conflict areas	Several governorates	7.2 million	2018-2021	Increasing the resilience of farmers' livelihoods in crisis-affected liberated areas through rehabilitation of damaged infrastructure
FAO, 2018. Iraq: Restoration of agriculture and water systems sub-programme 2018–2020.	Anbar, Diyala, Kirkuk, Ninewa and Salah al-Din	90 million	2018-2020	To make a significant contribution to the United Nations' two-year Iraq RRP by fast tracking the social dimension of reconstruction and rehabilitation in the retaken areas of central Iraq.

Lessons learned from past climate change experiences

224. Climate smart agriculture (CSA) approach. Adoption of new methods such as the CSA approach are often slow when part of the benefits of the new approach are largely public while the costs (of adoption) are private. Policies are needed that can incentivize the adoption of new technologies and create the impetus for adoption. The required approach would vary with circumstances. It may entail public investments, access to credit, insurance to address risk aversion, or payments for ecosystem services (PES) in the agricultural sector, or changes in input tariffs.
225. Promotion of sustainable water uses. Approaches that maximize benefits that cut across multiple dimensions of the water-climate nexus are needed to address water deficits. A smarter allocation of water across sectors will go a long way towards ensuring sustainable economic growth. Perhaps the most challenging but effective approach to enhancing efficiency and promoting more efficient water use is to provide incentives for more prudent use of water. The laws of demand and supply dictate that when water is provided cheaper, it is used more wastefully. In many countries, pervasive and perverse subsidies promote the cultivation of water-intensive crops like rice and

sugarcane in arid areas. The increasing competition for water calls for policy instruments to signal scarcity and promote more prudent and sustainable water uses.

226. Integrated approaches. Alternative technologies such as solar-powered pumps can reduce the pollution and greenhouse gas emissions associated with groundwater pumping but do nothing to ease the growing pressures on aquifers worldwide. These trades-offs between energy and water production are usually hidden, and rarely do they figure into cost-benefit assessments. However, integrated planning and management of infrastructure and investment projects can identify synergies that reduce trade-offs between the uses of water for energy and other requirements.
227. Water management. To maximize the project economic and social benefits, it is important to integrate the civil works development and rehabilitating irrigation and drainage infrastructure with improved agriculture and farming systems with farmer consultation for maximum synergies. Despite an adverse operating environment, infrastructure rehabilitation activities can be implemented cost effectively. Considering the current state of much of the irrigation and drainage infrastructure in the country, for rehabilitation purposes, a diagnostic performance assessment approach must be adopted, allowing an in-depth analysis of major shortcomings of an entire irrigation or drainage system to propose the necessary improvements considering an overall objective of restoring capacity, increasing efficiency, and improving O&M.
228. Project that develops a model to disseminate technology. In addition to defining the model, it is important to specify individual elemental technologies for improvement through the model and set quantitative indicators for each elemental technology. These indicators need to be organized so that the parties implementing the improvement can easily understand them. In addition, it is important that the parties involved in the improvement act with genuine conviction. For that purpose, communication that promotes the awareness of the parties involved in the improvement and motivates improvement is important. The baseline survey conducted at the model site can be positioned as a place for specifying elemental technologies applicable to the country concerned and motivating practitioners of elemental technologies. Conducting a baseline survey with such a sense of purpose leads to smooth model practice after the baseline survey, which in turn has a great impact on the performance of the model.
229. Recognizing strengths and weaknesses of collective action. The capacity of farmer institutions is key for project activities that require collective or group action. However, recognizing that the cooperative movement has not been a strong movement in this part of the world will help in identifying the limits of group action, avoid elite capture and at the same enable deriving some of the benefits of group action such as reducing transactions cost, aggregating produce for collective marketing, bargaining, and achieving economics of scale.
230. Risk mitigation strategies and participation of smallholder farmers. Small-scale farmers are willing to adopt improved production technologies, but they need to see results first. Given small scale farmers are risk averse, incentives to pay the cost of incremental inputs and services of new technologies for the first year, are essential to assist and encourage them to take risks.
231. Capacity building and training. Capacity building and training in the adoption of new technologies and assets is key for the effective use of any investments and needs to be accompanied by appropriate comprehensive course of training and skill development, introducing new technologies with proper training in the use of those technologies.
232. Early beneficiary participation in water management issues. Beneficiary participation, based on a preliminary agreement with the water users at the early stages of project's implementation, would

allow faster implementation of the irrigation works. Direct involvement of the beneficiaries in planning and implementation of O&M systems, even at a later stage, creates a sense of ownership among farmers, which is instrumental in achieving sustainable water management. To improve community participation, consultation of the farmer representatives and other decentralized entities, including local government representatives, on the design and objectives of the proposed activities is paramount. To further improve decentralization, the project management team could: (i) made the bidding documents available to the pertinent governorate in addition to Baghdad; and (ii) involved the pertinent focal persons in the MoWR regional directorates in the bid evaluation process.

233. Expanding participation of farmers in trainings. According to the final report of JICA “The Project for Spreading Water Users Associations for the Efficient Use of Irrigation Water”, the participants in the farmers’ training seemed to be influential persons in their governorate. While these people could help to expand the project activities to many other farmers in their governorates, the practical application of what the participants learned in the training course might not have materialized without the participation of farmers who engage in the agricultural work in the field. During technical trainings and/or seminars, it is essential that the participants be composed of responsible persons who engage in actual field agriculture in addition to local influential persons.
234. Establishment of water user associations (WUAs). WUAs shall be established and actively operating the improved irrigation facilities. Where WUAs have not been established, they need to be established as quickly as possible, and it will be necessary for them to operate an equal and efficient distribution of irrigation water. It is important to have new WUAs established one after another, and for these established WUAs to continuously evolve and develop.
235. Gender mainstreaming. Social norms made it difficult for female WUA members to attend the WUA general meeting directly, it was effective to incorporate activities such as holding women's meetings and establishing women's committees into the Participatory Irrigation Development Plan (PIDP) of each WUA as a mechanism for indirect participation means for women in WUA decision-making. Furthermore, in order to support female farmers, it is essential to assign female extension officers who can interact with women. It is also important to visit women farmers as much as possible to foster relationships of trust through dialogue and create an environment in which women can easily participate and gather opinions. Henceforth, it is necessary to support WUAs that already include gender activities in PIDP to ensure that they are implemented. For WUAs that do not currently include gender activities and WUAs that will create new PIDPs in the future, to recommend and promote the inclusion of gender activities in the PIDP by collecting and introducing the voices of the site such as the merits of women's participation from the WUA that is already implementing the gender activities. It is also important to secure at least one female extension officer in each directorate by issuing letters from the central government to continuously support gender activities by WUA. It is often difficult for women to participate directly in decision-making due to social norms of gender segregation. In such cases, it is effective to build a mechanism like a women's committee that allows women to participate in decision-making indirectly and incorporate it into the articles of bylaws or implementation plans of individual activity groups to institutionalize that mechanism.
236. Institutional capacity is of critical importance. It is crucial for the project management team to better understand operational policies and procedures to better manage project implementation, as well as bringing the best global practice to the country. Variations in the operating context and in levels of institutional capacity reduce opportunity to adopt standard approaches nationally but can encourage effective and creative solutions well calibrated to the local conditions. From the earliest stage, it is important to emphasize community consultation with the widest range of stakeholders including local leaders and community groups to address local concerns and benefit from local experiences, building

ownership. Equally, emphasize creation of local employment, which is a major concern due to rampant high unemployment.

237. Highly professional Fiduciary Monitoring Agent (FMA) is key. Development progress in post conflict environments is rarely predictable or linear and cannot be fully mitigated through design. The project implementation and supervision experiences showed that the work of the FMA had been very important and beneficial to the achievement of the Project outputs and outcomes. Especially in contexts where normal supervision missions cannot be carried out. Mitigating these risks can be by employing FMA to monitor the project physical and financial implementation progress and the recipients' compliance with financial management and procurement procedures. Capacity building of PMT and MoWR staff through internal and external training is also crucial to ensuring timely completion of projects in full compliance with implementation and management related policy and procedures. The extensive training on fiduciary aspects provided to PMT and MoWR staff had significantly improved the project procurement, disbursement and financial management implemented by the PMT. The MoWR established an effective and flexible delegation mechanism between the Minister's office and the PMT, and between PMT and the Governorate staff to manage the project. A well-maintained PMT under the leadership of a reputable engineer for the entire duration of the project is instrumental to the successful project implementation.
238. Security Situation. Due to the deterioration of the security situation, visits to Iraq apart from some regions are generally banned and monitoring at the site could be cancelled. As a result, the security situation made an impact on the project output. Project activities might have advanced more with the implementation of site monitoring. It is essential to consider that the project shall have a minimum impact on outputs despite the security deterioration. Insecurity has particularly affected the redeployment of international aid agencies to the rural areas and is substantially limiting local staff movement. Moreover, even though mass looting has stopped, theft and destruction remain a high risk in some areas, posing an important problem for all programs. The risk of delays due to insecurity could be mitigated by giving priority to work sites in lower risk areas. A weak private sector, including the construction and contracting, will also impede rapid development work. In essence, the low absorptive capacity of the system, particularly in rural areas, may slow down the pace of development. Financial systems and procedures under the project need to be designed to take account of these weaknesses. Iraq lacks many fundamental institutional capacities for undertaking development activities. Foremost is the inadequacy of the existing financial sector. The state-owned banks, which form the core of the banking system, are generally dysfunctional. The country therefore faces a major challenge in financial management of its development budget.
239. Innovative and flexible approach to implementation. Keep the project intentionally simple and flexible to accommodate to the weak institutional structures in the country. There is a need for an innovative and flexible approach to implementation, including supervision, monitoring, training, and disbursement procedures. For example, the World Bank drew on the supervision experiences of other donors operating in Iraq. World Bank monitoring and supervision activities were supported by three separate groups of consultants financed through the World Bank Iraq Trust Fund to ensure compliance with fiduciary, safeguard, and technical aspect of the Bank's responsibilities.
240. Institutional change is a complex process. The passage of any law or any legal change needs time and actions that usually go beyond the scope of a development project. Making of a new law relates to core government and legislative processes for which a donor-funded project usually cannot or should not have direct role or influence. Hence, the design of any foreign aided project should carefully avoid the provision of any indicator or objective that calls for direct interventions by the project for a time-bound change in the legal provision.

241. Sustainability. Along with achieving the project purpose, ensuring sustainability after the project is recognized as a general challenge. Especially in the case of a project in which the government of the recipient country implements technology/model expansion after the project is completed, it is important to actually expand the technology/model at least in the final year of the project, and clearly position it as the run-up period after the end of the project, to ensure sustainability.
242. Coordination between ministries. In Iraq, MoWR supervises DoWR, while DoA is not necessarily subject to MoA supervision due to the progress of decentralization. However, cooperation between MoA and DoA is important, and from this point of view, opportunity to consider the necessity of strengthening and reorganizing the organizational structure and to implement consensus building shall be provided. In addition, close and continuous coordination between MoWR and MoA is also important, and therefore, the relevant department/section should hold periodical meetings on monthly basis at both the central government and governorate levels. Courtesy visits made to the Minister of MoWR, to the Minister of MoA emphasized the importance of getting the support of senior policymakers and decision-makers. In addition, it is indispensable to obtain the cooperation of senior policymakers and decision-makers, to utilize the experience to continue activities for policy realization.

The agriculture and climate resilient agriculture sector

Introduction

243. The contribution of the agriculture sector to the GDP is currently 5.9 percent (2020)¹⁴¹, a decreasing trend compared to 1968 (16.8 percent). USAID (2017) reports that the decline of the agricultural sector (accelerated by climate change) has been evident in the continued loss of arable land, productivity variation, in addition to the reduced agriculture's overall contribution to GDP. Agriculture employs between 20 percent and 25 percent of the population. The agriculture sector provided employment for an estimated 44 percent of the total female workforce and the Women's participation in the sector in terms of employment has increased from 30 to 50 percent between 1980 and 2010 (World Bank), due to migration to urban areas [FAO, 2012]. Farms are rarely larger than 9 ha and most of the agriculture production and food security of the country is guaranteed by smallholders (80 percent according to national statistics), based on mixed-farming, growing wheat and barley if rainfed and rice, millet, corn, fruits and vegetables when irrigation is available.
244. Agriculture is the livelihood of an estimated 11 percent of Iraqi families (WFP, CSO, KRSO 2017). The country's food security largely depends on it. Among the agricultural households, roughly 75 percent of them engage in crop production as a major source of income, while the remainder rely on livestock or mixed crop and livestock activities (Lucani 2012). Inland fisheries and poultry raising provide additional and important income sources.
245. Farming units are in general small, with an average household size of seven individuals, the majority of whom are male and of working age. They employ on average 10 daily labourers. The median size of cultivated land is small and ranges from 3.5 to 5 ha. (FAO and Islamic Relief, 2014).
246. According to the information available in FAOSTAT (2018), the agricultural land covers an extension of 9.250.000 hectares (ha), of which 5.250.000 ha, or 56.8 percent, is used for cultivation of crops. Of area used for crop cultivation, 250.000 ha are covered with permanent crops, 1.109.000 ha is

¹⁴¹ Combines contribution of agriculture, fishery and forestry

used for temporary crops, and 3.891.000 ha are under temporary fallow. The arable land covers 5.000.000 ha.

Institutional set-up

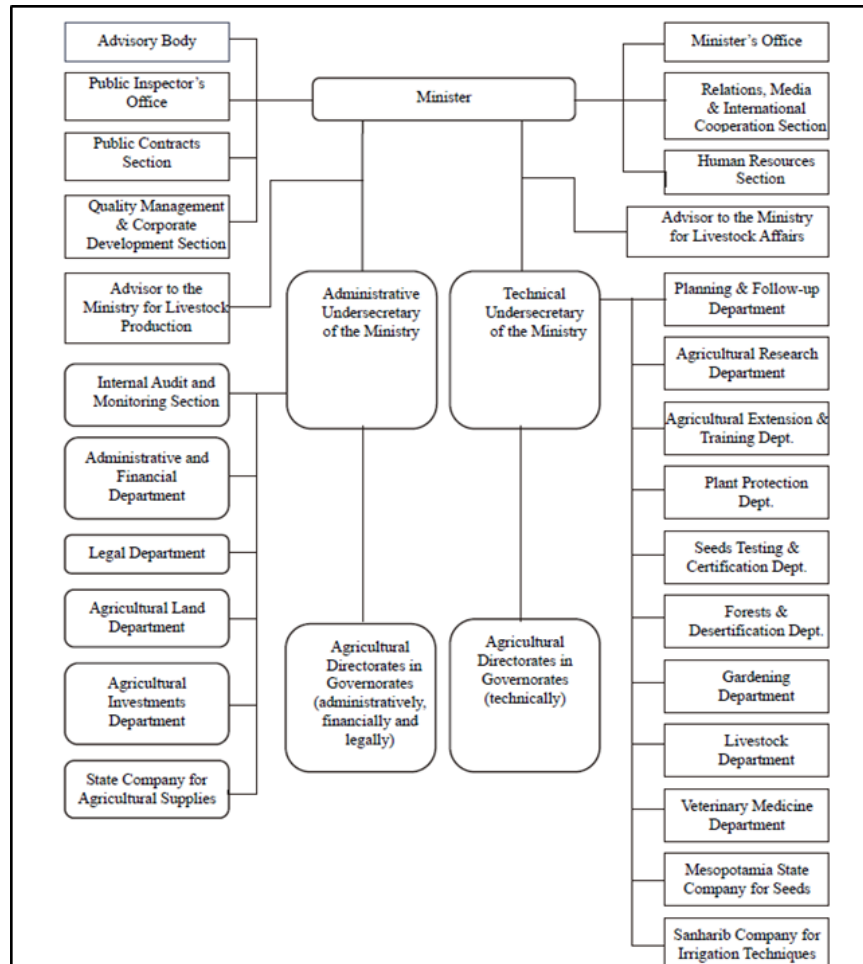
247. Ministry of Agriculture. Following the 1958 revolution, successive land reforms brought the government closely into the organization of the rural economy and society, and the resources from oil enabled the state to become a major investor in the provision of both water and agricultural services. The role of the state was expanded for the political expediency of centralized control, which continued to increase over the years. Thus, by the new millennium, Iraqi government was and still is controlling and directing the agricultural production. The Ministry of Agriculture (MoA) is responsible for assigning cropping patterns to the farmers to produce “strategic crops”, for distributing input rations at subsidized prices, and for marketing outputs at controlled prices. The MoA exercised control through Agricultural Directorates in each province. Actually, the ministry is comprised of nine technical departments and two state companies responsible for overseeing irrigation technology and seed certification. The Directorate of Agriculture (technical sector) is placed under the technical permanent secretary. Directorate of Agriculture (for administrative, financial, legal sector, etc.) and central departments for internal auditing and monitoring, finance, clerical, legal matters come under the administrative permanent secretary. The water saving irrigation methods at field level is implemented by Planning & Follow-up Department, Agricultural Research Department, Agricultural Extension & Training Dept, and Sanharib Company for Irrigation Technique (JICA, 2016).

248. The MoA¹⁴² also manages public and private agriculture in the country. Also implements programs and strategies oriented to improve productivity in the sector, disseminate innovations, sustainable practices and appropriate management of natural resources. This institution also disseminates climate change adaptation strategies. The main initiatives include:

- The national programme for the use of on-farm modern irrigation systems;
- The national programme for the improvement of wheat production;
- The national programme for the development of drought and salinity tolerant crops;
- The program for the establishment of an agricultural meteorology network;
- The programme for the genetic improvement of local animal breeds; and
- The conservation agriculture project.

Figure 39: Ministry of Agriculture at central and directorate level

¹⁴² Additional information in Rapid Agriculture Sector Assessment and Proposal of Component 2.



Source: JICA, 2016.

249. National Council for Seeds. Established by Law No. 50 of 2012 on Seeds and Seed Tubers. It is established in the Ministry of Agriculture. This Law organizes and encourages seeds production in both the public and private sectors, ensuring registration, adoption, and protection of the new agricultural varieties derived from Iraqi researchers. The Law is divided as follows: Section I: Definitions and Objectives. Section II: National Council for Seeds. Section III: Council tasks. They are, among others, to establish procedures and criteria for certification of seeds in line with international standards; institute committees to resolve disputes related to seeds production; increase resources for the funds to support the seeds system; and grant licenses to create, install and operate seed cleaning factories. Section IV: Seeds and Seed Tubers Accreditation.
250. Agricultural Research Institute (IPARC). Responsible for the improvement and development of new varieties of agricultural crops, such as cereals (barley, wheat, rice and maize), legumes (lentils, chickpeas and beans), but also of industrial plants (nuts, soya, sunflower), (IFAD, 2018).
251. State Council for Agricultural Research (SBARC). Responsible for grain, vegetables, and cotton, (IFAD, 2018).

State of the art

252. Agricultural production unavoidably depends on geographic variations in climate. Central and southern Iraq have a sub-tropical climate with warm, mild winters and very hot summers, while in the north a Mediterranean climate prevails, with mild to cold winters and hot summers. The majority of the country classifies as arid to semi-arid, leading to only 27 percent of the national surface considered suitable for farming (FAO Iraq, 2019), of which 50-67 percent is then actually farmed (FAO 2019)¹⁴³.
253. Iraq has eight agroecological zones. In all, agriculture is practiced from the North to the South of the country. The production systems include an irrigated-based system in the Center and South and a rainfed-based system predominantly in the North (IFAD 2018). The irrigated systems are used to cultivate cereals, where rice is a leading crop. In addition, this land is utilized for winter and summer vegetable production, such as maize and date palm. The rain-fed production systems are characterized by the cultivation of cereals, including wheat and barley, sunflower and sesame in oil seeds, chickpea, lentil, and dry broad bean in pulses and sugar beet in industrial crops. These systems are also characterized by the rearing of ruminants. Generally winter crops are grown during the period of October to May and summer season crops are grown from March to September.
254. Agricultural farms are small, mainly family run, and most of the jobs are for semi-skilled and skilled workers. These small farming systems are characterized by low crop yields, but also low inputs, such as advanced seed varieties and technology¹⁴⁴.
255. Low productivity is a characteristic of agricultural systems. Current crop yield levels are significantly lower than the international averages¹⁴⁵. The main causes of this situation are: (i) use of traditional and low yielding production technologies including mono-cropping and cereals-fallow rotation; (ii) lack of enabling agriculture input and output price policy -the prices of seeds, fertilizers, pesticides, veterinary drugs and agriculture machinery and equipment are very high for local producers to compete, without incentives, with the heavily subsidized imported food items available in the local market; (iii) weak agriculture extension services for technology transfer particularly to small producers; and (iv) limited access to rural financial services.
256. The general stagnation in agricultural productivity has been a characteristic of Iraq's agriculture over the last years and has steadily increased dependence on imports to meet domestic food needs and has made Iraq a major importer of agricultural products (FAO, 1012). Top import categories are wheat flour (over 1.3 million tonnes per year) and rice (over 1.2 million tonnes per year). Sugar, maize, tomatoes oils and fats, milk are also relevant¹⁴⁶. Top export categories were in 2019, dates, beans, potatoes, olives, and wool¹⁴⁷.
257. Agricultural degradation is due to a low efficiency of domestic agricultural production and the low agricultural productivity of crops and agricultural products, as well as low subsidies and a clear decline in the amount of water resources received in Iraq. All these indicators show that the goals of the National Development Plan (NDP) 2013-2017 were not achieved in this sector. The volume of water storage decreased from 157 to nearly 50 billion cubic meters in 2015, and 2017 is marked by a significant deterioration in storage volume due to low rainfall in the region and the small amounts

¹⁴³ Cited in the Iraq Socio-Economic Atlas. WFP. 2019.

¹⁴⁴ World Food Programme. Iraq Socio-Economic Atlas. 2019.

¹⁴⁵ Appendix 13 includes the average crop yields (2019).

¹⁴⁶ Appendix 14 contains the list of the top 20 imported agricultural products.

¹⁴⁷ Appendix 15 contains the list of the top 20 exported agricultural products.

received from source countries. Furthermore, no dams were established during the NDP period to increase the volume of water storage (Ministry of Planning, 2018).

Main challenges and CC impact

258. The agricultural sector faces a number of problems and challenges. Successive years of drought, fluctuation in rainfall, rising temperatures, environmental changes, and various risks, in addition to the loss of key cycles in agricultural marketing. This has led to losses in agricultural production from harvesting to consumers and the lack of agricultural insurance companies and associations specialized in agricultural mechanization, marketing, and transport, etc. (Ministry of Planning, 2018). Such matters are compounded by structural factors that include limited rural financing, weak research and extension capacities, low-level technologies, the increasing impact of climate change and the construction of dams in neighbouring countries, which is related to a reduction in water inflows and increased salinity.
259. In addition, water scarcity poses a challenge to the development and growth of the agriculture sector. In the past, water supply was stable and sufficient, albeit highly dependent on the Euphrates and Tigris Rivers and rainfall; however, upstream dam construction, increased salinity, variability in precipitation, limited groundwater recharge and decreased river discharge has resulted in water scarcity challenges (ESA, 2016), (MDPI, 2019). Thus, water resources in Iraq need to be managed more efficiently, particularly in the agricultural sector (FAO, 2019).
260. Also, the impacts of rising temperatures due to climate change is expected to be represented in the increase of water demand for cultivation in Iraq. In practice, this means that there will be pressure on available water resources to meet the crop water requirements. In addition, the possible decrease of rainfall and increase of drought events caused by climate change will generate pressure over the rainfed crop production and natural pastures, which already suffer from degradation. This last point is affecting the current fodder provision for livestock. An increase is also expected of decertified land area resulted from sand dunes coming from the desert towards agricultural lands, and the increased dust and sandstorms. Given the importance of agricultural production systems for livelihoods and food security at the local and national level, there is an urgent need to shift from current agricultural practices to climate resilient alternatives.
261. FAO identified several constraints that the Iraqi agricultural sector faces¹⁴⁸. According to the several consultations maintained with several stakeholders during the project design period, it can be stated that these limitations are still fully in force and are even aggravated. The following are the main¹⁴⁹:
- **Limited capacity of research and extension services.** These two agricultural services have been severely deteriorated mainly due to a lack of staff incentives, physical infrastructure, and operational resources. There is a weak connection between research, extension services, upstream suppliers and technology users (FAO, 2019).
 - **Limited supplies of good quality seeds, fertilizer, and pesticides.** The country capacity for seed production and processing and fertilizer production has severely deteriorated during the last two decades.
 - **Soil salinity and fertility.** Nearly 70 percent of the cultivable land suffers from salinity threats. Shortage of fertilizer supply forced farmers to reduce application rates which

¹⁴⁸ <http://www.fao.org/3/Y9870E/y9870e07.htm>

¹⁴⁹ The following text is an adaptation of the original. It contains adjustments and clarifications.

significantly reduced overall fertility levels of soil. Soils have considerably deteriorated in both physical and chemical properties. The fertility deterioration was mainly due to constant removal of crop residues (organic matter) to feed animals, absence of crop rotation and fallowing, compaction of soil due to high animal stocking and use of heavy machines and high erosion imposed by monoculture.

- **Monoculture tradition.** It was further aggravated by the introduction of a high mechanization approach. This practice has caused fast depletion of soil fertility and increased soil erosion. Monoculture farming has led to increased weeds, pests, and disease populations in the crop fields. During severe droughts, there is a severe shortage of feed and grazing area needed for the animals. This shortage compelled farmers to graze in the crop residues resulting in a significant depletion of organic matter from the field and high soil erosion.
- **Insect pests and weeds.** Insect pests such as sunn pest in wheat and barley, Dubas bug and borer in date palm, whitefly in citrus and vegetables, and mites in fruits and vegetables have caused severe damage. Similarly, several broad and narrow leaf weeds in major crops have also led to low crop yields. Many diseases cause substantial loss in vegetable and fruit production.
- **Landholdings, tenure, and credit facilities.** With an average farm size of less than 10 ha, uncertain tenure, and the absence of a functioning credit system, farmers have limited opportunities to improve agricultural products and income. There is minimal or no access to formal credit for most of the actors engaged in the examined value chains is a severe constraint, particularly for accessing inputs and machinery, and farmers rely on family for credit. In a survey conducted as part of the study *“Agricultural value chain study in Iraq – Dates, grapes, tomatoes, and wheat,”* only 7 percent of the interviewees requested a loan in the last three years, and only 30 percent of these 7 percent were granted a loan (2 percent of all interviewees) (FAO, 2019).
- **Post-harvest losses.** Most of the soft fruits and vegetables delivered to the wholesale markets have been damaged by inappropriate handling, packaging, and transport. The quality of grains is inadequate, mainly due to the admixture of foreign materials and weed seeds.
- **Agricultural marketing.** Market intelligence, pricing mechanisms, and physical facilities are insufficient to motivate farmers to strive for more significant profit through increased production or improved quality.
- **Conflict.** It has been a major constraint for agriculture through farmers’ displacements, damage to irrigation infrastructures, land lost to explosive hazards contamination, land degradation, and pollution. Tonnes of pollutants were released over extensive areas of farmland and rangelands, especially affecting Qayyarah and Al-Shirqat Districts¹⁵⁰.

262. The links between climate change issues and the agriculture challenges are summarized in the Table 34 below.

Table 35: Selected climate change impacts and needed responses in agriculture sector

Selected climate change (CC) impacts identified by the project	Major agricultural challenges associated with key CC impacts	Immediate response measures needed
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¹⁵⁰ World Food Programme. Iraq Socio-Economic Atlas. 2019.

Temperature increase will increase evapotranspiration ¹⁵¹	<p>Increased crop water requirements</p> <p>Short- and medium-term changes in timing, distribution and availability of water.</p> <p>Medium- and long-term decline of water supply from rivers and irrigation channels.</p> <p>Increased demand for groundwater for irrigation.</p>	<p>Support farmers to adopt:</p> <ul style="list-style-type: none"> • On farm water saving irrigation technologies. • Cropping practices that increase soil organic matter, and soil water content (conservation agriculture, organic fertilization).
Temperature increase and associated crop heat stress will decrease crop yields	Decrease crop yields. Mostly related to pollination and grain filling.	<p>Support farmers to adopt:</p> <ul style="list-style-type: none"> - Crops and varieties more tolerant to heat stress
Decrease of rainfall in RCP4.5 scenarios	Increase dependence on irrigation and demand for water from different sources (rivers, groundwater).	<p>Support farmers to adopt:</p> <ul style="list-style-type: none"> - Crops and varieties that require less water to complete production cycle and keep or improve current yields. - On farm water saving irrigation technologies. - Cropping practices that increase soil organic matter, and soil water content (conservation agriculture, organic fertilization).

263. A key aspect of climate change will be the increasing temperatures which will cause increased evapotranspiration (ET) of crops as mentioned in the table 34 above. In other words the amount of water needed to meet the water loss through evaporation and transpiration by crops is going to increase. In consequence, higher temperatures due to climate change will increase the crop water needs. The Iraqi agriculture sector in the project areas needs adaptation measures urgently to reduce the adverse impacts of climate change.

264. Climate-smart agricultural practices are also growing in uptake as farmers seek to optimize water use on farms, enhance crop diversification and improve soil management practices. For example, some farmers apply alternate year fallows, allowing rainfall to leach out salts. Others are compensating for the limited availability of fertilizers – particularly those providing urea and potassium to soil – by composting plant residues and using remains to fertilize land. In areas where salinity and water shortages are increasing, such as the northern districts of Al-Basrah, farmers are shifting away from barley and wheat towards water-efficient vegetable farming, requiring less water and providing better market opportunities (ITC, 2021).

¹⁵¹ According to FAO, “evaporation and transpiration occur simultaneously and there is no easy way of distinguishing between the two processes. Apart from the water availability in the topsoil, the evaporation from a cropped soil is mainly determined by the fraction of the solar radiation reaching the soil surface. This fraction decreases over the growing period as the crop develops and the crop canopy shades more and more of the ground area. When the crop is small, water is predominately lost by soil evaporation, but once the crop is well developed and completely covers the soil, transpiration becomes the main process” (<http://www.fao.org/3/x0490e/x0490e04.htm>).

SWOT Analysis of the Sector

Table 36: SWOT analysis in the agriculture sector



Strengths

265. **Agri-food sector has a crucial role in economic development in Iraq.** Agriculture contributes a substantial share of Iraq's economy (5.9 percent to Iraq's GDP (2020)¹⁵²) and is the largest source of employment in the country (approximately 20-25 percent percent). Women make up over 40 percent of agricultural work force compared to just 9 percent across all sectors—highlighting the sector's importance for social inclusion. Almost thirty percent of the population live in the rural areas and are largely dependent on agriculture for their income and livelihood. Agriculture production has large potential for expansion. It occupies only a limited fraction of Iraq's cultivable area (about a third or 5 million ha); it is practiced predominantly by small farmers, and irrigation, once it is rehabilitated, has the potential to greatly increase crop yields. Agriculture is also a key pathway for overall job creation in

¹⁵² Combines contribution of agriculture, fishery and forestry

Iraq. It can offer employment particularly to IDPs and help close the gender gap. Iraq is heavily dependent on food imports; its agriculture can expand based on its comparative advantage to respond to the growing domestic, and regional and international export demand. In the current fragile post-conflict context of Iraq, with appropriate policy reforms and targeted investments, the agrifood sector can make a significant contribution to employment, economic diversification, social stability, and contribute to climate resilience. A 1 percent increase in Agriculture GDP growth would lead to 1.2 percent increase in total employment (compared to just 0.35 percent for the industrial sector) (WB, 2019b). Improving the country's economic outlook depends on the agrifood sector.

266. **Diverse agroecological conditions.** These represent suitable for different options of crops and livestock species. Cool days during winter and dry, warm and sunny days during summer is a favourable condition for growing a variety of high value crops. Iraq has eight agroecological zones. In all, agriculture is practiced from the North to the South of the country. The production systems include an irrigated-based system in the Center and South and a rainfed-based system predominantly in the North (IFAD 2018). The irrigated systems are used to cultivate cereals, where rice is a leading crop. In addition, this land is utilized for winter and summer vegetable production, such as maize and date palm. The rain-fed production systems are characterized by the cultivation of cereals, including wheat and barley, sunflower and sesame in oil seeds, chickpea, lentil, and dry broad bean in pulses and sugar beet in industrial crops.
267. **Labour force.** Available labour and at relatively low cost. 29.5 percent of the population reside in the rural area (11.6 million), FAOSTAT, 2018. Agriculture is mostly practiced by smallholder farmers and is a low input-low output system. In rainfed areas, smallholders' holdings range from 2.5 to 7.5 hectares. In irrigated areas, smallholders hold less than four hectares. Overall, smallholders account for 35 percent of total number of farmers in Iraq. However, in parts of southern Iraq, smallholders account for 60 percent of the total farming population.
268. **Long tradition of agriculture.** Farmers have been practicing wide range of crops growing under both dry land and irrigated conditions for centuries. Agricultural land covers an extension of 9.250.000 hectares (ha), of which 5.250.000 ha, or 56.8 percent, is used for cultivation of crops. Of area used for crop cultivation, 250.000 ha are covered with permanent crops, 1.109.000 ha is used for temporary crops, and 3.891.000 ha are under temporary fallow. The arable land covers 5.000.000 ha. Land under permanent meadows and pastures equal to 4.000.000 ha. The land area equipped for irrigation is 3.525.000 hectares, which constitutes 38.1 percent of agricultural land, or 67.1 percent of the total cropland. The area occupied with permanent crops is only equivalent to 4.8 percent of the cropland
269. **Suitable soils with good texture and water holding capacity** (silty clay loams are the most common) which are suitable for wide range of crops production.

Opportunities

270. **Available climate-smart agriculture practices and technologies to deal with climate change.** There is evidence of a growing interest for climate-resilient production infrastructure (e.g. greenhouses) and modern irrigation systems (e.g. drip) as farmers seek to optimize water use on farms, enhance crop diversification and improve soil management practices. For instance, greenhouse farming is practiced by small-scale vegetables producers in Al-Zubair (Al-Basrah), where water salinity is relatively low and farmers have access to alternative water sources (shallow wells). Yet, uptake of greenhouse farming in remains limited due to, inter alia, constrained access to and high costs of equipment (IOM, 2020).

271. **Climate resilient agriculture** can also promote the creation of more jobs, especially in providing services to local processing. Migration from the villages to cities will also be reduced. For irrigated production systems, several kinds of water saving irrigation devices have been introduced in Iraq, such as center pivot, linear sprinkler, fixed/ movable sprinkler, micro sprinkler, and drip irrigation. In addition, land levelling and furrow irrigation are also effective methods to realize water saving at the on-farm level. Modern irrigation methods such as sprinklers or drip irrigation have been sponsored by the Ministry of Agriculture and cooperation agents through various projects.
272. **Large agricultural growth opportunities and existing local and national demand for agriculture products.** Iraq has great agricultural growth potential if it rebuilds key irrigation and transport infrastructure. Iraq's agriculture and agribusiness have large opportunities for development, in the short to medium-term through import substitution and export on regional markets, and, in the long term, by integrating into global agri-business value chains. According to the World Bank, the base for improvement exists, besides dates and cereals, there are several fruits and vegetables with significant volume of production and that exports are already taking place (World Bank, 2019b). Iraqi farmers have a comparative advantage in production of irrigated fruits and vegetables, and irrigation is readily available in parts of the southern part of the country. Iraq's domestic market offers an immediate consumer base to sustain expansion of production.
273. **Iraq is strategically positioned to derive a competitive advantage through trade and generate production surpluses.** Iraq is strategically positioned to have a competitive advantage through trade. With road infrastructure and other logistics investments, in the short-to-medium term, the country has the potential to export to markets in close geographic proximity. In the longer term, it could even develop the capacity to export to other markets that are currently out of reach (South and Central Asia, and Europe) should Iraq overcome infrastructure, capacity building and other barriers (WB, 2019b).

Threats

274. **Unsustainable environmental and natural resource management.** Iraq's environmental conditions have suffered greatly from the impact of poor policies on pollution and resource management. The years of conflict left chemical pollution affecting the livelihoods and safety of an estimated 1.6 million Iraqis (IFAD-AF, 2018). The natural resources for agriculture use, namely land, water, forest and pasture have been unsustainably managed with underground water resources overly exploited beyond their recharge capacity. The percentage of dried Mesopotamian marshlands is now 90 percent. This resulted in increasing threats of land degradation, desertification, water shortage, increased soil and water salinity, low irrigation efficiency, reduced soil fertility and low forest cover of 4.0 percent (IFAD-AF, 2018).
275. **Salinization and degradation.** Irrigated areas are confronted with salinization problems, which significantly depress yields. As water shortages are projected to worsen with climate change, salinization problems will worsen even more without deliberate strategies to adapt. FAO estimates that approximately 60 percent of cultivated land is negatively affected by salinity, and 20-30 percent has been abandoned. Furthermore, about 75 percent of the irrigated area of the Mesopotamian plain (more than 2 million ha) is moderately saline and another 25 percent has levels of salinity that have converted once productive lands into salt-affected wastelands. Over 39 percent of Iraq's agricultural land suffered a reduction in cropland between 2007 and 2009. Farmers of saline soils are using 30 percent of their land for cropping; they are 50 percent of the expected yields causing cropping systems to shift from high-value to lower-value crops (IFAD-AF, 2018). If this is not corrected, salinization is bound to lead to land degradation phenomena in central and southern Iraq and will continue to result in sluggish productivity growth in agriculture.

276. **Desertification risk.** As much as 31 percent of Iraq's surface is desert¹⁵³. Years of inappropriate farming practices and mismanagement of water resources have exacerbated the effects of an already dry climate and contributed to increasing rates of desertification. Declining fertility, high soil salinity, erosion and the extension of sand dunes are pervasive problems. The Government of Iraq reports that 21.4 percent of the country's land is arable, of which an average of 100,000 dunums is lost each year to degradation. Meanwhile 39 percent of the country's surface is estimated to have been affected by desertification, with an additional 54 percent under threat. Because of declining soil moisture and lack of vegetative cover, recent years have witnessed an increase in the frequency of vast dust and sandstorms, often originating in the western parts of Iraq (Gol, 2014).
277. **Climate change, unpredictable weather patterns, and lack of historical data** cause limited adaptive capacity to respond to climate change. Climate change is also responsible for exacerbating water scarcity in the agriculture sector. Increased temperatures also lead to increased evapotranspiration and cause heat crop stress. In practice, this means that there will be more pressure on available water resources to meet the crop water requirements. In addition, the expected decrease of rainfall and increase of drought events caused by climate change will generate pressure over the rainfed crop production and natural pastures, which already suffer from degradation. This last point is affecting the current fodder provision for livestock. An increase is also expected of decertified land area resulted from sand dunes coming from the desert towards agricultural lands, and the increased dust and sandstorms.

Weaknesses

278. **Policy and market drivers.** Inefficient price and subsidy policies manifested by depressed producer prices and non-transparent markets because of the heavy subsidy for imported food items. Limited access of smallholder farmers to remunerative market prices, rural financial services and affordable investment loans, performing extension services and incentives for the adoption of new technologies. High input prices - seed, fertilizer, pesticides, fuel, farm machinery and labour. The volatility of oil prices and the impact of the pandemic have both amplified Iraq's economic afflictions, reversing two years of steady recovery. These twin shocks have also deepened existing economic and social fragilities, adding to public grievances that existed pre-COVID-19. Gol's ability to provide a stimulus package for an economy highly dependent on oil exports for growth and revenue has been limited by this absence of fiscal space. As a result, the country has experienced the largest contraction of its economy since 2003 (World Bank, 2021a).
279. **Insufficient reliable data and information for planning and decision making.** It is very difficult to obtain data on the use of the different irrigation methods in productive farms. Current on-farm irrigation water use efficiencies are also unknown. In other words, it is not known precisely how many farmers use old (flood) or modern irrigation methods (sprinklers, furrow irrigation, drip irrigation).
280. **Limited access of smallholder farmers to remunerative market prices and financial services.** With an average farm size of less than 10 ha, uncertain tenure, and the absence of a functioning credit system, farmers have limited opportunities to improve agricultural products and income. There is minimal or no access to formal credit for most of the actors engaged in the examined value chains. This is a severe constraint, particularly for accessing inputs and machinery, and farmers rely on family for credit. In addition, market intelligence, pricing mechanisms, and physical facilities are insufficient to motivate farmers to strive for more significant profit through increased production or improved quality.

¹⁵³ Ministry of Environment Annual Report 2010

281. **Deteriorate rural productive infrastructure, particularly irrigation and drainage facilities,** and transportation infrastructure. Available water for agriculture is declining in spite of irrigation facilities existing in irrigated lands, and salt accumulation lessened available agricultural lands. When it comes to Iraqi agriculture, including rain-fed, further shrink of agricultural lands has been warned due to inappropriate and inadequate administrative functions under the unstable security situation.
282. **Inadequate soil, water, and cultivation practices** that make the issue of water scarcity and soil degradation more complex. Much land is left unused due to resigning of land ownerships and inefficiency of small-scale farmers. In particular, salinity of irrigation water, soil salinization by rising ground water, and excess irrigation has become serious issues. Therefore, about 70 percent of the total agricultural areas requires effective drainage systems to mitigate the soil salinization. At the same time, at least 2 million ha of new lands is also required for agricultural production in Iraq. In addition, the percentage of CaCO₃ in soil has reached approximately 25-35 percent, which means the soil lacks necessary nutrition for growing plants. As for soil gypsum, the content amounts to 20 percent, which results in impairment of nutrition absorption, imbalance of calcium and magnesium, and soils crack. The soil fertility is also deteriorated due to lack of the organic matter in it. It means **less than 0.5 percent** (JICA, 2016).
283. **Weak extension and technical assistance system.** Rural extension services are mainly provided by the Department of Agricultural Extension and Training of the Ministry of Agriculture. It should also note that the Department of Agriculture, and its Directorates in each governorate, also have an extension unit, whose agents contribute to knowledge and technology transfer. Most of agriculture research assets (buildings, labs and farms) have been damaged. Technicians are insufficient in number or quality. The sanctions imposed on Iraq disrupted for a long-time contacts with the outside world except to some extent with ICARDA and FAO. There is a lack of a real extension and training strategy with adequate operating budget, involving effective decentralization, privatization, gender empowerment, farmer participation, use of modern information technologies, linkages with research and other institutions such as universities, private sector, and support to women and youth.
284. **Low crop yields.** Current crop yield levels are significantly lower than the international averages. The main causes of this situation are: (i) use of traditional and low yielding production technologies including mono-cropping and cereals-fallow rotation; (ii) lack of enabling agriculture input and output price policy -the prices of seeds, fertilizers, pesticides, veterinary drugs and agriculture machinery and equipment are very high for local producers to compete, without incentives, with the heavily subsidized imported food items available in the local market; (iii) weak agriculture extension services for technology transfer particularly to small producers; and (iv) limited access to rural financial services.
285. **Weak technical capacities.** The technical capacity of the Ministry of Agriculture and Ministry of Water Resources and other government institutions to provide services to the agriculture sector is weak. There are budget constraints and a reduced level of services in agriculture support, such as: research, extension, animal health, artificial insemination, plant quarantine and pest control. Agricultural services have been severely deteriorated mainly due to a lack of staff incentives, physical infrastructure, and operational resources. There is also a weak connection between research, extension services, upstream suppliers and technology users.
286. **High agricultural inputs' prices** (seeds, fertilizers, pesticides, veterinary drugs and vaccines, fuel, farm machinery). Stakeholders agree that the biggest obstacles to introducing and promoting water saving irrigation proved to be farmers' conservative perspective and cost. The institutional side states

that farmers' view is more problematic because they can be financed without interest through a national agricultural bank. On the other hand, farmers are prone to emphasize high introduction costs rather than their conservative mindset.

Main Policy framework, strategy, laws

287. [The National Development Plan](#). In addition to what mentioned above, the NDP included desertification and salinization, as well as climate change impacts in the region:
- Desertification and salinization are pronounced due to the hot and dry climate and the hydrological and topographic aspects of soils. They are, however, aggravated by human activities (cultivation and irrigation procedures), which result in wider affected areas. In turn, this causes the emergence of other types of desertification, loss of vegetation, and it hampers the development of agriculture (especially in central and southern Iraq). Desert land amounts to 50 percent of Iraq's area, posing a serious threat to food security.
 - Climate Change. Iraq and other Arab countries will be at the heart of the major climate problem facing the world – namely, global warming effects and the risks of rising temperatures by 2050. Expected effects are shortage of rainfall and spread of drought and aridity. This a threat to food security, social stability, water resources, agriculture, health and biodiversity.
288. [The Iraq Vision 2030](#). The Iraq Vision 2030 is a road map and an action plan, which all ministries and local governments should adhere to ensure the vision realization. The vision embraces a new social contract between the state and its citizens to enhance their trust in the government and provide opportunities for self-development, work and generating income. The state seeks to develop the economic activities and pave the way of reforms, which tackle the past challenges and provide the needed development strategies in light of the external and internal challenges and the national capacities particularly a diverse people, natural resources and a strategic location. The Iraq Vision involves five sections which express Iraq's national goals (man building, good governance, a diversified economy, safe society, and sustainable environment) and meet the UN sustainable development pillars: people, prosperity, planet earth, peace and partnerships (Gol, 2019b).
289. [The Initial National Communication \(INC\) to UNFCCC](#). In response to the current substantial and alarming climate change impacts, there is a need for appropriate adaptation actions at all levels (institutional, policy level, and technical and farmer's capacity development). In addition, there is a need to implement climate-resilient agronomic systems and technologies, prevention and restoration of climate-induced soil and water degradation, awareness-raising among all rural communities. 14 adaptation actions were developed, and the most significant priorities were observed in the agriculture and water sectors, for more information, please refer to the [Natural Resources, climate and climate change section](#) below.
290. **The Strategic Plan of the Ministry of Agriculture (2015-2025)**. This instrument governs the national agricultural policy. Its strategic objective is to *"develop the agricultural sector to reach the highest possible levels of self-sufficiency in agricultural products to achieve sustainable food security and environmental protection."* This Plan establishes several country priorities within plant production (wheat, barley, vegetables, potatoes, and dates). It included animal production as well, especially ruminants (for milk and red meat), poultry (white meat and table eggs), and fisheries. It continued the existing programs for the rest of the animal and vegetable agricultural products. Other priorities are transferring technology, such as using modern irrigation technologies and developing productivity by transferring agricultural research results to the field. The plan recognizes that wheat and barley stand at the top of the priority list and Iraqi people's demand for agricultural products. Wheat is essential to

produce all kinds of bread, which is a cornerstone in the citizen's food basket and providing fodder for livestock through large quantities of hay and butts.

291. The plan emphasizes promoting several actions in line with the "Strengthening climate resilience of vulnerable agriculture livelihoods Project." These are:

- (i) Expand the use of conservation agriculture to maintain the vitality and moisture of the soil;
- (ii) Spread the use of modern irrigation methods that increase the productivity of the land and the water unit in the irrigated areas;
- (iii) The use of supplemental irrigation in the rainy areas to create a state of stability in production, increase the unit area and reduce costs;
- (iv) Development, propagation and use of high-yielding varieties suitable for environmental conditions;
- (v) Raise the percentage of organic matter in the soil through organic and green fertilization, and spreading the technology of producing organic fertilizers from agricultural waste;
- (vi) Regulate irrigation provided to crops in terms of quantity and timing, and
- (vii) Increasing the water use efficiency.

292. [Strategy for the Reduction of Poverty in Iraq \(2018-2022\)](#). The Strategy for the Reduction of Poverty in Iraq (PRS) adopts the 2030 Sustainable Development Goals as a general framework. Within that, the PRS has a goal of reducing poverty by at least 25 percent by 2022. The Strategy formulates a plan to contribute to improving standards of living, protection against risks and hazards and economic empowerment to turn the poor into productive individuals who are economically and socially integrated, rather than being dependent on their communities or the charity of others. In this context, the Strategy adopts six outcomes that represent the key dimensions of poverty, including "sustainable income for the poor from work". This includes supporting factors for increasing productivity of agricultural work be made available to the poor through the provision and maintenance of infrastructure supportive to production and marketing, setting programmes to train farmers on modern agriculture and irrigation techniques and reviewing the package of agricultural legislation and policies in favour of poor farmers.

Main past, existing and planned projects

293. **The restoration and strengthening of the resilience of agri-food systems in Southern Iraq Project.** It is a Ministry of Agriculture and FAO initiative whose objective is to assist rural people of southern Iraq overcome poverty and achieve food security by supporting sustainable and resilient livelihoods that bolster local economies and recovery of the agriculture sector. Its implementation predominantly takes place in the governorates of Basrah, Missan, and Thi-Qar in southern Iraq, focusing on the irrigated lands associated with the Euphrates and Tigris Rivers. This large-scale project seeks to: (i) improve knowledge management among target stakeholders in the agriculture and water sectors; (ii) strengthen the capacity of public and private agricultural service providers in target value chains; (iii) improve on-farm management of natural resources (especially water) and biodiversity; (iv) increase productivity and commercialization capacity of smallholders in target value chains; (v) develop homestead and group-based micro-enterprises.

294. **Iraq Restoration of agriculture and water systems sub-programme 2018–2020.** It is the FAO's component of the United Nations Recovery and Resilience Programme. This initiative aims to improve food security and nutrition and reduce poverty for the rural and peri-urban populations of Anbar, Diyala, Kirkuk, Ninewa and Salah al-Din governorates affected by the conflict – including returnees and remainees. The FAO's Sub-programme sought the restoration of irrigation schemes and crop and

livestock production systems. It also supported the stakeholder evidence-based agrifood systems planning, programming, and monitoring and evaluation. It was focused on vulnerable smallholder farmers and livestock owners and the rural poor of rural and peri-urban areas (in particular women, female-headed households and youth).

295. **Smallholder Agriculture revitalization project by IFAD (2017-2025).** This project aims to enable poor smallholder farmers to improve crop and livestock productivity, develop activities to diversify their income sources, and become more resilient to the effects of climate change. Activities include rehabilitating or completing irrigation schemes to supply water to 8,322 hectares in the project area, improving nutrition by diversifying crops, and developing and increasing dairy, fish and poultry production. Marshland communities who are engaged in fishing, raising livestock and hunting will also be included. The project is being implemented in the four southern governorates of Missan, Muthanna, Qadisiya and Thi Qar.
296. **JICA's Irrigation Sector Loan Phase I (2008-2018)/ Phase II (2018-2026).** The objectives of the Project Phase 1 are to improve and upgrade the existing irrigation systems by the rehabilitation of pumps and related facilities and provision of necessary equipment and machineries for the operations and maintenance (O&M), thereby contributing to increasing agricultural production, creating medium-term and long-term job opportunities, and accelerating regional development. Phase II of the project is focusing on constructing and rehabilitating irrigation and drainage facility and agricultural land mainly in the Tigris-Euphrates River Basin to improve agricultural productivity, thereby contributing to socioeconomic reconstruction in Iraq.

Lessons learned from past climate change experiences

297. Climate resilient agriculture (CSA) approach. Adoption of new methods such as the CSA approach are often slow when part of the benefits of the new approach are largely public while the costs (of adoption) are private. Policies are needed to incentivize the adoption of new technologies and create the impetus for adoption. The required approach would vary with circumstances. It may entail public investments, access to credit, insurance to address risk aversion, or payments for ecosystem services (PES) in the agricultural sector, or changes in input tariffs.
298. Adaptation technologies implemented by projects. These technologies need to be tested by the National Agricultural Research System (NARS) and other partners (e.g. ICARDA, FAO) through several regional agriculture research for development (R4D) projects and demonstrate their effectiveness in enhancing resilience to climate change, agricultural productivity, as well as the sustainable use of natural resources. Thus, the investments will have relatively secured results, and the fund are not being used on testing technologies with unknown effectiveness.
299. Recognizing strengths and weaknesses of collective action. The capacity of farmer institutions is key for project activities that require collective or group action. However, recognizing that the cooperative movement has not been a strong movement in this part of the world will help in identifying the limits of group action, avoid elite capture and at the same derive some of the benefits of group action such as reducing transactions cost, aggregating produce for collective marketing and bargaining and achieving economics of scale.
300. Risk mitigation strategies and participation of smallholder farmers. Small-scale farmers are willing to adopt improved production technologies but need to see results first. Given small scale farmers are risk averse, incentives to pay the cost of incremental inputs and services of new technologies for the first year, are essential to help them take risk. On-farm adaptive research

complemented by a network of demonstrations at farmer's field composed of a lead farmer and several satellite farmers, and/or a network of farmer field schools (FFS) are effective platforms for quick dissemination of technologies. During this process, knowledge is shared and interactions among farmers produce a long-term effect. The sustainability of impact generated investment projects beyond the completion date requires government commitment to continue funding technology transfer activities and beneficiaries' ownership to operate and maintain the collective assets created by the project.

301. Expanding participation of farmers in trainings. According to the final report of the JICA "The Project for Spreading Water Users Associations for the Efficient Use of Irrigation Water", the participants in the farmers' training seemed to be influential persons in their governorate and not the farmers who worked in the fields. While these people could help to expand the project activities to many other farmers in their governorates, the practical application of what the participants learned in the training course might not have materialized without the participation of farmers who engage in the agricultural work in the field. During technical trainings and/or seminars, it is essential that the participants be composed of responsible persons who engage in actual field agriculture in addition to local influential persons.

302. IFAD (2018) conducted a very extensive compilation of lessons learned on initiatives related to the agricultural and water sector's resilience. This helpful review is contained in the project document "Building Resilience of the Agriculture Sector to Climate Change in Iraq (BRAC)." These approaches have been implemented and tested by national agriculture development programs, ICARDA, FAO, and other development partners. The main lessons and experiences are as follows:

- **Supplemental irrigation** in rain-fed areas resulted in higher yield, increased water productivity from 0.96 kg to 3.7 kg of grain per m³ of water, prevented excessive use of water, and modified the crop calendar considered as an adaptation measure to climate change.
- **Irrigation through mechanized raised bed technology** increased wheat productivity while saving on water resources - applied water was reduced by 30 percent, yields increased by 25 percent, seed rate reduced by 50 percent, and on-farm water use efficiency increased by 72 percent.
- **Comparison between water use efficiencies for various irrigation methods** (drip, basin and bubbler) on date palms have shown that the drip system has the highest water use efficiency. Economic analysis found that the total cost for the subsurface drip irrigation system per hectare (including investment management, operation, etc.) can be less than 30 percent compared to the center pivot system.
- **Conservation agriculture**, which is considered as a climate change adaptation best practice, grain yield increased from 460 kg/ha to 860 kg/ha under zero tillage in rain-fed farming.
- **For rainfed integrated crop-livestock production systems**, diversification helped spread the risk and increase revenues. Diversification included on-farm feed production, use of by-products for making feed blocks, barley production, cactus and fodder shrub plantations, improved natural pasture and range management, as well as alley cropping.

303. In 2016, JICA conducted a comprehensive study on the causes of low water use efficiency at the farm level. The main issue is that farmers are stuck on typical/traditional methods of irrigation. The origin of this issue is the lack of farmers' knowledge due to insufficient dissemination and training. It is essential to secure a budget, establish a ministries' support system, and update the insufficient training contents to face this problem. Based on their experience, JICA recommends addressing the following points:

- **Soil salinity**, introduction of salinity-tolerance crops is effective when soil salinity happens. In order to develop the market using these farming methods, it is essential to cooperate with not only local communities but also private companies. When crop density is high, it

reduces water evaporation from soil surface, and inhibits soil salinization. In order to introduce such kind of measure, the conventional farming methods should be reformed.

- In addition to **modernization of the irrigation system**, some measures, which do not require high expenses, should be planned and applied to the system. For instance, the strategy of water management in the field should be planned, and the measure for reducing soil salinization and the management for irrigation projects should be strengthened. At the same time, it is necessary to make the guideline for effective use of water resources.
- **Water saving method shall be selected** by adopting stepwise approach to make it effective. High technology method beyond farmers' skill such as sprinkler and drip irrigation system with pressurized pipeline might oppositely increase the irrigation loss.
- **Capacity development such as dissemination and training**, including training for trainers, instruction on the formulation of dissemination guidelines, training on "communication with farmers," and training on WUA reinforcement.
- **Water saving irrigation methods**, dissemination of water saving irrigation methods and promotion and farmers' training.

304. Lessons and recommendations from FAO:

- **Good agricultural practices (GAP)** that, in addition to enhancing crop productivity, could strengthen resilience to climatic shocks in value chains. The most popular GAP among tomato farmers in Erbil, Duhok and Salah Al-Din are water optimization, retention of crop residue and time planting. Despite raising awareness, knowledge constraints remain in selected domains, such as efficient pest control (pesticide application) and breeding of new seed varieties (FAO, 2021).

Renewable energy resources sector

Introduction

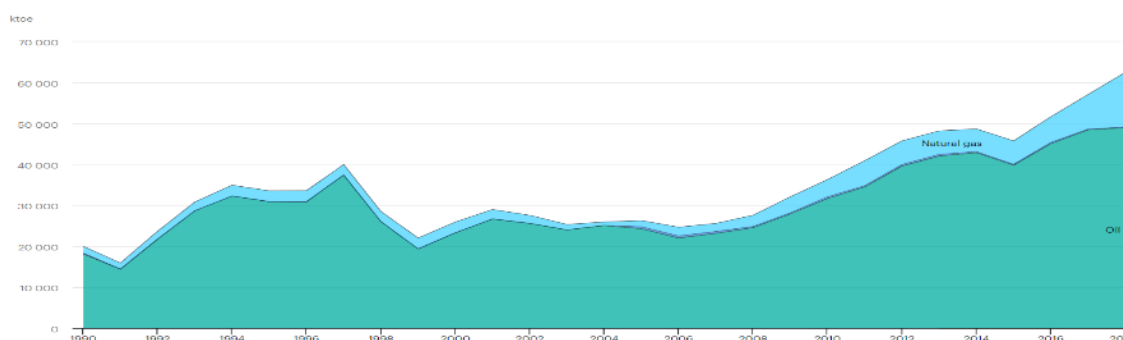
305. As mentioned above, Iraq has abundant fossil fuel reserves and oil and gas production dominate with a contribution of 60 percent to the GDP. According to the International Energy Agency (IEA), Iraq produced 4.7 million barrels per day in 2018 and will add a further 1.3. million barrels a day by 2030, which will make the country the 4th largest producer in the world¹⁵⁴ and on the 10th position with regards to natural gas reserves.¹⁵⁵ Crude oil reserves provided 80 percent of foreign exchange earnings in 2016 and more than 90 percent of government revenues (2016).

306. Total energy supply in the country grew by 221 percent from 1990 to 2018 and is currently largely covered by oil with 78 percent of the share coming from this source. The share of natural gas is constantly growing, especially since 2010 (6.7 percent) and corresponds now to 21 percent. Renewable Energy Resources mainly hydropower and some wind, solar and biofuels contribute to the remaining marginal share of approx. 0.3 percent (see Figure 40).

Figure 40: Total Energy Supply (TES) by Source, Iraq 199-2018

¹⁵⁴ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

¹⁵⁵ <https://www.government.nl/binaries/government/documents/publications/2019/02/05/climate-change-profiles/Iraq.pdf>



Source: IEA, 2021

307. Electricity consumption has increased by 114 percent since 1990 and was 48.83 Terawatt hours (TWh) in 2018. Oil and Natural Gas resources contributed almost in equal shares to its generation with 48 percent and 49 percent respectively in 2018, the remaining is covered by hydropower with 2.2 percent and some solar Photovoltaic (PV) with 0.07 percent (IEA, 2021). Peak electricity demand is growing at a very high rate – it grew by 64 percent between 2013 and 2016.¹⁵⁶ In 2019, electricity demand was estimated to be 32 Gigawatt (GW) with a tendency to increase continually further reaching eventually 52 GW by 2030.¹⁵⁷ In the same time period, the share of renewable energy from hydropower and solar energy exploitation could technically reach a share of 20-30 percent.¹⁵⁸
308. Since electricity production costs from natural gas is lower than from oil, it is expected that natural gas will gain even more importance in this sector in the future. Since Iraq is currently not able to capture all of its gas sources (over 60 percent is being flared without further utilization), it mainly imports from Iran increasing its dependency on foreign resources and its energy security risk.¹⁵⁹
309. Most of the electricity consumed comes from the residential sector (46 percent), followed by the governmental sector (31 percent), the industrial sector (11 percent), commercial sector (5 percent) and a small amount in the agricultural sector (2 percent).¹⁶⁰ Energy capacity for the agricultural sector is estimated to be 131 MW in 2021 and is expected to grow further reaching 194 MW in 2030.¹⁶¹
310. Electricity consumption is currently at 1,300 kWh per capita per year and is significantly lower than the world average (3,127 kWh/p) and the regional average in countries such as Jordan (1,954 kWh/p) and Saudi Arabia (9,658 kWh/p). It has to be noted however that actual demand is probably up to 4 times higher than the current number.¹⁶²
311. Despite the large availability of fossil fuels, the country faces continuous electricity shortages that date back to 1991. While shortages were exacerbated due to the economic embargo in the aftermath of the Persian Gulf War, since 2003, the main reason is the inadequate and poorly maintained infrastructure.¹⁶³ As a consequence, more than 67 percent of the electricity is lost through technical losses (21 percent) and collection losses before billing (46 percent), and only 11 percent of the costs for production and delivery of energy are recovered through tariff collection, leading to extreme pressure

¹⁵⁶ https://www.rcreee.org/sites/default/files/afex_ee_2017.pdf

¹⁵⁷ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

¹⁵⁸ <http://library.fes.de/pdf-files/bueros/amman/16324-20200722.pdf>

¹⁵⁹ https://www.researchgate.net/publication/328345510_SOLAR_ENERGY_IN_IRAQ_FROM_OUTSET_TO_OFFSET

¹⁶⁰ RCREEE & UNDP, 2017. Renewable Energy Context in Iraq.

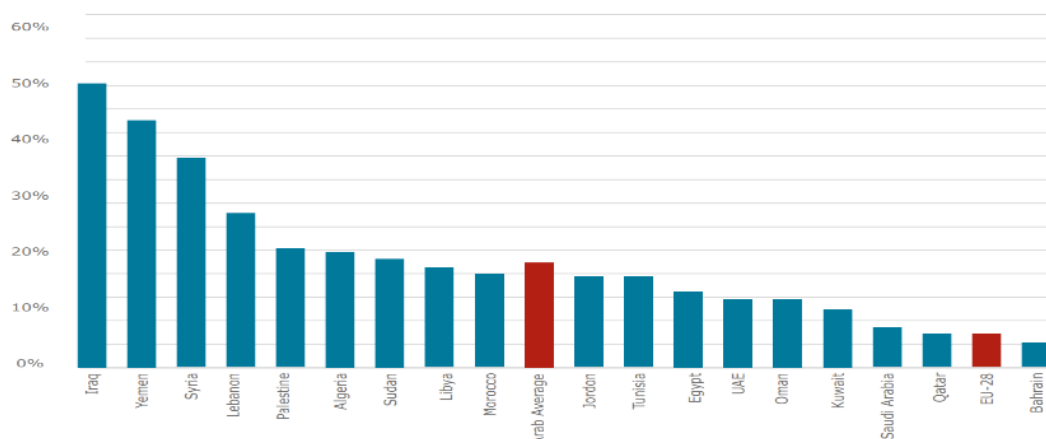
¹⁶¹ <https://www.mdpi.com/2079-9276/8/1/42>

¹⁶² https://www.researchgate.net/publication/328345510_SOLAR_ENERGY_IN_IRAQ_FROM_OUTSET_TO_OFFSET

¹⁶³ <https://www.aimspress.com/article/id/4336>

on government's budget.¹⁶⁴ The losses are among the highest in the world and extremely high when compared to all neighbouring countries (see Figure 41).

Figure 41: Transmission and Distribution Losses in Arab Region, 2015 (percent of Output)



Source: Arab Future Energy Index¹⁶⁵

312. Although the electricity generating power is constantly increasing, for example, in the period from 2012 – 2018 almost by 90 percent,¹⁶⁶ the gap between supply and peak demand is becoming larger (Figure 42). In the summer, due to extremely high temperatures and a high demand for air conditioning, peak demand is estimated to be approximately 50 percent higher than average demand.¹⁶⁷ Iraq Ministry of Electricity (IME) estimated the gap to be up to 6 GW for the period from May until September.¹⁶⁸ Estimations on the losses in revenues due to power shortages range between USD 40 bln ¹⁶⁹ and USD 55 bln per year.¹⁷⁰

313. To compensate for the insufficient grid providing only between 18 - 11 hours of electricity per day throughout the country,¹⁷¹ 90 percent of households have to rely on neighbourhoods and household generators.¹⁷² In Baghdad alone, power from private generators is estimated to be 900 MW. Although the private producers are utilizing subsidized fuels, HH costs for obtaining generator electricity is 10 to 15 times higher than the one from the grid.

Figure 42: Peak demand and maximum power supply from the grid in Iraq, 2014-18

¹⁶⁴ <http://library.fes.de/pdf-files/bueros/amman/16324-20200722.pdf>

¹⁶⁵ https://www.rcreee.org/sites/default/files/afex_ee_2017.pdf

¹⁶⁶ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

¹⁶⁷ <https://www.mdpi.com/2079-9276/8/1/42>

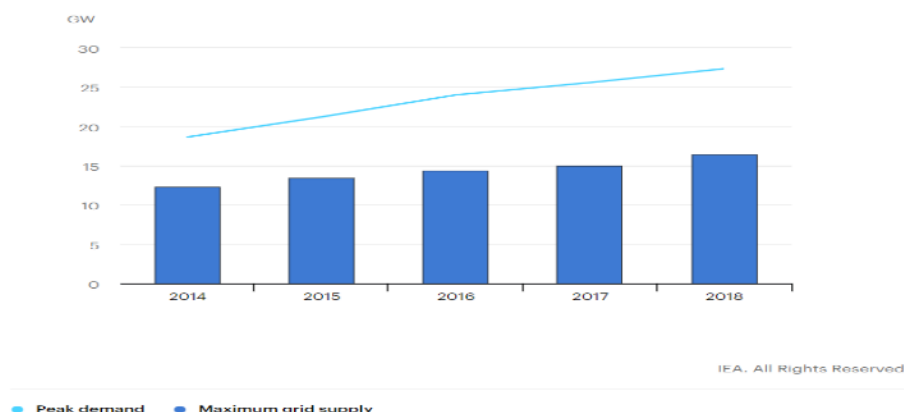
¹⁶⁸ https://www.researchgate.net/publication/324994095_Analysis_of_stand-alone_solar_photovoltaic_for_desert_in_Iraq

¹⁶⁹ <https://documents1.worldbank.org/curated/en/406941467995791680/pdf/105893-WP-PUBLIC-INES-Summary-Final-Report-VF.pdf>

¹⁷⁰ <https://auis.edu.krd/sites/default/files/WahabiRISReport.pdf>

¹⁷¹ RCREEE & UNDP, 2017. Renewable Energy Context in Iraq.

¹⁷² <https://www.aimspress.com/article/id/4336>



314. The year 2020 was a particularly difficult year for the electricity sector because of the compounding effects of obsolete infrastructure, the COVID-19 pandemic, an increase in political instability and the global collapse of oil prices that led to budget cuts and consequently to a further deterioration of the infrastructures due to inadequate budgets for management and maintenance. The pressure of these challenges also delayed the much needed sectoral reforms on stand-by. This led to a temporary worsening of energy supply and most Iraqi households had access to the electricity supply from the grid for only 5-8 hours.¹⁷³ The situation illustrates the fragility of energy security in the country.

315. Reforms are also needed in the pricing of electricity which is very difficult to achieve due to the economic impacts of measures. Until 2015, the heavily subsidized tariffs were set to approx. USD 0.017 kWh for most consumers leading to significant financial loss in revenue. Beginning in the year 2016, the IME started introducing modifications to the tariffs, which are currently as follows¹⁷⁴:

- Residential: 0.84- 10.08 US\$/kWh
- Commercial: 5.0 - 10.08 US\$/kWh
- Industrial: 5.0 US\$/kWh
- Agricultural: 5.0 US\$/kWh

316. Although the government reform increased tariffs, the revenues collected are still not sufficient to cover production costs, which corresponded in the year 2020 to Iraqi Dinar (IQD) 180.70 (US\$ 15.12) per kWh for the Government.¹⁷⁵ The electricity subsidies are among the highest in the world and the government budget allocated for this purpose is USD 2.4 bln per year, equivalent to 1 percent of GDP, 2,78 percent of total federal public expenditure and about the same as the budget spent on public health. Despite these expenditures, given the high costs for generators for bridging the gap due to power cuts, the electricity costs for households are very high: Average costs for 1 Ampere per month and 8 hours per day is USD 8.4 and for 6 Ampere for the entire day it is USD 100.¹⁷⁶ Average bill per household to receive 15 Ampere per month from a neighbourhood generator is 300 USD. In total the neighbourhoods generators are estimated to capture in this way 4 billion USD in 2018.¹⁷⁷

317. In terms of enabling environment for energy efficiency, Iraq ranked 19th of 20 Arabic countries analysed by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE). The country had a lower performance compared to the regional average in almost all assessed categories (Figure 43):

¹⁷³ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

¹⁷⁴ https://www.researchgate.net/publication/338203074_Iraq's_electricity_tariff_reform

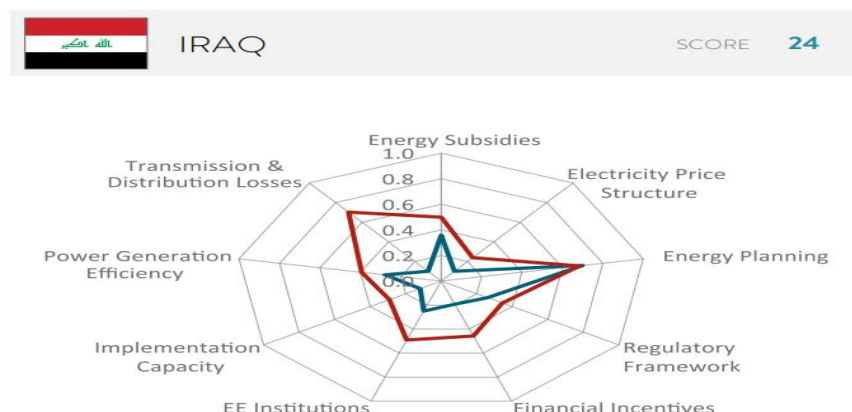
¹⁷⁵ <https://iraqenergy.org/product/residential-electricity-subsidies-in-iraq-exploring-options-for-reform-report/>

¹⁷⁶ Ibid

¹⁷⁷ https://www.researchgate.net/publication/338203074_Iraq's_electricity_tariff_reform

Energy Subsidies, Electricity Price structure, Regulatory Framework, Financial Incentives, EE Institutions, Implementation Capacity, Generation Efficiency, and Transmission and Distribution losses. Only with regards to Energy planning with the adoption of the “Electricity Master Plan 2030” and the “First National Energy Efficiency Action Plan” significant progress from 2014 could be assessed. This planning however did not translate in the necessary Energy Efficiency (EE) laws or bylaws.

Figure 43: AFEX Energy Efficiency assessment of Iraq. Red lines are regional average and blue lines the score of Iraq

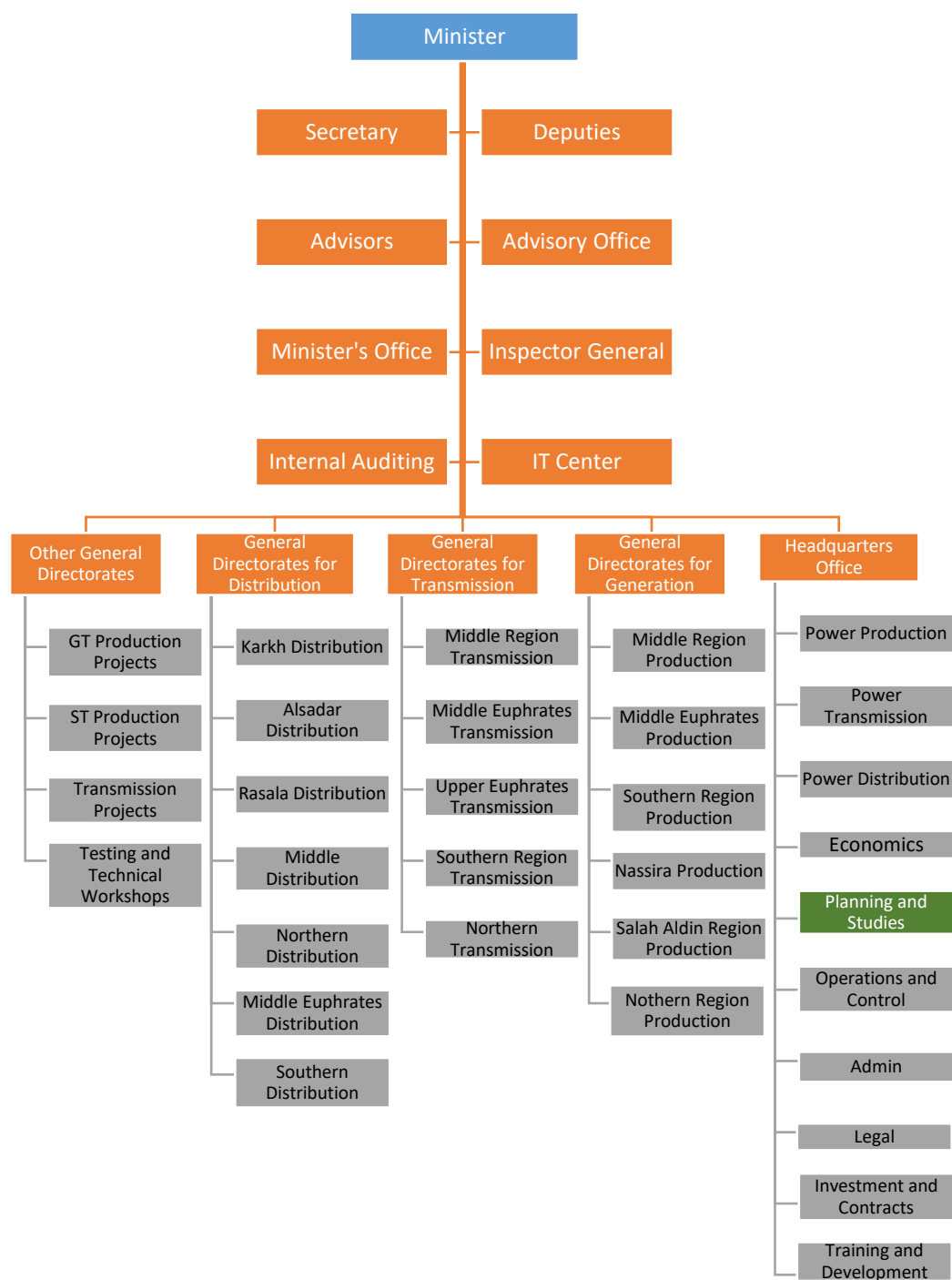


Source: Arab Future Energy Index, 2017

Institutional set-up

318. **Iraq Ministry of Electricity (IME)** is in charge of sectoral policies, oversight, and planning of electricity supply in the country. It is divided into general directorates responsible for generation, transmission, and distribution based on regional/geographical directorates (Figure 44). A separate General Directorate deals with the implementation of projects and technical facilities. There are 2 divisions which are part of the Headquarter office within the planning and study department that are of crucial importance for the GCF initiative: (i) The department of Renewable Energy and Energy Efficiency, responsible for the implementation of initiatives in support of the sector and the (ii) Regulatory Office that is tasked with developing the regulatory framework for the enhancement of the power sector including the elaboration of regulations related to solar energy generation and grid integration. There is currently no Electricity Regulatory Agency present, the Power Off-taker for large RES project is the Directorate for Transmission and the Directorate of Transmission Project.

Figure 44: Organizational structure IME



Source: RCREEE & UNDP, 2017

319. The **Ministry of Higher Education and Scientific Research** has recently incorporated the Ministry of Science and Technology that has been actively involved with the evaluation of solar energy applications since 2006 and is the focal point for the International Renewable Energy Agency (IRENA).

320. The **Ministry of Environment (MoE)**. Besides being the crucial counterpart of the project in its role as the National Designated Authority (NDA), is also the reference institution for the UNFCCC and

responsible for aspects of greenhouse gas mitigation and pollution control. In this regard it is also responsible for promoting RES in policy dialogues and public awareness campaigns.

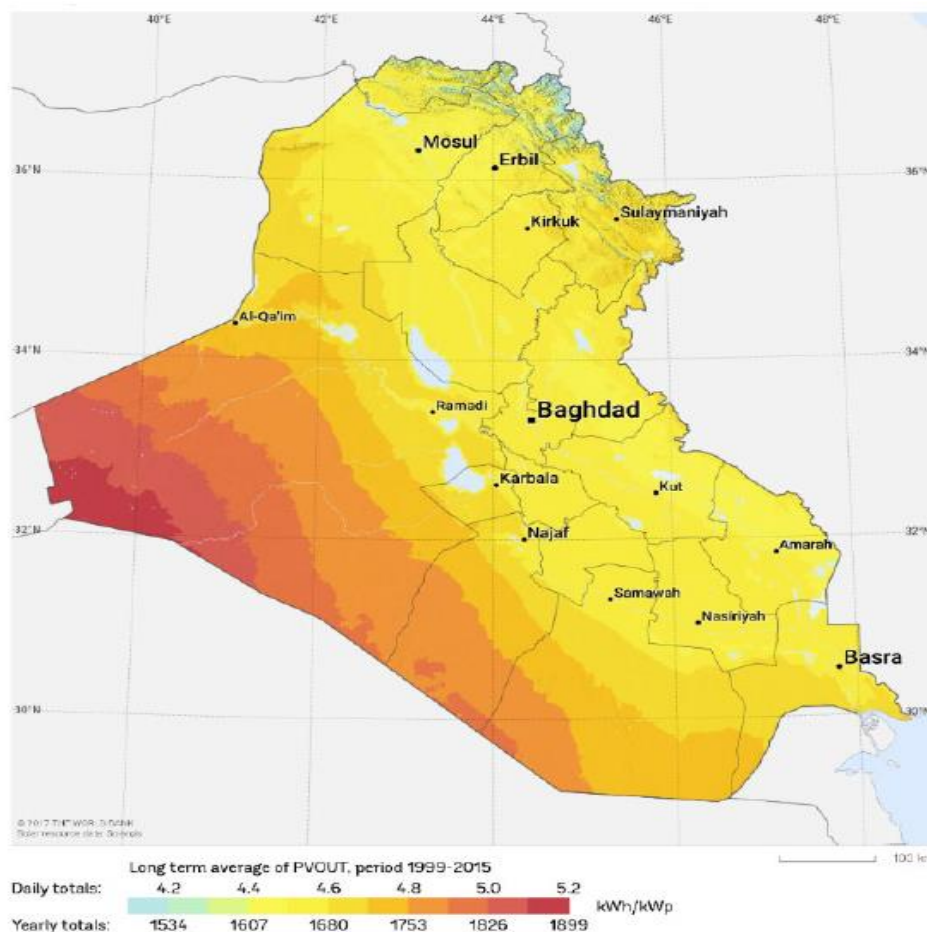
321. The **Ministry of Finance**, in particular its affiliated entity **the General Commission for Taxes**, is the competent entity for defining tax rates and incentives to enhance national and international investments in the sector. The **National Investment Commission** defines investment policies and promotes investment schemes related to RES.

322. The **Ministry of Agriculture and the Ministry of Water Resources** are normally not considered part of the institutional set-up of the energy sector but are expected to play a significant role within the present initiative. Within the MoA, the state agencies responsible for overseeing irrigation technology and the Planning and Follow-up Department that implements water saving irrigation methods at field level will be contacted for collaboration related to the implementation of the activities concerning Solar Powered Irrigation Systems (SPIS). The **Ministry of Water of Water Resources** will be involved with activities concerning the energy use of water pumping systems, through its regional Departments of Water Resources. There are several large pumping stations, which are operated by the Ministry providing water to reservoirs in agricultural fields, which are then delivered to irrigation sites. The plants are supplied with electricity from the grid or diesel pumps. Given the electricity shortages, solar operated pumps will be demonstrated under the project.

State of the art

323. Like all countries in the Middle East, Iraq has a large potential for solar energy with an average irradiation of 5.6 kWh per m² per day and over 3,000 hours of sunshine. Solar energy has therefore a high potential to increase energy security, to decrease oil exports, reduce the subsidy burden, decentralize energy generation, boost local job creation and business opportunities and decrease overload on the national grid. Especially in the Southern Regions including Karbala, Najaf and Muthanna and in the western regions, the potential is very high as indicated in Figure 45. Furthermore, it is worthwhile to point out that the peak demand of electricity occurs in most governorates in the summer during the hours 12pm to 4pm when the country has high consumption for air conditioning because of extremely high temperatures. This time coincides with the highest availability of solar energy and highlights once more the exceptional potential for the PV technology to enhance energy security in the country.

Figure 45: Solar Irradiation Iraq



Source: RCREEE & UNDP, 2017

324. Electricity generation from Solar PV was 57 GWH in 2018, a share of only 0.07 percent. Compared to other middle Eastern/GCC countries, investment costs in Iraq are still considerably higher and the country is lagging behind in the promotion of RES.¹⁷⁸ Due to the instability of the government and the weak enabling environment it is difficult to attract foreign investments. In fact, Iraq is currently ranked only 168th (2018) in the country performance under International Ease of Doing Business.¹⁷⁹

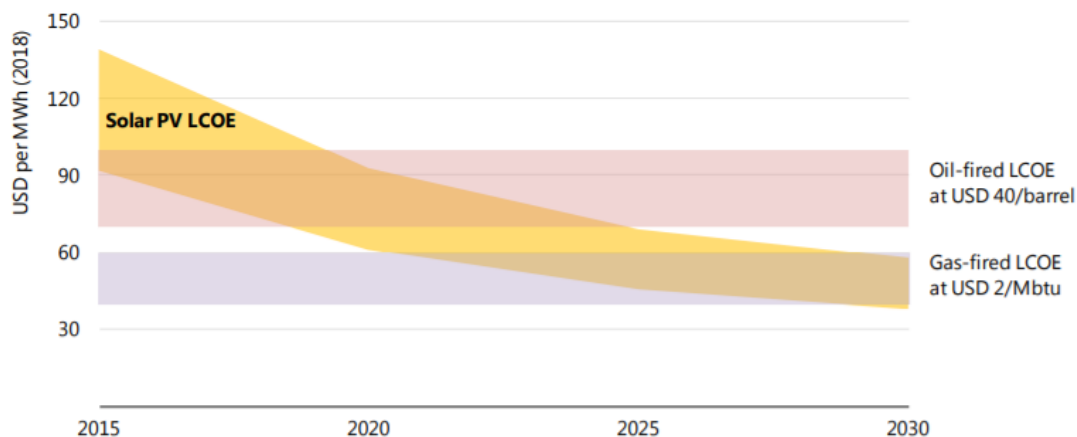
325. Driven by the global development of the technology, the prices for PV have fallen significantly by 50 percent from 2013-2018 and are competitive with oil-fired generation. The Levelized Costs of Electricity (LCOE)¹⁸⁰ of Photovoltaic (PV) systems in 2018 was approx. USD 70/MWH which is significantly lower than the costs for neighbourhood generators. Given the steadily decreasing prices, PV prices are expected to fall to USD 50/MWh by 2025 and to be competitive with gas-fired generation within 2030 (Figure 46).

Figure 46: Solar PV levelized costs relative to oil- and gas-fired generation in Iraq, 2015 – 30

¹⁷⁸ <http://library.fes.de/pdf-files/bueros/amman/16324-20200722.pdf>

¹⁷⁹

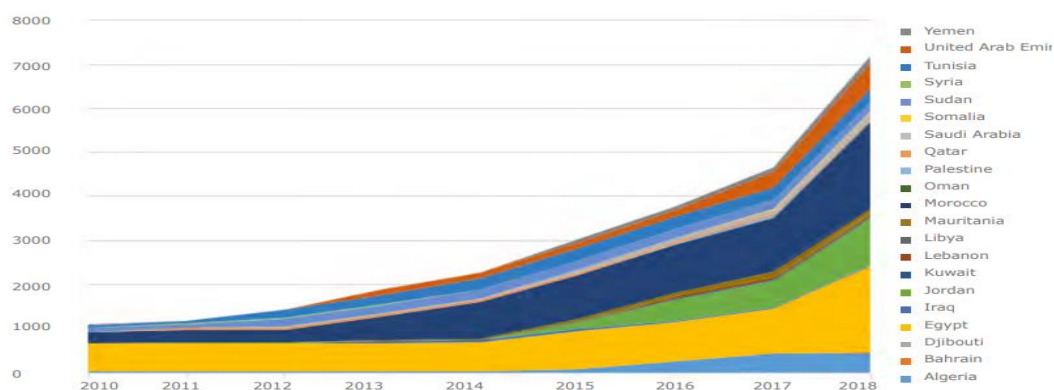
¹⁸⁰ The levelized cost of electricity (LCOE) is used to quantify the average net present cost of electricity generation over the lifetime of the generator



Source: IEA, 2019¹⁸¹

326. Given the relatively high hydropower capacities and even though there are no significant contributions by wind and solar energy yet, Iraq ranks relatively high in 2019 in terms of RES capacities installed among the 20 Arabic member countries of RCREEE. Excluding hydropower, its position is only 13th. Ranking only PV capacities pushes Iraq up to the 11th position.¹⁸² Furthermore, as figure 47 shows, while the total PV capacities in the region grew significantly (mainly due to the increase in Jordan, Egypt UAE, and Algeria) there was only little increase in Iraq in the last years.

Figure 47: Total Renewable Energy Capacities in the Arab Region excluding Hydro (2010-2018)



Source: Arab Future Energy Index, 2019

327. Electricity consumption in the target regions is highlighted in Table 36. Interestingly, while average income per family in Karbala, Muthanna and Najaf regions is much lower than in the capital, average electricity consumption per HH is significantly higher. This is particularly striking for Muthanna, which, despite having the lowest income, has the second highest electricity consumption of all governorates¹⁸³. This might be partly explained by the highest number of average family members per HH and due to the warm temperatures that require more use of air conditioning than in other provinces.

¹⁸¹ https://www.rcreee.org/sites/default/files/final_afex_re_2019_final_version-1.pdf

¹⁸² Ibid

¹⁸³ Only 11 of the 15 Iraqi governorates have been analyzed. The provinces Ninawa, Salahuddin, Anbar, Kirkuk have not been included.

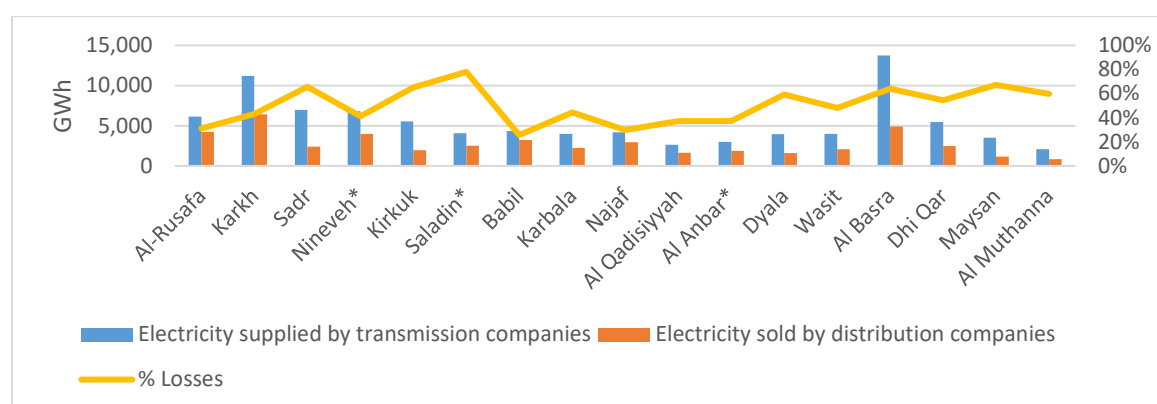
Table 37: Average electricity consumption in target regions and Baghdad

Governorate	Average Family size	Electricity per HH (kWh)/year	Income per family (k IQD)
Baghdad	6	14,267	2,108
Karbala	6.7	17,245	1,683
Najaf	7.3	16,333	1,557
Muthanna	8.4	18,787	1,136

Source: Iraq Energy Institute

328. Transmission and distribution losses are highest in Muthanna with more than 60 percent, followed by Karbala with more than 40 percent and Najaf with approximately 30 percent (Figure 48).

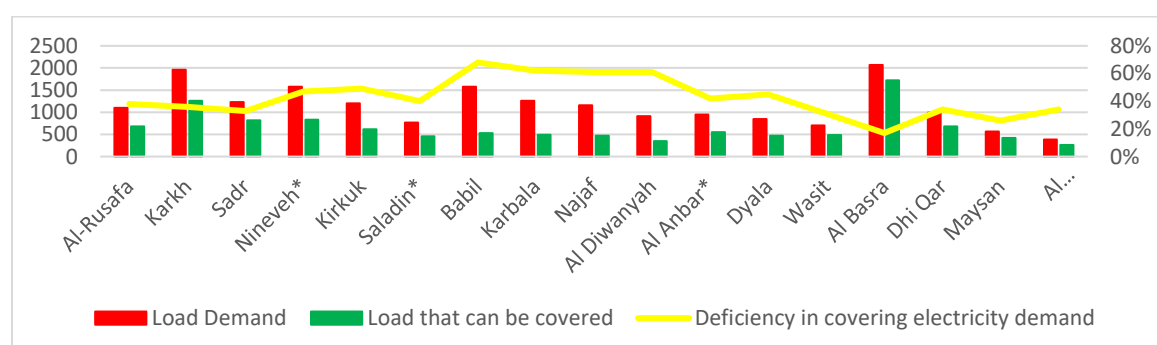
Figure 48: Transmission and Distribution losses in Iraq



Source: RCREEE & UNDP, 2017. Renewable Energy Context in Iraq

329. As demonstrated in figure 49, deficiency in covering electricity demand was more than 30 percent in Muthanna and approximately 60 percent in Najaf and Karbala.

Figure 49: Average Load Demand and Covered Electricity Load in 2016



Source: RCREEE & UNDP, 2017. Renewable Energy Context in Iraq.

330. **Other Renewable energy sources:** Hydropower represents approximately 13 percent of total installed capacity for electricity production. Installed power was 1,864 MW in 2012, although the

generation itself corresponded to only 855 MW. The Government has ambitious plans of increasing production up to 14 TWh until 2035 by installing 8 new hydropower dams.¹⁸⁴ According to the [IEA](#), hydropower produced fluctuated between 2010 and 2018 between 4,8 and 1,8 TWh, with decreasing trends. Wind energy has also been pointed out as a potential source, its availability is however less predictable than solar energy and restricted to certain areas.¹⁸⁵ Fostering wind power is nonetheless important as it would diversify the renewable energy mix and private sector investments.

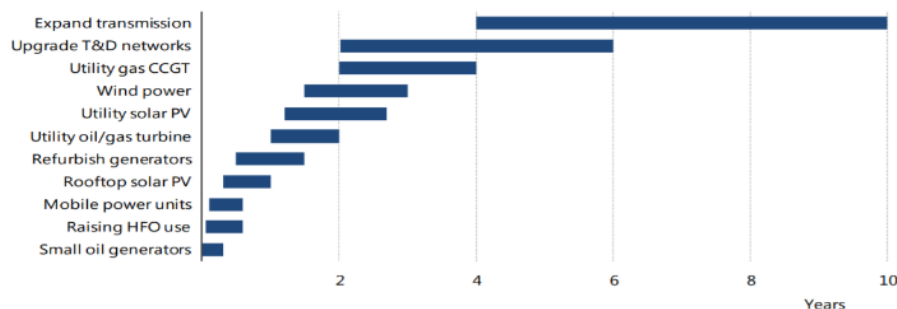
331. Projections elaborated by the IEA estimated that if supply of new generation continues, Iraq will be adding up to 10,000 MW to the grid within 2025, reaching up to 30,000 MW, including up to 1,500 MW of RES, mainly from PV. The latter however requires smart autonomic systems to capture highly fluctuating RES supply and a significant reduction of technical losses. There are so far only small projects known in the area. The government plans however to install several utility scale PV plants in Karbala and Muthanna, and UNDP is planning to support the provision of solar pumping systems to provide communities with drinking water.

332. There are a variety of options that could be implemented to strengthen electricity supply. According to the IEA the most efficient ones are:

- Mitigating network losses
- Enhance regional interconnections,
- Utilize captured gas in efficient power plants
- Increase share of RES in electricity mix

333. Carrying out the aforementioned is a necessary, but time-consuming endeavour. RES sources, in particular Photovoltaic, have in this regard the advantage to be a high impact measure with comparatively low project cycle for installation and operation. Energy could be provided within shorter time frames, especially when compared to other high impact measures, as indicated in figure 50.

Figure 50: Technology options to improve electricity supply by time to complete project type



Source: IEA, 2019

334. The strategies of the government have so far not been successful in achieving market penetration of solar energy. One of the measures introduced in the past and recently revoked was a feed-in-tariff (FiT) of 3.5 USD cent per kWh in 2017. Evaluations concluded that FiTs might be an interesting option to promote small scale PV systems. To allow take-off of medium and large-scale PV systems it is more advisable however to concentrate on competitive schemes like auctions, which have proven to decrease costs significantly¹⁸⁶. It appears clear however that at least at the moment, and considering the unstable political and economic environment, costs to be paid for the Iraq government

¹⁸⁴ <https://www.mdpi.com/2079-9276/8/1/42>

¹⁸⁵ Ibid

¹⁸⁶ In Dubai for example in 2018 a project was awarded with a cost of USD 24/MWh, one of the lowest costs worldwide at the time

will be much higher than in neighbouring countries. In 2020 between USD 60-90/ MWh for large scale projects. Even with these relative high costs, however, the LCOE is only a fraction of the one of neighbourhood generators that range from USD 640 – 1,300 / MW.

335. Net-metering schemes are currently being tested at several sites, but there is so far no official regulation approved on a governmental level. UNDP recommends however to base any possible future introduction of a net-metering-scheme on the settlement of electricity balances and not on financial transactions.¹⁸⁷

Main challenges and CC impact

336. Iraq's GHG emissions corresponded in the year 2018 to 216,19Mt CO₂eq, representing a 216 percent increase compared to 1990 [Climate Watch Data]. Of these emissions, the energy sector accounted for 186,56Mt CO₂Eq, while agriculture represented 7,39Mt CO₂Eq (3 percent of the total GHG emissions). The energy sector increased by 216 percent its GHG emissions compared to the 1990 levels, while the agriculture did not show any significant variations.
337. Iraq has abundant fossil fuel resources, and these are also responsible for the high share of GHG emissions of the energy sector. The importance of these resources is also reflected by the fact that Iraq's economy is dominated by oil production. The revised NDC (2021) set the targets to reduce greenhouse gas (GHG) by 17 percent below business-as-usual (BAU). Fifteen percent of these reductions are conditional on receiving international support and 2 percent is unconditional (financed from Iraq's own resources).
338. Studies assume that there are more than 2 million generators running throughout the country on diesel. The negative effects of these appliances that are mostly completely unregulated are manifold and range from noise disturbances to the emissions of GHG and other air pollutants.¹⁸⁸ The generators contribute to the bad air quality in particular in densely populated areas. In Baghdad, e.g. fossil fuel engines are responsible for more than 50 percent of the local fine particulate matter (PM 2.5) emissions, which are particularly damaging to human health, and exceed the maximum recommended levels of the WHO by 7 times.¹⁸⁹
339. In addition, a diesel generator produces 10 g of waste oil per kWh output energy, corresponding to approximately 300 kg of waste oil during its operating lifetime, with evident risks of pollution of soil and groundwater (1 liter of waste oil can contaminate up to 1,000 m³ of groundwater). The appropriate disposal of these substances cannot be guaranteed in some of the Iraqi context, which makes irrigation with PV systems an ideal solution to eliminate the risks.¹⁹⁰
340. One has to consider also that significant amounts of water are required for the extraction of oil: the average quantity necessary is 1.3-1.5 barrels of water for every barrel of oil, and water demand will increase from 5 mb/d today to 8 mb/d by 2030 for Iraq's oil production.¹⁹¹ In a water scarce country like the one in Iraq, the extraction of oil is putting further pressure on water resources emphasizing once more the need to switch from fossil fuels to cleaner RES.

¹⁸⁷ <https://erc.undp.org/evaluation/evaluations/detail/12612>

¹⁸⁸ https://www.researchgate.net/publication/324994095_Analysis_of_stand-alone_solar_photovoltaic_for_desert_in_Iraq

¹⁸⁹ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

¹⁹⁰ https://energypedia.info/images/7/74/Solar_Powered_Irrigation_Systems_percent28SPIS_percent29_-_Technology_percent2C_Economy_percent2C_Impacts.pdf

¹⁹¹ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

SWOT Analysis of the Sector

341. The solar energy sector in Iraq requires a diverse set of actions to secure INDC and SDG targets. Weaknesses, strengths, opportunities, and threats are reported below.

Strength	Weaknesses
<ul style="list-style-type: none"> • Renewable and local energy source with high solar radiation throughout the year. • Potential to be used to power irrigation systems to pump canals water to fields. • Public sector commitment to solar energy development as part of the national strategy to enhance energy security in particular in rural areas • Low operation and maintenance cost • Different projects in the sector financed by the World Bank. • Technical support by international organizations, such as IEA, IRENA, RCREEE and the UNDP. • Keen interest by the private sector. 	<ul style="list-style-type: none"> • Limited awareness of solar technology at key decision-making levels, among technicians and the general population. • Community solar and microgrid are yet to be exploited but demand a thorough investigation of local energy grid, and specific policies and extensive regulatory and supportive administrative policies and awareness of technicians and consumers. • Lack of local expertise for engineering planning, installations, operation, and maintenance. • Highly subsidized electricity and fossil fuels decrease competitiveness. • Lack of clear strategy for the promotion and dissemination of information of competent institutions. • Quality and safety standards for SPIS related appliances not available • Outdates laws and regulations are not keeping pace with dynamic and fast changing international RES market • Limited access to funding sources and high initial investment costs • Limited involvement of private sector and financial institutions due to limited understanding of costs and benefits. • Lack of cooperation between institutions, private sector, and citizens • Obsolete and unstable Grid and infrastructure make integration of PV difficult • No mechanism in place to sell excess energy to public utility • Lack of innovation
Opportunities	Threats
<ul style="list-style-type: none"> • Offers low emissions and sustainable solution to provide off-grid communities or consumers with electricity. • Recent relaunch of ambitious renewable energy targets until 2030 • Growing interest from the private sector in the sector. 	<ul style="list-style-type: none"> • Once SPIS are installed there is no fuel consumption anymore and therefore no incentive for users to rationalize use of pumping. This can be problematic when pumping groundwater as it can lead to unsustainable pumping

<ul style="list-style-type: none"> • Growing Interest from donor community to invest in sector • Growing interest and commitments from International Investors to install utility scale solar systems • Small/Medium scale PV systems can be installed quickly compared to large thermal power plants and provide therefore opportunity for both decentralized and centralized solutions • Solar components are constantly and significantly decreasing in price • Solar energy contributes to reducing the share of imported energy, buffering oil exports, and reducing the subsidy burden • Job creation especially for the youth that could counteract rural depopulation • Possibilities to create local business opportunities for economic development and employment • Possibility to include Renewable Energy Offset Programs (REOP) in agreements with oil companies.¹⁹² 	<ul style="list-style-type: none"> • Unstable government structure and policies increase perceived risk of investor and decrease confidence • Highly unstable security situation that can discourage private sector investment and increase costs. • Risk of theft and damaging of PV installations
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Main Policy framework, strategy, laws.

342. The policy framework related to RES in general, and to solar energy is not well developed yet and needs to be strengthened to ensure market penetration of the technology. There are however some references in policy documents as indicated below:

343. The **National Development Plan 2018 – 2022**: While the enhancement of RES is not directly mentioned in the objectives of the plan, one of the 8 objectives for the electricity sector is to improve “the environmental impact of electricity activity by reducing the emissions of CO₂”. RES can have a crucial role in reducing the emissions of the sector, furthermore the plan highlights that one of the many challenges the country is facing is the “reliance on non-renewable energy” and that the country has so far missed the opportunity to introduce alternative energy sources among the policy priorities.

344. **Iraq Vision 2030**: The promotion of RES is indicated as one of the most important measures to achieve Goal (5-1): “Reduce environment pollution and greenhouse emissions.”

¹⁹² Taken from Istepanian: “Renewable Energy Offset Program (REOP) is an economic agreement required by the oil companies to invest in development of renewable energy projects. It aims to help Iraq for meeting the high demand for electricity and commitment for reduction of greenhouse gasses from oil & gas extraction operation. REOP aims to offset an amount being a proportion of the main oil or gas energy produced towards a secondary objective, which is generating electricity from renewable energy sources. REOP can be promoted as an important element of Iraq’s energy policy in delivering sustainable solutions for the electricity shortage.” “A similar economic agreement to REOP was recently signed between Kuwait National Petroleum Company (KNPC) and the Ministry of Electricity and Water (MEW). According to a PPA, KNPC will invest in building and operating 1,200 MW PV Al-Dibdibah power plant at Shagaya Renewable Energy Park and sell the generated electricity to MEW over the next 25 years. (https://www.researchgate.net/publication/328345510_SOLAR_ENERGY_IN_IRAQ_FROM_OUTSET_TO_OFFSET)

345. The Integrated National Energy Strategy (INES), developed by the Iraq Prime Minister Advisory Commission in 2014 assigns to the development of Renewable energy infrastructure great importance. Solar energy is a key source in the short term for supplying energy to remote off-grid locations. In the medium- to long-term, solar and wind power capacity will be developed for connection with the grid, and the potential for hydro-power development will be further examined. The strategy expects that by 2030 renewable capacity will exceed 2 GW, approximately 4-5 percent of total system capacity.¹⁹³
346. The **Electricity Master Plan 2010 - 2030**, developed by the IME for the upgrading of its power plants and general improvement in the efficiency and capacity of the electricity sector.
347. The **solar energy plan 2017 – 2020** by the IME was created with the aim to diversify energy resources and to reach 2,240 MW of PV as indicated in Table 37. So far however, the full implementation of the plan does not seem to have started as only a few MW of PV have been installed in the country. By 2018, there were only 27 MW installed compared to a target of 545 MW.

Table 38: Projected solar PV capacities in Iraq

Governorate name	2017 (MW)	2018 (MW)	2019 (MW)	2020 (MW)	Total (MW)
Baghdad	50	30	30	30	140
Muthanna	50	30	50	50	180
Al Najaf Alashraf	100	50	50	50	250
Al-Qadisiyah	30	50	50	50	180
Dhi Qar	50	50	30	30	160
Missan	30	50	50	50	180
Anbar	50	100	100	100	350
Karbala Al-Qadisiyah	30	30	30	30	120
Wassit	100	30	30	30	190
Diyala	15	25	25	25	90
Babil	100	100	100	100	400
Total	605 MW	545 MW	545 MW	545 MW	2240 MW

Source: RCREEE & UNDP, 2017. Renewable Energy Context in Iraq.

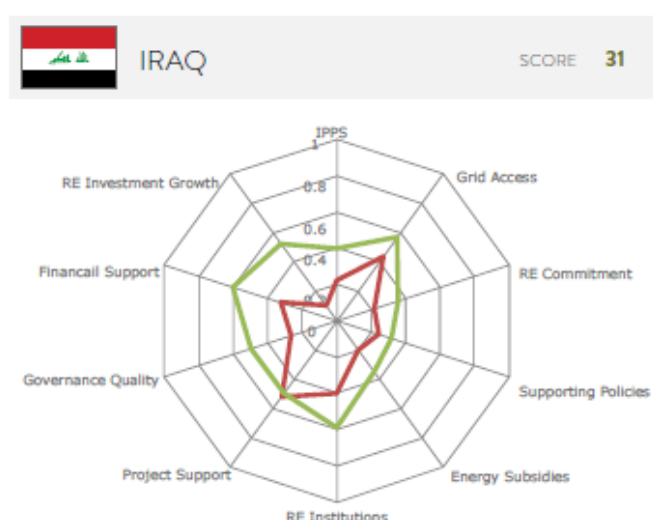
348. Relevant laws: **Investment law no.13**, 2006, created the National Investment Commission (NIC) and the Provincial Investment Commission (PIC) to foster private investments. Companies investing in RES are exempted from operation and income taxes, duty exemption for imported equipment and land for RES projects can be leased at 2 percent of the annual lease return (40).
349. The promotion of RES is also briefly mentioned in article 2 of the **Electricity law no. 53** (2017): “Supporting and encouraging the use of renewable energies in various fields and the settlement of their industries”.
350. A **draft law for RES** submitted to the Ministerial Energy Council in 2019 promotes the cooperation between public and private sector in the field. The law should furthermore permit the production of electricity for individuals and institutions for their own use or to sell it to the IME via

¹⁹³ <https://documents1.worldbank.org/curated/en/406941467995791680/pdf/105893-WP-PUBLIC-INES-Summary-Final-Report-VF.pdf>

Power Purchase Agreements (PPA).¹⁹⁴ Approval is however still pending and there is hence no law in place allowing a selling of excess electricity to the public utility grid.

351. RCREEE ranking for Iraq in 2019 at the 15th position in terms of enabling environment comparing to other countries in the region (see Figure 51). In addition, to the Infrastructural weakness of the electricity supply system, the evaluation highlighted above all insufficient policy schemes with no support to decentralized solutions, no financial or fiscal incentives in place. Solar energy has however been indicated as the most feasible RES option to address the current challenges. International Partners have supported the country in the few last years to improve the enabling framework, in particular the project “Catalysing the Use of Solar Photovoltaic Energy”, implemented by UNDP addressed many of the aspects that are of crucial importance for market penetration of Solar energy, in particular the development of the grid code for PV integration and incentive schemes.

Figure 51: AFEX Renewable Energy 2019 of Iraq



Green lines are regional average points, red lines country scores. Overall score is 31 of 100 points.

Source: Arab Future Energy Index, 2019

Main past, existing and planned projects

352. Solar energy is recognized as an environmentally friendly and reliable technical solution to enhance energy security, especially in remote rural areas and for agricultural purposes worldwide. Iraq has stepped up in the last years its efforts in the sector.

353. With the support of international donors like the World Bank, the Government of Iraq started to promote two development paths of solar energy, (i) utility scale that can lead to a significant decrease of fossil fuel utilization and (ii) rooftop solar contributing to individual HH energy security: in 2018 with the installation of rooftop PV systems with a total amount of 8 MW in public buildings in the whole country. Related to utility scale projects, the IME launched in 2017 a tender for the construction of 7 PV systems ranging from 30 MW to 225 MW and a total capacity of 695 MW. It had to be retendered however several time and until recently the procedure appeared to be on hold.¹⁹⁵

¹⁹⁴ <https://library.fes.de/pdf-files/bueros/amman/16923.pdf>

¹⁹⁵ <http://library.fes.de/pdf-files/bueros/amman/16324-20200722.pdf>

354. In 2021, the plans for launching investments in utility scale PV systems have been revived and several specialized international news outlets¹⁹⁶ reported that the Iraqi government plans to install [10 GW of PV systems](#) by 2030 contributing to a share of 20 percent RES. In the frame of this announcement the Ministry for Oil confirmed that the tender for 750 MW has been awarded, among others with installations in the regions Karbala and Muthanna. Other significant news was the signature of an agreement with the French company, total for the installation of 1 GW PV and the talks with Norwegian companies for further investments.
355. Another milestone for attracting investments is the [signature of an agreement](#) with the Abu-Dhabi based developer Masdar that will act as an independent power producer (IPP) in the frame of the Investment law 13/2006 for the installation of 2 GW of PV systems in Southern and Central Iraq. It seems therefore that after years of stagnating developments, among others also following the negotiation talks with IPPs during the Iraq Energy Forum 2019 that did not seem to materialize,¹⁹⁷ 2021 could be the year that large scale investments are finally taking off. It is therefore even more crucial to ensure that investments will also benefit pro poor and rural development. Besides the inflow of necessary investment capitals, the participation of international investors is also important as it allows to learn from other transferable experiences in the region which could contribute to an eventual decrease in costs.
356. In the frame of the European Union (EU) funded program “[Supporting Recovery and Stability in Iraq through Local Development](#)”, in 2020, the [United Nations Development Programme \(UNDP\)](#) signed a letter of agreement to provide Duhok with a solar park with a peak capacity of 2 MW (budget 2 mln USD). The system will be installed at the local university and support the local city grid to meet the increased electricity demand from Syrian refugees and Internally Displaced Persons. Other activities promoting the use of solar energy in the agricultural field and in everyday life are taking place in Erbil.
357. “[Catalysing the Use of Solar Photovoltaic Energy](#)” created the capacities of the Iraqi government on solar energy. Among the main successes of the project are the preparation and adoption of the PV grid connection code and the support to the development of the draft Renewable Energy law. Furthermore, the initiative provided 6 grid-connected pilot solar PV rooftop installations, assisted in the preparation of the tender for utility scale PV systems (total capacity 700 MW, systems ranging from 30 to 300 MW per system) and provided technical assistance to a variety of other solar energy projects.
358. [RCREEE](#) is promoting renewable energy and energy efficiency practices across the Arab region and is therefore carrying out a crucial work for knowledge exchange. The international agency delivered also key contributions to the preparation of the renewable energy law and to other regulatory documents. It will therefore be essential to involve RCREEE to extend planning instruments also to rural areas.
359. [USAid](#) has some examples of activities related to the training of local experts and the installation of small SPIS, especially in the Kurdistan region. The agency is interested in expanding its activities in the sector in the future and to work through capacity development of central institutions.

Lessons learned from past climate change experiences

360. **Iraq has relaunched private sector investment in large scale solar energy:** After years of stagnating development, it appears that Iraq is starting to remove barriers for market penetration of

¹⁹⁶ Among others the news has been published on the specialized online magazines [Bloomberg](#) and [PV Tech](#)

¹⁹⁷ <http://library.fes.de/pdf-files/bueros/amman/16324-20200722.pdf>

RES for large scale investments of solar energy. There are already projects in place aiming at grid integration of utility scale PV systems (e.g., 2MW system in Duhok by UNDP) and several agreements with IPPs to produce large GW investments have been signed in 2021 with others being negotiated. It is important now to ensure that investments will also provide rural areas with much needed energy security, as also foreseen in the INES. PV installations on water canals offer in this regard an important opportunity to increase energy and food security and rural development in remote agricultural areas.

361. **Capacity Development is essential for sustainability:** In the last few years, the country has experimented with the installation of solar powered applications, e.g., the Ministry of Municipalities and Public Works (MoMPW) has installed 700 PV-powered water purification stations in remote areas. The initiative proved however to have low sustainability, above all because of the lack of expertise for installation, operation, and maintenance, showing once more the importance of appropriate capacity development activities for achieving long term sustainability and avoiding negative visibility.
362. **Irrigation systems powered by solar energy are a climate-friendly and cost-effective technology** for provision of irrigation water, especially in rural and remote areas with unreliable energy access. The systems have relatively high investments costs, but once installed, comparably low maintenance and no running costs for fuels. Within SRV-ALI solar systems for groundwater pumping are foreseen.
363. **Costs of solar systems are decreasing worldwide** and becoming feasible options for farmers of all sizes. The prices for PV technologies have seen a dramatic decrease by more than 80 percent in the last decade and are expected to fall further by 25-50 percent, but also prices for solar water pumps and controllers have decreased by 30 percent from 2009 to 2017.
364. **Integrated approach necessary for planning in agriculture:** When designing policy strategies and subsidies programs for SPIS it is necessary to adapt an integrated water-energy-food nexus approach to prevent unsustainable water use, in particular related to groundwater. Appropriate design of SPIS however allows for the implementation of a variety of irrigation techniques and can also integrate fertigation and filtration.
365. **Support to sector can enhance local economic development:** Most of the components of SPIS have to be imported from international companies. There is however also the potential to produce components locally and this can give an important motivation for the local economy to invest in the sector.
366. **Involvement of private sector enhances sustainability of management:** There are several management models that appear to be successful for management of SPIS, the involvement of the private sector is one of the most prominent ones. After the installation, the companies train the users on the correct utilization and maintenance of the systems. The private sector can and should play a vital catalytic role in the promotion of solar irrigation schemes and collaborate with farmers and extension officers.
367. **Solar energy can have many applications in agriculture and contribute to diversification of activities:** Besides water application, enhanced energy availability from solar systems could be also useful for enhancing post-harvest methods and providing possibilities for income diversification through value chain techniques like food processing, heating/cooling, storage etc. at a farm and cooperative level. This requires however policies, regulations and an enabling environment related to decentralized microgrids which are currently not in place in Iraq.

4. PROJECT AREAS AND TARGET GROUP

Selection criteria for project areas:

368. The selection of project target areas was guided by climate change challenges and related vulnerabilities, the presence of a significant number of poverty pockets, and potential for site-specific Climate Change Adaptation (CCA) interventions. A precondition for the layout of the selected distributary canals and their watercourses is that they will not be in the vicinity of/have any impact on physical cultural resources - their right of way is free from any physical cultural resources including graves. The identification of target areas and distributary canals was based on consultations with stakeholders during the project identification and design. National consultations were held with stakeholders, including the National Designated Authority (NDA); relevant ministries, including the Ministries of Environment, Agriculture, Water Resources, Electricity and Planning; and representatives of each target Governorate.

369. Data and analysis reported in the previous sessions allowed the identification of the proposed target areas according to the following criteria: a) exposure of ecosystems and communities to climate variability and changes, and extreme weather events natural hazards triggered by (or made worse by) climate variability and change; b) vulnerability of ecosystems and communities to climate change; c) mitigation potential in terms of energy and water efficiency; d) high dependency of communities from natural resource exploitation for food production; and e) socio-economic vulnerability of communities. Given the five criteria reported above, participants of the national engagement process, the NDA and the FAO convened that the areas with the higher monitorable exposure and vulnerability are the three governorates of Karbala, Najaf and Muthanna. Table 38 briefly reports the most relevant elements for each of the five reported criteria.

Table 39: Brief description of selected target areas

Governorate	Criteria				
	Exposure of ecosystems and communities to climate variability and changes, and extreme weather events	Vulnerability of ecosystems and communities to climate change	Mitigation potential in terms of energy and water efficiency	Communities' dependence on natural resource for food production	Socio-economic vulnerability of communities
Karbala	High Exposure to Winds, Sand and Dust Storms, Floods	Fragile ecosystems characterized by desertified lands pastures and limited arable lands	Potential for energy and water savings as a result of high efficiency for agriculture production	Dependency of communities from natural resource exploitation is high	The poverty rate in Karbala is 12 percent. ¹⁹⁸ The Multi-dimensional Vulnerability Index (MVI) ¹⁹⁹ is 0.143
Najaf		High evapotranspiration and low water productivity			The poverty rate amounts to 11 percent of the Najaf population The MVI is 0.145

¹⁹⁸ https://planipolis.iiep.unesco.org/sites/default/files/ressources/iraq_prs_arabic_2018.pdf

¹⁹⁹ A multidimensional index tailored to measure social deprivation in dimensions affected by the crisis. The index includes four dimensions measured at household level, namely education and health dimensions capturing access to services, and living conditions and financial security dimensions capturing household living standards and resilience to cope with shocks. Source: COVID-19 Impact on Poverty and Vulnerability (2020) / Data on Public Distribution System Ration Cards is taken from CFSVA, 2016.

Muthanna		Energy inefficiency and loss		<p>The poverty rate is 52 percent of the population in Muthanna</p> <p>The MVI is 0.258</p>
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370. As reported in the introduction, data and analysis related to climate and environment have been organized in the form of an Atlas that presents the rationale behind areas' selection and that form the main part of the baseline in terms of distribution, density, status and vulnerability of target ecosystems (forests and pastures) and communities. The Atlas presents key information such as climate variables, including average, maximum and minimum temperatures, precipitations, demography, agriculture productivity, infrastructures' distribution, pasture user associations grazing areas, forest fund lands and others. The ensemble of presented data constitutes the context generating the assessed needs as well as the context into which the validity of the paradigm shift will be objectively demonstrated.

371. Within the three governorates selected, the project has identified priority areas based on the targeted canals (primary and secondary), as well as to be-upgraded canals for solar system installation where, according to the referenced criteria, investments on canals, solar panels and adoption of climate resilient agricultural practices will have the higher potential impact. Additional criteria include: a) relevance of ecosystem services such as those provided by pastures and forests (i.e. protection, livelihood, water) benefitting communities; b) potential sustainable use of products and resources for local communities; c) availability of public land of at least 1,000 hectares; and d) agreement of communities for reducing pressure on identified areas.

Demographic and socio-economic profile of project areas

372. In addition to the criteria outlined above, the economy in these three selected areas is agriculture based and the economic development is hindered by poor infrastructure and lack of public and private investment. The three selected governorates present some of the most destitute and neglected governorates in Iraq on various dimensions: vulnerability to climate change, socio-economic (poverty, food insecurity, unemployment...etc), and economic development. These dimensions are elaborated more in depth below. Also, as demonstrated in the previous section (main past, existing and planned projects), these three governorates receive limited attention from the major development partners in renewable energy, agriculture and climate change adaptation and mitigation.

373. The total population in the three governorates amounts to 3,596,941 inhabitants – which represent 9 percent of the total Iraqi population. Women constitute 49.4 percent of the total population in the country with target governorates recording slightly higher percentages than the national average (49.6 to 49.9 percent). Overall, the three governorates are among the least populated governorates in Iraq. Among the three governorates, Najaf is the most populated (1.5 million) and Muthanna has the least number of people (0.8 million).

Table 40: Population of target governorates: Karbala, Najaf, and Muthanna²⁰⁰

²⁰⁰ Source: Central Statistical Organization (CSO), Ministry of Planning, Government of Iraq, 2019 / Data on Average HH Size is taken from Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, World Food Programme and CSO, Government of Iraq / Data on number of villages taken from Governorate Rural Development Surveys (2017)

	Total Population	Share of Female (percent)	Avg. HH Size	Rural	HH	Female
Karbala	1,250,806	49.6	6.3	375,242	59,562	186,120
Muthanna	835,797	49.7	7.6	250,739	32,992	124,617
Najaf	1,510,338	49.9	6.3	453,101	71,921	226,097
National	39,127,889	49.5	6	11,738,367	1,956,395	5,810,492
Total 3 Governorates	3,596,941	49.7333		1,079,082	164,475	536,834

Source: Central Statistical Organization (CSO), Ministry of Planning, Government of Iraq, 2019 / Data on Average HH Size is taken from Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, World Food Programme and CSO, Government of Iraq / Data on number of villages taken from Governorate Rural Development Surveys (2017)

374. Based on a poverty mapping study [WB, 2015], the national poverty rate in Iraq was 18.9 percent in 2012. Muthanna is the poorest governorate in Iraq, and the proportion of poor Iraqis households in Muthanna is nearly triple that of Iraq's national average.²⁰¹ Poverty in Muthanna stands at 52.5 percent, while in Karbala is 12.4 percent and Najaf is 10.8 percent. Both Karbala and Najaf witnessed a drastic reduction in poverty rates from 2007 to 2012, where it was 36.9 and 24.4 percent, respectively, while in Muthanna poverty increased from 48.8 to 52.5 over the same period.

375. While the proportion of food insecure households in Najaf is similar to the national average (2.5 percent), in Karbala it is more than twice the national average and more than four time higher in Muthanna. The share of households vulnerable to food insecurity is alarmingly high in all three governorates—65 percent in Karbala, 67 percent in Muthanna, and 87 percent in Najaf (Table 40)²⁰², all of which are above the national share of 53.2 percent.

Table 41: State of Food Security in project areas

	Food Security Zone	Food Secure HHs (percent)	Marginally Food Secure HHs / Vulnerable to Food Insecurity (percent)	Food Insecure HHs (percent)
Karbala	Food Deficit Semi-Arid Rangelands	28.9	65.2	5.9
Muthanna	Drought Prone Desert Area	22	66.7	11.3
Najaf	Drought Prone Desert Area	10.3	87.3	2.5
National	--	44.3	53.2	2.5

Source: CFSVA 2016, WFP, FAO and Government of Iraq / Data on Food Security Zones taken from Iraq Socio-Economic Atlas, WFP (2019)

376. Women's labour force participation is markedly low in the target governorates and women's unemployment is a significant national issue. In comparison to 81 percent at the national level, nearly 90 percent of women, excluding internally displaced persons (IDPs), are out of the labour force in Muthanna, 79 percent in Najaf, and 76 percent in Karbala. Within the three governorates, women's

²⁰¹ Where are Iraq's Poor: Mapping Poverty in Iraq (2015) <https://documents1.worldbank.org/curated/en/889801468189231974/pdf/97644-WP-P148989-Box391477B-PUBLIC-Iraq-Poverty-Map-6-23-15-web.pdf>

²⁰² CFSVA 2016, WFP, FAO, CSO Government of Iraq

unemployment is highest in Najaf, 31.4 percent, which is significantly greater than the national average of 22 percent. The unemployment rate for young women is twice the rate for men. In 2017, about 56 percent of young women were unemployed compared to 29 percent for young men²⁰³. Overall, the national unemployment rate is high at 10.8 percent.²⁰⁴ Muthanna has one of the highest unemployment rates, 14.5 percent, among the three governorates. The unemployment rate is roughly 9.5 percent in Najaf and 7.1 percent in Karbala.

377. Illiteracy is widespread in the target governorates, especially among women, and the prevalence rate is highest in Muthanna (30 percent).²⁰⁵ In Karbala, 22 percent women are illiterate as compared to 14 percent men. Although the completion rates vary in the targeted governorates, the trend of decreasing completion rates as the level of education increases is common to all, i.e., primary level completion rates are nearly twice that of upper secondary level. In Karbala, 72 percent of students completed primary level education, 43 percent graduated from lower secondary, and 39 percent completed upper secondary.²⁰⁶ The education completion rates are even lower in the other two governorates, where merely 24 percent completed upper secondary in Muthanna and 37.5 percent completed it in Najaf (table 41).²⁰⁷

378. As for gender disparities, percentage of total completion rates of primary and upper secondary education is higher for boys than for girls, whereas, it is slightly higher for girls at the lower secondary level than boys are. Moreover, completion rate for all three levels of education is higher in urban areas and households in high wealth quintiles. Agriculture is still the only livelihood for the poor and food insecure of the country.

Table 42: Illiteracy and completion rates (primary to upper secondary)

	Illiterate (percent) (>= 6 years of age)	Illiterate – male (percent)	Illiterate – female (percent)	Completion Rates – Primary	Completion Rates – Lower Secondary	Completion Rates – Upper Secondary
Karbala	17.8	14.2	21.6	71.7	43.4	39.0
Muthanna	30.3	22.7	37.8	68.7	29.9	23.9
Najaf	20.5	15.4	25.8	64.7	39.9	37.5
National	17.8	12.9	22.8	75.7	46.4	44.3

Source: Data on illiteracy taken from CFSVA 2016, WFP, FAO, CSO Government of Iraq / Data on completion rates taken from Iraq Multiple Indicator Cluster Survey (MICS) 2018, CSO, Government of Iraq and UNICEF

379. The three governorates have the smallest proportion of arable land [WFP, 2019], with the highest drought prone area, the highest percent of food insecure males (up to 11 percent) and females (up to 15 percent) and the highest percent of female-headed households (up to 14 percent). A quarter of the population lives below the national poverty line (24 percent), with Muthanna considered as the poorest governorate. The average unemployment in the governorates is around 14 percent, and almost half (45 percent) of jobs are unwaged, mostly in the agriculture and trade. According to the 2018 data, only 18.1 percent of women over 15 years are economically active compared to 74.1 percent of men.²⁰⁸ Moreover, women are excluded from the industry sector represented only by 3.9 percent (mostly related to the oil sector) compared to men (23.4 percent), whereas they are fairly more active in the

²⁰³ World Bank Group, Iraq Economic Monitor from War to Reconstruction and Economic Recovery, Spring 2018.

²⁰⁴ https://docs.wfp.org/api/documents/WFP-0000110173/download/?_ga=2.138894384.2074700103.1650638488-656116822.1650638488

²⁰⁵ Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, WFP, FAO, CSO Government of Iraq

²⁰⁶ Iraq Multiple Indicator Cluster Survey (MICS) 2018, CSO, Government of Iraq and UNICEF

²⁰⁷ *ibid*

²⁰⁸ UNDP, Gender Inequality Index, 2018; <http://hdr.undp.org/en/composite/GII>

agriculture sector (mostly informally and with poor social protection), accounting 43.9 percent of labour compared to 12.3 percent men.²⁰⁹ In 2011, the percentage of women in agricultural employment was 49 percent, while men represented 17.1 percent. In 2017, 43.7 percent of women and 16.1 percent of men were working in the agricultural sector (see Annex 8).

380. The vast majority of agricultural households in Karbala do not own the land but retain control, as in use of the land, (70.8 percent) through contracts with the government and 13 percent farm on government owned land. In the case of Muthanna, 44.5 percent agricultural households contract farmland, while 39.7 percent own it, the highest proportion of households who own land among the three governorates. Similar to Karbala, nearly half of the agricultural households in Najaf do not own the land but control it (48.6 percent), while a significant proportion, 10.9 percent, rents it without a contract, see Table 42.

Table 43: Agricultural households' access to land

	Agricultural households (percent) – Own land	Agricultural households (percent) – Not owned but has control	Agricultural households (percent) – Contracted	Agricultural households (percent) – Government land	Agricultural households (percent) – Rented without contract
Karbala	16.1	70.8	0.1	13.0	0.0
Muthanna	39.7	4.4	44.5	4.7	6.7
Najaf	28.6	48.6	10.3	1.6	10.9
National	46.6	20.7	25.1	3.4	3.8

Source: Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, WFP and Government of Iraq

381. Discussions with local non-governmental organizations (NGOs) working in target governorates reveal that women are involved in the complete farming life cycle, from cultivation to selling produce, i.e., there are few stages or activities exclusive to men now. Particularly in Karbala and Najaf, women play a lead role in the agriculture sector, sharing the responsibility of land preparation (women operate tractors in Karbala), planting/sowing, irrigation, applying fertilizer, weeding, harvesting, and even marketing. While women do not participate in land preparation and marketing produce in Muthanna, it is generally the women's responsibility to manage family's livestock and poultry in the governorate, see Table 43.

Table 44: Division of agricultural activities by gender in the targeted governorates

	Land Preparation / Ploughing		Seed Sowing / Planting		Irrigation / Fertilizer / Weeding		Harvesting / Threshing / Storage		Marketing		Rearing Livestock	
	F	M	F	M	F	M	F	M	F	M	F	M
Karbala	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NEI ²¹⁰	NEI
Muthanna		✓	✓	✓	✓	✓	✓	✓		✓	✓	NEI
Najaf	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NEI	NEI

Source: Consultation with Iraqi NGOs operating in target Governorates

²⁰⁹ World Bank, Gender Data Portal, 2017

²¹⁰ NEI: Not enough information was provided in the discussions on this aspect.

382. Women in rural areas spend long hours every day in crop and livestock production. In crop production, they are involved in almost all aspects, with the exception of land preparation and other mechanized and capital-intensive activities. The tasks women perform are often non-mechanized and labour-intensive: they broadcast seeds and fertilizers by hand, hand weed and harvest, pick fruits and vegetables and carry produce. Women also spend many hours in post-harvest activities such as threshing, cleaning, sorting and grading while men are performing most of the mechanized activities, land preparation, irrigation, and marketing of the products. Women in these areas are facing greater food insecurity as well as more barriers to land tenure, education, formal employment and access to finance, which hinders their progress out of poverty and limits their adaptation to climate change.

383. Twelve percent of households in Karbala are women-headed, 11 percent in Muthanna, and 11 percent in Najaf. Moreover, women-headed households that own or have control over of farmland is comparatively higher in Muthanna and Najaf (5 to 8 percent) than Karbala (1 to 4 percent). Similarly, a significantly greater percentage of women-headed households' own livestock in Muthanna (5 to 10 percent) than Karbala and Najaf (0.1 to 5 percent), see Table 44.²¹¹

Table 45: Female-headed households' ownership of farmland and livestock in targeted governorates

	Female-headed households (percent)	Female headed households that owned or had control of farmland (percent)	Female-headed households that owned livestock (percent)
Karbala	11.6	1 - 4	0.1 - 5
Muthanna	11.5	5 - 8	5.1 - 10
Najaf	10.6	5 - 8	0.1 - 5

Source: Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, WFP, FAO, CSO Government of Iraq

384. The prevalence of youth illiteracy and unemployment is highest in Muthanna than Najaf and Karbala. While the overall youth literacy rate in Karbala and Najaf is between 75 to 85 percent, it is less than 75 percent in Muthanna. Likewise, the literacy for young women is less than 65 percent in Muthanna, nearly 10 percent less than that of the other two governorates (75.1 to 80 percent).²¹²

385. The youth unemployment rate in Muthanna hovers in the range of 21 to 25 percent, whereas, the rate is somewhere between 11 to 15 percent in Karbala and Najaf. Interestingly, young women's unemployment rate is significantly greater in Karbala, 51 to 60 percent, than the other 2 governorates, 36 to 40 percent. Still, Young men's unemployment rate is considerably higher in Muthanna, 16 to 20 percent, while it is less than 10 percent in Karbala.²¹³

Climate, water, irrigation and water management

386. [Natural Resources, climate and climate change](#) section above and Atlas (Annex 16-A) provide specific information on the natural resources, climate and climatic vulnerability nationally and in each of the selected governorate. Iraq is already experiencing the adverse impacts of climate change leading to changes in rainfall and temperatures and other extreme weather events (e.g floods, storms etc), increased evaporation, increased salinization and high desertification risks are the main determinants of climate change hazards in Iraq. The impact of these will result in reduced availability of surface water and groundwater reserves as well as lower agriculture productivity due to increased

²¹¹ Comprehensive Food Security and Vulnerability Analysis (CFSVA) 2016, WFP, FAO, CSO Government of Iraq

²¹² Ibid

²¹³ Iraq Socio-Economic Atlas, World Food Programme (2019)

salinization and the limited tolerance of crops, increased water requirements and water variability, especially in rainfed production.

387. The three selected governorates are among the most vulnerable ones to climate change, due to their location in the tropical desert climate zone in the south and their exposure to future climate impacts.
388. Climate change trends are expected to worsen in the next 20 years, particularly in the three-targeted governorates – Karbala, Muthanna and Najaf, with adverse effects on water and agriculture. Average temperatures have increased between +0.22°C and +0.56°C per decade in the target governorates and by +0.37°C per decade on a national level since 1980. The trends will be exacerbated in the future, in particular in Karbala, Muthanna and Najaf, with adverse effects on water availability and on agriculture. FAO analysis of local meteorological data of the target governorates indicates that annual average and maximum temperatures²¹⁴ and Potential Evapotranspiration (PET) will increase in the 2020-2060 period in all scenarios (see table 7 above), while average annual precipitation is expected to decrease in the same period in RCP4.5.
389. Irrigated agriculture is prevalent in the three governorates of Najaf, Karbala and Muthanna, where rainfall is limited and fluctuates during the winter, while it substantially decreases during the summer. The Euphrates River and its branches are the main source of water for irrigated agriculture, which is concentrated in the eastern parts of the three governorates that are areas of high population density, especially in rural parts.
390. The crops grown differ for each governorate. Rice cultivation predominates in the sites of Najaf governorate, while the yellow corn crop is concentrated in addition to summer vegetables in the Karbala governorate sites. As for Muthanna, the cultivated area is small due to the scarcity of water in summer, and it is often planted with salinity-tolerant sorghum.
391. The project sites, especially in the governorates of Najaf and Muthanna, represent a model for the old earthen irrigation networks lacking the means of organization and control, whether the feeding channels, the distribution channels, or watercourses, which makes these sites one of the most vulnerable areas towards climate change and its effects. The candidate sites vary in terms of canals size, lengths, and irrigated areas. Channels also differ in the way water is supplied (by gravity or pumping). Most of the irrigation network suffers from operation and maintenance problems.
392. Most of the farmers in the targeted areas are small holders, where the average agricultural holding ranges between 2-4 hectares. Traditional surface irrigation with low efficiency is the common method at the farm level, while the use of drip irrigation systems is restricted to very limited areas in the cultivation of winter and summer vegetables.

Governorate of Najaf

393. Irrigated agriculture in Najaf depends on the Euphrates River, which branches in the Kifl District, south of Babil Governorate into two branches: Shatt Al abbasiya with a length of 26 km and Shatt Al alkufa with a length of 72 km. Water is released from the downstream of Al Hindiya barrage to reach the Kufa and Al Abbasiya barrages systems, which regulate the water distributions between the two branches during the winter and summer seasons. From Shatt Al abbasiya and Shatt Alkufa branches,

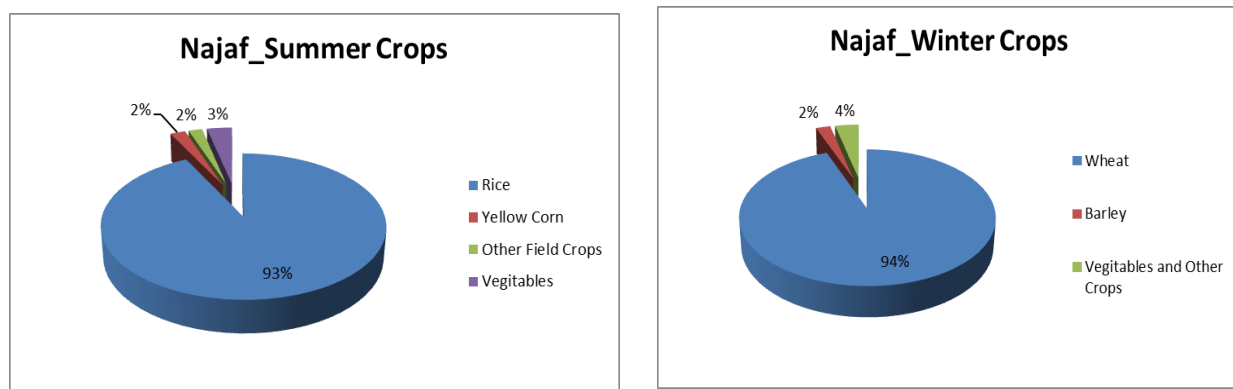
²¹⁴ Related to minimum temperature, only Karbala showed with -0.64°C per decade a change, while it was not possible to identify trends in the other governorates and on the national level.

there are earthen lateral canals branches on the right and left sides that differ in their lengths, discharge and irrigated areas.

394. The irrigated area in the governorate is about 52 thousand hectares, distributed over a number of projects. The main part is within the Kifl-Shanafiya project, with an area of 46 thousand hectares, and the rest is distributed among the projects of Bani Hassan, Hilla Diwaniyah and Hilla Kifl. The old earthen irrigation networks represent more than 95percent of the irrigation system in Najaf, where the planned development projects have not been implemented, except of 2,200 hectares reclaimed areas within the Kifl Shanafiya project and a part of the main and secondary drainage networks.

395. Najaf represents the main area for rice cultivation in Iraq during the summer season. The summer season is the main agricultural season where rice constitutes more than 90 percent of cropped area (Figure 52).

Figure 52: Cropping pattern in Najaf



Source: MOA

396. The number of WUA established until 2020 does not exceed 5 WUAs in Najaf with a total coverage area over 9,000 hectares (Table 21).

Table 46: Water Users Associations in Najaf till 2020

	District	Name of WUA	Covered Area (ha)
1	Abbasiya	Canal (1-0-2c)	200
2	Qadisiya	Abu gresa river	359
3	Mishkhab	Abu safafa	212
4	Hira	Bidariya river	4,024
5	Bahr Alnajaf	Najaf province	4,616
	Total Area (ha)		9,411

Source: State commotion for operation of irrigation and drainage department- MoWRs

397. The Directorate of Water Resources in Najaf presented a list of candidate sites for the project interventions (Table 46).

Table 47: Information of proposed sites for project interventions (Najaf)

I D	Name	district	Irrigation project	Water Source	Feed from sou.	Len (m)	Irrigated area		Disch L/ s	Water courses				DIV to W.C	Div to Farm s
							Don	hac		L	R	Tot	Tot. Len m		
	Najef														
1	Kashkheel (divided into 2 branches)	Al Manathra	Kifil- shnafiya h	Euphrates R. Shat ALKufa	G	10200	2227	557+ 225 in Diwa niya	3000	24 + 97 Farm intakes	24 + 103 Farm intakes	48 + 200 Farm intakes	9250	G+P	G+P
2	Albachai	Al Manathra	Kifil- shnafiya h	Euphrates R. Shat ALKufa	G	2000	1011	253	1000	5 + 59 Farm intakes	2 + 60 Farm intakes	7 + 119 Farm intakes	1175	G+P	G+P
3	Kata'at Alzarfaat	Al Mishkhaab	Kifil- shnafiya h	Euphrates R. Shat ALKufa	P Elec.	2500	400	100	600	0	0 + 39 Farm intakes	0 + 39 Farm intakes	0	G	P
4	Kata'at Almarash dah	Al Mishkhaab	Kifil- shnafiya h	Euphrates R. Shat ALKufa	P Elec.	2600	172	43	300	0 + 15 Farm intakes	0	0 + 54 Farm intakes	0	----	P
5	Tabr Alkhan	Al Haydariya	Bani- hasan	Bani-hasan MC	G	3500	726	182	250	0 + 14 Farm intakes	0 + 13 Farm intakes	0 + 27 Farm intakes	0	P	G
6	Tabr Alshaib	Al Haydariya	Bani- hasan	Bani-hasan MC	G	4000	883	221	500	1 + 25 Farm intakes	0 + 30 Farm intakes	1 + 55 Farm intakes	N.A	G	p
7	Alajda'a	Al Haydariya	Bani- hasan	Bani-hasan MC	G	6000	2925	731	1000	6 + 9 Farm intakes	0 + 12 Farm intakes	6 + 21 Farm intakes	N.A	G	G
Total Najef						30800	8082	2021		36 + 219	26 + 296	62 + 515 Farm intakes			

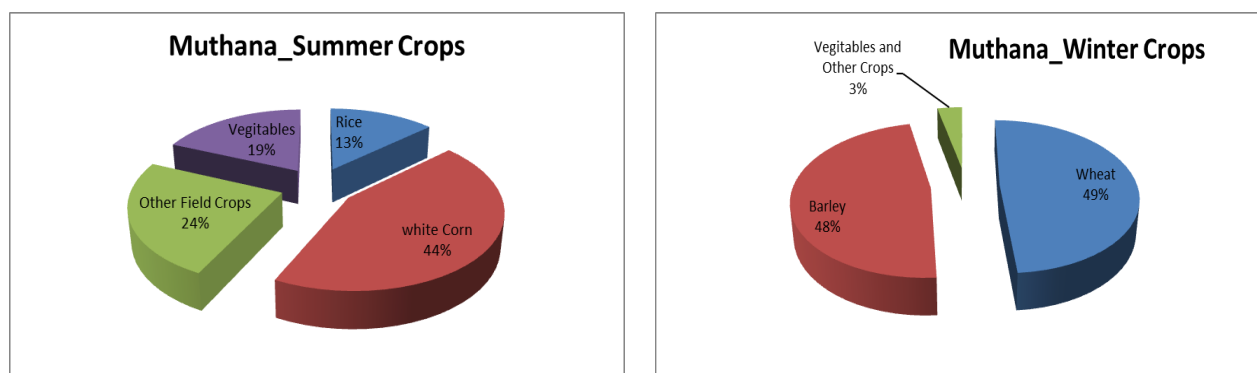
Source: DoWRs (Najaf)

Governorate of Al Muthanna

398. Despite the passage of many rivers, Al-Muthanna Governorate suffers from chronic water scarcity problems. The most important problem in addition to the chronic water scarcity is the low water productivity for agricultural uses. The reason is mainly due to the old earthen irrigation networks and inefficient irrigation management practices by farmers at both on farm and off farm levels. There is also the problem of soil salinity and the lack of areas developed with a drainage network. The planned area for development is 130 thousand hectares but only 16 thousand hectares have been developed so far.

399. Barley and wheat are the two main crops in the winter season. The percentage of barley cultivation increases in Muthanna compared with other governorates, as it is a crop tolerant to salinity and drought conditions. Sorghum, rice and vegetable crops are the main crops in the summer season where irrigated areas are limited due to lack of water (Figure 53).

Figure 53: Cropping pattern in Muthanna



Source. MOA

400. By the end of 2020, only 6 water users associations have been established in Muthanna covering around 1,627 hectares (Table 47).

Table 48: Water Users Associations in Muthanna by end 2020

	District	Name of WUA	Irrigated Area (ha)
1	Najmi	Aksha	189
2	Majed	Najariya Canal	125
3	Hilal	Gadeer	578
4	Hilal	Kawther	328
5	Warka'a	Ta'azeez Alouja	219
6	Khudhir	Ain abu siad	188
	Total Areas		1627

Source: MoWRs

401. The Directorate of Water Resources in Al-Muthanna presented a list of candidate areas for project interventions (Table 48).

Table 49: Information of proposed sites for project interventions (Muthanna)

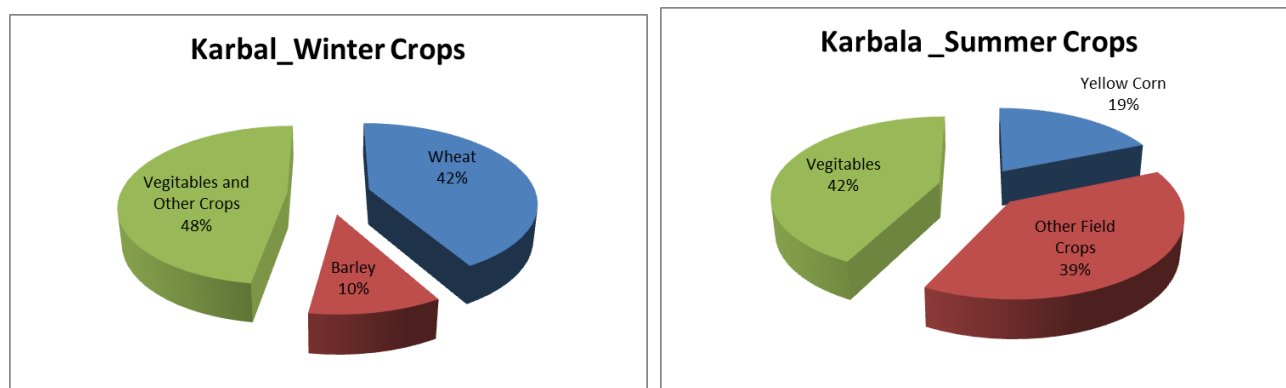
I D	Name	distri ct	Irrigation project	Water Source	Feed from sou.	Len (m)	Irrigated area		Dis ch L/ s	Water courses				DiV to W.C	Div to Far ms
							Don	hac		L	R	Tot	Tot. Len m		
1	project Alkadeer (/Um Alrigaif)	Hilal	Shnafiya h- nasiriya	Euphrates river- Alkadeer MC	G	3500	1000	250	300	1 + 40 Farm intakes	50 Farm intakes .	1 + 90 Farm intakes	500	G	G
2	Alhumad i canal	Majd	Muthanna	Euphrates river- Alswair river	P	2500	2000	500	400	1	1	2	4100	G	G
3	Alaksha	Najmi	Diwaniya h- shafi'iyah	Shat Alrumatha- left Side	P Deisl	7000	2700	675	220	0	5	5	10300	G	G
	Total Muthana					13000	5400	1350		2 + 40	6 + 50	8 + 90 Farm intake s	14900		

Source: DoWRs Muthanna

Governorate of Karbala

402. Karbala is characterized by the cultivation of horticulture and vegetables, as the cropping pattern of the Hussainiyah project is designed at a rate of 50 percent for horticulture. The rest of the crops are distributed between wheat and barley in winter and maize in summer (Figure 58).

Figure 54: Cropping pattern in Karbala



Source: MOA

403. By the end of 2020, only 3 water users associations have been established in Karbala covering an area around 1,627 hectares (Table 49).

Table 50: Water Users Associations in Karbala by end 2020

	District	Name of WUA	Irrigated Area (ha)
1	Al hur	Al rushdiya river	1004
2	Alkhairaat	Bani Hassan	311
3	Al hur	DC17, DC15	709
	Total Area		2024

Source: MoWRs

404. The Directorate of Water Resources in Karbala presented a list of candidate areas for project interventions (Table 50).

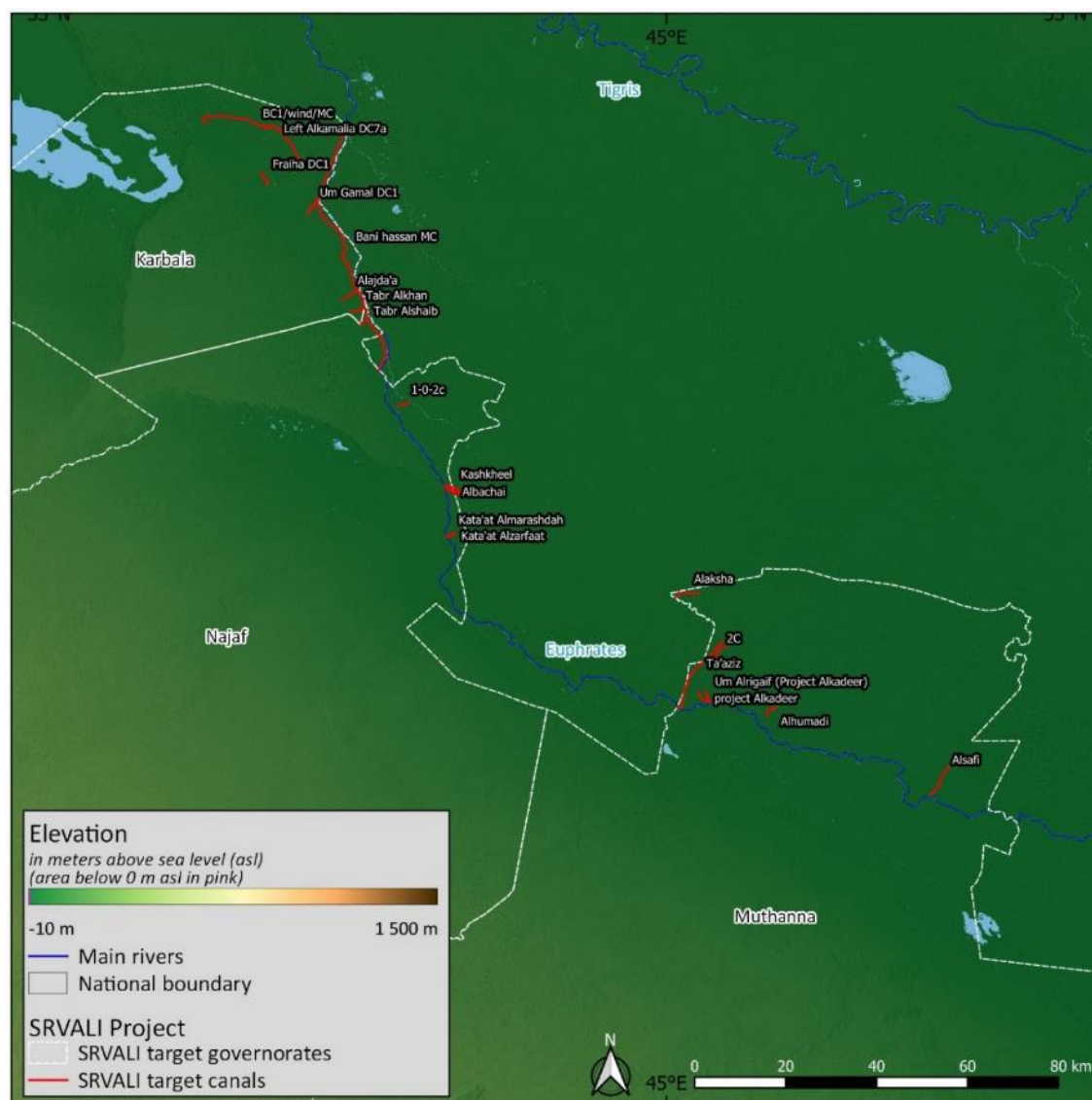
Table 51: Information of proposed sites for project interventions (Karbala)

I D	Name	district	Irrigation project	Water Source	Feed from sou.	Len (m)	Irrigated area		Disch L/ s	Water courses				Div to W.C	Div to Farms
							Don	hac		L	R	Tot	Tot. Len m		
1	Left Alkamalia DC7a+ (DC7a-1)	Al Husainiya	Husainai a	Husainaia MC – kamalia BC1	G	3900 (DC7a)+ 3650 (DC7a-1)	1460	365	316	16	3	19	12048	G	G
2	Fraiha canal DC1	Al Husainiya	Husainai a	Husainaia MC	G	4250	518	130	250	6	6	12	6000	G	G
3	Um Gamal DC1	Al Jawal algharbi	Bani- hasan	Bani hasan Canal MC- BC6	G	4330	4120	1030	520	7	9	16	8853	G	G
	Total Karbala					16130	6098	1525				47	26901		

Source: DoWRs Karbala

405. Proposed target canals in each governorate are shown in figure 55. Additional information is provided under [Investments in irrigation canals upgrading \(sub-component 1.1\)](#)

Figure 55: Location of the target governorates and the 19 target canals within the SRVALI project



Data source: NASA / USGS / JPL-Caltech (Farr et al., 2007), WWF HydroSHEDS (Lehner et al., 2008; Grill et al., 2019) and JRC Yearly Water Classification History (Pekel et al., 2016).

406. The National Strategy for Water Resources and Land Management for Iraq shows that approximately 20-24 percent of these canals are with concrete lining. Table 51 shows lining ratio of main canals, branch canals, and secondary canals. Lining ratio of distributary canals is shown in Table 52. Although MoWR did not register the length of pipeline systems, SWRLI states that about 2 percent of canals will be shifted to pipeline system.

Table 52: Length and lining ratio of main, branch and secondary canals (JICA 2016)

	Main canals			Branch canals			Secondary canals		
	lined canal	Earth canal	other	lined canal	Earth canal	other	lined canal	Earth canal	other
Length (km)	1,972	7,729	26	2,332	9,330	254	2,353	6,018	1,493
Ratio (%)	20.3%	79.5%	0.3%	19.6%	78.3%	2.1%	23.9%	61.0%	15.1%

Source. (JICA, 2016a)

Table 53: Length and lining ratio of distributary canals

	Distributary canals			Total
	lined canal	Earth canal	other	
Length (km)	7,860	7,264	3,422	18,546
Ratio (%)	42.4%	39.2%	18.5%	100.0%

Source. (JICA, 2016a)

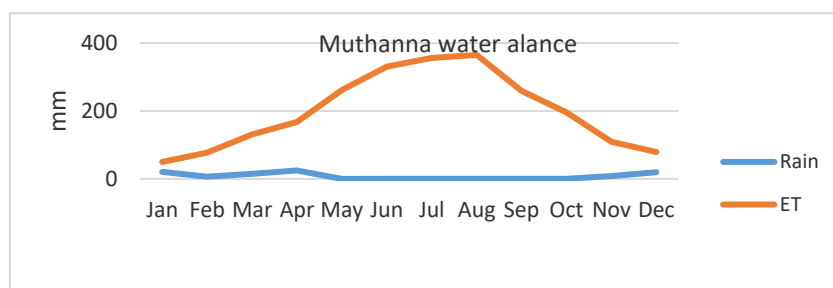
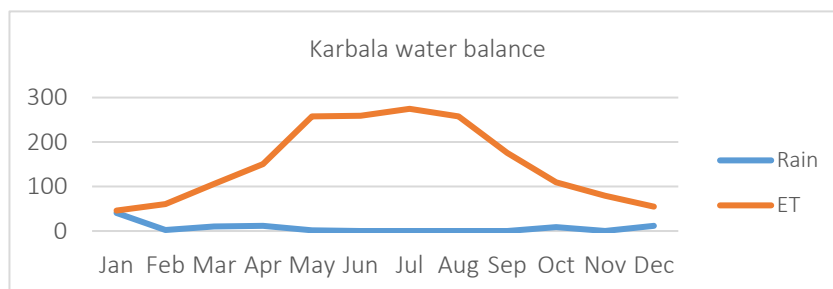
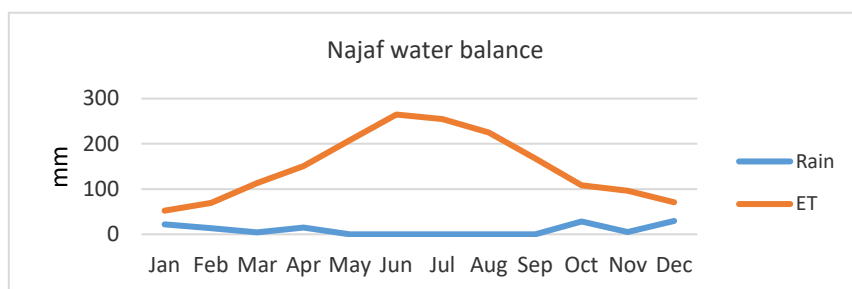
The agriculture and climate resilient agriculture sector

407. The agricultural sector in Iraq is highly vulnerable to climate change impacts as mentioned above. Climate change is already showing major impacts in terms of water scarcity and soil salinization, with increased vulnerability of poor rural communities. Since agriculture is the economic and social safety net of the rural poor in the country, any poverty reduction strategy has to incorporate climate change risk reduction objectives. The predicted future climate conditions will significantly reduce water availability in the spring/summer periods critical for crop production, causing marked reduction in runoff relative to input precipitation, increased evapotranspiration, decreased soil moisture, and increased soil salinity risk. Irrigation in Iraq, and especially in identified project areas, requires consistent investments: to reduce conveyance losses from damages and evaporation, to provide water efficiently to farmers and to adapt to changing climatic patterns (e.g. rainfall and temperature) by shifting to water efficient production systems.

408. Within the three target governorates, agriculture is highly vulnerable to climate change impacts, as a result of the increasing temperatures and changing precipitation patterns. These two climatic changes increase heat stress on crops, increase evapotranspiration, reduce soil moisture, and increase water consumption by crops. Additionally, increasingly variable and unpredictable precipitation under a RCP8.5 scenario (Annex 16 – page 61) will increase crop failure risk and increase the dependence of crop production on irrigation water use. These challenges apply to all production systems in the three target districts.

409. The agricultural production systems in the three governorates where the project will be implemented are highly dependent on water availability provided by the irrigation systems and groundwater. The current rainfall, which averages around 100 mm per year, does not meet the crops' water needs. This can be seen in Figure 56, which illustrates the current monthly precipitation and the reference evapotranspiration for each of the three governorates. In other words, crop production in these areas requires the provision of water through alternative sources to atmospheric precipitation (rain), which in practice translates into existing irrigation systems and groundwater obtained through the drilling of wells and subsequent pumping of the water. Figure 30 shows the water balance in each governorate.

Figure 56: Najaf, Muthanna and Karbala water balance



Source: GCF FFP Working Paper Rapid Agriculture Sector Assessment and Proposal of Component 2. Prepared using data from Google Earth Map.

410. The project areas present the same challenges of agricultural systems in the rest of the country, i.e., soil salinity problems, the high salt concentration in irrigation water, inadequate and unsustainable management of crops and water available for irrigation, limited extension services, restricted access to financing sources, somewhat obsolete cultivation and harvesting machinery, and inadequate crop harvesting and post-harvesting practices that affect the quality and conservation of products.
411. Effects of climate change are reported with special emphasis in these areas. Weather extremes bring both drought and flooding at various times of the year (WFP, CSO, KRSO 2012). Drought is reportedly increasing in frequency in the hottest regions of central and south-western Iraq and recent droughts have reduced agricultural production by 30 percent on average and contribute to desertification of arable land (CSO, 2018; USAID 2017). Water scarcity poses additional threats, as availability in the Tigris and Euphrates declines (USAID 2017).²¹⁵
412. The project will help replicate and up-scale climate-resilient irrigation and agriculture management practices and technologies in the target governorates, rehabilitate and upgrade irrigation

²¹⁵ Cited in: World Food Programme. Iraq Socio-Economic Atlas. 2019.

canals to improve water availability and efficient use, and build capacity and support institutional development for the upscaling of results at both policy and local implementation levels.

5. Beneficiaries

Project Beneficiaries Calculation and Accounting

413. The table below provides the estimated numbers of all the project's beneficiaries, including ultimate and intermediaries' beneficiaries (i.e. government staff, service providers...etc.). Annex 23 provides more details on the accounting of the beneficiaries.

Table 54: Beneficiaries calculations and accounting

Components/outputs	Beneficiaries			Women			Assumptions
	Direct	Indirect	Total	Direct	Indirect	Total	
Output 1.1.1: Open canal shifted from open to closed systems benefiting 8,457 people							
Targeted Households	1,244	760	2,004				<p>Direct beneficiaries: The canals rehabilitated supply irrigation water for a total area of 4,044 ha (see table 5 of the FFP). Given that the average cultivated area under irrigation in the target areas is 3.25ha per HH, it is estimated that the rehabilitation will directly improve water supply efficiency to farm gate of around 118 farmers in Najaf, 408 farmers in Karbala and 300 farmers in Al Muthanna (1,244 HH in total). The HH are multiplied with the average number of people per HH (ranging from 6.3 in Najaf/Karbala to 7.6 in Muthanna) to obtain total number of direct beneficiaries.</p> <p>Indirect beneficiaries: Given the water savings obtained through the rehabilitation of 68 km of canals of output 1.1, it will be possible to provide water to an additional area of 2,471. Given that the average cultivated area under irrigation in the target areas is 3.25ha per HH, it is estimated that 760 HH, or 5,167 persons will indirectly benefit from the activities of output 1.1.</p>
Number of beneficiaries	8,457	5,167	13,624	4,203	2,568	6,771	
Output 1.2.1: Water canals covered with solar panels, providing 1,000 kW of renewable energy							
Targeted Households	446		446				<p>Direct beneficiaries: The installation of solar systems on water canals will improve the energy and water security of canals supplying irrigation water to at least 1,450 ha of agricultural land (see table 6 of the FFP). Given that the average cultivated area under irrigation in the target areas is 3.25ha per HH, it is estimated that this output will improve resilience of at least 446 HH in the target areas. The HH are multiplied with the average number of people per HH (ranging from 6.3 in Najaf/Karbala to 7.6 in Muthanna) to obtain total number of direct beneficiaries.</p>
Number of beneficiaries	3,151		3,151	1,566		1,566	
Output 1.3.1 500 technical staff trained in design, installation and maintenance of irrigation, drainage and energy technologies.							
Number of beneficiaries	530	600	1,130	106	120	226	<p>Direct Beneficiaries: The Capacity development activities will involve 500 technicians and 30 teachers. Number of Women is estimated based on the assumption that they comprise 20% of teachers and technicians.</p> <p>Indirect beneficiaries: Given that the curricula will be updated on a national level it is assumed that it will benefit in total 600 teachers on a national level. It is assumed that 20% of teachers are women.</p>
Output 2.1.1. 400 Extension Staff trained on climate resilient agricultural practices and technologies to train 10,000 farmers in adaptive practices and technologies.							

	Beneficiaries			Women			
Components/outputs	Direct	Indirect	Total	Direct	Indirect	Total	Assumptions
Number of beneficiaries	412	n.a.	412	63	n.a.	63	The output will train 12 Master Trainers and 400 extensionists that can operate all over the Southern Governorates. The Number of women assumes that 15 percent of the extension staff are women.
Output 2.1.2 Enhanced capacity of farmers in Climate Resilient Agriculture							
Number of Farming HHs	10,000	30,000	40,000	3,000			Direct Beneficiaries: 10,000 farmers will be trained on CRA methodologies directly impacting the resilience of their HH. The total number of beneficiaries is calculated based on the average number of members per household of 6.8. Women beneficiaries are calculated based on the assumption that at least 30 percent of women will be part of FFS and that the share of women of the total population represents 49.7 percent. Indirect Beneficiaries: Calculations are carried out, based on the assumption that each beneficiary will capacitate three additional farmers with at least one of the topics learned and that 6.8 is the average number of members per household in the target area and that the share of women of the total population represents 49.7 percent.
Number of beneficiaries	67,982	201,000	268,982	33,786	99,894	133,680	
Output 2.1.3 Farmers reached through ICT4C technologies							
Number of Farming HHs	100,000		100,000				The output is aiming to reach 100,000 farmers. Total beneficiaries are the members of the farming HH (calculated with an average of 6.8 members per HH).
Number of beneficiaries	679,823		679,823	337,862		337,862	
Output 2.2.1.: Technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events							
Number of beneficiaries	12,090			5,982			90 stakeholders (30% women) are expected to be trained on solar energy applications in the agricultural field. At the same time the awareness of 12,000 citizens will be raised on the same topic in the frame of events.
Output 2.3.1: A cadre of 150 Climate Wise Women (CWW) trained as change agents for climate adaptation.							
Number of Farming HHs	150			150			150 women will be capacitated on the CRA topics. The total number of beneficiaries is calculated based on the average number of members per household of 6.8.
Number of beneficiaries	1,005			650			
Output 2.3.2: 40,500 women adopt climate adaptive measures.							
Number of Farming HHs	40,500		40,500	40,500		40,500	It is assumed that each CWW will extend her outreach to 270 women over the life of the project reaching in total 40,500 women with CRA topics. 40,500 women will be capacitated by CWW (output 2.5) on CRA. Total beneficiaries are the members of the farming HH (calculated with an average of 6.8 members per HH).
Number of beneficiaries	271,350		271,350	133,776		133,776	
Component 3.1.1: A climate resilient water allocation strategy							

	Beneficiaries			Women			
Components/outputs	Direct	Indirect	Total	Direct	Indirect	Total	Assumptions
Targeted Households		54,277	54,277				Indirect beneficiaries: It is expected that the allocation strategy will improve the water supply of approximately one third of the rural population of the target area that corresponds in total to 1,079,082.
Number of beneficiaries		356,097	356,097		177,155	177,155	
Output 3.2.1: Enhanced planning for solar rural electrification							
Targeted Households		51,553	51,553				Indirect beneficiaries: It is expected that 10% of the population in the target governorates benefit from enhanced rural planning related to solar energy
Number of beneficiaries		350,470	350,470		174,178	174,178	
Total Number of targeted Households	152,340	136,590	288,930	43,650		43,650	
Total Number of beneficiaries	1,044,800	913,334	1,958,134	517,994	453,915	971,909	

6. Key technologies, practices and sectorial approaches identified by stakeholders to address climate change adaptation and contribute to climate change mitigation

Component 1: Strengthening resilience against climate induced water scarcity

Investments in irrigation canals upgrading (subcomponent 1.1)

Output 1.1.1 68 kms of canals shifted from open to closed systems benefiting 8,457 people

414. Reportedly, Iraq is among the most vulnerable countries (ND-GAIN rank: 126/181) and it is the 28th less ready to adapt country²¹⁶. The country has both a great need for investment and innovations to reduce adaptation deficit and a great urgency for action. This is particularly evident in the farming areas of central and southern Iraq where increased temperatures, changes in rainfall distribution patterns, recurrent droughts and reduced water availability from the Tigris and Euphrates are severely affecting irrigated crops (wheat, barley, rice and corn).
415. Outdated irrigation infrastructures, energy shortage, inappropriate cultivation practices and lack of climate resilient crops, limited skills of both farmers and extension officers and the incomplete policy and strategic framework are the main bottlenecks to climate change adaptation in Iraq and in the farming communities of the central and southern plains. In a business-as-usual scenario, the farming communities of these areas will soon not be able to secure their livelihood from agriculture. Given that agriculture in target areas employs about 25 percent of the total population and that the region produces about 55 percent of the rice and 10 percent of the other cereals, the implications of such scenario may jeopardize the food security and stability of the country. Therefore, the project will work with key stakeholders in Iraq²¹⁷ to address identified bottlenecks and to enhance the climate resilience of rural livelihoods through the introduction of climate adaptive technologies and farming practices to increase water use efficiency and availability at the farm level and enhance water productivity²¹⁸ in the governorates of Muthanna, Najaf and Karbala.
416. The agricultural sector in Iraq is highly vulnerable to climate change impacts. Climate change is already showing major impacts in terms of water scarcity and soil salinization, with increased vulnerability of poor rural communities. Since agriculture is the economic and social safety net of the rural poor in the country, any poverty reduction strategy must incorporate climate change risk reduction objectives. The predicted future climate conditions will significantly reduce water availability in the spring/summer periods critical for crop production, causing marked reduction in runoff relative to input precipitation, increased evapotranspiration, decreased soil moisture, and increased soil salinity risk. Irrigation in Iraq, and especially in identified project areas, requires consistent investments: to reduce conveyance losses from damages and evaporation, to provide water efficiently to farmers and to adapt to changing climatic patterns (e.g., rainfall and temperature) by shifting to water efficient production systems.

²¹⁶ <https://gain-new.crc.nd.edu/country/iraq>

²¹⁷ Ministry of Environment (NDA), the Ministry of Water Resources, the Ministry of Agriculture, the Ministry of Energy, relevant central and local institutions, CSO, water user associations, farmers and private sector

²¹⁸ Water invested per unit of production

417. The project will help replicate and up-scale climate-resilient irrigation and agriculture management practices and technologies in the target governorates, rehabilitate and upgrade irrigation canals to improve water availability and efficient use, and build capacity and support institutional development for the upscaling of results at both policy and local implementation levels.
418. This Project conforms to the development issues and policies of Iraq is likely to contribute predominantly to SDG 6, “Ensure availability and sustainable management of water and sanitation for all”. It will also contribute to the achievement of:
- SDG 1, “End poverty in all its forms everywhere”;
 - SDG 2, “end hunger, achieve food security and improved nutrition and promote sustainable agriculture”;
 - SDG 5, “Achieve gender equality and empower all women and girls”;
 - SDG 7. Ensure access to affordable, reliable, sustainable, and modern energy for all
 - SDG 12, “Ensure sustainable consumption and production patterns”; and
 - SDG 15, “Protect, restore and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss”.

Proposed action, rational, and feasibility

419. The primary goal of this subcomponent is to improve water conveyance efficiency. Given the required budget for a full-scale intervention of this nature, the project is intending to use this intervention more as a showcase for a purpose of scaling up by the GoI within a larger target in the future. The intervention aims at shifting from open distributary and watercourse earth canals to buried irrigation pipelines. The upgraded irrigation infrastructure will improve beneficiaries’ access to irrigation water during droughts, while also improving their ability to use water efficiently.
420. Despite being a country with abundant fossil fuel resources, Iraq has not achieved full energy security for its citizens yet and power cuts are frequent. At the same time, solar energy potential is formidable, especially in southern regions, and so far, largely unexploited. In line with the national strategy the project foresees therefore to enhance solar energy utilization in rural agricultural areas while at the same time strengthening the Water-Energy-Food-Nexus as a driver for sustainable rural development.
421. The project will adopt a socio-technical modernization approach in conjunction with components 2 and 3. This would involve not only rehabilitation (upgrade), but also where necessary would introduce appropriate infrastructure to enable and strengthen the practical aspects of irrigation and drainage management under the new institutional arrangements. This would require the establishment of suitably sized, financially viable, and autonomous (technical) hydraulic units for the self-governing WUAs to establish and/or strengthen. Technical design would therefore require attention to flow-control and flow-measurement at key outlet points, to enable performance-based legal agreements between the WUA and the higher-level, bulk-water operator (DoWR). Hydraulic structures would also be needed to enable practical and enforceable distribution modalities within the boundary of the WUA area of operation. Normally, irrigation water is delivered to the WUAs at one location by an off-take, after measurement of irrigation water. Therefore, the distribution of irrigation water has to be organized by the WUA itself. For this reason, the existing off-takes of the secondary canals will be preserved as they are. Livestock watering points will be located and taken into consideration during the detailed design. The final locations will be determined during the construction phase together with the local population concerned.

422. As emerged during the meetings with the DoWR, the operation of the water pumping stations often suffers from unreliable electricity from the national grid or, in case of utilization of generators, from insufficient diesel supply. The project foresees therefore the installation of at least 3 Solar Photovoltaic (PV) systems (one in each beneficiary Governorate) for powering pumping stations managed by the DoWR, totalling a capacity of up to 1 MW. The systems will significantly increase energy security and hence also water security and will furthermore be installed on water canals, allowing saving of valuable agricultural land and costs for expropriation, and reducing evaporation of water and algae growth. The solar systems will be designed in accordance with the demand/capacity of the water pumps and the electricity will be directly used to pump water from rivers to water canals (no batteries will be employed).
423. The gravity fed pipeline system follows the same Hydraulic principals as an open channel system but in completely closed circuit and with low speed and pressure. Low speed reduces friction losses but increases the diameter of the pipes. For pipes carrying large flows, the material often used in Iraq (according to DoWR) is ductile iron. Installation is easy and safe for workers who can cut and tap Ductile Iron Pipe on site. For lower diameters (630 mm and below), the material often used in Iraq is PVC pipes.
424. Free water always leads to waste. Hence, the need to install a prepaid water meter at each individual outlet²¹⁹. The design of the prepaid meter can take many forms, and the bidder will make the selection of a particular type with final approval by the supervising engineer. Essential characteristics are required for this design:
- It must have a lockable cover, with sufficient space for the maintenance,
 - It should measure volumes and be able to shut off the water at prepaid amounts,
 - It must be able to transmit the use to a central data recording unit, usually by SMS on mobile phone,
 - It can work either by mobile money or by credit card type transaction,
 - It should be mounted on a concrete anchor with erosion protection.
425. Prepaid meters are available from several prepaid meter providers who use cards to open and distribute paid volumes. There are contactless cards that use a radio frequency between it and the reader without the physical insertion of the card. Rather, the card is passed outside the reader who reads it. Models include cards proximity made read-only. This technology guarantees the integrity of the meter and nothing is introduced into the meter, keeping out insects, soil and foreign object. This prepaid card technology has shown very clear benefits in farming communities. Those benefits include:
- Water available in time and quantity;
 - Eliminate collection costs;
 - Guaranteed water for all;
 - Eliminate corruption, favouritism or political interference;
 - Ensures economical use of water leading to cost reduction;
 - Limits alterations to the meter;
 - Easy to use especially where literacy is lacking; and
 - Reduces electricity costs through efficient water use.
426. Within the actual setting of established WUAs, women are not directly involved in decision making at the level of WUAs and will need to voice their concerns through intermediaries (women's committee or male relatives who could attend the general assembly meetings on their behalf). The

²¹⁹ In Iraq, irrigation water service fees have been frozen for several years

power given to the president of WUAs can lead to issues of elite capture and marginalization of women. Female head households will be consulted and arrangements will be made to have their participation in the WUAs more effective through either their direct involvement in the Women water committees or any other means to be discussed and agreed upon as part of the activities laid out under subcomponent 2 for reinforcement of WUA capacities.

427. The achievement of this **Output 1.1.1** 68 kms of canals shifted from open to closed systems benefiting 8,457 people requires the following activities:

Table 55: Activities under output 1.1.1

Activity 1.1.1.1	Prepare engineering designs, bills of quantities, cost estimates and tender/procurement documents (consulting services). In close collaboration with all concerned stakeholders (i.e. government agencies and water users), undertake feasibility studies and prioritize irrigation water control and systems for the fast tracking of repair, rehabilitation and construction works.	<ul style="list-style-type: none"> • Draft ToRs for consulting firm²²⁰ to conduct the detailed technical studies, • Conduct the bidding process to select the consulting firm to do the job, • Prepare detailed design and bidding document, • Approve the studies by the contracting authority.
Activity 1.1.1.2.	Provide services for control and supervision of construction works	<ul style="list-style-type: none"> • Assist the contracting authority in conducting the process for construction works award, • Assist the contracting authority for the control and supervision of construction works.
Activity 1.1.1.3	Implement the planned changes to the selected irrigation canals (works). Repair, rehabilitate and construct selected irrigation infrastructure through MoWR approved contractors. Labour-intensive activities, utilizing local labour inputs as much as practicable, are encouraged.	<ul style="list-style-type: none"> • Conduct the bidding process to hire a firm or firms for the construction works, • Execute the construction contract(s) under the supervision and control of the consulting firm, • Prepare the manual of operation and maintenance of the implemented infrastructure, • Proceed by the reception of the construction works by the contracting authority.

²²⁰ It is advisable that the same firm provide both engineering design and construction control services.

<p>Activity 1.1.1.4.</p>	<p>The establishment of the Water Users Association will be a precondition for starting the arrangements for the project's interventions in the irrigation infrastructure. Submission of a request by the Water Users Association for the development of infrastructure will be the second precondition.</p> <p>Water User Associations will be involved through the whole process in the selected Governorates for the operation and management of the improved systems. After establishment of WUAs, it is the intention of government that these systems will be managed by these WUAs</p>	<ul style="list-style-type: none"> • Arrangements, such as a scheme management code and training, will need to be put in place between the responsible Government irrigation structure (DoWR) and the WUAs. • The rehabilitation (upgrade) will also include a review of the <u>water allocation modalities</u> for the targeted schemes. • The consulting firm will establish as part of the detailed design, elements necessary to guarantee a good operation and maintenance of the targeted irrigation schemes. • At the end of the construction phase, an Operation and Maintenance Manual should be prepared by the consulting firm when all the elements of the equipment actually supplied will be known, including the instructions of the equipment suppliers.
<p>Activity 1.1.1.5.</p>	<p>To provide technical support to the PMU, the project will hire a highly qualified irrigation expert and an environmental, an energy expert, a procurement specialist, and engage the environmental and social safeguards specialist to support the process and the execution of all technical activities.</p>	

Cost assessment

428. The total cost of the upgrade of irrigation canals is estimated at USD 22.6 million (Table 56). The cost estimates are based on the preliminary design for the Left Alkamalia DC7a and DC7a-1 distributary canals and their watercourses (see appendix 17). This preliminary design was used to

establish an average investment cost per ha for canals upgrade that was then used to estimate the budget for the upgrade of the pre-selected canals as shown in table 56 below.

Table 56: Costs under sub-component 1.1

COMPONENT 1: Strengthening resilience against climate induced water scarcity				
Sub-Component 1.1. Investments in irrigation canals upgrading	Total Cost	GCF	GVT	FAO
Output 1.1.1. Open canals shifted from to closed systems benefiting 8,457 people				
Activity 1.1.1.1	1.330.476	1.330.476	-	-
Activity 1.1.1.2	1.330.476	1.330.476	-	-
Activity 1.1.1.3	16.337.760	16.337.760	-	-
Activity 1.1.1.4	840.000		840.000	-
Activity 1.1.1.5	2.795,158	2,297,758	324.000	173.400

Specific Execution Modalities²²¹

429. FAO Iraq has implemented dozens of projects that address critical problems similar to those addressed under this subcomponent. FAO- headquarters will assign some of the functions to FAO-Iraq such as coordination, technical supervision, administrative and financial management, procurement, monitoring, etc. To perform its Accredited Entity functions, FAO-Iraq will set up a Project Management Unit (PMU) to be based in Najaf, Iraq. The PMU led by a Project Coordinator (PC)/Irrigation Specialist. The PMU will be supported by technical experts assigned to each technical intervention for support and oversight. The PMU will include international and national specialists directly recruited by FAO-Iraq on a full time or part-time basis. These specialists include an Energy Specialist, Agronomy and Climate resilient Agriculture, Gender and Social Inclusion Specialist, Environmental and Social Safeguards Specialist, Monitoring and Evaluation Specialist, Procurement Specialist, Finance Management Specialists and Administrative Assistants. The PMU will coordinate with contractors recruited to design and implement the irrigation investments and solar energy investment. Detailed Terms of Reference of the PMU will be prepared by FAO in consultation with the Ministry of Environment. FAO-HQ as AE will ensure that the project is executed in compliance with GCF and FAO rules and regulations, policies and procedures, including relevant requirements on fiduciary, procurement, monitoring and evaluation, environment and social safeguards, and other project performance standards.

430. In close collaboration with FAO, the Ministry of Water Resources (MoWR) through the DoWR in each governorate will lead the implementation of all activities associated with this subcomponent in partnership with relevant government ministries and their national and governorate directorates, concerned local authorities, and non-governmental service providers (e.g. NGOs and private sector organizations/companies). Other ministries responsible for rural infrastructure will be consulted on the feasibility and design studies. The project will use consulting services for engineering design, bidding assistance, construction supervision.

²²¹ When execution modalities are not explicitly reported, these will be executed directly by FAO.

431. Based on ToRs prepared by the PMU, the project will contract a consulting firm to undertake feasibility studies; prepare detailed engineering designs and cost estimates; and prioritize irrigation schemes for fast tracking of repair, rehabilitation and construction works in collaboration with the DoWRs and WUAs in the respective governorates. Once the detailed engineering studies finalized, the selected consulting firm will have to prepare tender documents for the realization of the rehabilitation works. The engineering firm selected for the preparation of the detailed design will also assist with the bidding process and handle the supervision and control of construction works. Construction works will be done through MoWR approved contractors. It is planned to carry out this work in three separate lots one for each Governorate.
432. Within the MoWR, the Center for Studies and Engineering Design and its sections at Governorate level have the capacity to design and supervise the construction works for irrigation infrastructure. However, under the project the selection of design and contracting companies will be undertaken through a competitive process in which both the public and private companies can bid. Implementing partners will be selected inter alia based on their technical expertise, prior performances, operational capacity and field-level presence. International and national consultants/specialists with the requisite technical expertise and experience will be considered.
433. Under this subcomponent, funds will be provided for studies, consulting services, works, and equipment. The activities associated with the environmental and social management plan (ESMP) of this intervention, will be financed as services by the project. This intervention will also support the implementation of the RAP and Environmental and Social Impact Assessments (ESIA) activities. The contractor(s) of works, as part of his (their) duties, will be in charge of its timely implementation.
434. The selection of the canals for conversion from open to closed systems have been closely coordinated with the Directorates of Water Resources in each of the Governorates. The MoWR and the DoWR have identified canals, which have adequate water quotas and using the following criteria: (i) free of resettlement, relocation and land acquisition issues; (ii) not budgeted from other resources; (iii) consistent with MoWR's strategic priorities and plans; (iv) prepared in consultation with other line ministries where feasibility studies for new proposals are involved to avoid duplication and conflict. Based on environmental and social considerations, any selected areas that may have a significant adverse impact on the environment and society will be excluded/replaced. Tentative candidate canals are shown in the table below (Table 57) ²²²:

Table 57: List of canals selected for rehabilitation (upgrade)

Governorate	Name	District	Proposed transformation	Latitude	Longitude
Karbala	Um Gamal DC1	Al Jawal algharbi	Pipeline	32.5713	44.1998
	Fraiha DC1	Al Husainiya	Pipeline	32.6367	44.0748
	Left Alkamalia DC7a	Al Husainiya	Pipeline	32.7291	44.1167
Muthanna	Alaksha	Najmi	Pipeline	31.6662	45.0217

²²² Selected distributary canals include also their watercourses

	Alhumadi	Majd	Pipeline	31.3937	45.2308
	Um Alrigaif (Project Alkadeer)	Hilal	Pipeline	31.4276	45.0971
Najaf	Alajda'a	Al Haydariya	Pipeline	32.3632	44.2930
	Tabr Alkhan	Al Haydariya	Pipeline	32.3263	44.3080
	Tabr Alshaib	Al Haydariya	Pipeline	32.2992	44.3154
	Albachai	Al Manathra	Pipeline	31.9109	44.4954
	Kata'at Almarashdah	Al Mishkhaab	Pipeline	31.8040	44.4984
	Kata'at Alzarfaat	Al Mishkhaab	Pipeline	31.8031	44.4985

Source. (Compiled by author based on information provided by DoWR in the three selected Governorates)

435. Detailed design to be carried out during the first year of project implementation. Civil engineering works and equipment selected through open bid consultation. Proposals should be labour-intensive, utilizing local labour inputs as much as practicable. The tentative schedule for the implementation of construction works is to last 24-27 months²²³ with three lots (one for each Governorate). The consulting firm will assist the contracting Authority during the provisional and final reception of the work. In general, the consulting firm will inform, assist and help the owner to exercise his role; fulfil its commitments; and take any decision necessary and useful for the proper conduct and completion of the project. The consulting firm informs the project coordinator and the contracting authority in advance of the end date of the work and requests the provisional reception of the work within the time limits stipulated in the contract. Before the client sets the official date for this reception, it may proceed, depending on the case, with a technical pre-acceptance. Depending on the results of this pre-reception, the contracting authority then invites the construction company to take-over operations in accordance with the contractual provisions and on a set date. The reception will take place in the presence of the project coordinator, a representative of the project owner (DoWR) and the beneficiaries (AUEA). Any observations by beneficiaries will be recorded in the report. Assistance to the contracting authority during provisional and final reception involve the drafting of the corresponding minutes which will mention all the agreed arrangements as well as the services that the construction company must provide during the warranty period.

436. In the recently implemented Irrigation Sector Loan Project (JICA-2008-2018), the Ministry of Water Resources, the executing agency of the project, had difficulties in agreeing with farmers on the timing of rehabilitation works because the repair of irrigation and pumping facilities needed to be scheduled for when they were not being used for farming. Therefore, with assistance from consultants, this Project will develop a mechanism to share information between the Ministry of Water Resources in Baghdad and the directorates of water resources and water users' associations in individual governorates to ensure information sharing and communication on the schedule of construction works between the relevant local parties, the MoWR and the MoA.

437.

438. The project is likely not to interrupt irrigation. Nonetheless, to mitigate all possible risks, the project, during the preparation of each annual working plan and budget will discuss the work plan with communities and present a comprehensive mapping and timetable of the works. Works will be executed in periods where irrigation is not needed and in all cases water flow will not be interrupted

²²³ Taking into consideration the bidding process

439. WUAs re-established and/or strengthened for improved equitable water distribution and irrigation system maintenance, repairs and efficient water delivery should be a pre-requisite to the implementation of the activities under this subcomponent.

Operation and maintenance

440. The aim of this project is to increase the agricultural productivity in the project areas through the upgrade of the secondary and tertiary canals. Future management of the upgraded system will be put in the hand of the WUAs. The DoWR in each Governorate will handle the operation and maintenance of all investments after commissioning of the rehabilitated systems. Water User Associations will be involved through the complete process in the selected Governorates for the operation and management of the improved systems. After establishment of WUAs, it is the intention of government that these systems will be managed by these WUAs. The responsibilities for operation and maintenance of the irrigation and drainage infrastructure would be transferred gradually to the WUAs. Arrangements, such as a scheme management code and training, will need to be put in place between the responsible Government irrigation structure (DoWR) and the WUAs. The rehabilitation (upgrade) will also include a review of the water allocation modalities for the targeted schemes.
441. The consulting firm will establish as part of the detailed design, elements necessary to guarantee a good operation and maintenance of the targeted irrigation schemes. At the end of the construction phase, an Operation and Maintenance Manual should be prepared by the consulting firm when all the elements of the equipment actually supplied will be known, including the instructions of the equipment suppliers.

Economic, financial, social and environmental sustainability

442. The project will generate employment for local population, contribute to local development with various supports to be given to local communities, create development of economic activities around the work sites, generate business opportunities for economic operators of the area (catering, supply of materials and equipment to contractors, etc.). Targeted farmers can benefit from increases in agricultural productivity from the targeted irrigation schemes.
443. Through infrastructure investments and support for intensifying production, the project will benefit more than 8,457 direct beneficiaries (via improved irrigation and drainage infrastructure) and around 5,000 indirect beneficiaries. The project will also improve the resilience of the farming community within the targeted areas through the improvement of water service delivery and reducing the energy consumption. The expected benefits include a total volume of water saved equivalent to around 17 million cubic meter offering the possibilities to expand the irrigated area to around 920 ha within the three targeted Governorates. This improvement in water use efficiency will lead to savings in energy consumption of around 255 MWh equivalent per year which correspond to about 101 tCO₂-e reduction per year.
444. Making farmers pay a fee as it has been already agreed upon should not pose a problem as long as the users are receiving a water service that fits their needs. Actually the water service fee is set at 5,000 IQD/dunum for each cropping season. In cases where cropping is done twice, winter and summer, in a year, the fees is 10,000IQD/dunum which is equivalent to 27.5 USD/ha/year. Therefore,

all the suggested upgrades including flow-control, flow-measurement, and the installation of individual prepaid water meters would bring positive outcome to farmers as it will allow them to have a more equitable access to surface water. Paying the service fee won't then be a burden. It is estimated that improved access to surface water resources would allow farmers to save up to 54.9 USD/ha/year. Also these improvements will allow farmers to access surface water instead of pumping groundwater to supplement their needs as it is the case actually. The savings from energy used to pump groundwater is 177 estimated at around 19 US\$/ha/year. That said the project is not pretending to address all the complex issues around the water delivery service but definitely the project through the proposed actions will contribute to improve the situation and bring about the paradigm shift in the way improvements in water delivery service is approached.

Investments in renewable energy efficient systems (sub-component 1.2)

Proposed action, rational, and feasibility

445. The **sub-component 1.2 (Output 1.2.1) One km of Water canals covered with solar panels, providing 1,000 kW of renewable energy** addresses the Water-Energy-Food Nexus with an innovative activity installing solar systems on water canals. These kinds of systems have been installed in many parts of the world and a recent study in Nature concluded that over-canal solar could reduce annual evaporation by an average of 39 ± 12 thousand m³ per kilometre of 30 m wide water canals in California²²⁴.

446. The solar systems will be used as a showcase for innovative energy solutions in the agricultural sector. The power generated will be used to operate water pumping stations managed by the DoWR which often suffer from unreliable electricity from the national grid or, in case of utilization of generators, from insufficient diesel supply. The project foresees therefore the installation of at least 3 Solar Photovoltaic (PV) systems (one in each beneficiary Governorate) for aforementioned pumping stations, totalling a capacity of up to 1 MW. Table 58 provides a list of canals proposed by DoWR for the installations of solar systems.

Table 58: List of canals for solar panels proposed by DoWR

Governorate	Name	District	Proposed transformation	Latitude	Longitude	Gross Irrigated area (ha)
Karbala	BC1/wind/MC	Al Husainiya	Solar panel	32.7234	44.1253	3,004.00
Muthanna	2C	Al Rumetha	Solar panel	31.5514	45.1368	850.00
	Ta'aziz	Al Rumetha	Solar panel	31.5616	45.1260	NA
	Alsafi	Al Khudir	Solar panel	31.2123	45.6062	NA
	Project Alkadeer	Hilal	Solar panel	31.4253	45.1024	2,000.00
Najaf	Bani Hassan MC	Al Haydariya	Solar panel	32.3648	44.2934	2,500.00
	1-0-2c	Al Abassiyah	Solar panel	32.1084	44.4094	600.00

447. The solar systems will be designed in accordance with the demand/capacity of the water pumps and the electricity will be directly used to pump water from rivers to water canals. The systems will significantly increase energy security and hence also water security and will furthermore be installed on water canals with the following advantages:

²²⁴ https://escholarship.org/content/qt8cj5j07p/qt8cj5j07p_noSplash_da7010b14e05c8089355f67e9f443a6f.pdf?t=qq63ir

- Mitigation of evaporation of water running underneath panels;
- Mitigation of aquatic weed growth;
- When semi-conductor material of the PV systems is made of cadmium telluride (CdTe), due to the cooler microclimate next to the canal, the panel efficiency is higher than in overground systems;
- Less need to disturb natural and working lands with development of installation; and
- Cost saved for land

448. The **Output 1.2.1** will be achieved through the following activities:

Table 59: Activities under output 1.2.1

Activity 1.2.1.1.	Prepare engineering designs, bills of quantities, cost estimates and tender/procurement documents (consulting services). In close collaboration with all concerned stakeholders (i.e. government agencies and water users), undertake feasibility studies and prioritize irrigation water control and systems for the fast tracking of repair, rehabilitation and construction works	<ul style="list-style-type: none"> • Draft ToRs and conduct the bidding process to select the consulting firm²²⁵ for detailed design, • Prepare and validate tender documents, including detailed design and engineering of the PV systems.
Activity 1.2.1.2.	Provide services for control and supervision of construction works.	<ul style="list-style-type: none"> • Assist the contracting authority in conducting the process for construction works award, • Assist the contracting authority for the control and supervision of construction works.
Activity 1.2.1.3.	Implement the planned changes to the selected sites (works).	<ul style="list-style-type: none"> • Execute civil works and supplies including, testing, commissioning and start-up of the PV systems in coordination with the corresponding DoWR in each Governorate, • Prepare the manual of operation and maintenance of the implemented infrastructure, with detailed instructions about the steps to be carried out to guarantee a smooth functioning of the installation. • Proceed by the reception of the construction works and supplies by the contracting authority.

²²⁵ Consulting firm will be in charge of engineering design and construction supervision

Activity 1.2.1.4.	The DoWR in each Governorate will be responsible for the operation and maintenance of all investments after handing over. The Water User Associations will be involved in all related capacity development activities.	<ul style="list-style-type: none"> • Handing-Over of Projects to the respective DoWR, • Operation and maintenance by DoWR staff with support from the construction firm (establishing guidelines to monitor the performance, including effects of the solar panels on evaporation, algae growth etc and training of DoWR staff on operation and maintenance). During the first year the maintenance will be carried out by the construction company, which will at the same time train the staff and provide for this purpose the O&M manual
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Cost assessment

449. The total cost for the installation and operation and maintenance during project implementation of solar systems on water canals is estimated at USD 2.1 million (table 60 below). The cost estimates are based on the preliminary feasibility estimations for the canals in Najaf and Muthanna (Appendix 20). These estimation were used to establish an average investment cost per 1,000kWp of the installation of solar systems on the pre-selected canals as shown is table 58 above.

Table 60: Costs under sub-component 1.2

Sub-Component 1.2 Investments in Energy Efficient Systems				
Output 1.2.1 Water canals covered with solar panels, providing 1,000 kW of renewable energy	Total Cost	GCF	GVT	FAO
Activity 1.2.1.1	99.300	34.755	-	- 64.545
Activity 1.2.1.2	34.300	12.005	-	- 22,295
Activity 1.2.1.3	1.911.400	668.990	-	- 1,242,410
Activity 1.2.1.4	58.000	-	58.000	-

Specific Execution Modalities²²⁶

450. The PMU in Najaf, Iraq, led by a Project Coordinator (PC) will be composed of several technical and management specialists. In order to allow a sound preparation and implementation of all activities related to solar energy, the PMU will be supported by a National Energy specialist that will work on a daily fee base. His duties are in particular to:

- Define the ToRs for the companies designing, supervising, and implementing the solar systems in Component 1;
- Monitor the works and installations of the Solar systems;

²²⁶ When execution modalities are not explicitly reported, these will be executed directly by FAO.

- Monitor the performance of the Solar Systems, in coordination with the DoWR/WUAs;
- Support the detailed definition of all other energy related activities;
- Facilitate exchange of know-how with all national and local stakeholders; and
- Support the capacity development activities

451. FAO HQ and FAO Iraq will closely collaborate with the final beneficiary, the Ministry of Water Resources (MoWR) that will have a leading role in the implementation of component 1 and will, through the DoWR and in cooperation with the WUA, coordinate in each governorate the implementation of all activities related to planning, implementation and operation and maintenance. Furthermore, the DoWR will establish partnerships with other competent and related Ministries and local and national stakeholders for an exchange of know-how and diffusion of the innovative technology that is expected to achieve a paradigm shift in the planning and utilization of solar energy.

Operation and maintenance

452. Operation and maintenance costs will be costed and covered under output 2.2.1 (paid by the government).

Economic, financial, social and environmental sustainability

453. Solar powered irrigation systems have a significant impact on the reduction of GHG emissions as they avoid the utilization of fossil fuel generated electricity: Most Life Cycle GHG emissions in SPIS are related to the production and disposal of the equipment of the systems (PV panels etc.), once the SPIS system is installed however, the operation itself is free of emissions. When considering the emissions with a life cycle assessment (LCA), the emissions of an off-grid solar system, depending on location, solar cell efficiency and technology, can vary from 16 to 32 g CO₂ eq. per kWh, compared to emissions of 600 g/kWh considering the global electricity mix and 684 g CO₂eq/kWh in the case of the electricity produced in Iraq. For the replacement of a typical diesel generator by an off-grid solar system, 1 kg CO₂equiv. per kWh of savings can be considered.²²⁷ The potential reduction in GHG emissions per unit of energy used for water pumping (CO₂-eq/kWh) is 95 to 97 percent lower as compared to pumps operated with grid electricity (global average energy mix) and 97 to 98 percent as compared to diesel-pumps.²²⁸

454. Installation of solar systems on water canals: since water canals are constructed mainly in rural areas and pass often near centers of electricity consumption (e.g. water pumps, villages, farms) they can offer space for solar systems saving precious agricultural land and deliver energy to off-grid areas, substituting or avoiding the installation of diesel generators.

455. Solar Powered Irrigation systems: Utilization of SPIS is a meaningful adaptation measure as it enhances water security and can compensate for erratic rainfall patterns and water storages and can furthermore enhance filtration and fertigation systems.

456. Water Canals: Solar systems installed on water canals can increase agricultural resilience due to the decrease in water evaporation and hence availability of the resource. Also, the more surface water is available the less likely unsustainable groundwater practices will be carried out, in particular in times of drought.

²²⁷ https://energypedia.info/images/7/74/Solar_Powered_Irrigation_Systems_percent28SPIS_percent29_-_Technology_percent2C_Economy_percent2C_Impacts.pdf

²²⁸ <https://www.ccardesa.org/knowledge-products/solar-powered-irrigation-systems-clean-energy-low-emission-option-irrigation>

457. The project promotes the utilization of PV – systems as a substitute for diesel generators, which can, apart from climate change mitigation, also have other important environmental and health impacts: Studies assume that there are more than 2 million generators running throughout the country on diesel. The negative effects of these appliances that are mostly completely unregulated are manifold and range from noise disturbances to the emissions of GHG and other air pollutants.²²⁹ The generators contribute to the bad air quality in particular in densely populated areas. In Baghdad, e.g. fossil fuel engines are responsible for more than 50 percent of the local fine particulate matter (PM 2.5) emissions, which are particularly damaging to human health, and exceed the maximum recommended levels of the WHO by 7 times.²³⁰
458. In addition, a diesel generator produces 10 g of waste oil per kWh output energy, corresponding to approximately 300 kg of waste oil during its operating lifetime, with evident risks of pollution of soil and groundwater (1 litre of waste oil can contaminate up to 1,000 m3 of groundwater). The appropriate disposal of these substances cannot be guaranteed in some of the Iraqi context, which makes irrigation with PV systems an ideal solution to eliminate the risks.²³¹
459. For the calculation of the evaporation savings the recent study published in Nature estimating that over-canal solar could reduce annual evaporation by an average of 39 ± 12 thousand m3 per kilometre of 30 m wide water canals in California has been used as a reference for the methodology. For the estimations have been considered reductions in evaporation for shading in the range of 44 percent to 90 percent derived from related studies.²³² Applied to Iraqi context this methodology gives the following result for an average Potential Evapotranspiration (PET) value of approximately 2,500 mm and considering a canal width of 10 m:
- $$2,500 \text{ mm (PET)} * 10\text{m (canal width)} * 1,000 \text{ m (length canal covered by solar panels)} * 44 \text{ percent (shading effect)} = 11,000 \text{ m3 annual evaporation reduced}$$
460. With regards to water and energy one has to consider also that significant amounts of water are required for the extraction of oil: The average quantity necessary is 1.3-1.5 barrels of water for every barrel of oil, and water demand will increase from 5 mb/d today to 8 mb/d by 2030 for Iraq's oil production.²³³ In a water scarce country like the one in Iraq, the extraction of oil is putting further pressure on water resources emphasizing once more the need to switch from fossil fuels to cleaner RES.
461. By promoting RES for power production Iraq can make itself less dependent on imported fossil fuels. Costs for solar panels are expected to further decrease significantly in the coming year, up to 59 percent until 2025 compared to 2015. SPIS are particularly useful in areas with unreliable energy provisions as they can guarantee the access to water of many farmers.²³⁴
462. Some countries (e.g., India) apply subsidies schemes to SPIS in off-grid areas since they consider it less expensive then providing a grid extensions and transmission of electricity over long distances.
463. PV systems are a market with high tech development. It shifts away the work from more labour intense energy production (diesel generator) to more innovative solutions and could therefore counteract brain drain from rural to urban areas. Given that more than 40 percent of the population is

²²⁹ https://www.researchgate.net/publication/324994095_Analysis_of_stand-alone_solar_photovoltaic_for_desert_in_Iraq

²³⁰ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

²³¹ https://energypedia.info/images/7/74/Solar_Powered_Irrigation_Systems_percent28SPIS_percent29_-_Technology_percent2C_Economy_percent2C_Impacts.pdf

²³² https://escholarship.org/content/qt8cj5j07p/qt8cj5j07p_noSplash_da7010b14e05c8089355f67e9f443a6f.pdf?t=qg63ir

²³³ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

²³⁴ <https://www.fao.org/3/i9047en/i9047EN.pdf>

younger than 14 years old there exists the potential of a large share of the society to support these innovative processes.

464. A study in Egypt concluded that for each 1 MW PV installations in the agricultural field, between 3.9 and 23.6 jobs could be created for activities like installations, operation and maintenance, electric connections, pipes, fittings and civil works. Applied to the Iraqi context this development could contribute to positive trends in employment, desperately needed to alleviate the high youth unemployment of approximately 40 percent.²³⁵

Investments in knowledge transfer, behaviour change and training (sub-component 1.3)

Proposed action, rational, and feasibility

465. In Iraq, there are no specialized vocational schools for irrigation and drainage, but there are departments of water resources' technologies (irrigation and drainage techniques branch) at the level of technical institutes, that provide two years curricula after high school to form field agents involved in day-to-day operation and maintenance of the irrigation scheme. There are also departments of water resources in colleges of engineering that form irrigation engineers. On the other hand, there are agricultural vocational schools that form field agents intervening in agriculture production activities. To ensure the sustainability of the actions promoted under this project in particular with regard to the solar covered canals and the utilization of PV systems in the agricultural field, it is suggested to develop a first package of activities that foresees the creation of special modules to be integrated in the curricula of agricultural vocational schools and the technical institutes informing about the advantages and possibilities for solar energy in agricultural production and informing about the advantages and possibilities for water savings technologies including solar energy applications to that end. A validation workshop will be organized at the end of the process and the information disseminated through Training of the Trainers activities targeting teachers in these institutions.
466. The other set of activities is linked to the capacity building of technical staff which will be approached in three stages: holistic assessment to define the needs and design and implement a multiyear extensive capacity development program targeting the change agents, and ensure the transfer and application of the knowledge acquired through this process. This intervention will take stock and build on the FAO-RNE experience with ESCWA for a 3 years capacity development program. The training will provide practical knowledge and deeper understanding of issues and topics related to design, installation and maintenance of irrigation, drainage and energy technologies.
467. The project is also using participatory approaches across all of its interventions that ensure sustainability through close collaboration with the key partners and beneficiaries by engaging male and female farmers in all activities. This includes the establishment and/or reinforcement of Water Users Associations assisting with improved water management practices. The project will build on the work achieved through JICA assistance to develop the sustainable irrigation water management by WUA in model sites. As mentioned earlier the project will adopt a socio-technical modernization approach in conjunction with components 2 and 3.
468. This subcomponent will finance consulting services, equipment, and training. It is organized into two sets of outputs:

²³⁵ https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/Iraq_Energy_Outlook.pdf

469. **Under Output 1.3.1:** 500 Trained technical staff in design, installation and maintenance of irrigation, drainage and energy technologies. The achievement of this output will be through the implementation of the following key activities:

Table 61: Activities under output 1.3.1

Activity 1.3.1.1	Capacity building will be approached in three stages: holistic assessment to define the needs, design and implement a multiyear extensive capacity development program targeting the change agents, and ensure the transfer and application of the knowledge acquired through this process. The training workshops are intended to enhance local capacity on how to design, install and maintain proposed technologies. Priority will be given to beneficiaries from target areas. Nonetheless, the project will include in the training interested candidates from the entire country from the MoWR, MoA, IME and MoE.	<ul style="list-style-type: none"> • Draft the TORs for the TA to develop new curricula for national vocational schools, • Engage the TA (consulting firm or NGO) (procurement process), • Carry out an assessment to define the needs, design and implement a multiyear extensive capacity development program targeting the change agents, and ensure the transfer and application of the knowledge acquired through this process, • Conduct the training sessions, • Evaluate the training sessions and define the way forward beyond the project lifecycle.
Activity 1.3.1.2.	A first package of activities that foresees the creation of special modules to be integrated in the curricula of agricultural vocational schools and the technical institutes informing about the advantages and possibilities for solar energy in agricultural production and informing about the advantages and possibilities for water savings technologies including solar energy applications to that end	<ul style="list-style-type: none"> • Draft the TORs for the TA to develop a new module, • Engage the TA (consulting firm) (procurement process), • Conduct consultation meetings and workshops at local and national levels to assess the needs and define the elements to include in the new module, • Elaborate a new module and its dissemination strategy, • Validate the prepared module and its dissemination strategy in a national workshop, • Train teachers from vocational schools and technical institutes in the integration of developed modules.

470. **Under Output 1.3.2.** Supported 15 WUAs in developing and adopting more efficient and climate sensitive water-distribution plans. This output will be achieved through the implementation of the following key activities:

Table 62: Activities under output 1.3.2.

Activity 1.3.2.1	<p>The project will work closely with the WUA section within both ministries (MoWR and MoA) to mobilize actions and complete the procurement and logistical preparations for establishing and/or reinforcing the capacities of WUAs in the selected project areas. A Technical Assistance (TA) will be engaged through a competitive bidding process to help assess the legal framework in which WUAs operate in Iraq, and define and/or clarify the management rules for irrigation schemes in the targeted governorates. Based on this first step, the TA will also work at national level for supporting the preparation of an appropriate legal framework for irrigation management by the WUAs within the framework of the existing Water Code. The TA mission will also define the level of support needed at each WUA to insure implementation and respect of the scheme management code and the rules of procedures.</p>	<ul style="list-style-type: none"> • Draft ToRs for the TA , • Engage the TA (consulting firm) (procurement process), • Conduct assessment of the legal framework in which WUAs operate in Iraq, and define and/or clarify the management rules for irrigation schemes in the targeted governorates, • Update the legal framework for irrigation management by the WUAs within the framework of the existing Water Code, • Establish additional WUAs, • Assess and define the support, with block grants to each WUA, for improvements of their facilities (buildings, equipment, etc.), • Provide support and follow up to ensure that the defined improvement are implemented accordingly.
Activity 1.3.2.2	<p>The TA mission will also include organizing and conducting training in good practices/technical and irrigation scheduling with targets and outreach measures to ensure participation of female farmers around the three defined modules: i) Developing and adopting water-distribution plans based on crops requirements and climate change projections; (ii) minimizing degradation of water quality in the surface and ground water through improved agriculture and irrigation practices; and (iii) managing,</p>	<ul style="list-style-type: none"> • Organize and conduct training sessions around the three defined modules • Enhance technical capacities of WUAs and stakeholders on solar energy.

	operating and maintaining irrigation schemes.	
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Cost assessment

471. The total cost for the implementation of subcomponent 1.3 is estimated at USD 2.32 million (Table 63).

Table 63: Costs under sub-component 1.3

Sub-Component 1.3 Investments in knowledge transfer, behaviour change and training				
Output 1.3.1.	Total Cost	GCF	GVT	FAO
Activity 1.3.1.1.	219.000	219.000	-	-
Activity 1.3.1.2.	237.000	237.000	-	-
Output 1.3.2.				
Activity 1.3.2.1.	1.760.000	650.000	1.110.000	-
Activity 1.3.2.2.	100.000	100.000	-	-

Specific Execution Modalities

472. The PMU, in close coordination with FAO, the Ministry of Water Resources (MoWR) through the DoWR in each governorate will have the lead role in the implementation of all activities associated with this subcomponent. The activities under this subcomponent will be carried out in partnership with the Ministry of Agriculture (MoA) and its national and governorate directorates, concerned local authorities, universities, and non-governmental service providers (e.g. NGOs and private sector organizations/companies).

473. This subcomponent will finance consulting services, equipment, and training. The project will work closely with the WUA section within both ministries (MoWR and MoA) to mobilize actions and complete the procurement and logistical preparations for establishing and/or reinforcing the capacities of WUAs in the selected project areas. A Technical Assistance (TA) will be engaged through a competitive bidding process to help assess the legal framework in which WUAs operate in Iraq, and define and/or clarify the management rules for irrigation schemes in the targeted governorates related to:

- Irrigation aspects of the land tenure arrangements and usufruct rights of women farmers,
- WUA rights and duties,
- WUA legal/financial oversight,
- Infrastructure rehabilitation and transfer agreements if any,
- Rights and duties of the parties in charge of irrigation scheme management,
- Water fee recovery and other sources of funding for WUAs,
- A dispute resolution mechanism if any,
- WUA membership criteria (inclusion of women based on usufruct); and
- Place of female leadership in WUAs.

474. Based on this first step, the TA will also work at national level for supporting the preparation of an appropriate legal framework for irrigation management by the WUAs within the framework of the existing Water Code. The TA mission will also include:

- organize and conduct training in good practices/technical and irrigation scheduling with targets and outreach measures to ensure participation of female farmers around the three defined modules²³⁶;
- define the level of support needed at each WUA to insure implementation and respect of the scheme management code and the rules of procedures; and
- assess and define the support, with block grants to each WUA, improvements of their facilities (buildings, equipment, etc.).

475. Capacity building of technical staff will be approached in three stages: holistic assessment to define the needs; design and implement a multiyear extensive capacity development program targeting the change agents; and ensure the transfer and application of the knowledge acquired through this process. For this, the project will hire a TA through an open bidding process to develop new curricula for national vocational schools, develop guidelines and procedures to upscale proposed technologies and approaches at the national level, and organize a series of capacity building training and workshops. The training workshops are intended to enhance local capacity on how to design, install and maintain proposed technologies. Priority will be given to beneficiaries from target areas. Nonetheless, the project will include in the training interested candidates from the entire country from the MoWR, MoA, IME and MoE.

Operation and maintenance

476. There is no operation and maintenance under sub-component 1.3.

Economic, financial, social and environmental sustainability

477. Sustainability of project achievements is predicated on a number of project design features inter alia aimed at improving irrigation development and management in the MoWR. In particular establishing the necessary frameworks and regulations for compulsory adhesion to WUAs. Institutional strengthening and transformation of WUA will make it a more effective institution, which is expected to result in more sustainable outcomes for the project area and for the general development of agriculture. Empowering local-level stakeholders through training and capacity building to address specific challenges is key to the sustainability of the actions promoted under SRV-ALI. With regards to WUAs, the project SRV-ALI will build on the achievements of others projects' support to Iraq in this field. The SRV-ALI will work toward consolidating what could be and improving the environment in which these WUAs operate via the following actions:

- Work closely with the WUA section within both ministries (MoWR and MoA).
- Build on the work achieved through JICA assistance to develop the sustainable irrigation water management by WUA.
- Adopt a socio-technical modernization approach in conjunction with components 2 and 3. This presents a paradigm shift and would involve not only rehabilitation (upgrade), but would also require the establishment of suitably sized, financially viable, and autonomous (technical) hydraulic units for the self-governing WUAs.

²³⁶ i) Developing and adopting water-distribution plans based on crops requirements and climate change projections; (ii) minimizing degradation of water quality in the surface and ground water through improved agriculture and irrigation practices; and (iii) managing, operating and maintaining irrigation schemes

- Define the level of support needed at each WUA to insure implementation and respect of the scheme management code and the rules of procedures.
- Technical design would require attention to flow-control and flow-measurement at key outlet points, to enable performance-based legal agreements between the WUA and the DoWR, and enable practical and enforceable distribution modalities within the boundary of the WUA area of operation.
- The rehabilitation (upgrade) will also include a review of the water allocation modalities for the targeted schemes.
- Conduct training in good practices/technical and irrigation scheduling with targets and outreach measures to ensure participation of female farmers.
- At national level support the preparation of an appropriate legal framework for irrigation management by the WUAs within the framework of the existing Water Code (departing from what was already suggested by JICA project).

478. Farmers, WUAs, and other beneficiaries may have inadequate capacity to effectively implement the ESMF requirements under component 1. An environmental, health safety and social focal point will be proposed by each WUA. Designated focal points responsible in the long-run for implementing the environment, health workplace safety, and social requirements in the cultivable fields and during postharvest activities, will attend training on ESMF/ESMP implementation and good practices for the protection of the environment, including water, energy, soil health, biodiversity and pest ecology management, and to manage grievances and GBV issues. In addition, the project will provide farmers with training and TA.

479. The activities linked to the rehabilitation of existing secondary and tertiary canals, would not require displacement of producers inside the perimeters concerned. The selection of the canals for conversion from open to closed systems have been closely coordinated with the Directorates of Water Resources in each of the Governorates. The MoWR and the DoWR have identified canals, which have adequate water quotas. Furthermore, proposed canals are: (i) free of resettlement, relocation and land acquisition issues; (ii) not budgeted from other resources; (iii) consistent with MoWR's strategic priorities and plans; (iv) prepared in consultation with other line ministries where feasibility studies for new proposals are involved to avoid duplication and conflict. The layout of the selected distributary canals and their watercourses should allow an easy access and their right of way must be free from any physical cultural resources including graves. Based on environmental and social considerations, any selected areas that may have a significant adverse impact on the environment and society will be excluded/replaced. Potential temporary livelihood losses due to construction works during cropping seasons will be considered during the detailed design. A detailed table will be prepared based on the possibilities for allowing irrigation of parcels as the work progresses. Work will be organized in such a way that the canals will be functional without long downtime. The development of these canals upgrades should be done within a period when the irrigation water demand is minimal to greatly reduce any necessary compensation measures. Some of these measures could eventually include compensation in terms of providing unskilled labor services for the rehabilitation of the schemes linked to the protection of the water resources in the intervention area of the project

480. In the recently implemented Irrigation Sector Loan Project (JICA, 2014), the Ministry of Water Resources, the executing agency of the project, had difficulties in agreeing with farmers on the timing of rehabilitation works because the repair of irrigation and pumping facilities needed to be scheduled for when they were not being used for farming. Therefore, with assistance from consultants, this Project will develop a mechanism to share information between the Ministry of Water Resources in Baghdad and the directorates of water resources and water users' associations in individual governorates to

ensure information sharing and communication on the schedule of construction works between the relevant local parties, the MoWR and the MoA. Temporary livelihood losses due to construction works during cropping seasons will be considered during the detailed design. A detailed table will be prepared based on the possibilities for allowing irrigation of parcels as the work progresses. Work must be organized in such a way that the canals will be functional without long downtime. The development of these canal upgrades should be done within a period when the irrigation water demand is minimal to greatly reduce any necessary compensation measures. Some of these measures could eventually include compensation in terms of providing unskilled labour services for the rehabilitation of the schemes linked to the protection of the water resources in the intervention area of the project.

481. All the contractual ESMP documents for the project will include a section on Gender Based Violence (GBV) with proposed mitigation measures, and a section in the code of conduct to manage the question of labour influx. In addition, the project will have to identify the precautionary measures for the management of the expected migrant influx in the project area, identify measures to ensure security around the perimeters.
482. Iraq has an existing institutional structure overseeing environmental and social safeguards, notably the MoE, which is responsible for approving ESIA's. The country also has a comprehensive environmental legal framework, including the Law of Environmental Protection and Improvement N° 27 of 2009 that organizes the technical and legal framework of the Ministry of Environment (MoE), by including provisions for the protection of human, environment and biodiversity from water, air, and soil pollution. Any project for which an environmental assessment is carried out is subject to the administrative and technical supervision of the relevant authorities, which focus especially on the effective implementation of the ESMPs, developed as required under the framework of the ESMF.
483. The environmental and social safeguards specialist of the project management team (PMT) will be the immediate and core responsible person for ensuring good environmental and social performance, and in line with the ESMF and subsequent ESMPs. However, to promote a mid- and long-term management of environmental and social issues associated with the improvements of irrigation, drainage infrastructure and smart climate agriculture, environmental and social functions will be mainstreamed into MoE functional organigram.
484. Sustainability of project achievements is predicated on a number of project design features inter alia aimed at improving irrigation development and management in the MoWR. In particular:
 - Establishing the necessary frameworks and regulations for compulsory adhesion to WUAs. As WUAs are strengthened and transformed, it is expected that they take over many of the DoWR responsibilities before or during the last year of the project (thereby assuring the sustainability of the project);
 - Mid- to long-term management responsibility over parts of the irrigation schemes shifted to WUAs (formed, trained and capacitated under the project), dealing with both production and maintenance aspects of their production cycle, and with their organizational governance (including women leadership) and financial management;
 - Increasing competitiveness in the agriculture sector by enhancing productivity and resilience through promotion of private sector participation in irrigated agriculture and access to improved agricultural technologies;
 - Ensuring sustainable support to farmers' access to relevant production information and best practices for decision-making;

- Addressing specific challenges such as largely increasing the cropping intensity and productivity and gaining economies of scale for creating a growth pole for agricultural development in the selected areas; and
- Empowering local-level stakeholders through training and capacity building to address specific challenges. Institutional strengthening and transformation of WUA will make it a more effective institution, which is expected to result in more sustainable outcomes for the project area and for the general development of agriculture.

Component 2: Climate Resilient Agriculture Production

485. The objective of the **Component 2: Climate Resilient Agriculture Production** is to address adaptation deficit of farming communities via the national extension system, knowledge transfer processes, and empowerment of women as change agents for climate adaptation, and through e-extension options or Information Communication Technology for Climate Change (ICT4CC), including **Sub-Component 2.1: Strengthening Adaptive Capacity of Farmers**, **Sub-component 2.2 Enhancing Awareness about Energy Efficient Solutions**, **Sub-component 2.3 Enhancing Climate Resilience for Women**.

Strengthening adaptive capacity of farmers (sub-component 2.1)

486. The **Sub-component 2.1** aims to train 400 Extension Staff on climate resilient agricultural practices and technologies (output 2.1.1), enhance capacity of 10 000 farmers in Climate Resilient Agriculture (output 2.1.2), reach 100,000 farmers through ICT4CC technologies (output 2.1.3)

Proposed action, rational, and feasibility

487. Under **output 2.1.1.**, at least 400 extension service officers from the national and local institutions like the Ministry of Agriculture, Ministry of Water Resources, Najaf Council of Agriculture, partner development institutions, and local NGOs will receive training to cover the technical content of the selected CRA practices and technologies²³⁷, farmer's field school methodologies and modern facilitation techniques.

488. The **Output 2.1.1.** will also enhance capacity of 10,000 farmers in Climate Resilient Agriculture. The **activity 2.1.1.1.** will allow the review and adjustment of the curriculum that will be used as the basis for implementing the FFS and making the necessary improvements. The **activity 2.1.1.2** will conduct training for the extension officers, staff, and/or employees from partner organizations that are interested in improve their knowledge and implement CRA. The **activity 2.1.1.3** will enable the selection of government extension staff to be trained and will focus on the extension workers active in the fieldwork. Training for technical extension personnel may cover officers working in other institutions. However, the officials from the Ministry of Agriculture will be the priority. There will be a quota of 400 people. Technicians from other partner organizations may fill the positions that are not in demand. The logic in leaving a more significant number of specialists in ASC is to spread the knowledge imparted through the project into other initiatives at the national level. Such partner organizations would include: (i) non-governmental organization; (ii) on-going projects; (iii) universities; (iv) research institutes; and (v) private sector companies including input marketing, output marketing, processing or others. The **Output 2.1.1.** will be organized as follows:

²³⁷ Table (55) below contains the first proposal for the FFC training curricula. These selected CRA practices and technologies will serve to demonstrate the economic benefits coming from its adoption.

Table 64: Activities under output 2.1.1.

Activity 2.1.1.1	To provide technical support to the PMU, the project will hire highly qualified staff to support the implementation of the output and all technical activities.	<ul style="list-style-type: none"> • Hire technical expertise
Activity 2.1.1.2.	This set of activities are designed to put in place arrangements for implementing a training programme for CRA.	<ul style="list-style-type: none"> • Hire a national/international CRA expert to develop the training curricula to be held at the FFS. (6 months)²³⁸. • Organize a technical workshop, including national and local institutions, to validate the reviewed content. • Organize a stakeholder workshop to validate the training content, linguistic and include farmer's suggestions. • Hire a national expert in communication for development to review the proposed training material and to include training aids specially designed for adults (3 months). • Develop two sets of training materials (manuals), which will be used to train extensionists and farmers. It will contain a detailed description of each resilient agriculture practices, including specific options for the main crops (rice, wheat, barley, corn). The topics to be covered will be the same in both sets, but it is necessary to prepare a training manual for trainers (extension team) and one for the farmers. The training material developed for extensionists will include additional elements to improve capacities on participatory approaches and facilitation and communication skills. • Physical and virtual printing of training materials.
Activity 2.1.1.3.	Develop a team of Master Trainers for CRA	<ul style="list-style-type: none"> • Select or hire a group of at least 12 master trainers (3 working at national level and 3 per governorate) who will conduct the training process for the extensionists. The master trainers could be staff members from the national extension service, or hired experts.

²³⁸ This expert will also collect existing training materials from the FFS and trainings with FAO's involvement, as well as from partners like IFAD and WFP.

		<ul style="list-style-type: none"> • Define a plan for the training of master trainers, including dates, location, and logistics. • Organize a workshop to train the master trainers. They will be trained by the expert who developed the training material.
Activity 2.1.1.4	Put in place the arrangements for training of extension staff.	<ul style="list-style-type: none"> • Select or define a group of at least 400 field extensionists²³⁹ who will lead the training process addressed to farmers. • Define a plan for the extensionists trainings. This plan should include dates, location, logistics, facilities, and use of training materials. • Organize the workshops (16²⁴⁰) to train the extensionists team. They will be trained by the group of 12 facilitators (master trainers).

489. **Under Output 2.1.2.** 10,000 (3 000 women) farmers (including members from the existing WUAs) will be trained via Farmers Field Schools on the application of key climate resilient agriculture and irrigation practices and technologies such as: i) on farm water saving irrigation methods / technologies, like: flood irrigation, but comprising plot or land levelling, furrow irrigation and multi-crop bed planter, sprinkler irrigation (mini, micro, and pivot), drip irrigation methods, irrigation scheduling to avoid misuse, and monitoring of soil water content; (ii) resilient crop and soil agricultural management practices, like: application of the three principles of conservation agriculture: (minimum tillage, soil cover, crop rotation), organic fertilization, appropriate crop and variety selection (the use of water stress and salinity tolerant crops / varieties).

490. Using the FFS approach, a participatory adult learning methodology will be applied where participants will observe weather, crop and irrigation water use, soil characteristics, plant development, costs and yield. This process also will demonstrate the economic benefits of adopting recommended CRA practices and technologies, and will replicate the FAO experience coming from on-going Farmer Business School projects in the country.

491. As a part of the farmer's business development capacity around each FFS, the project will also introduce participants to private sector partners that are providing services that can help them take adaptation measures and establish possible links to business opportunities. The project will also provide advice and essential information on how producers can access state subsidies designed for purchasing seeds for more resilient crops, irrigation equipment, and machinery. This activity will be carried out by the extension workers who will be trained by the master trainers (Activity 2.1.2). Training activities will be conducted through the implementation of FFD, on farmer's demonstration plots. Each farmer group will agree on a specific training curriculum to follow, training frequency.

Table 65: Activities under output 2.1.2.

²³⁹ The gender ratio will be based on current gender composition of the extension staff.

²⁴⁰ 25 participants per workshop.

Activity 2.1.2.1:	This activity will allow the organization of at least 400 groups of farmers interested in implementing CRA. Each group will consist of a maximum of 25 producers.	<ul style="list-style-type: none"> • Disseminate the training curricula among the farmers of each governorate. • Create a list of farmers interested in participating in the training process. • Establish groups of a maximum of 25 participants who will form a FFS. The establishment of the groups will be based on these criteria: common topics of interest and territorial proximity, as well as gender considerations.
Activity 2.1.2.2:	Designed to disseminate the good CRA practices learnt at the FFS.	<ul style="list-style-type: none"> • Agree selection criteria for locations (farmers' production units) to establish demonstration sites for the CRA practices and technologies set by each FFS. • Select the specific locations for each FFS (demonstration plots). • Procure the agricultural materials and inputs needed for the implementation of all demonstration farms / plots. • Implement the CRA practices and technologies (agreed under the activity 2.1.1), in each demonstration plot, in coordination with the farmer-owner of each demonstration plot. • Carry out the training program according to the scheduled lessons, field days, and activities planned individually in each FFS.

492. Under the output 2.1.3, 100,000 farmers are reached through ICT4CC technologies. This output will create a wider enabling environment that will support the scaling up of climate resilient agriculture, among extension agents, farmers, and private sector, at the national level. ²⁴¹People in the country will

²⁴¹ Activities related to ICT4CC and FFS (sub-component 2.1) will also support awareness raising related to food system diversification, circular economy, farm to fork principles and reducing food loss and waste.

be reached through e-extension systems and Information and Communication Technology for Climate Change (ICT4CC).

493. During the project's design, it was impossible to obtain a precise picture of the current state of use of information and communication technologies. Nevertheless, it was learned that the utilization of ICTs, especially those related to social networks, is highly appreciated by farmers (both male and female).

494. The Ministry of Agriculture, specifically the Extension and Training Department, currently has some materials. They are mainly audiovisual products that are disseminated through social networks. However, there is a lack of precise information on which technologies are most widely used. For this reason, the project envisages hiring a national expert who will be responsible for preparing a rapid assessment of the use of ICT in the agricultural sector and, based on this analysis, will develop an action plan that will articulate the actions proposed in the project with ongoing government initiatives and those of other development partners.

495. The ICT4CC use will imply the development and diffusion of media programs to be broadcasted in collaboration with Government, Universities and NGOs aiming to reach a wider audience to raise awareness on climate resilience approaches including climate tolerant crop varieties, efficient water management and irrigation systems, advantages of renewable energy and recycling, sustainable land use practice and others. The implemented farmers field schools will serve as a basis for the preparation of materials to be disseminated.

496. In accordance with what was established and agreed upon in the action plan, the project will also disseminate training and communication materials via mobile telephones, WhatsApp, Facebook²⁴², and other social media groups. Other relevant materials that extension staff may use during training activities or in connection with demonstrations or field day events will be shared too. The use of ICTs will be promoted to complement and strengthen the capacity of farmers to observe on the ground through the FFS, deduce from observations, and apply the findings.

497. The implementation of this output will be organized as follows:

Table 66: Activities under output 2.1.3

2.1.3.1.	The project will hire a national expert who will be responsible for preparing a rapid assessment of the use of ICT in the agricultural sector and, based on this analysis, will develop an ICT4CC action plan that will articulate the actions proposed in the project with ongoing government initiatives and those of other development partners.	<ul style="list-style-type: none"> • Hire a national ICT expert • Develop a rapid assessment of the use of ICT options in the Iraqi agriculture sector. • Develop an ICT4CC action plan that will articulate the project's efforts with major ongoing ITC initiatives. • Develop information and communication services and products that enable farmers to adopt climate resilient practices and technologies.
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²⁴² For example, the Extension Service (MoA) manages a Facebook space which is popular among farmers: <https://www.facebook.com/iraqirshad>

		<p>Materials designed for FFS training will be disseminated to a broader audience.</p> <ul style="list-style-type: none"> • Maintain active the different ICT options chosen and agreed upon in the ICT4CC action plan with the focal points of the Ministry of Agriculture. • Disseminate the training activities conducted in the demonstration farms and plots among the farmers of the project area and at a national level.
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Cost assessment

498. The total cost for the implementation of this subcomponent will be USD 5.08 million and the cost assessment is organized as shown in the table below:

Table 67: Costs under sub-component 2.1

COMPONENT 2: Climate Resilient Agriculture Production	Total Cost	GCF	GVT	FAO
Sub-Component 2.1 Strengthening Adaptive Capacity of Farmers				
Output 2.1.1. 400 Extension Staff trained on climate resilient agricultural practices and technologies				
Activity 2.1.1.1.	1,203,404	406,406	-	8223,998
Activity 2.1.1.2	90.950	-	-	- 90,950
Activity 2.1.1.3	15.270	-	-	- 15,270
Activity 2.1.1.4	189.360	-	-	- 189,360
Output 2.1.2 Enhanced capacity of 10 000 farmers in Climate Resilient Agriculture				
Activity 2.1.2.1	59.976	29.988	-	- 29.988
Activity 2.1.2.2	3,260,800	1.865.600	-	- 1,395,200
Output 2.1.3 100,000 farmers reached through ICT4CC technologies				
Activity 2.1.3.1	229.000	112.000	-	- 117,000

Specific Execution Modalities

499. The PMU, in close coordination with FAO, the Ministry of Agriculture through the Agriculture Extension and Training Department, at national and in each governorate (Karbala, Muthanna and Najaf), will have the lead role in the implementation of all activities associated with this subcomponent.

500. The PMU will be in charge of providing the consulting services, contract in qualified technical specialists for specialized activities such as designing and delivering the training materials to be used in the FFS, hire the master trainers in case that the necessary personnel are not available and purchase equipment, materials, training, travel and other logistical expenses. Procurement processes will be carried out in accordance with FAO policies and regulations.
501. This component of the project will benefit from FAO Iraq's expertise. FAO Iraq has implemented dozens of projects that address the main agriculture issues. The PMU led by a Project Coordinator (PC) will include the following specialists: irrigation specialist, procurement specialist, social & environmental safeguards specialist, finance specialist, accountant and an M&E specialist.
502. This component is expected to have a permanent coordinator, who will be in charge of implementing all the activities described above. The work will be reinforced by the technical specialists included in the detailed description of the activities.
503. At project start-up, the project will put in place arrangements with subject matter specialists, research institutes, and universities (to be selected by FAO) for a final review and refinement of the identified practices for the specific sites. This review of practices will be completed during the first year of project implementation.
504. The project will have a core team of 12 full-time master trainers – 3 working at national level and 3 in each governorate. They will be procured by the implementation partner in accordance with FAO procurement policy. These master trainers will conduct the training to develop capacity of about 400 extension workers. As a result, extension officers will be in a position to impart skills and conduct training of intended project beneficiaries directly reaching around 10.000 farmers during the project implementation period
505. In addition, the output 2.1.2. will be carried out by the extension workers who will be trained by the master trainers (Activity 2.1.2.2). Training activities will be conducted through the implementation of FFD, on farmer's demonstration plots. Each farmer group will agree on a specific training curriculum to follow, and training frequency.

Operation and maintenance

506. Operation and maintenance are not applicable under subcomponent 2.1

Economic, financial, social and environmental sustainability

507. Strengthening adaptive capacity of farmers and providing them with climate resilient practices adapted to farmers' needs will enable to increase the crop water productivity by at least 10 percent²⁴³ (depending on each crop) thanks to introduced resilient technologies and practices. The increase of crop water productivity combined, the improvement of irrigation efficiency combined with climate resilient practices adopted by farmers will secure agriculture production levels that could lead to an increase of farmer's incomes, and increased crop yields, decreased net irrigation requirements and improved food security. This will also lead to an increase of biomass, increased soil organic matter and carbon capture. The modelling was done through FAO Aquacrop and can be summarized as follows (Table 68):

²⁴³ This data was estimated by using the FAO AquaCrop model.

Table 68: Results from FAO Aquacrop

Scenario		Climate (2019)			
		Average yield (t/ha)	Water productivity**	Biomass (t/ha) (potential vs. obtained)	
Wheat Najaf	Without PP: Flood irrigation	3,08	1,66	9,54	6,18
	WithP: Sprinkler irrigation + 50 percent mulch + improved varieties	3,70	1,94	7,48	
Barley Muthanna	Without P: Flood irrigation	1,70	1,16	7,05	5,49
	WithP: Sprinkler irrigation + 50 percent mulch + improved varieties	1,81	1,29	5,78	
Rice Najaf	Without P: Flood irrigation	3,80	0,46	16,31	14,14
	WithP: 50 percent mulch + improved varieties (heat tolerant variety) + intermittent irrigation	4,67	0,56	14,11	

** kg of yield per m3 water evapotranspiration

508. Overall, farmer field schools promote sustainable capacity strengthening programmes that will enable to increase farmer's resilience in the 3 governorates while increasing farmer's incomes. The FFS will also enable extension services staff to replicate good practices and to train farmers beyond the project duration.

Enhancing awareness about Energy Efficient Solutions (sub-component 2.2)

Proposed action, rational, and feasibility

509. **The Output 2.2.1.** aims to increase technical capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events.
510. Agriculture is a highly energy dependent sector, and some irrigation systems can only work with consistent and reliable energy supply. In areas where constant electricity is lacking and/or diesel fuel is difficult to purchase or is expensive, Solar Powered Irrigation systems (SPIS) can significantly increase energy security. SPIS can be used in large-scale irrigation systems as well as for decentralized, small-scale irrigation and are recognized as innovative mitigation and adaptation measures in the agricultural sector. Furthermore, since prices for PV technology have fallen dramatically over the last decade (more than 80 percent) and are expected to decrease further in the coming years, the technology is becoming increasingly attractive all over the world.
511. Calibrating SPIS is a however a complex procedure and needs the demand (water requirements and irrigation calendar) and supply side (the PV and Pumping systems) to be perfectly adapted. It is therefore the scope of the activity to: (i) disseminate climate sensitive technical innovations for SPIS based on international best practices and to (ii) raise the awareness on the technical and economic feasibility of the technology. For this purpose, the output foresees the development of specialized trainings for extensionists and other stakeholders and awareness raising events for the citizens of the 3

governorates to increase general knowledge about solar energy and on related investment opportunities.

512. In combination with the training courses, the project will install 3 complete Solar Powered irrigation demonstration systems (1 in each governorate) on communal land that include all equipment for the PV – systems and the drip lines. The systems will be installed for WUA that have resources available to cover the costs for the maintenance of the SPIS and are willing to invest own resources for the O and M. The following are the requirements for WUAs to obtain the systems:

- At least 3 members of the WUA have participated in the training for Solar Powered Irrigation systems and have been determined by the trainers to be capable for monitoring and operation of the systems and are available to carry out the O&M of the systems, once installed.
- WUA have cultivated communal agricultural land available in which the SPIS could be installed (only surface water to be used, no groundwater pumping permitted)
- WUA have resources available to cover the costs for the maintenance of the SPIS and are willing to invest own resources for the O and M.
- Be willing to share what they have learned with other farmers and to host FFS

513. The output 2.4 will be implemented through the following activities:

Table 69: Activities under output 2.2.1.

<p>Activity 2.2.1.1.</p>	<p>Organize a 2 days' workshop for stakeholders on technical and economic advantages and feasibility of the Solar Powered Irrigation systems (SPIS). The trainings address the topics planning, installation, supply, operation, and maintenance and also the financing of the systems. Training material is above all a guideline for the development of SPIS applications designed for the Iraqi context, including technical specifications and quality requirements of the equipment. The training will tackle on-farm solar irrigation systems (without groundwater pumping), will be repeated twice in each of the beneficiary governorates, and involve extensionists, representatives of WUA and the private sector.</p>	<ul style="list-style-type: none"> • Hire an international SPIS expert and a national SPIS expert to develop together the training manual, the ToRs for the mobile training lab and for the 3 demonstration systems. The national expert will be also responsible for monitoring the functioning of the demonstration systems during the lifetime of the project, and to hold the training courses • Organize a technical workshop, including national and local institutions, to validate the proposed content. • Organize a mobile demonstration lab inclusive of functioning PV in combination with an irrigation system to support aspects of visibility and practical training. The laboratory will be handed over to 1 of the extension services of the beneficiary areas.
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		<ul style="list-style-type: none"> • Install 3 complete Solar Powered irrigation demonstration systems (1 in each governorate) on communal land that include all equipment for the PV – systems and the drip lines. The systems will be installed in WUA that have resources available to cover the costs for the maintenance of the SPIS and are willing to invest own resources for the O&M. • Identify participants for the trainings • Organize 2 trainings in each of the governorates (6 in total)
Activity 2.2.1.2.	<p>To increase awareness of the general public on the technology, each year (from Y2-Y5) in a different municipality of each beneficiary governorate 1 public event demonstrating the functionality and advantages of solar energy in rural areas will be organized. For this purpose, the mobile training laboratory created in activity 2.4.1. is utilized and exposed at the events, together with awareness raising material. The purpose of the open energy days is to sensitize the general public on the project and on possibilities for exploiting Renewable Energy Sources (RES) in rural areas in an entertaining and interactive way. Ideally, the open energy days should be organized in synergy with other exhibitions/fairs/events taking place to increase visibility. However, it is also possible to organize own standing events.</p>	<ul style="list-style-type: none"> • Hire a national expert in communication for the development of the communication strategy of the events, the identification of the host locations and the specifications of the communication and dissemination material specifically designed for the beneficiaries • Hire a national energy expert to provide the communication expert with information related to solar energy in rural areas (technology, economic feasibility, financing possibilities etc.) • Preparation of communication materials. In the course of the years the communication and energy expert will update the material according to the latest information. • Organize 12 open energy days (4 in each governorate)

Cost assessment

514. Total costs are estimated at USD 0.18 million and the cost assessment of this subcomponent is organized as follows:

Table 70: Costs under sub-component 2.2

Sub-Component 2.2 Enhancing Awareness about Energy Efficient Solutions				
Output 2.2.1. Technical Capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and awareness raising events	Total Cost	GCF	GVT	FAO
Activity 2.2.1.1.	95.994	-	-	95.994
Activity 2.2.1.2.	83.800	24.500	-	59.300

Specific Execution Modalities

515. The PMU will be in charge of providing the consulting services, contract the qualified experts, organize the purchase of equipment and other materials and the organization of trainings and workshops. Procurement processes will be carried out in accordance with FAO policies and regulations.
516. In close coordination with FAO, the Ministry of Agriculture through the Agriculture Extension and Training Department, at national and in each governorate (Karbala, Muthanna and Najaf), will have the lead role in the implementation of all activities associated with this subcomponent.

Operation and maintenance

517. The 3 SPIS will be provided to WUAs that will be responsible for Operation and maintenance.

Economic, financial, social and environmental sustainability

518. The project will train experts and governmental staff for sustainable use of solar energy in the agricultural sector through technical workshops. This will aid in proper assessment, design, installation, operation, and maintenance, policy making and devising effective strategies for wider dissemination and installation of this low emissions sustainable energy source. Solar irrigation pilot systems will be implemented in the three governorates which will enable the communities to familiarize with solar energy, including to raise the awareness on the technical and economic feasibility of the technology. The series of trainings will adopt a participatory approach with the pilots, and will be combined with the dissemination of communication materials that will help ensure the sustainability of good practices and lasting implementation.
519. The output 2.2.1 also contributes to promote clean energy in the three governorates, in complement with the activities under component 1. Open days on clean energy will also reach additional citizens in the governorates to increase awareness and sensitization on energy. Indirect beneficiaries will reach around 92,800 people.

Enhancing Climate Resilience for Women (sub-component 2.3)

Proposed action, rational, and feasibility

520. Women in rural areas are disproportionately affected by climate change with unequal access to resources and assets, barriers to decision-making and limited mobility. At the same time, women

have the potential to become agents of change – leaders, practitioners, educators and influencers in climate change adaptation and mitigation.

521. Empowering rural women as agents of change for climate adaptation has been identified in the literature as critical to addressing climate change challenges. The GCF project proposes the creation of a cadre of young women as agents of change for climate adaptive practices from the rural areas in the three target Governorates of Muthanna, Najaf and Karbala. These young women will be advocates and repositories of knowledge and technical guidance and support on climate change adaptation, anchored in rural communities. The women will be trained and certified through a customized sixteen-week training delivered over the course of a year in state-of-the-art techniques for climate adaptive agriculture, agri-business planning and development and use of social media for climate change adaptation and advocacy.

522. The knowledge and expertise of the CWW will be developed further through monthly meetings with women agronomists from the Agricultural Extension Departments. The presence of these young women in the rural communities will bring practical knowledge and sustained support for climate adaptive agriculture to the doorstep and optimize, especially for women and youth, the benefits of project interventions. They will be able to leverage the expertise of the Agricultural Extension Officers and strengthen the linkage between farmers and the AEOs. At the national level, it will highlight women's role as change agents in Climate Change in Iraq and provide the government with informed, community-based interlocutors for mainstreaming gender in climate change.

523. The Climate Wise Women will also be engaged in a research designed by the International and National Climate Adaptation and Gender & Social Inclusion Specialists and gather data on the roles of women in agriculture, their specific challenges and coping strategies in adapting to climate change and the lessons learnt from the CWW intervention.

524. These young women will perform a range of functions, supporting the behaviour change objectives of project interventions: (i) advocates and resource persons of climate adaptive agriculture for women and men farmers in their communities and graduates of Farmer Field Schools (ii) practitioners of climate adaptive agriculture, demonstrating the efficacy of climate adaptive techniques on their own farm (iii) facilitators of understanding and dialogue on climate change and modern climate adaptive agriculture among women (iv) researchers on the impact of climate change on women (v) advocates for mainstreaming women and small-holder farmers perspectives and needs in national and governorate policies and plans through stakeholder dialogues with policy makers.

525. The implementation of the sub-component 2.3 will be organized into 2 different outputs: **output 2.3.1. 150 Climate wise women trained as agents of change, and output 2.3.2. 40,500 persons sensitized to Climate Adaptive Measures.**

526. Under **output 2.3.1.**, the following activities will be implemented:

Table 71: Activities under output 2.3.1.

Activity 2.3.1.1.	Technical assistance will be procured for development of a short-course for training of climate wise-women as change agents.	<ul style="list-style-type: none"> Develop ToR for hiring an international expert on gender and climate adaptive agriculture, and a national training specialist, to conduct a rapid needs assessment, review available training curricula and
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		<p>materials and develop two training courses: (i) Training for master trainers of Climate Wise Women and the training course for Climate Wise Women.</p> <ul style="list-style-type: none"> • Hire national and international experts for the development of the master trainer's course (7 weeks) and Climate Wise Women training courses (12 weeks) • Design needs assessment (methodology, instrument, sample size) to assess validity of selection criteria, appropriate methodology, content, duration and timing of training as well as finalize kit to be delivered to Climate Wise Women.
Activity 2.3.1.2.	A Social and Behaviour Change Communication Strategy will be developed for branding, positioning and specifying slogans and behaviour change products for CWW	<ul style="list-style-type: none"> • Develop ToR for hiring a social and behaviour change communication specialist to design an SBCC strategy which specifies the branding, slogans, social and behaviour change products for the Climate Wise Women • Hire international expert to develop the SBCC • Draft Social and Behaviour Change Communication Strategy for Climate Wise Women • Hire service provider to design and printing communication material • Implement SBCC activities through specified channels
Activity 2.3.1.3.	A service provider will be hired to conduct the training needs assessment and based on it training manuals will be designed for Master Trainers and Climate Wise Women.	<ul style="list-style-type: none"> • Develop ToR for hiring a service provider to conduct the needs assessment for the modules to be developed for Climate Wise Women. • Conduct training needs assessment in the target area of the project in Karbala, Najaf and Muthanna. • Design training for master trainers and Climate Wise Women specifying contents of kits to be provided to master trainers and Climate Wise Women. The women will be trained in state-of-the-art techniques for climate resilient agriculture, agri-business planning and development and use of social media for climate change adaptation advocacy. This will

		<p>be done by a team of three experts, the International expert on Climate Adaptive Agriculture, the Training Specialist and the Gender and Social Inclusion Specialist (PMU).</p> <ul style="list-style-type: none"> • The course content may include modules on irrigation technology, soil management, organization and management of the dissemination of key technologies, communication skills with a focus on listening skills and problem-solving skills, budgeting and business plan development. • Organize 6 two-day peer review workshops to vet the 12 modules developed for Climate Wise Women with 2 modules reviewed in each workshop. Peer reviewers will be drawn from the Directorate of Agriculture, Extension staff of the Centre of Extension and Centre of Extension and the private sector if required. Fifty percent of the peer reviewers will be women. • Field test training for Climate Wise Women through holding a workshop (15 rural women selected using the criteria identified for CWW) • Revision of modules incorporating lessons learnt from field test • Organize a Validation workshop for CWW modules with the relevant technical experts from GOI and stakeholders • Develop ToR for service provider to design and print training manuals and materials • Hire service provider to print manuals, training material • Print manuals, training material
Activity 2.3.1.4.	Master Trainers will be selected from pool nominated by Directorate of Agriculture and Centre of Training and Extension and trained	<ul style="list-style-type: none"> • Elicit nominations from the Directorate of Agriculture and Centre of Training and Extension for women Master Trainers • Interview and select 5 women Master trainers per Governorate • Organize 7- week training of Master Trainers • Provide Master Trainers with kit

Activity 2.3.1.5.	Competitively selected candidates will be trained for a 12-week period in climate adaptation practices over the course of 18 months	<ul style="list-style-type: none"> • Develop a field plan for community mobilization and providing information on the application process for CWWs through master Trainers (12 days per Master Trainer in the field with each Master trainer responsible for visiting 5 villages at least twice) • Organize selection of CWWs (one per village) in each Governorate in accordance with specified criteria through a board comprising representatives from the Executing Agency, Government Extension Departments, Master Trainers etc. • Recruit selected candidates with contractual agreement specifying the obligation to complete the course, deliver training and support for climate resilient agriculture practices, awareness on climate change issues to women and men farmers and youth in their communities with a small monthly stipend. • Develop training plan for each Governorate with details of selected training venues (one per cluster of 25 villages), dates, timings, transportation arrangements for master trainers and Climate Wise Women, daycare facilities, refreshments. • Procure kits for Climate Wise Women • Deliver 2 training courses per Governorate (36 days in 12 three day workshops each over 18 months) with 25 participants selected as Climate Wise Women in each course. The two courses in each Governorate will begin simultaneously with a team of two Master Trainers facilitating each course.
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527. The planned courses under Activity 2.5.3 for the Master Trainers and Climate Wise Women explained in the table below.

Table 72: Courses planned under activity 2.3.1.

Topic	Subtopic
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Understanding Climate Change	How Climate Change has affected Iraq: temperatures, precipitations and extreme events Concepts of adaptation and mitigation, including the necessity of adopting adaptation measures and mitigation scenario
Climate Change and its Impact on livelihoods	Exposure/sensitivity/vulnerability How CC impacts sectors, ecosystem services, livelihood and communities How CC impacts are visible in the ecosystem, livelihood and communities
On farm water saving irrigation technologies	Flood irrigation + plot/land levelling Furrow irrigation + multi-crop bed planter. Sprinkler irrigation (mini, micro, and pivot). Drip irrigation. On farm water management
Resilient crop, water and soil agricultural management	Irrigation scheduling and avoiding misuse. Application of the three principles of conservation agriculture: (minimum tillage, soil cover, crop rotation). Appropriate crop / variety selection (use of water stress and salinity tolerant crops / varieties). Soil organic matter / organic fertilization / mulching.
Crop diversification options	Animal fodder (salt tolerant) production systems. Crop rotation / crop diversification. Vegetable cropping / backyard gardening (especially for women).
Improved post-harvest and storage practices	Good harvesting practices. Adequate storage facilities. Adequate packing. Basic shade/cooling constructions.
Basic Business Plan Development for agriculture and livelihoods	Understanding current situation: product production costs, resources, marketing Developing a Vision and Setting goals Developing a Business and Marketing Strategy Implementing and Monitoring the Business and Marketing Strategy
Interpersonal Communication and Behaviour Change Strategies for Promoting Climate Adaptive Practices	Basic interpersonal Skills (Listening, Speaking) Basic skills in persuasion and negotiation Understanding of Behaviour Change Identification of Behaviour Change Strategies
Action Plan for field work and reporting requirements	Developing Action Plan for Field work Understanding Reporting Requirements

528. Under **Output 2.3.2.** 45,500 Persons sensitized for climate adaptive measures, activities will be organized as follows:

Table 73: Activities under output 2.3.2.

Activity 2.3.2.1.	The Climate Wise Women (CWW) will hold dialogues with groups of women in the communities to enhance their awareness about climate change and how best to cope with the risks associated with it and enhance their resilience.	<ul style="list-style-type: none"> Develop field plan with Climate Wise Women for home visits to support climate resilient practices, advocacy on climate resilient practices with communities and social media campaigns on climate change with young women and men in the final week of their training
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		<ul style="list-style-type: none"> • CWW conduct home visits (5-10) per month and small training sessions /dialogues (10 sessions). The Climate Wise Women will also use social media to lead dialogues on climate change especially with young people and introduce them to modern climate adaptive agriculture. • Monitor CWW activities through monthly meetings in year 4, 5 and 6 with Master Trainers. In each Governorate, 5 trainers will monitoring 10 Climate Wise Women each.
Activity 2.3.2.2.	<p>The Climate Wise Women Forums will be organized in Year 3, 4 and 5 of the project. These events will serve to highlight the role of women as change agents; identify achievements and challenges for climate adaptation at the community level for women, men and youth; provide feedback to the Government of Iraq on actions required at multiple levels to address climate change.</p>	<ul style="list-style-type: none"> • Develop ToR for service provider to organize and document 3 multi-stakeholder Climate Wise Women forums • Hire Service Provider through competitive selection process • Organize three Climate Wise Women Forums in Year 4, 5 and 6. These events will serve to highlight the role of women as change agents; identify achievements and challenges for climate adaptation at the community level for women, men and youth; provide feedback to the Iraqi government on actions required at multiple levels to address climate change. The participants will be the Climate Wise Women from the three different Governorates, young men and women from target communities, Government representatives from MOA and MoE at the national level and the Agriculture and Environment departments at the governorate level and relevant Civil Society Organizations. • Produce reports on each CWW forum documenting process, learning and recommendations of CWW forums.

Cost assessment

529. Total costs are estimated at USD 1.8 million and the cost assessment under sub-component 2.3 is organized as follows:

Table 74: Costs under sub-component 2.3

Sub-Component 2.3 Enhancing Climate Resilience for Women
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Output 2.3.1. A cadre of 150 Climate Wise Women (CWW) trained as change agents for climate adaptation	Total Cost	GCF	GVT	FAO
Activity 2.3.1.1.	506.894	230.292	-	276.602
Activity 2.3.1.2.	29.128	-	-	29.128
Activity 2.3.1.3.	46.000	-	-	46.000
Activity 2.3.1.4.	102.500	-	-	102.500
Activity 2.3.1.5.	585.804	181.324	-	404.480
Output 2.3.2. 40,500 women adopt climate adaptive measures				
Activity 2.3.2.1.	472.050	253.475	-	218.575
Activity 2.3.2.2.	30.000	10.000	-	20.000

Specific Execution Modalities

530. The execution will be under the FAO's responsibility with technical assistance, and the support of the Ministry of Agriculture.

Operation and maintenance

531. The operation and maintenance is not applicable here, sub-component 2.3 focuses on capacity strengthening.

Economic, financial, social and environmental sustainability

532. The project will empower young women from rural areas to become change agents for climate resilience in their communities. They will particularly be able to support women farmers whom agricultural extension services do not reach due to shortage of women extension staff. The presence of these CWWs who will be linked to women extension staff will leverage the expertise of the Extension staff. The development of these linkages and relationship during the life of the project will carry over and increase the access of the women farmers to technical advice. The CWWs are village based so women farmers can continue to benefit from their expertise and these young women will continue to be a resource that the Agriculture department and other projects can tap into. The CWWs will also function as a pilot to demonstrate to the Government of Iraq, the value of a grassroots network of women in mitigating the impact of climate change and promoting climate resilient agriculture. The project will assist in deepening the participation and leadership of women in the implementation of Iraq's INDC (2015). The active engagement and leadership of women will help to enhance women's adaptive capacity, strengthen their self-confidence, and demonstrate to the community the important role that they can play and serve as a role model for other women to emulate in the community

Component 3: Scaling up climate adaptation through policy formulation and planning

533. This component will address the strategic and legal framework for water management to scaling-up climate change adaptation into key national water policy frameworks and mainstreaming it across stakeholders (institutions, private sector, and civil society). The aim for the MoWR is to be able

to regulate according to a participatory and climate adaptive water allocation system leading to higher water use efficiency.

534. The policy framework necessary to mainstream climate change across sectors and to develop key transformative climate and environment related strategy is incomplete and slowed by lack of coordination and technical capacities among stakeholders. Water allocation policies and implementation mechanisms can build on the ongoing work by FAO-RNE to develop guidelines for sustainable water allocation of water and the application tools that goes with it. The idea is to use the project activities under this component as pilot to implement the developed guidelines and mainstream them within the framework of the actual GCF project activities.

535.

536. This component will mobilize consulting services and complete the procurement and logistical preparations for consultation meetings/workshops. It is organized into three sets of outputs: **output 3.1.1.** a climate resilient water allocation strategy and its action/legal/coordination plan developed, **output 3.1.2** improved national compliance practices for management of irrigation water supply, **output 3.2.1.** enhanced planning for solar rural electrification.

A climate resilient water allocation strategy and its action/legal/coordination plan developed (output 3.1.1)

Proposed action, rational, and feasibility

537. The achievement of this output will be through the implementation of the following key activities:

Table 75: Activities under output 3.1.1

Activity 3.1.1.1	<p>This participatory consultation process will bring crosscutting sectors to take part in a whole government approach to foster climate adaptive water management practices to ensure the resilience of the agricultural sector without compromising the needs of the other sectors. The consultation process will address both aspects of policy coherence at horizontal and vertical levels related to water allocation within the framework of water-energy and food nexus.</p>	<ul style="list-style-type: none"> • Draft ToRs for the TA, • Engage the TA (consulting firm) (procurement process) to conduct the mutli-stakeholder consulting process combining an analysis based on both descriptive and analytical work plus consultation workshops: <ul style="list-style-type: none"> • Perform a desk study on the relevant strategies and programs and their implementation modalities having an effect on the management and sustainable use of water resources. • Conduct interviews with the institutional actors involved, both centrally and regionally, in order to identify the key interactions between the implementation modalities of the selected instruments and the priority arbitration needs. • Collect data in the field, in the selected Governorates, in order to
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		<p>revisit or reaffirm the hypotheses and the first results emerging from the documentary study and from the interviews at the national level.</p> <ul style="list-style-type: none"> • Discuss the preliminary results of the analysis during a brainstorming workshop involving several stakeholders from both government and non-governmental organizations. The workshop would provide additional information relating to the issue of sectoral policy coherence and its effects on water use, as well as supplement the recommendations for the process to be initiated to strengthen convergence and minimize inconsistencies. • Organize and facilitate multi-stakeholder consultation meetings. This participatory consultation process will bring crosscutting sectors together for participation of key government players in fostering climate adaptive water management practices to ensure the resilience of the agricultural sector without compromising the needs of the other sectors. • Draft a climate resilient water allocation strategy and its action/legal/coordination plan with clear guidelines about water allocation agreements and procedures, managing social conflicts around water, and its sustainable use in light of climate change. • Organize and facilitate a workshop with all concerned stakeholders to validate the draft strategy.
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Cost assessment

538. Total costs are estimated at USD 0.75 million and the cost assessment under output 3.1.1. is organized as follows:

Table 76: Costs under output 3.1.1

COMPONENT 3: Scaling-up climate adaptation through policy formulation and planning				
Output 3.1.1. A climate resilient water allocation strategy and its action/legal/coordination plan developed	Total Cost	GCF	GVT	FAO
Activity 3.1.1.1.	750.400	377.000	-	373.400

Specific Execution Modalities

539. FAO as a specialized United Nations agency can act as a neutral broker for the Government and its development partners in difficult and complex issues related especially to policies, institutions and legal and regulatory reforms. This makes the Organization an ideal partner for implementing this component. FAO has an excellent working relationship with the MoA and MoWR and prospective service providers (e.g. national and international NGOs) through its letter of agreement (LoA) partnership framework. FAO is hence well suited to spearhead the activities under this component and provide effective technical assistance. The MoWR, MoA and IME will also be involved with improving the system of water allocation in discussion with other key stakeholders. This would also require a facilitation support from the MoE.

540. This component will mobilize consulting services and complete the procurement and logistical preparations for consultation meetings/workshops. The TA will conduct multi-stakeholder consultation meetings to develop a climate resilient water allocation strategy and its action/legal/coordination plan. The multi-stakeholder consulting process will combine an analysis based on both descriptive and analytical work plus consultation workshops. Moreover, the TA will analyse compliance practices. The farmers' and other water-users' perspectives are a top priority in the desired shift to a service-oriented culture. The plan is to collaboratively identify the underlying core problems and establish new service-delivery performance targets for water users and service providers (DoWR). Functions and responsibilities need to be defined and assigned to different actors. Agree on general objectives for the reform among actors and set performance objectives, define the functions needed to achieve these, and allocate responsibilities to the different actors.

541. The project with the support from the MoE and in close collaboration with all the concerned stakeholders will also undertake actions to organize visits²⁴⁴ for knowledge exchange to learn from neighbouring MENA countries and national experiences to best plan manage and maintain irrigation water supply and drainage. Other forms of knowledge exchange encompass the organisation of webinars to address the bottleneck (pinged during the consultation workshops) based on the neighbouring countries experiences

Operation and maintenance

542. Operation and maintenance do not apply under output 3.1.1., as the activities will focus on capacity strengthening and policy development.

Economic, financial, social and environmental sustainability

543. Sustainability of project achievements is predicated on a number of project design features inter alia aimed at improving irrigation development and management in the MoWR. In particular establishing the necessary frameworks and regulations for compulsory adhesion to WUAs. Institutional strengthening and transformation of WUA will make it a more effective institution, which is expected

²⁴⁴ For government staff and WUA representatives

to result in more sustainable outcomes for the project area and for the general development of agriculture. Empowering local-level stakeholders through training and capacity building to address specific challenges is key to the sustainability of the actions promoted under SRV-ALI. With regards WUAs, the project SRV-ALI will build on the achievements of others projects' support to Iraq in this field. The SRV-ALI will work toward consolidating what could be and improving the environment in which these WUAs operate via the following actions:

- Work closely with the WUA section within both ministries (MoWR and MoA).
- Build on the work achieved through JICA assistance to develop the sustainable irrigation water management by WUA.
- Adopt a socio-technical modernization approach in conjunction with components 2 and 3. This presents a paradigm shift and would involve not only rehabilitation (upgrade), but would also require the establishment of suitably sized, financially viable, and autonomous (technical) hydraulic units for the self-governing WUAs.
- Define the level of support needed at each WUA to insure implementation and respect of the scheme management code and the rules of procedures.
- Technical design would require attention to flow-control and flow-measurement at key outlet points, to enable performance-based legal agreements between the WUA and the DoWR, and enable practical and enforceable distribution modalities within the boundary of the WUA area of operation.
- The rehabilitation (upgrade) will also include a review of the water allocation modalities for the targeted schemes.
- Conduct training in good practices/technical and irrigation scheduling with targets and outreach measures to ensure participation of female farmers.

544. At national level support the preparation of an appropriate legal framework for irrigation management by the WUAs within the framework of the existing Water Code (departing from what was already suggested by JICA project).

Improved national compliance practices for management of irrigation water supply (output 3.1.2)

Proposed action, rational, and feasibility

545. The achievement of this output will be through the implementation of the following key activities:

Table 77: Activities under output 3.1.2

Activity 3.1.2.1.	The farmers' and other water-users' perspectives are a top priority in the desired shift to a service-oriented culture. The plan is to collaboratively identify the underlying core problems and establish new service-delivery performance targets for water users and service providers. Functions and responsibilities need to be defined and assigned to	<ul style="list-style-type: none"> • Draft ToRs for the TA²⁴⁵, • Engage the TA (consulting firm) (procurement process) to analysis and develop best-fit solutions for the three areas of performance: water service delivery, organizational resources, and governance. • Develop and agree on an action plan to achieve key targets informed by the consultations,
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²⁴⁵ It is possible to combine TA for activities 3.2.1 and 3.2.2 under one contract.

	different actors. Agree on general objectives for the reform among actors and set performance objectives, and then define the functions needed to achieve these. Allocate responsibilities to the different actors	reflections and problem analysis of the previous stages.
Activity 3.1.2.2.	The project will undertake actions to organize visits (for government staff and WUA representatives) for knowledge exchange to learn from neighbouring MENA countries and national experiences to best plan manage and maintain irrigation water supply and drainage. Other forms of knowledge exchange encompass the organisation of webinars to address the bottleneck (pinged during the consultation workshops) based on the neighbouring countries experiences.	<ul style="list-style-type: none"> • Organize visits²⁴⁶ to exchange knowledge and learn from neighbouring MENA countries and national experiences to best plan, manage and maintain irrigation water supply and drainage, • Organize webinars to address the bottleneck (pinged during activity 3.2.1.) based on the neighbouring countries experiences.

Cost assessment

546. Total costs are estimated at USD 474,272 and the cost assessment is organized as follows:

Table 78: Costs under output 3.1.2

Output 3.1.2 Improved national compliance practices for management of irrigation water supply	Total Cost	GCF	GVT	FAO
Activity 3.1.2.1	236.000	-	-	236.000
Activity 3.1.2.2	240.272	64.272	-	176.000

Specific Execution Modalities

547. Please refer to [Specific Execution Modalities](#) under output 3.1.1

²⁴⁶ For government staff and WUA representatives

Operation and maintenance

548. Operation and maintenance do not apply under output 3.1.2, as the activities will focus on capacity strengthening and policy development.

Economic, financial, social and environmental sustainability

549. Please refer to economic, financial, social and environmental sustainability under output 3.1.1

Enhanced planning for solar rural electrification (output 3.2.1)

Proposed action, rational, and feasibility

550. In line with the provisions of the Integrated National Energy Strategy, that assigns to solar energy a key role for providing energy security in rural areas. This output will focus on the elaboration of a road map for investments in the sector to help the country to achieve its target of a 20 percent share of RES within the next decade. The plan will contain clearly defined strategies and targets to be reached within the lifetime of the project and beyond. Furthermore, it is the aim of the road map to up-scale the energy related projects. The road map will contain the delineation of the policy framework, with a particular focus on rural households and the opportunity to utilize solar energy in off-grid, on grid and distributed solutions, taking into consideration a development of the sector towards international best practice standards.

551. The **output 3.2.1. Enhanced planning for solar rural electrification** will be organized as follows:

Table 79: Activities under output 3.2.1.

Activity 3.2.1.1..	<p>In line with the provisions of the national energy plans, in particular, with the Integrated National Energy Strategy, that assigns to solar energy a key role for providing energy security in rural areas in short and medium term, the activity will focus on the elaboration of a road map for investments in the sector. The plan serves also to mobilize/leverage parts of the foreseen national investments from the private sector to achieve a 20 percent share of RES within the next decade. The plan contains clearly defined strategies and targets to be reached within the lifetime of the project and beyond, concerning market development, and anticipates learning curves of the different actors involved. Furthermore, an inventory of potential</p>	<ul style="list-style-type: none">• Initial review of the policy framework and strategies, needs, bottlenecks, and gaps,• Mapping of stakeholders and private sector actors (e.g., services and tech providers),• Geospatial desktop analysis in combination with ground truthing indicating the potential for off-grid, on-grid and decentralized solar energy project development in support of rural electrification,• Elaboration of a road map plan including financing strategy with exemplified solar energy projects,• Stock taking of policy developments,• Elaboration of investments possibilities,• Organize and facilitate multi-stakeholder consultation meetings and workshops for the validation and implementation of the road map,• Workshops for the banking/finance sector and the private sector on the
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	<p>investments for the agricultural regions will be developed, together with a mapping and analysis for potential and sustainable exploitation. This analysis represents the basis for informed and sound decision making for public and private intervention.</p> <p>The road map contains the delineation of the policy framework, with a particular focus on rural households and the opportunity to utilize solar energy in off-grid, on grid and hybrid solutions, taking into consideration a development of the sector towards international best practice standards.</p>	opportunities for financing RES in rural areas.
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Cost assessment

552. The total cost for the implementation of this subcomponent is estimated at USD 137,242 (Table 80).

Table 80: Costs under output 3.2.1.

Output 3.2.1. Enhanced planning for solar rural electrification	Total Cost	GCF	GVT	FAO
Activity 3.2.1.1.	137.242	-	-	137.242

Specific Execution Modalities

553. The PMU will be in charge of providing the consulting services, contract the qualified experts, organize materials and workshops. Procurement processes will be carried out in accordance with FAO policies and regulations.

554. The implementation of the output requires a team of specialized experts (GIS, policy) that are led by a RES finance expert under the supervision of the different line Ministries of Electricity, Environment, Agriculture and Water. Works will start up with a consultation workshop and the preliminary results will be presented at a validation workshop.

555. Afterwards, the team will create and hold a training to representatives of the banking sector and to the private sector (installation/construction companies, suppliers of equipment etc.) to highlight possibilities for investments in the sector.

556. Every 2 years further workshops will be held supervising the status of implementation of the road map. In this occasion the Expert Team will update the plan according to the latest developments.

Operation and maintenance

557. Operation and maintenance do not apply here as output 3.2.1. is covering capacity strengthening activities

Economic, financial, social and environmental sustainability

558. To enhance demand for the energy source, rural households will be made aware of the costs and benefits of the technology and facilitated to interact with the private sector suppliers.
559. The banking sector will be encouraged to provide appropriate loan products for the financing of solar technologies. The loan tenure and payment instalments will be synchronized with the reduction in energy costs.
560. The rural electrification road map aims at scaling up the activities and to attract investments from the private sector to increase energy security in rural areas. In this regard the plan can contribute in shifting the perception of the private sector of seeing investments not only from a monetary perspective but with an integrated approach, with benefits for local sustainable development. The road map on rural electrification shall raise awareness on the necessity to decrease subsidies and on the advantages of the RES also from a LCOE standpoint. In fact, solar energy is already competitive with oil in will become so with gas within the next decade.
561. The draft RE energy law is currently in the final stages of approval and has the potential to improve the enabling environment significantly. The project will ensure that its impact for rural solar electrification will be disseminated, and potential projects and investments will be highlighted within the corresponding road map.

Options Analysis

562. This section provides a description of the options analysis conducted to evaluate the potential impact of each option and its interventions under each component of this project. The criteria included in evaluating each option considered: the advantages and disadvantages of each option, the cost implications, the climate resilience potential, the value for money and specific related factors to each component.

Component 1: Strengthening resilience against climate induced water scarcity

563. The options considered under component 1 included: Do Nothing Option, the use of the traditional system of lining canals, and the shifting of canals from open to closed piped systems. The option of converting selected canals to piped systems was selected based on the criteria outlined above and following discussions with the key stakeholders on all the options. This option appeared to be the most efficient and effective in dealing with climate change and was also the most feasible from a financial perspective. Table 81 provides more specific information on each option explored.

Table 81: Options Analysis for Irrigation Investments

Option Analysis	Cost implication	Climate Resilience	Advantage	Disadvantage	Water Use efficiency	Value for money
Option 1: Do nothing (BAU)	Aggregated losses due to climate change impacts are estimated at USD 4,5 million per year from year 10-on (following the IFAD-CARD Tool forecast on yield reduction due to climate change). This would result in higher costs of imports and require subsidies from the Government. It would also include an increase in Government spending in emergency response, and deterioration of current infrastructure with an increase in operation and maintenance costs.	Farmers will face acute water insecurity that will be aggravated due to climate change.	None	<ul style="list-style-type: none"> Increased food insecurity Increased conflict over natural resources Reduced value of agricultural production Unsustainable natural resource use High dependency on individual fossil fuel use for water pumping 	Conveyance efficiency: 69% and an overall efficiency of the system of around 38%	Due to climate change trends, the do-nothing option results in a decrease in crop yields in a 10-year period (IFAD-Card Tool; 2019) ²⁴⁷ estimated at 10.91 percent (Al Muthanna), 14.28 percent (Al-Najaf), and 11.86 percent (Karbala) for Rice and 2.61 percent (Al Muthanna), 2.06 percent (Al-Najaf), and 3.2 percent (Karbala) for Wheat. This entails financial losses for farmers at around USD 24 per hectare for Wheat and USD 253 per hectare for Rice.
Option 2: Off farm investments – Basic (lining of water canals)	The lining of canals of the identified length (68 km) without addressing the existing energy needs can be achieved at half the cost or USD 15 million. However, the yearly cost of maintenance and operation would be about USD 300,000 (or 2%/Y) compared to USD 0 in the BAU scenario.	This option provides improved water supply compared to option 1, but does not provide adequate protection from conveyance losses. Furthermore, not addressing energy needs will not guarantee a continuous flow of water for farmers resulting in a lower climate resilience.	Compared to option 1, reduces seepage and conveyance losses.	<ul style="list-style-type: none"> Planning and construction have significant social impact as it might entail expropriations and displacement of people. Aggravates the discharge variation, affecting reliability of water deliveries, especially when the canal heads fall below the design level. Lining does not solve the problem of inequity created by sedimentation in the upper reaches of the canal. Losses can still occur due to evaporation, seepage, overflows and unregulated direct abstraction of water from farmers 	Conveyance efficiency estimated to be slightly higher than with option 1 at around 75% and an overall efficiency of around 41%	Canal lining cannot be justified in terms of the value of water saved

²⁴⁷ <https://www.ifad.org/en/web/knowledge/-/publication/climate-adaptation-in-rural-development-card-assessment-tool>

Option Analysis	Cost implication	Climate Resilience	Advantage	Disadvantage	Water Use efficiency	Value for money
Option 3: Off-farm investments – Shifting canals from open to closed systems and energy investments	Total Project Costs: USD 30.2 million. This option foresees the shifting of 68 km of gravity fed canals from open to closed systems and the installation of three solar systems on water canals to provide energy to pump surface water	Farmers will dispose of more water to cope with increasing temperatures and increased variability of precipitations. Nonetheless, the lack of knowledge of advanced and climate smart irrigation technologies and procedures will not allow farmers to efficiently transform the additional water made available in increased productivity.	<ul style="list-style-type: none"> • Less social impact as the pipes will be buried in the ground: Less need for expropriation and displacement. • Equal distribution of water and reduction of conflicts. • Reduced groundwater pumping [-16,903,258 m3 per Y]. • Reduced electricity needs for groundwater pumping [-255 MWh per Y]. • Reduced evaporation [0% in the closed system]. • higher conveyance efficiency [93%]. • Reduced GHG emission for irrigation [-1,127 tCO2 per Y] • Enhanced water security through more reliable energy supply. • Reduces energy needs for surface water pumping (50%) • Lower cost of operation and maintenance (0.75%/Y compared to 2%/Y of Option 2). 	<ul style="list-style-type: none"> • High public investment required. • Efficiency only until farm gate, afterwards, with no further investments from farmers there will be water wastage. 	Conveyance efficiency: 93% Overall efficiency: 51%	Not possible to achieve positive economic and financial profitability with public investment alone. IRR without on-farm investments is estimated at 2.54 percent and results in a negative NPV.
Option 4: Off and on farm investments – Shifting canals from open to closed systems and energy investments in combination with climate adaptive agricultural practices	Total project Costs: USD 38,1 million This option foresees the rehabilitation the shifting of 68 km of gravity fed canals from open to closed systems and the installation of three solar systems on water canals to provide energy to pump surface water. Furthermore the option includes activities to raise awareness and adaptive capacity of farmers and extension officers	Combination of improved water conveyance and the enhancement of farmer's capacity to plan, source and manage water will allow for higher climate resilience.	<ul style="list-style-type: none"> • Less social impact as the pipes will be buried in the ground=> Less need for expropriation and displacement. • Equal distribution of water and reduction of conflicts. • Reduced groundwater pumping [-16,903,258 m3 per Y] • Reduced electricity needs for groundwater pumping [-255 MWh per Y] • Reduced evaporation [0% in the closed system]. 	<ul style="list-style-type: none"> • Requires high public (off-farm) and private investments (on-farm). • Needs capacity development and awareness raising to guarantee user acceptance and long-term sustainability. 	Conveyance efficiency: 93%. Overall efficiency: 61%	Positive economic internal rate of returns and Net present value of investment (IRR at 14.12 percent and NPV at USD 44 million).

Option Analysis	Cost implication	Climate Resilience	Advantage	Disadvantage	Water Use efficiency	Value for money
	thanks to FFS and CWW.		<ul style="list-style-type: none"> • Reduced GHG emission for irrigation [-1,127 tCO₂ per Y] • Enhanced water security through more reliable energy supply. • Reduces energy needs for surface water pumping (50%). Lower cost of operation and maintenance (0.75%/Y compared to 2%/Y of Option 2). • Increased agricultural production for rice, barley and weed [19%]. • Maintained soil moisture content. Reduced, decreased runoff and controlled deep percolation losses => improved on-farm application efficiency (from 55% to 65% in average). • Reduced ill effects of over irrigation decreasing water logging and washing out of fertilizers and pesticides. • Works well on poor soils, prevents weed growth and reduces operational costs associated with weed prevention like spraying of weedicides and pesticides etc. 			

Component 2: Climate Resilient Agriculture (CRA) Production

564. The various options for strengthening small-holders' resilience were assessed from among those deployed traditionally in the agriculture sector. These are presented in the Table 82 below. The options included: Do Nothing, the use of the Traditional Train & Visit (T&V) System, the general agricultural extension approach, which is used quite extensively in Iraq, the theatre approach and the FFS approach. These options were assessed based on the criteria outlined above. The Farmer Field School method was selected as the most efficient and effective mechanism for implementing the adaptive practices in the selected Governorates.

Table 82: Options Analysis for Climate Resilient Agriculture Practices

Option Analysis	Cost Implication	Climate Resilience	Advantage	Disadvantage	Value for Money
<i>Option 1: Do Nothing</i>	Aggregated losses due to the climate change impacts would add up	Climate resilience of communities and	None.	Agriculture output will remain highly exposed to climate change and	Due to the climate change trends, the do-nothing option results

Option Analysis	Cost Implication	Climate Resilience	Advantage	Disadvantage	Value for Money
	to USD 4,5 million per year from year 10-onwards (following the IFAD-CARD Tool forecast on yield reduction due to climate change). This would result in a higher need of imports and subsidies from the Government.	infrastructures will remain limited.		the adaptation deficit of all farmers will remain high. Furthermore, smallholders (especially women) will remain excluded from advanced agriculture.	in a decrease in crop yields in a 10-year period (IFAD-Card Tool; 2019) 248 estimated at 10.91 percent (Al Muthanna), 14.28 percent (Al-Najaf), and 11.86 percent (Karbala) for Rice and 2.61 percent (Al Muthanna), 2.06 percent (Al-Najaf), and 3.2 percent (Karbala) for Wheat. This entails financial losses for farmers at around USD 24 per hectare for Wheat and USD 253 per hectare for Rice.
Option 2: Traditional Training & Visit (T&V) System that has been used in many countries to transfer the latest technologies and practices from research to farmers.	The costs include maintaining a large numbers of extension staff with operational and logistics to maintain their field visits.	Climate issues have not been properly understood or dealt with in the T&V system. Furthermore, the complexity of the topic requires constant support to fully mainstream climate resilience practice among farmers and their communities	The T&V system was used to address a lack of professionalism and improve the accountability of extension agents. Advantages include regular farm visits, continuous training for agents, and a more professional approach to extension	Top-down, rigid, and financially unsustainable. The T&V system focuses more on larger farmers and does not fully cater to the needs of small holders or women	It shows less value for money as it presents higher transactional costs for smallholder farmers, and it is financially unsustainable as it requires a high amount of staff allocated and operational expenses that are not part of the Iraqi Government budget (and will not be presumably maintained after the project ends).
Option 3: The general agricultural extension approach. The purpose is to help farmers increase their production. Planning is done on a national basis by the central government "which knows better than farmers".	Field personnel tend to be large in number and high in cost, with the central government bearing most of the cost.	The approach lacks a two-way flow of information. It fails to adjust messages for each different locality or factor in climate risks or properly assist farmers with adaptation to climate risks.	The approach provides farmers with information on a number of production alternatives from one single source.	This is a typical case of top-down planning. The rate of adoption of important recommendations and increases in national production are the measures of success. Only farmers who seek advice benefit, and these tend to be large-scale wealthier farmers.	There are no strong references in literature and/or research on its value for money in the region that may justify to apply it instead of FFS.
Option 4: The Theatre Approach: While this approach has been used for some time for HIV/AIDS messages, it is now being used for climate change and other complex topics.	The approach entails travel and time costs for farmers who have to travel to a central place for the training. The cost for Government entails qualified personnel, extension materials, training room.	Climate issues have generally not been properly understood or dealt with adequately in the Theatre system. Furthermore, the complexity of the topic requires constant support to fully mainstream climate resilience practice	It is a useful tool to bring across key messages in a powerful, memorable way. Theatre is effective because it is entertaining and has an impact.	It is time- and resource-intensive. Special skills are needed to elaborate good scripts, and unless local capacity is developed and used, sustainability is non-existent. Women are generally excluded from this approach with limited	The effectiveness and efficiency of this approach to deal with climate resilience aspects is still unknown. There are no strong references in literature and/or research on its value for money in the region that may justify

²⁴⁸ <https://www.ifad.org/en/web/knowledge/-/publication/climate-adaptation-in-rural-development-card-assessment-tool>

Option Analysis	Cost Implication	Climate Resilience	Advantage	Disadvantage	Value for Money
		among farmers and their communities.		participation of smallholders. The level of retention and behaviour change that may arise from the deployment of this approach is not fully understood	applying it instead of FFS.
Option 5: Farmer field schools (FFS) Farmer field schools represent a holistic and process-oriented method for teaching complex practices that must be experienced (first-hand experience) by beneficiaries to be understood, and experiential learning and discovery learning are critical elements of this method.	The intensive training offered over a long period is costly in terms of human and financial resources, However, it is observed that the FFS impart lessons that can be integrated into farming practices by smallholders over time with high adoption rates.	The approach is well suited to understanding and outlining how to adapt to climate risks as it involves sustained level of engagement with smallholders over the entire crop season. The approach also lends itself to listening to and adapting to climate risks faced by smallholders.	Takes an adult education, participatory, group-based approach. Wide experience, FFS are used in over 90 countries on many different topics, from integrated pest management to business management.	It is resource intensive. It requires commitment and regular participation over at least one season of the cropping cycle.	The approach can also be used for empowerment, and for building social capital. The EFA analysis proves the efficiency and effectiveness. Besides, FFS have been shown to be effective at reaching women and those with less education ²⁴⁹ . Component 2.1 EIRR is estimated at 31.6 percent with an NPV at USD 29.9 million

Component 3: Scaling-up climate adaptation through policy formulation and planning

565. In the context of policy formulation for the water and energy sectors, two main options were considered: the scenario under which the project does not intervene and does nothing and the scenario under which the project helps the GoI refine its water allocation and energy sector policies. These two options are outlined in the Table 83 below. The project decided to intervene in this area because of the significant value added of refining the policy in these two very critical sectors for a paradigm shift, scalability and sustainability.

Table 83: Options for Scaling-up climate adaptation through policy formulation and planning

Option Analysis	Cost Implication	Climate Resilience	Advantage	Disadvantage	Value for Money
Option 1: Do Nothing	Current water policy in Iraq is ill equipped to deal with the water shortage induced by climate change and will entail huge losses due to limiting or banning on selected crops. Banning rice alone led to a cost of USD196 million at the export market price. The existing energy policy leads to waste of energy powered by fossil fuel and adds to GHGs.	The water scarcity issues are exacerbated by climate change and negatively impact Iraqi livelihoods in rural areas. The energy issues will grow and become worse due to increase in the average temperatures in the country.	There is no advantage of continuing with the existing policy framework for the water or energy sectors which leads to inefficient use of scarce water resources and does not capitalize on the potential to generate solar energy and reduce the wasteful use of fossil fuels.	Some crops like wheat and maize are subsidized leaving farmers little incentive to take a more long-term view of water management. ²⁵² Other crops like rice are sometimes completely banned leading to considerable loss of income.	Deficit of 11 billion cubic meters of water by 2035 (the gap between supply and demand) if no solutions are implemented. ²⁵³ More than 67 percent of the electricity is lost and only 11 percent of the costs for production and delivery of energy are recovered through tariff collection, leading to extreme pressure on government's budget. ²⁵⁴

²⁴⁹ <https://www.g-fras.org/en/good-practice-notes/0-overview-of-extension-philosophies-and-methods.html#poponline14>

²⁵² <https://tcf.org/content/report/iraqs-climate-crisis-requires-bold-cooperation/?agreed=1&agreed=1>

²⁵³ <https://tcf.org/content/report/iraqs-climate-crisis-requires-bold-cooperation/?agreed=1&agreed=1>

²⁵⁴ <http://library.fes.de/pdf-files/bueros/amman/16324-20200722.pdf>

Option Analysis	Cost Implication	Climate Resilience	Advantage	Disadvantage	Value for Money
	Estimations on the losses in revenues due to power shortages range between USD 40 bln ²⁵⁰ and USD 55 bln per year. ²⁵¹				
Option 2: Reform Water Policy Framework: The project will address the strategic and legal framework for water management to scale-up climate change adaptation.	The cost of this activity is estimated to be USD 478,000.	The water policy will be designed to encourage the efficient use of water and address the growing climate change risks in the agriculture sector.	Sustainable allocation and use of water leading to the introduction of a service-oriented culture that will bring about long-term sustainability.	The introduction of a system of more efficient water allocation, and water metering may disturb the status quo and is likely to be resisted by those who have to adjust to the growing water scarcity.	There is considerable value added in reforming the use of water and energy. The overall project has an economic rate of return of 29.44 percent, and NPV of US\$ 89.81 million.
Option 3: Enhanced planning for solar rural electrification: The road map will contain the delineation of the policy framework, with a particular focus on rural households and the opportunity to utilize solar energy in off-grid, on grid and hybrid solutions.	The cost of this activity is estimated to be USD 135,514	Solar energy can mitigate frequent power shortages, increase security for surface water pumping and efficient irrigation and provide energy to off-grid areas. There is growing need for power for controlling air temperatures due to increasing temperatures.	Elaboration of a road map for investments in the energy sector can contribute to the country's target to achieve a 20 percent share of RES within the next decade and transforming the sector. An enhancement of the sector can increase energy security, provide possibilities for rural economic development and stem the tide of migration to urban centers.	There is no disadvantage of planning for a more efficient rural electrification policy.	

7. Environmental and Social Management Framework

566. The Environmental and Social Management Framework (ESMF) is used as guidance for the preparation of Environmental and Social Management Plans (ESMPs) (full framework provided in Annex 6). The ESMF constitutes an initial environmental and social impact assessment, and notes that SRVALI project sub-activities will undertake - once specific target activity areas have been identified, and activities fully defined - further environmental and social impact assessments whence FAO and/or national environmental and social impact assessment standards/regulation will be followed, whichever is most stringent. The ESMF identifies the ESS policy triggers for the project, the potential environmental and social impacts of project activities, and measures to mitigate the identified risks.

Mitigation measures and approach to enhance positive impacts

Expected project impacts

²⁵⁰ <https://documents1.worldbank.org/curated/en/406941467995791680/pdf/105893-WP-PUBLIC-INES-Summary-Final-Report-VF.pdf>

²⁵¹ <https://auis.edu.krd/sites/default/files/WahabiRISReport.pdf>

567. **Positive impacts** of the project include improving water distribution systems, stabilizing and increasing water availability at the farm level; increasing crop water productivity; transforming the existing irrigation network into more energy efficient systems; strengthening of water management institutions and the water distribution regime; and reducing the adaptation deficit of farming communities via specific and tailored training and capacity development. With the instalment of PV panels, the renewable energy generated is intended to satisfy the needs of the agriculture sector, being a reliable source of energy for pumping of irrigation water in remote areas, where electricity grid and maintenance service are not guaranteed and diesel is being used at the moment. This will ensure clean energy availability and enable farmers to get access to advanced irrigation technologies that will increase productivity without increasing water consumption to provide a more efficient and sustainable system and reduce costs. GHG emissions will be avoided due to the (a) installation and use of solar panels on irrigation canals; (b) introduction of climate resilient practices such as minimum soil disturbance; (c) crop rotations that include diverse species; (d) improved rice production practices, etc. Converting earthen open irrigation canals to closed systems will improve beneficiaries' access to irrigation water during droughts, while also improving their ability to use water efficiently. Upgrades to the existing irrigation schemes, including flow-control, flow-measurement, and the installation of individual prepaid water meters are expected to bring positive outcome to farmers as it will allow them to have a more equitable access to surface water, also reducing the need for pumping groundwater. Covering irrigation canals with PV panels is also expected to save water due to the reduction of water evaporation.

568. **Potential negative impacts** are mitigatable, and are mainly related to construction works for upgrading existing irrigation infrastructure and installation of solar panels. These impacts can be of physical nature (involving construction practices); other potential impacts during construction works are related to Operational Health and Safety Risks (OHSR), and human health (e.g. COVID-19 considerations). Potential social risks are related to the involvement of women in decision-making; power given to the president of Water User Associations, for example, can lead to issues of elite capture and marginalization of women. Pesticide use is not envisaged, and Indigenous Peoples are not present in the project area; both these are, however, accounted for in the ESS mitigation plan of this ESMF

Mitigation of environmental and social impacts

569. SRVALI is designed to have positive environmental and social outcomes. Major project interventions (e.g. the introduction of climate adaptive infrastructure, technologies and farming practices to stabilize and possibly increase water availability, water use efficiency and securing agriculture yields at the farm level) will contribute to enhancing the climate resilience of vulnerable agriculture households in Iraq. Project priority criteria were developed and agreed upon with stakeholders for each project component. Women's inclusion is a significant aspect of the project, as can be seen in project activities (e.g. Climate Wise Women initiative). The Gender Action Plan is a tool prepared to ensure gender objectives and targets are met.

570. Some project activities could, however, create localized and unintended impacts. Table 84 (below) identifies the main activities and potential issues that may emerge depending on the project activities – and then identifies actions that need to be ensured to happen, or mitigation measures to take - in order to *not* have negative consequences. All infrastructure works will undergo an ESS assessment prior to activity commencement, and ESMPs will be prepared. ESMPs will consider the mitigation actions described in the table below.

Table 84: ESS mitigation plan: potential environmental and social impacts, and actions

Activity	Potential risk	Actions (ensure avoidance of/mitigation of) to address potential impacts
Conversion of open distributary and watercourse earth canals to buried irrigation pipelines.	Inappropriate site selection.	<ul style="list-style-type: none"> - The selection of the canals for conversion from open to closed systems are closely coordinated with the Directorates of Water Resources in each of the Governorates. - A precondition for the selection of, and layout of the selected distributary canals and their watercourses is that they will not be in the vicinity of/have any impact on physical cultural resources, and that their right of way is free from any physical cultural resources including graves. They will also be free of resettlement, relocation and land acquisition issues. - Livestock watering points will be located and taken into consideration during the detailed design. - Irrigation infrastructure works will commence only after WUAs are established and they submit a request for the development of such infrastructure. - The final locations will be determined during the construction phase together with the local population concerned.
	Inappropriate design	<ul style="list-style-type: none"> - Technical design will require attention to flow-control and flow-measurement at key outlet points, to enable performance-based legal agreements between the WUA and the higher-level, bulk-water operator (DoWR). - Hydraulic structures need to enable practical and enforceable distribution modalities within the boundary of the WUA area of operation.
	Deployment of inappropriate or ineffective construction methods and materials.	<ul style="list-style-type: none"> - The repair, rehabilitation and construction of selected irrigation infrastructure will be undertaken through MoWR approved contractors. - National legislation and standards concerning the rehabilitation of existing irrigation schemes will be respected, and Iraqi standards for irrigation engineering works will be followed. - Materials used will be according to good practice in Iraq: for pipes carrying large flows, the Directorate of Water Resources states that the material often used in Iraq is ductile iron. Installation is easy and safe for workers who can cut and tap ductile iron pipe on site. For lower diameters (630 mm and below), the material most often used in Iraq are PVC pipes. - All waste is to be collected, recycled if possible, and removed from the site for disposal at an appropriate disposal site.
	Disturbance during cropping period.	<ul style="list-style-type: none"> - The project will ensure that no disturbance to the cropping season occurs during the implementation of system upgrades. Should, however, any unavoidable disruption occur and therefore income lost, farmers will be given opportunity and priority to be hired during t construction works as unskilled labour.
	Unstructured operation and maintenance (O&M) hand-over.	<ul style="list-style-type: none"> - Responsibilities for O&M of rehabilitated systems are established: <ul style="list-style-type: none"> - The DoWR in each Governorate will be responsible for the operation and maintenance of all investments after commissioning of the rehabilitated systems. - Water User Associations will be involved through the whole process in the selected Governorates for the operation and management of the improved systems. After establishment of WUAs, the responsibilities for O&M of the irrigation and drainage infrastructure will be transferred gradually to the WUAs.

Activity	Potential risk	Actions (ensure avoidance of/mitigation of) to address potential impacts
		<ul style="list-style-type: none"> - Arrangements, such as a scheme management code and training, will be put in place between the responsible Government irrigation structure (DoWR) and the WUAs. - As part of the detailed infrastructure design, elements necessary to guarantee a good O&M of the targeted irrigation schemes will be included. An Operation and Maintenance Manual will be prepared, which will include the instructions of the equipment suppliers. - Training will be provided to DoWR and WUAs. - Training of technical staff and through vocational schools will provide practical knowledge and deeper understanding of issues and topics related to design, installation and maintenance of irrigation, drainage and energy technologies.
	Temporary pollution during construction.	<ul style="list-style-type: none"> - Soil removed through any excavation should be used as back filling or immediately removed from the project site. - Any excavated soil remaining temporarily on site should be placed in a proper location and covered. - Construction should be avoided during periods of anticipated rainfall or sand/dusts storms to prevent any soil erosion. - All concrete waste is to be collected, recycled if possible, and removed from the site for disposal at an appropriate disposal site.
	Operational Health and Safety Risks (OHSR).	<ul style="list-style-type: none"> - Compliance with general rules and regulations on OHSR. - Ensure workers are equipped with protective gear (e.g. helmets, boots, gloves, masks, and earplugs). - Ensure the availability of first aid kit at work sites and necessary information on rescue during emergency. - Ensure workers are trained on OHSR risk prevention and management on site. - Make barrier around any excavation and install warning signs to prevent passers-by and animals from falling in. - (i) WHO guidance on prevention of the spread of the COVID-19 virus; (ii) Government of Iraq COVID-19 guidelines; and (iii) FAO guidance on undertaking fieldwork under the COVID-19 pandemic will be followed.
	Unfair employment.	<ul style="list-style-type: none"> - Prohibit admission of children employees or underage workers to construction site by applying age verification before the employment of workers. Employment will be in line with national legislation and/or UN/FAO regulation, whichever is most stringent. - Utilizing local labour inputs as much as practicable, will be encouraged.
Installation of photovoltaic (PV) systems	Site selection	<ul style="list-style-type: none"> - The selection of the canals for conversion from open to closed systems are closely coordinated with the Directorates of Water Resources in each of the Governorates.
	Inappropriate design	<ul style="list-style-type: none"> - Solar systems to be designed in accordance with the demand/capacity of the water pumps and the electricity will be directly used to pump water from rivers to water canals (no batteries will be employed).
	Operation and maintenance	<ul style="list-style-type: none"> - The DoWR in each Governorate will be responsible for the operation and maintenance of all investments after handing over. - Operation and maintenance by DoWR staff with support from the construction firm (establishing guidelines to monitor the

Activity	Potential risk	Actions (ensure avoidance of/mitigation of) to address potential impacts
		<p>performance, including effects of the solar panels on evaporation, algae growth etc. and training of DoWR staff on operation and maintenance).</p> <ul style="list-style-type: none"> - O&M manual prepared.
Prepaid water meters	Inappropriate design considerations	<ul style="list-style-type: none"> - Be mounted on a concrete anchor with erosion protection. - Must have a lockable cover, with sufficient space for maintenance. - Be able to measure volumes and be able to shut off the water at prepaid amounts. - Must be able to transmit the use to a central data recording unit, usually by SMS on mobile phone. - Must function either by mobile money or by credit card type transaction.
Climate resilient agricultural production practices.	Seeds that are used do not conform to FAO ESS 3 (plant genetic resources for food and agriculture).	<ul style="list-style-type: none"> - Seeds that will be used have already been developed and tested by the Iraqi Agricultural Research Institute (IPARC). These varieties are already registered and authorized by the National Council for Seeds. No seeds will be procured. - An increased use of pesticides resulting from project activities is not foreseen. Should this however occur, the project works with farmers through FFS, where IPM or other ecological pest management approaches practices would be promoted.
Establishing WUAs	Potential exclusion of some farmers.	<ul style="list-style-type: none"> - The power given to the president of WUAs can lead to issues of elite capture and marginalization of women. Female head households will be consulted and arrangements will be made to have their participation in the WUAs more effective. - Women are targeted and empowered in the project through the Climate Wise Women initiative.
	Reinforcement/ establishment of WUAs does not consider essential issues.	<ul style="list-style-type: none"> - Essential issues to be considered should include: <ul style="list-style-type: none"> - Irrigation aspects of the land tenure arrangements and usufruct rights of women farmers. - WUA rights and duties. - WUA legal/financial oversight. - Infrastructure rehabilitation and transfer agreements if any. - Rights and duties of the parties in charge of irrigation scheme management. - Water fee recovery and other sources of funding for WUAs. - A dispute resolution mechanism if any. - WUA membership criteria (inclusion of women based on usufruct among others). - Place of female leadership in WUAs.
Entire project	Gender violence due to (perceived) gender empowerment.	<ul style="list-style-type: none"> - Issues related to gender equity are addressed in project design/activities and the Gender Assessment and Gender Action Plan. The GRM is established as the platform whereby grievances related to the project ESMF can be addressed.

8. Identified actions to transfer technologies and practices and to scale up results nationally

Trainings

571. Farmers in the three governorates will be able to move to climate resilient agriculture practices and technologies and will gain a solid understanding of new technologies that will last after the project implementation. Agricultural Extension Services will act as extension agents and will be equipped with tools and methodologies to train farmers and replicate good practices.
572. The model of Farmer Field Schools (FFS) is already *per se* a replication of good practices from other countries – already applied in 90 countries worldwide, and trainers will be able to train other farmers in the three governorates and replicate the lessons learned from the project, as well as continue to use all the available training materials. In addition, the project will replicate the FAO experience coming from on-going Farmer Business School projects in the country.
573. The component 2 also carries a farm model that will showcase the positive effects of climate resilient agricultural practices and technologies, as well as a training process and effective methodology with a training curriculum to help with tackling climate change and agriculture adaptation deficit.
574. The Solar Powered Irrigation Systems is also an innovative opportunity to replicate and upscale in other areas, as well as to disseminate knowledge and good practices. 3 complete Solar Powered irrigation demonstration systems (1 in each governorate) that include all equipment for the PV – systems and the drip lines will be set up and will enable to train services extensionists.
575. Regarding the component 1, the training intervention will take stock and build on the FAO-RNE experience with ESCWA for a 3 year capacity development program. The training will provide practical knowledge and deeper understanding of issues and topics related to design, installation and maintenance of irrigation, drainage and energy technologies.

Field conferences

576. In the context of the FFS, field days will be organized where farmers will test alternatives, adapt, and improve new techniques and systems. A field plot shared by several farmers will be used to test the alternatives and comparing them with the traditional approaches. The main result of this training process is the adoption of new options voluntarily in the own plots. These field pilots could be upscaled in other governorates or areas.
577. The project with the support from the MoE and in close collaboration with all the concerned stakeholders will also undertake actions to organize visits²⁵⁵ for knowledge exchange to learn from neighbouring MENA countries and national experiences to best plan manage and maintain irrigation water supply and drainage. Other forms of knowledge exchange encompass the organisation of webinars to address the bottleneck (pinged during the consultation workshops) based on the neighbouring countries experiences

Awareness

578. Following the different training programs, the field conferences, FFS and upgraded FFS curricula with the adoption of new technologies and climate resilient agricultural practices will enable the increase of awareness among service extensionists and farmers.

²⁵⁵ For government staff and WUA representatives

579. The purpose of the open energy days under activity 2.4.2 will also sensitize the public on the project and on possibilities for exploiting Renewable Energy Sources (RES) in rural areas in an entertaining and interactive way.

580. Around 100.000 farmers will also be exposed to project-promoted CRA through Information Communication Technology for Climate Change (ICT4CC) actions, which will also increase the awareness level among the farmer communities.

E-Knowledge diffusion

581. The solar systems are planned to be installed as off-grid solutions, it will be however possible to integrate the solutions in the grids, once national infrastructure has been modernized and proven to be capable of being able to handle variable RES. Furthermore, the rural electrification plan will also analyse the possibility and opportunity to plan utility scale projects on water canal and offer SPIS for larger scale solutions. In this regard the project will analyse the possibility to up-scale interventions.

582. The project will ensure on the job training of 500 students at vocational schools and of 90 stakeholders on solar energy, a dynamic and constantly growing market. This will ensure that there are sufficient technical experts available to support the development of the solar energy market and of to plan and carry out installation in a sound way. Furthermore, the education provides the participants with qualifications enhancing their possibilities in job searches or career advancements.

583. The Information Communication Technology for Climate Change (ICT4CC) actions and through Climate Wise Women Forums will also contribute to knowledge diffusion.

Update of the national curricula

584. Vocational schools and technical institutes' curricula will be updated in the context of the FFS, through a climate adaptation approach and including climate resilient practices. To ensure the sustainability of the actions promoted under this project in particular with regard to the solar covered canals and the utilization of PV systems in the agricultural field, a special module will be created and integrated in the curricula of agricultural vocational schools and in the technical institutes to inform about the advantages and possibilities for solar energy in agricultural production, advantages and possibilities for water savings technologies including solar energy applications to that end.

585. Under Technical institution curricula will be also updated for the design, installation and maintenance of irrigation, drainage.

Private Sector Involvement

586. Under component 1, potential for exporting key structural elements of the proposed programme or project elsewhere within the same sector as well as to other sectors, regions, or countries (**replicability**): In 2016 there were 275 pumping stations managed by the DOWR in the country (34). Given that these are generally located in rural areas and that electricity is furthermore identified as a limiting factor for sustainability of the pumping stations, there is therefore a significant potential to replicate activities presented in SRVALI. Furthermore, it must be emphasized that many canal water pumping systems are run by the private sector, which shows increasing interest in solar energy.

587. Solar panels installed on canals are a technology that have passed demonstration stage and incorporate a variety of best practices. It can be an innovative business model with the potential to be implemented by fossil fuel producing companies wishing to offset parts or all their emissions. This option will be further explored in the elaboration of the road map that will create a robust pipeline of projects and increase the capacity of public sector and of the private sector to plan transformative changes ahead.

Civil Society Organizations Involvement

588. The ICT4CC use under component 2 will imply the development and diffusion of media programs to be broadcasted in collaboration with Government, Universities and NGOs aiming to reach a wider audience to raise awareness on climate resilience approaches

Climate Wise Women

589. Climate wise women will be advocates and repositories of knowledge and technical guidance and support on climate change adaptation, anchored in rural communities. The women will be trained and certified through a customized sixteen-week training delivered over the course of a year in state-of-the-art techniques for climate adaptive agriculture, agri-business planning and development and use of social media for climate change adaptation and advocacy. These practices can be upscaled and replicated in other governorates. More specifically, the training courses and the Social and Behaviour Change Communication Strategy (SBCC) for Climate Wise Women can be applied in other areas after the project completion.
590. Climate Wise Women Forums will enable to highlight the role of women as change agents, including for climate adaptation at community level, and will provide feedback to the Iraqi government on actions required at multiple levels to address climate change. These events will be drivers of change in the society and will open new replicating and upscaling opportunities in other governorates, as well as at the national level.

Farmer Field Schools

591. Farmer Field Schools (FFS) is a successful approach to educate and promote social mobilization on climate resilient agriculture. They are a non-formal adult education process. The conventional approach to farmer training is to organize field days. Here the extension agent shows demonstrations of new technologies or practices. The problem with this type of training is that farmers are, in most cases, passive participants. Usually, they just listen to the recommendations given by extensionists or technical experts, but do not participate in the process of choosing or adapting the best climate resilient technologies and practices. The result is that farmers continue to use traditional methods and are not motivated to try new technologies or practices.
592. FFS offers the opportunity to test alternatives, adapt, and improve them by introducing new elements from farmers. A field plot shared by several farmers is used to test the alternatives and comparing them with the traditional approaches. The main result of this training process is the adoption of new options voluntarily in the own plots.
593. FAO has set up Farmer Field Schools (FFS) in over 90 countries. It is a very successful educational method. These schools have been well received by farmers, governments and development partners. FAO recommends this methodology based on the following five points:
- FFS uses a dynamic, participatory, and interactive learning approach that emphasizes problem-solving and discovery-based learning.
 - FFS builds farmers' capacity to understand and observe their production systems, identify problems and test possible solutions.
 - FFS encourages making informed decisions, adopting, or adapting the practices and technologies that are most suitable to each farmer's particular system.
 - FFS reinforces the participant's understanding of complex ecological relations in the field.

- FFS provides a risk-free and conducive learning environment for participants to experiment by combining local knowledge on potential adaptive solutions with options proposed by experts and farmers.

594. In addition, being part of FFS, participants learn to organize themselves and their communities. The method promotes collaboration with each other. The resulting social capital is a strong asset in the implementation of collective actions to respond to the impacts of climate change and other drivers of change (Adapted from FAO, 2021)²⁵⁶.

595. Farmer field schools (FFS) have been shown to outperform other extension methods with respect to: (i) adoption of practices; and (ii) retention of those practices after the project/intervention (Mvena et al., 2013). They allow farmers to critically analyse situations and develop their own solutions (Bunyatta et al., 2006). A review of FFS was (2010) in some Asian and African countries, and indicated that the approach was "more effective than traditional technology transfer in imparting knowledge" (Mvena et al., 2013)²⁵⁷.

596. The most relevant climate resilient practices were identified after a consultation process with different national and international stakeholders. They will be promoted and disseminated by using farmer field schools.

597. The proposal in the table below contains a list of topics and subtopics that may be chosen individually for each FFS. Each conformed FFS will select the topics that they consider most relevant. This will be an agreement between the FFS lead extensionists and farmers, which will be reflected on paper and contain the detailed scheduling of each training session.

Table 85: FFS training curricula

Topic	Subtopic	Climate resilience approach	Resilience Benefit indicators
1. On farm water saving irrigation methods / technologies	<p>Flood irrigation + plot/land levelling.</p> <p>Furrow irrigation + multi-crop bed planter.</p> <p>Sprinkler irrigation (mini, micro, and pivot).</p> <p>Drip irrigation.</p> <p>Irrigation scheduling and avoiding misuse.</p> <p>Monitoring of soil water content.</p> <p>On farm water management.</p>	<p>Crop water stress</p> <p>Water savings</p>	<p>Improve water application (use) efficiency</p> <p>Improve crop water productivity (at field level).</p> <p>Increase cropping intensity</p>

²⁵⁶ <http://www.fao.org/climate-smart-agriculture-sourcebook/enabling-frameworks/module-c2-supporting-rural-producers/chapter-c2-3/ru/#c548995>

²⁵⁷ Adapted from the proposal: Transforming the Indus Basin with Climate Resilient Agriculture and Water Management Pakistan. Food and Agriculture Organization of the United Nations (FAO). 2019.

2. Resilient crop and soil agricultural management	<p>Application of the three principles of conservation agriculture: (minimum tillage, soil cover, crop rotation) + Organic fertilization.</p> <p>Appropriate crop / variety selection (use of water stress and salinity tolerant crops / varieties).</p>	<p>Crop water stress</p> <p>Water savings</p> <p>Salinity</p> <p>Heat tolerant varieties</p>	<p>Improve crop water productivity (at field level).</p> <p>Improve crop production yields</p> <p>Improve agroecosystems</p> <p>Avoid dust and sandstorms</p> <p>Improve crop water productivity (at plant level).</p> <p>Decrease the agricultural inputs (seeds, fertilizer and fuel)</p> <p>Increase soil organic matter content</p> <p>Increase soil water retention</p>
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Policy Dialogue

598. The project will promote policy dialogue to improve policy coherence between national decision-makers from different Ministries and governorates, the private sector, academia and civil-society to support the enhancement of climate resilience of vulnerable agriculture households in Iraq's rural communities.
599. Policy dialogues and stakeholder consultations are fundamental feature of the various project components. Community, governorate and national level engagements are designed to facilitate understanding around climate change challenges and its impact on rural farming communities. The exchanges and consultations provide opportunity to: build consensus around the way forward; foster climate adaptive water management practices to ensure the resilience of the agricultural sectors; raise more knowledge on climate change and renewable energy; and mobilize for actions around climate change resilience and adaptive measures in the relevant sectors.
600. The project will hire national and international experts to support stakeholders in the process. From year one of execution, the project will organize conferences and workshops to ensure the highest possible participation of all involved actors. This approach will help deliver the country specific paradigm shift strategies including specific adoption mechanism to ensure adoption of the proposed changes and to ensure no exclusion approaches.

9. PROJECT FEASIBILITY ASSESSMENT

601. The feasibility of the project derives from a series of analysis executed by national and international experts. Analysis is contained in a series of specific working papers that have been used to develop the main proposal and the annexes. These have been developed to assess the feasibility of proposed activities against the following:
- **Climate Atlas**, which analyses how the project is responding to the precise climate changes described in the climate scenario of this document and how proposed activities contribute to the adaptation of target communities and/or beneficiaries.

- **Coherence with National Policies and Standards**, which analyses how the project is aligned with the existing climate change policy framework as well as with the existing laws and standards of each sector addressed by the project. When laws and standards are not yet in place the project will be assessed against available international standards and/or legal frameworks in place in similar contexts in other countries.
- **Technical Feasibility**, which analyses how proposed activities will be executed and by whom. The analysis will also factor in the capacity of proposed executors as well as their presence and capacity to operate in the project areas.
- **Economic and Financial Feasibility**, which compares the resources required for the project's implementation (represented in overall costs) with the expected impacts, calculated as benefits for the proposed activities.
- **Social Feasibility**, which analyses how the project will ensure gender equality and equity and how as well as ensure the respect of social safeguards.
- **Environmental Feasibility**, which analyses the environmental and social context of the country and target governorates; how the project is aligned with national environmental legislation; how the project will comply with GCF and FAO environmental and social safeguards.

602. The combination of these analyses allowed a more precise assessment of how the project is expected to deliver against the [GCF investment criteria outlined below](#);

- (i) Impact Potential.
- (ii) Paradigm Shift Potential
- (iii) Sustainable Development Potential.
- (iv) Need of Recipient.
- (v) Country Ownership.
- (vi) Efficiency and Effectiveness.

603. The main elements of the feasibility are reported in tables 86, 87, 88. For the economic/financial, social/gender and environmental feasibility detailed information is reported in Annex 3, 6 and 8. Concerning climate and water details and additional information are available in the chapters 4 and 6 of this document.

Table 86: Component 1 main elements of feasibility

Component 1: Strengthening resilience against climate induced water scarcity						
Project Component/Sub-component	Climate Relevance ²⁵⁸	Coherence with National Policies and Standards ¹	Technical Feasibility	Economic Feasibility ²⁵⁹	Social Feasibility ²⁶⁰	Environmental Feasibility ²⁶¹
Output 1.1.1 Open canals shifted from open to closed systems benefiting 8,457 people	Water shortages are projected to worsen due to climate change, including salinization problems. Climate change will significantly affect rainfall patterns and temperature in Iraq, increasing the country's vulnerability to drought and decreased water availability	The Intended National Contributions and Initial National Communications identified as priority to upgrade the water use efficiency in distribution networks and water consumption meters. The activities are also aligned with the objective of optimal use of water resources, and the integrated water resources management using modern technologies and	The Ministry of Water Resources (MoWR) through the DoWR in each governorate will lead the implementation of all activities associated, in partnership with relevant government ministries and their national and governorate directorates, concerned local authorities, and private sector companies involved with	EIRR: 5.2 percent Economic NPV: \$1.96 Water Savings: 36,958,118.90 m3	The project will target the most vulnerable households in rural areas by upgrading the current irrigation systems.	Upgraded irrigation systems will enable to mitigate salinization impacts, as well as increase the water use for agricultural activities.
Output 1.2.1 Water canals covered with solar panels, providing 1,000 kW of renewable energy	Upgraded irrigation systems and energy efficiency will lead to decreased evapotranspiration			EIRR: 10.2 percent Economic NPV: \$ 1.19 Energy savings: 1,460,000 kWh/year		
Output 1.3.1 500 technical staff trained in design, installation				NA		

²⁵⁸ Details on climate change and climate change adaptation are above in chapter 3

²⁵⁹ Details of the economic and financial feasibility are available in Annex 3

²⁶⁰ Details on social feasibility are available in Annex 6 and Annex 8

²⁶¹ Details on environmental feasibility are available in Annex 6 and above in Chapter 3 and 4.

and maintenance of irrigation, drainage and energy technologies	and increased energy efficiency	advanced planning tool (Strategy on Water and Land Resources, 2013)	construction and supervision			
Output 1.3.2 15 WUAs supported in developing and adopting more efficient and climate sensitive water-distribution plans		The activities will also enable to increase renewable energy capacity of the Country, aligned with the Integrated Energy Strategy (2012), by reaching a 20 percent share of RES by 2030	The rehabilitation (upgrade) and establishment of suitably sized, financially viable, and autonomous (technical) hydraulic units for the self-governing WUAs will be strengthened and this will ensure a country ownership in the institutional changes brought by the project			

Table 87: Component 2 main elements of feasibility

Component 2: Climate Resilience Agriculture Production						
Project Component/Sub-component	Climate Relevance ²⁶²	Coherence with National Policies and Standards ¹	Technical Feasibility	Economic Feasibility ²⁶³	Social Feasibility ²⁶⁴	Environmental Feasibility ²⁶⁵

²⁶² Details on climate change and climate change adaptation are available above in chapter 3

²⁶³ Details of the economic and financial analyses are available in Annex 3

²⁶⁴ Details on social feasibility are available in Annex 6 and Annex 8

²⁶⁵ Details on environmental feasibility are available in Annex 6 and above in chapter 3 and 4.

Output 2.1.1 400 extension staff trained on climate resilient agricultural practices and technologies	Climate adaptation deficit of farmers due to undated agricultural practices	The Ministry of Agriculture through the Agriculture Extension and Training Department, at national and in each governorate will be leading the implementation of all activities associated.	The Ministry of Agriculture through the Agriculture Extension and Training Department, at national and in each governorate will be leading the implementation of all activities associated.	EIRR: 31.6 percent Economic NPV: \$53.83	The project will target the most vulnerable households in rural areas and will adopt techniques and approaches that are gender sensitive and that will allow the participation of women active in farming.	The activity will promote technologies and practices that do not have adverse impacts on environment. Climate resilient practices will enable farmers to become more resilient to climate change impacts. Water productivity is expected to be improved as well as increased crop resistance to salinization.
Output 2.1.2 Enhanced capacity of 10,000 farmers in Climate Resilient Agriculture	Agricultural yields remain very low due to the environmental conditions which are exacerbated by climate change				FFS are a participatory and integrated approach that will bring positive social impacts, including for women	
Output 2.1.3 100,000 farmers reached through ICT4CC technologies	High evapotranspiration and exacerbated desertification phenomena as a result of increased temperatures	The Initial National Communication included priorities on the design and promotion of alternative crops of less water consumption.	The implementation of these activities will also benefit from the FAO Iraq experience in addressing agriculture issues			
Output 2.2.1. Technical Capacities of 90 stakeholders and knowledge of 12,000 citizens on solar energy increased through trainings and	Agriculture sectors are not resilient to extreme weather events such as sand and dust storms, high winds. Women are very vulnerable to climate change as	The Strategic Plan of the Ministry of Agriculture (2015-2025) planned to	Each conformed FFS will select the topics in agreement	NA	Information Communication Technology for Climate Change (ICT4CC) will benefit a large audience and enable the dissemination of good practices and	

awareness raising events	a result of their limited recognition in the society and lack tools to adapt to climate change	expand the use of conservation agriculture and the use of modern irrigation methods for productivity increase in the irrigated areas, among other.	between the FFS lead extensionists and farmers at the governorate level.		increase climate change awareness	
Output 2.3.1 150 climate wise women trained as agents of change					Women will become Climate Wise agents by being empowered and trained to adapt to climate change	
Output 2.3.2 15,000 persons sensitized to Climate Adaptive Measures						

Table 88: Component 3 main elements of feasibility

Component 3: Scaling-up climate adaptation through policy formulation and planning						
Project Component/Sub-component	Climate Relevance ²⁶⁶	Coherence with National Policies and Standards ¹	Technical Feasibility	Economic Feasibility ²⁶⁷	Social Feasibility ²⁶⁸	Environmental Feasibility ²⁶⁹

²⁶⁶ Details on climate change and climate change adaptation are available above in chapter 3

²⁶⁷ Details of the economic and financial feasibility are available in Annex 3

²⁶⁸ Details on social feasibility are available in Annex 6 and Annex 8

²⁶⁹ Details on environmental feasibility are available in Annex 6 and above in chapter 3 and 4.

Output 3.1.1 A climate resilient water allocation strategy and its action/legal/coordination plan developed	These activities will enable Iraq to strengthen their political and strategy instruments for adaptation planning and integrated climate approach.	The activities will be aligned with the draft National Adaptation Plan: enabling environment, policies and institutional coordination, environmental awareness and education and finance.	The plan is to collaboratively identify the underlying core problems and establish new service-delivery performance targets for water users and service providers (DoWR). Functions and responsibilities need to be defined and assigned to different actors.	NA	The project will target the most vulnerable households in rural areas and will adopt techniques and approaches that are gender sensitive and that will allow the participation of women active in farming.	The activities will promote the adoption of a climate resilient allocation strategy and national compliance that do not have adverse impacts on environment.
Output 3.1.2 Improved national compliance practices for management of irrigation water supply						
Output 3.2.1 Enhanced planning for solar rural electrification		<p>The activities will provide Iraq with adaptation and policy framework to tackle climate change impacts</p> <p>Aligned with the Integrated National Energy Strategy that assigns to solar energy a key role for providing energy security in rural areas in</p>				

		short and medium term.				
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10. PROJECT COORDINATION AND COLLABORATION

604. FAO will serve as the Accredited Entity (AE) for the Project. FAO will be responsible for overall management of the Project, including: i) All project evaluation aspects; ii) Administrative, financial and technical supervision throughout implementation of the Project; iii) Supervision of effective management of funds to achieve the results and objectives; iv) Quality control of Project monitoring and reporting to the GCF; v) Project closure and evaluation. FAO as AE will ensure that the project is executed in compliance with GCF and FAO rules and regulations, policies and procedures, including relevant requirements on fiduciary, procurement, monitoring and evaluation, environment and social safeguards, and other project performance standards.
605. The project will include several Government of Iraq line Ministries with the mandate to provide water, agriculture extension services and energy. Thus, the Ministry of Water Resources and its affiliated departments at the Government level will be involved as beneficiaries. The Ministry of Agriculture and its affiliated Directorates in the field will assist with the facilitation of activities in the project Governorates. The Ministry of Energy will participate in the activities connected with energy supply. The monetary value of the facilitation support that the line Ministries provide in the field through use of their field offices, staff and logistics support will be recorded to show their contribution as co-financiers. The participation and contribution of the Ministries will help to build their ownership and sustainability of project investments. MoE will play a supportive and facilitative role during project implementation in its capacity as the NDA and identify opportunities for building synergies with other projects dealing with climate finance change.
606. The **Project Steering Committee** (PSC) will be established for the overall strategic guidance of the project. The Ministry of Environment (MoE) as the National Designated Authority (NDA) for GCF in Iraq will notify the formation of the PSC and chair and convene regular six-monthly meetings to assess performance and issue appropriate guidance. The PSC will be composed of primary stakeholders such as the Ministry of Planning (MoP), Ministry of Finance (MoF), the Ministry of Water Resources (MoWR), the Ministry of Agriculture (MoA), the Ministry of Energy, and the Governors of Najaf, Karbala and Muthanna. The Steering Committee will meet on a bi-annual basis. The role of the PSC will be to: (i) Provide overall guidance and direction to the project; (ii) Ensure that co-financing support is provided in a timely and effective manner and report against its availability and use; (iii) Address project issues as raised by the PMU and/or PSC members or EEs; (iii) Review the project progress, and provide direction and recommendations to ensure that the agreed deliverables are produced satisfactorily and within the approved project framework; (iv) Review and approve annual work plan and provide necessary strategic guidance for its implementation; (v) Appraise the annual project reports; (vi) make recommendations for subsequent work plans to build on achievements and address any shortcomings, etc. The Project Coordinator of the PMU will act as Rapporteur to the PSC.
607. In addition, the project will also establish a Coordination Committee which will include key experts from the Ministry of Environment, MoA and will have the following responsibilities: facilitate coordination between Project Management Unit (PMU) and the project stakeholders (partners and beneficiaries within the target governorates); ensure alignment with national climate change adaptation strategies and priorities; coordinate and bring together the different actors and partners implementing climate change adaptation projects in the country to ensure complementarities; ensure that the project activities have no negative environmental and social impacts; and coordinate all activities relevant to policy dialogue and to regional and local adaptation

plans and strategies. The TORs of this committee will be formulated by FAO-Iraq and validated by the PSC.

608. FAO Representation in Iraq (FAO-Iraq) will be the Executing Entity of the Project. FAO-Iraq will establish a dedicated Project management Unit (PMU) to be in charge of the execution of the project as a whole. FAO-Iraq will sign MoUs with selected Ministries to clarify their role in the project and the type of support and field coordination required from them. FAO will also sign contractual agreements with service providers identified for the project in accordance with FAO procurement procedures.
609. To perform its Executing Entity functions, FAO will set up a Project Management Unit (PMU), in Najaf which is one of the project Governorates. The PMU will be under the direct responsibility of FAO-Iraq and will be led by a Project Coordinator/Irrigation Specialist. The PMU will be supported by technical experts assigned to each technical intervention for support and oversight. The PMU will include international and national specialists directly recruited by FAO-Iraq on a full time or part-time basis. These specialists include an Energy Specialist, Agronomy and Climate Resilient Agriculture, Gender and Social Inclusion Specialist, Environmental and Social Safeguard Specialist, Monitoring and Evaluation Specialist, Procurement Specialist, Finance Management Specialists and Administrative Assistants. The PMU will coordinate with contractors recruited to design and implement the irrigation and solar energy investments. The PMU in association with the MoWR will coordinate activities with respect to the investments in the irrigation systems with the Department of Water Resources at the Governorate level. The PMU will be directly responsible for the implementation of the training activities through the Farmer Field Schools (FFS). The PMU will also manage the work of the service provider recruited to implement the Climate Wise Women sub-component. Detailed Terms of Reference of the PMU will be prepared by FAO in consultation with key stakeholders. The Social Inclusion and Gender Specialist working together with the M&E unit will also have the mandate to ensure that the Gender Action Plan including the promotion and execution of orientation of the PMU staff in gender mainstreaming and the prevention of sexual harassment is undertaken.
610. The project via the Project management Unit (PMU) and the FAO will establish collaborations with a diverse group of projects and national organizations to ensure magnification of impacts and optimization of resources. When possible, the project will act as catalyser of the different actions ongoing in target areas connecting municipalities and communities with projects and with other initiatives that could magnify and/or scale up project's impacts.
611. Since the nexus between water and climate change is among the most pressing issues concerning sustainable development in the country, it is not surprising that there is a series of important projects implemented. The project will establish a wide range of collaborations with a diverse group of projects and national organizations to ensure magnification of impacts and optimization of resources. When possible and feasible, the project will learn from past and ongoing project and will act as catalyser of the different actions ongoing in project areas to connect communities with other projects that could extend and/or scale up impacts. Lesson learned and best practices are and will be derived from the listed projects under, [agriculture and climate resilient agriculture sector](#), [natural resources, climate and climate change](#) and [renewable energy resources](#) sections discussed above.
612. In the spirit of collaboration and coordination with other entities, SRVALI project will work closely with WFP's GCF project: "Promoting Climate Resilient Livelihoods of Food Insecure People

in Southern Iraq”, to ensure synergies between activities, complementarities and coordination between the two projects’ mechanisms (Table 89).

Table 89: Collaboration and complementarities between GCF Projects in Iraq implemented by FAO and WFP

Title of the project	Governorates	FAO	WFP	Outputs with potential complementarity	Agreed Complementarity	Coordination Mechanism
Strengthening Climate Resilience of Vulnerable Agriculture Livelihoods in Iraq’s rural Communities (SRVALI)	Kerbala, Najaf, Muthanna	YES	-	1.4: 15 WUAs supported in developing and adopting more efficient and climate sensitive water-distribution plans. 2.1: 400 Extension Staff trained on climate resilient agricultural practices and technologies to train 10,000 farmers in adaptive practices and technologies. 2.3: 100,000 farmers reached through ICT4CC technologies	FAO and WFP agreed to extend all the trainings related to capacity development of institutions, civil society organizations, water user associations and private sector operators to the governorates targeted by both projects to ensure higher impact and complementarity. To this end, FAO and WFP will exchange their programs of activities and capacity development curricula to ensure complementarity and to guarantee that stakeholders in both projects areas will receive integrated trainings using a jointly developed curricula. FAO and WFP will also evaluate options to ensure that best practices introduced by WFP in WFP project areas and by FAO in FAO project areas, are all made available in the ICT4CC deliverables for potential adoption and replication.	FAO and WFP will participate in each other’s steering committees as non-voting members. On the operational level, FAO and WFP PMUs will have regular meetings to ensure continuous coordination and alignment. Furthermore, FAO and WFP will include coordination and complementarity among their reporting items to the GCF
Promoting Climate Resilient Livelihoods of Food Insecure People in Southern Iraq	Qadisiyah, Thi-Qar and Basra	-	YES	2.1: Climate risk management tools and services are provided and improved to enhance decision-making capacities 2.3: Climate change adaptation experiences documented and disseminated to support replication and integration into regional and local adaptation plans and strategies		

Source: author elaboration

11. PLANNING, M&E AND KNOWLEDGE MANAGEMENT

613. Planning: The annual working plan and budget (AWPB) constitute the main formal instrument to ensure ownership and participation of stakeholders and beneficiaries. It represents the resultant of the national engagement process and the main planning tool of the project. The PMU will formulate an Annual Work Plan & Budget based on the annual physical targets indicated in the proposal and monitor performance against the plan. Formats will be developed for each of the reports namely the monthly statistical reports, the quarterly statistical and narrative reports and the Annual Performance Reports (APRs) by the M&E Unit with support from the chief technical advisor. To this end the PMU, via its M&E unit and partners, will secure constant dialogue with target communities and administrations and will ensure their participation in the AWPB formulation process.

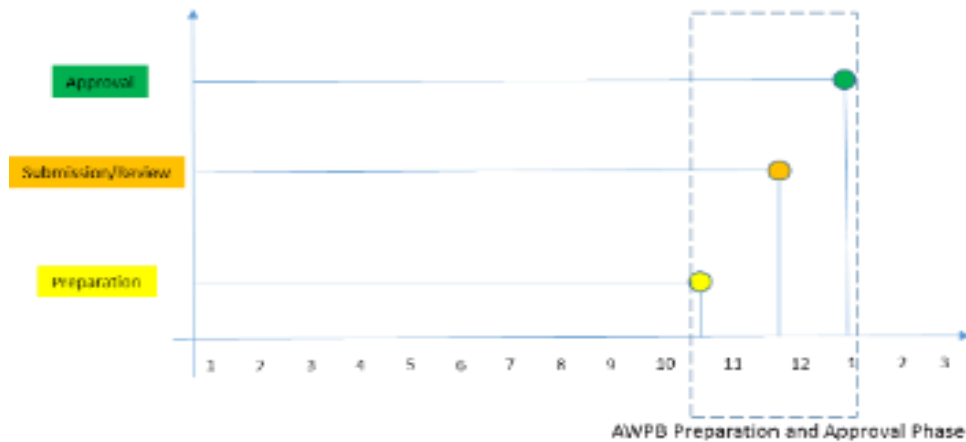
614. The AWPB will be georeferenced and will report clearly the coordinates related to planned interventions. The AWPB will contain 7 main sections as described below:

- 1) Georeferenced²⁷⁰ Annual Report (after year 1);
- 2) Georeferenced Annual Sub-LFM;
- 3) Timeframe with annual milestones;
- 4) Working Plan Rational;
- 5) Communication and KM annual strategy;
- 6) Budget;
- 7) Sub-Procurement Plan.

615. **Georeferenced Annual Report.** Other than for the first AWPB, the PMU will present on a yearly base the annual report including the GPS coordinates of each executed activity. The report will describe executed activities and present milestones against targets including data and analysis from the M&E unit. The report will also include a detailed description of past years expenditures and it will highlight issues encountered in procuring goods and services. Also, the report will contain a section dedicated to media, publications, and other communication/awareness activities funded or participated by the project. A detailed outline of the annual report will be developed with partners and PMU at start-up.
616. **Georeferenced Annual Sub-LFM.** The AWPB will include a sub logframe matrix reporting activities and expected contribution to project's targets. Proposed activities will have to clearly present geographical coordinates related to planned investments and soft activities.
617. **Timeframe with annual milestones.** The AWPB will contain the annual timeframe identifying as well reporting deadlines, SC meetings and targets to be reached for the year. The timeframe will also report, community engagement milestones as well as M&E targets for the year.
618. **Working Plan Rational.** Each activity presented in the Sub-LFM will be clearly detailed including description of planned approaches and tools deployed to achieve annual goals, milestones and community engagement. Rational will also include results of geospatial analysis performed on areas identified for the execution of activities.
619. **Communication and KM annual strategy.** The AWPB will also include clear description of project's communication and knowledge management strategies including, approaches, methodologies targets and list/rational of key stakeholders to be reached by the proposed set of actions.
620. **Budget.** The AWPB will contain a detailed budget built following the one presented in Annex 4 of the project document and will include co-financiers. The budget will contain all planned expenditures according to FAO rules and procedures or else according to covenants of the project financial agreement.
621. **Procurement Plan:** The procurement plan will be prepared according to FAO rules and procedures and will relate to Annex 10 of the project document.
622. Planning and approval of the AWPB will be done at the end of each fiscal year and will require formal approval of both the Steering Committee (SC) and FAO (Figure 57).

Figure 57: Timeframe Scheme of the Planning and Approval phase of the AWPB

²⁷⁰ Georeferencing is the process of assigning a unique set of geographical coordinates to data, information, physical elements, areas, and any other point/action/activity/process related to your project including policy development and training.



623. The Annual Work Plan and Budgets (AWPB) will be presented by the PMU to the Project Steering Committee for approval. In order to ensure a smooth and effective ESMF process, an ESS specialist will be engaged by the project to be responsible for the environmental and social safeguards process (including GRM), interacting on a regular basis with key stakeholders and being available to respond to any grievances.

Monitoring and Evaluation

624. **M&E Structure:** A monitoring and evaluation system will be established for the SRVALI project in keeping with the guidelines of GCF to report on its Integrated Results Management Framework designed to measure the core indicators. The PMU established in Najaf will be responsible for monitoring of the project activities with the oversight of FAO-Iraq and technical back-stopping by the regional office where required. An M&E system will be developed with an M&E Officer and a Monitoring Information System (MIS) to keep track of performance and core indicators at the national and Governorate level. All service contracts, Letters of Agreements and MOUs with implementing partners will specify their responsibility with respect to sex-disaggregated data collection and reporting.
625. The implementing partners will submit reports to the PMU which will prepare a consolidated report on an annual basis. Regular meetings for monitoring and follow-up will be organized where problems will be discussed and, when needed, corrective measures will be recommended. FAO as the main implementing agency will be responsible for maintaining records on all project activities on standard reporting formats. All implementing partners will be required to provide information on the core indicators, impact, outcome and output level indicators specified in the Integrated Results Management Framework (IRMF). FAO-HQ will support the PMU in reviewing and analysing progress reports and to assess performances against baseline and targets. FAO will manage and coordinate reporting to the GCF according to its standards procedures.
626. **Types of Reports:** The PMU at the FAO office in Najaf will formulate an annual work plan and budget based on the annual physical targets based on the implementation plan (Annex 5) which will be approved by FAO-Iraq and the PSC. Reporting formats will be developed for each of the reports namely the monthly statistical reports, the quarterly statistical and narrative reports and an Annual Performance Reports (APRs). These reports will be prepared by the technical staff at the PMU under the guidance of the M&E Specialist at the PMU. The key reports that will be submitted have been identified in the M&E Reporting Matrix given below together with their timelines and reporting responsibility. More details are provided in Annex 11. The Annual Performance Reports

(APRs) will document the progress towards achieving the indicators in GCF's IRMF and any additional project level indicators that have been selected for the project. APRs will also contain a narrative with updates on the progress of each output and outcome envisaged at the project level. The contracts with the service providers will specify their reporting responsibilities, the frequency of the reports to be produced and provide them with the formats to be used for reporting. All partners will be required to review the Gender Action Plan which is an integral part of the proposal and report on its implementation. All data will be disaggregated by sex to enable an assessment of the progress in inclusion of women in the project.

627. **MIS System:** An MIS system will be developed for the project to record key information of all beneficiary households. The M&E Unit in the PMU will coordinate and produce a consolidated MIS report for the project on an annual basis. Within the first quarter of the second year, when activities have been initiated and sufficient outreach has been achieved and the M&E data base begins to get populated, thematic maps will be generated by the project and will be monitored through consolidated remote sensing practices or geospatial analysis. This is expected to yield a better understanding of trends and patterns and make the analysis more meaningful in understanding the relationship between climate parameters and the pattern of adoption and participation in project activities. The MIS system will geo-reference all activities using FAO's Remote Sensing application- Earth Map. The MIS system will also record beneficiary phone numbers for feedback from participants. The MIS system will also be used for tracking beneficiaries over time and assessing impact.

628. **Survey Methods:** The project will construct a baseline using secondary data against which subsequent changes and impact will be measured. To measure attributable changes, the evaluations will draw on mixed methods, using qualitative methods (e.g. participatory rural appraisal, focus group discussions, key informant interviews, etc). Information on some of the key GCF indicators like food-security, water security, awareness about climate information, resilience to climate risks will be measured through specific questions on these elements. All surveys and impact assessments will be sex-disaggregated and key gender-sensitive indicators both quantitative and qualitative outlined in the Gender Action Plan will be captured in the initial and subsequent surveys and findings. In addition, all impact evaluations will be conducted by external parties to ensure that there is no bias in the findings.

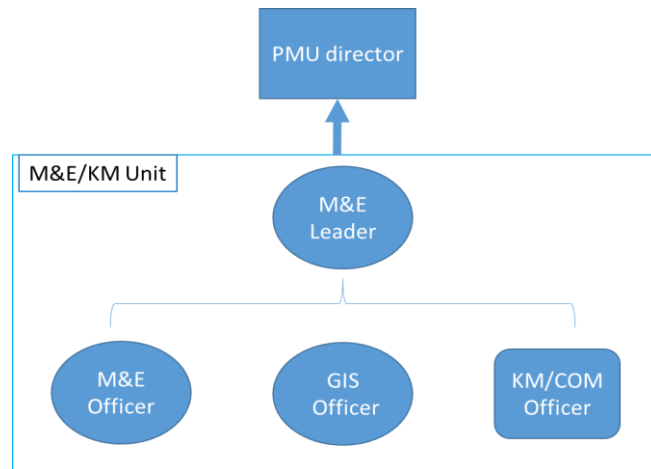
629. **Mid-term and final evaluations:** The project will undertake independent and external surveys at mid-term and at completion to assess the performance of the project, draw important lessons and incorporate beneficiary feedback. The independent external surveys will feed into these review reports. A representative sample of women will be ensured and findings will be disaggregated by gender. The interim or mid-term survey will incorporate key aspects of impact on the targeted households up to that period as well as specify the impact on women. At project completion, a final impact assessment will be undertaken to assess the overall impact of the project on the beneficiaries and specifying the impact on women. The mid-term and final impact will compare project results with the expected outreach, adoption of climate adaptation practices and assess the overall impact on the paradigm shifts outlined in the project log-frame and the indicators of resilience outlined at the impact level. The project completion review will also assess the extent to which the intervention has contributed to the Fund's higher-level goal of achieving a paradigm shift in adaptation to climate change at the national level and in the selected project areas in Iraq.

630. **Beneficiary Feedback:** FAO will establish a mechanism for beneficiary feedback and demonstrate how they have incorporated the feedback in improving their implementation approach. The M&E staff of the PMU will undertake periodic visits to the project areas to discuss

with the farmers (both men and women) about their views of conversion of the open systems to closed irrigation system, the system of water regulation and paid metering, the use of solar pumps, etc. The beneficiary feedback will also entail discussions with WUAs about their experience with the project and the way implementing partners engage with them during the implementation of the various components. The beneficiary feedback will be organized so that the reports provide sex-disaggregated perspectives. The PMU will also establish a grievance redress system which ensures confidentiality. FAO's Guidelines for Compliance Reviews will follow the procedures for Complaints Related to the Organization's Environmental and Social Standards.

631. **Learning and knowledge management:** The Project will synthesize the lessons that emerge from the Project in a separate section in the APRs, including lessons on some of the innovative aspects of the investments such as the conversion of the open irrigation systems to piped systems, installation of solar panels on canals, the impact of strengthened WUAs on the management of the irrigation system, the experience with Climate Wise Women, the impact of the change of the regulatory policy of water, the lessons from the experience with FFS and field days on improved resilience to climate risks, etc. A survey will be conducted to document the views of women on how they are impacted by climate change to develop a solid evidence base of how climate risks impact women. This document will be developed as a knowledge product for wider dissemination. These lessons will be shared with the MoE to enable them to incorporate them in the strategies and plans being developed by the country in its NAP and other key strategy documents. The outcome of the policy work on water allocation, compliance practices for water and rural energy road map will be especially highlighted as knowledge products. TAs working on specific topics and policy briefs will be required to develop knowledge products for wider dissemination. FAO will also capitalize on its in-house expertise to develop and disseminate knowledge products for wider circulation as a policy advocacy tool.
632. **Communication:** All the interventions, data and results generated by the project will be communicated and disseminated to different stakeholders and beneficiaries at the national and Governorate level. FAO will use its offices in Iraq and capitalize on its access to other forums in the country for wider dissemination. All the documents requiring multi-lingual support will be made available in Arabic and English.
633. The M&E process will be under the responsibility of the PMU. The M&E unit (Figure 58), will consist of an M&E Specialist who will lead the M&E Unit and three officers (M&E/GIS/KM-COM). The M&E Specialist will report directly to the PMU director and to the NCCC (SC).

Figure 58: M&E Unit Composition



634. During execution of the project, the M&E unit will ensure, among other, support at the following levels:

- 1) **Monitoring of Execution Performances:** the unit will be responsible for: (a) collecting data from identified service providers / partners / authorities and (b) submitting progress reports on approved targets on a quarterly basis to the PMU manager. The M&E unit will ensure correct and efficient filing of collected GPS coordinates. Once coordinates will start populating the M&E database, activities will be shared by the PMU via thematic project's maps and will be monitored via consolidated remote sensing practices (geospatial analysis). This aspect of the process is paramount to ensure knowledge building within the PMU and among stakeholders and in evaluating direct and indirect impacts of project's activities. Showing activities in their exact location - visualizing relations with the context - will allow a more objective impact's evaluation and will provide decision makers with an objective, transparent and evidence based support to national strategies. Data, collected via reports prepared by service providers/partners and verified with beneficiaries, will be disaggregated by gender, among the others, and will be georeferenced. Data will be stored in a database accessible to the NCCC as well as to FAO. Functions of the M&E unit also include verification and respect of the social and environmental safeguards as described in the Annex 6.
- 2) **Community Monitoring and Ground Truthing:** The project will also apply a new approach to monitoring ensuring participation of target beneficiaries and stakeholders into the process. Given the importance and relevance attributed by the theory of change to community's participation in water management and renewable energy technologies, the M&E unit will ensure annual consultations in target areas so to support planning and monitor execution of activities. Thanks to the described dereferencing process, communities will participate directly both in planning and in groundtruthing the results obtained via FAO spatial analysis tools and methodologies. This particular aspect of the M&E strategy will allow as well for enhanced and evidence-based knowledge sharing with local communities and their administrations as well as for mainstreaming climate change among key stakeholders. As per all the other activities data deriving from this exercise will be part of the project atlas and available for consultation via KMZ files upon request.
- 3) **Strategic Advice:** annual results and related analysis, jointly reviewed by FAO and the PMU, will form the base for each annual year planning exercise via the AWPB. These will be presented to the SC in order to support its strategic role and to secure transparency and evidence based strategy development.

Project's Baseline

635. Project's baseline is the resultant of data collected in project areas via: (i) literature review; (ii) focus group discussions (FGDs), in-depth interviews (IDIs), and key informant interviews (KIIs) focusing on local issues faced by farmers, women's involvement in agricultural activities, and farmers' awareness of climate change and its impact on agriculture, the role of extension officers/NGOs in supporting farmers, and key areas where farmers require training or support; and (iii) geospatial analysis.

636. Goal of the baseline is to collect socio-economic and biophysical data (including climate) in project areas. Main objectives of the baseline are: **Establish the ex-ante project's climatic/environmental and socio-economic status.** Baseline data have been collected both at the national and community level. Project areas have been selected within the national engagement process and according to data and assessments available in literature review and fine-tuned by FAO with Earth Map, a full description of target areas and target communities is available in Section 7 of this document. Local data have been collected in the following governorates:

1. Najaf
2. Muthanna
3. Karbala

637. Baseline data reported in Section 3, 4 and 6 are fully georeferenced and available in both Earth Map and Google Earth Pro. A summary of existing baseline data is presented below (Table 90).

Table 90: Baseline Summary according to LFM

Data	Origin	Verification period	Extension	Location
Socio Economic Baseline	World Bank, FAO, Central Statistical Organization, Literature	Annual	PDF, KMZ, HTML	NDA FAO PMU GCF
Water availability / distribution and Efficiency	World Bank, FAO, Central Statistical Organization, Earth-Map; Iraqi Meteorological Organization and Seismology	Annual	PDF, KMZ, HTML	
Energy Efficiency	Central Statistical Organization, literature			
Policy Framework Mainstreaming and Community Participation Baseline	FAO, Institutional stakeholders, literature	Interim / Final Evaluation /	PDF	

Description of Selected Indicators

638. The project identified a series of indicators deriving from both GCF core performance indicators and from FAO experience in the country and in the region. Selected indicators have been discussed and agreed with the NDA and with partners during the design phase and within the national engagement process. The full list and description of indicator is available in the full funding proposal section E.

639. Selected means of verification (MoV), will allow the project to secure and enhance data collection and to guarantee data analysis and processing. MoV will include independent external surveys, national statistics and data collected by the project and/or by its partners (MoWR, MoA, MoP) and service providers (Table 91).

Table 91: Project's means of verification

#	Means of Verification
1	MIS Systems
2	Survey methods
3	Interim and final evaluations
4	Beneficiary feedback
5	Expert evaluation
6	Project's Database
7	AquaCrop model simulations
8	Institutional Partners Databases
9	O&M reports

640. In order to ensure reduced reliance from internal data and information, the M&E unit will prioritize data collection from external sources not linked to the project or its partners. MoV have been organized according to their relevance in understanding achievements against targets.

Monitoring Strategy

641. Data will be collected by the M&E unit from the means of verifications described in the previous sections. Data will originate from described sources and will be organized in a georeferenced M&E database. Data will be presented annually according to milestones fixed by each approved AWPB. Specific wrap-up sections will be organized and supported by FAO at midterm and completion to secure data availability to external evaluators.

642. Within the set of activities planned in the AWPB and approved by the AE, the PMU will ensure that all project's expenditures contain clear maps reporting investments' coordinates as well as georeferenced cadaster maps (if available) describing the areas of intervention. Absence of coordinates and maps will negatively affect the process denying automatically the authorization to proceed with expenditures. Project's data and information will be georeferenced and provided in ArcGIS compatible formats, shapefile if vector format and GeoTIFF if raster. Each dataset and information, including maps attached to the no objection process, will be also reported as KML file for uploading and sharing via Google Earth Pro. Produced datasets will be uploaded in Earth Map where geospatial algorithms are already available and fine-tuned for Iraq in order to perform a large spectrum of remote sensing analysis. Analysis via Earth Map will support the mapping and understanding of achievements and impacts in target areas.

643. Coordinates will be taken in a unique and known reference system, which by preference should be the geographic coordinate system (datum WGS84 and unit in decimal degrees). The full set of coordinates and KMZ files will represent the geographical location and distribution of the interventions in the project areas and will be included in the “Project’s Atlas” that will be prepared and maintained by the PMU via its M&E unit. Produced maps will be provided in digital format (ArcGIS or equivalent) with all the metadata and sources of information. Maps shall be reported as well as in KML/KMZ format.
644. Institution and stakeholders (including the Steering Committee) will be involved both directly and indirectly via dedicated communication and training processes. The PMU-M&E unit will ensure communication via the annual reporting processes, national ownership workshops and via the project atlas. Communication documents will be constantly updated at the disposal of stakeholders.
645. Finally, the project will ensure coordination and complementarity with past and current projects/programs supporting the Country in the field of GIS, remote sensing and mapping funded by donors such as JICA, IFAD, USAID, UNDP, WFP and UN Environment among others.

Reporting, Supervision and Evaluation

646. FAO as accredited entity of the project will ensure annual reporting to the GCF. The report will include the audit report as well that will be commissioned by FAO to an independent firm according to FAO covenants, rules and standards. Project’s reporting will consist of four elements:
- Technical Reports (TRs) prepared by Partners / Service Providers. TRs will describe executed activities and involved beneficiaries according to M&E indicators and means of verification as reported in the previous paragraphs. Partners and service providers will ensure Georeferencing of each executed activity and will present TRs on a quarterly base to the M&E Unit.
 - Quarterly reports (QRs) prepared by the M&E for PMU Director. QRs will present the work and achievements of activities presented in the AWPB. It will include among the other data, comments and information from the beneficiaries and other involved stakeholders. QRs are prepared by the M&E team for the PMU and will contribute to the annual report.
 - Annual reports (ARs) prepared by the M&E for the SC and FAO. ARs will present the work and achievements reported by the M&E unit via the QRs and will include implementation and fiduciary chapters. ARs will include findings and recommendations of FAO supervision reports (SRs). ARs will include as well independent annual audit reports (AARs) and the “Project’s Implementation Atlas” presenting the maps and charts obtained thanks to the georeferencing of project activities. Both will be presented as annexes of the AR. ARs are prepared by the M&E Unit, validated by the PMU director and after inclusion in the AWPB are validated by the SC and FAO and are transmitted to the GCF by FAO-HQ.
 - Evaluation Reports are commissioned by FAO to an external and independent entity according to FAO covenants, rules and standards. ERs are shared with the NCCC and the PMU for comments and after finalization sent to the Green Climate Fund at midterm (MTE) and within six months from project’s closure (FE). In accordance to FAO procedures for the evaluation of initiatives funded by voluntary contributions, the project will undertake:
 - a. An independent Interim Evaluation, when delivery will reach 50 percent of the initial total budget and/or mid-point of scheduled project duration, to review efficiency and effectiveness

of implementation in terms of achieving project objective, outcomes and delivering outputs. The MTE will be instrumental for contributing through operational and strategic recommendations to improved implementation for the remaining period of the project's life. FAO Office of Evaluation, in consultation with project stakeholders, will be responsible for organizing and backstopping the Mid-Term Evaluation, including finalizing the ToR, selecting and backstopping the team and Quality Assurance of the final report.

- b. An independent Final Evaluation, within six months prior to the actual completion date (NTE date) of the project. It will aim at identifying project outcomes, their sustainability and actual or potential impacts. It will also have the purpose of indicating future actions needed to assure continuity of the process developed through the project. FAO Office of Evaluation, in consultation with project stakeholders, will be responsible for organizing and backstopping the Final Evaluation, including finalizing the ToR, selecting and backstopping the team and Quality Assurance of the final report (Table 92).

Table 92: Project Reporting Framework

Evaluation			
Type	Timing	Independent/Self-evaluation	Indicative Budget USD
<i>Participatory</i>	Each Year	Self-Assessment	5,000
<i>Formative</i>	Year 1	Independent	100,000
<i>Impact</i>	Year 6	Independent	100,000
Interim Evaluation	Year 4	FAO Office of Evaluation	FAO
Final Evaluation	Year 6	FAO Office of Evaluation	FAO

647. The M&E and reporting process will also form the foundation of the project's communication and knowledge sharing strategy. Thanks to data collected and analysed during the whole project, stakeholders and public will be constantly exposed to best practices and lessons learned so to capitalize on project's experience and to magnify impacts in target areas as well as in others not directly involved in the project. All the interventions, data and results generated by the project will be communicated and disseminated to different stakeholders and beneficiaries at the national and Governorate level. FAO will use its offices in Iraq and capitalize on its access to other forums in the country for wider dissemination. All the documents requiring multi-lingual support will be made available in Arabic and English. Table 93 provides a list of the report that the project will generate.

Table 93: Project Reports

Types of Reports	Reporting Timeline	Responsibility
Baseline Survey	Constructed using secondary data	M&E Staff at PMU
Annual Work Plan	Two months prior to the start of the relevant PY.	C/PMU

Quarterly Statistical and Narrative Reports on physical and financial progress.	Two weeks after the end of the relevant quarter.	PMU/M&E Unit/FAO
Geospatial analysis through thematic maps.	Annual basis	PMU- M&E Unit/FAO
Annual Progress report on outputs and core indicators.	One month after the end of the relevant PY.	PMU- M&E Unit/FAO
Case studies to highlight the impact of the project on women especially the progress with respect to CWW.	Periodic	Gender Specialist PMU/FAO.
Policy notes and briefs to highlight the project progress with policy and regulatory reform for water and the road map for rural electrification.	On a periodic basis at each significant point of reform.	Technical Assistance
Report on Co-financing in absolute numerical terms in accordance with the provisions of the relevant legal agreements between the AE and the GCF.	One month after the end of the relevant PY.	Financial Specialist
Environmental & Social Safeguards Quarterly Report	Two weeks after the end of the relevant quarter	Environmental and Social Safeguards Specialist
Beneficiary Feedback Analysis with both men and women.	On a regular basis at the completion of key project investments.	M&E Unit
Learning and Knowledge Products	Periodically	TA/FAO
Interim Evaluation	Year 4	Independent Third Party
Final Impact	Six months prior to end of the project in PY 6.	Independent Third Party

M&E Outputs and budget

648. Results of the process will be available to stakeholders and partners in both project reports and Google Earth Pro Files. In order to execute evidence based and result management approach the project will ensure hiring of a dedicated M&E unit that will work under the direct supervision of the PMU Project's Director.

649. Budget of the M&E function is fully reported in the budget. It includes the cost of human resources, equipment as well as the cost of data collection and processing. Additionally, it contains adequate resources to ensure activities with communities as well as with administrations and stakeholders. Cost of the process also includes the cost of Mid Term Evaluation and Terminal Evaluation.

Learning and Knowledge Management

650. Learning and knowledge management represents a paramount element of the project. The project will aim at transferring not only information and knowledge generated during execution of activities but also tools and skills that will support stakeholders in factoring in climate change into the decision-making process (institutions and private sector) and into livelihood strategies (communities).

651. The project will ensure transfer of knowledge to stakeholders across the 3 identified components via trainings and knowledge sharing events well identified on a yearly bases in the AWPBs and described in each of the components. To this end, stakeholders' involvement from planning to monitoring will be among the main objectives of the project. Each of the identified components will support the Learning and Knowledge Management process with specific trainings targeting both communities and institutions. Key objective of the learning and knowledge management process is to mainstream relevant policy frameworks and climate change related information to all the stakeholders involved in project's activities as well as to the public.

Appendices

Appendix 1. Chronology of major events in the Euphrates–Tigris River Basin

Year	Plans/Projects/Treaties/Conflicts	Countries involved	Main aspects
1914	Hindiya barrage on the Euphrates	Iraq	Flood control and irrigation purposes
1920	Treaty regarding utilization of the waters of Euphrates and Tigris rivers	France and Great Britain	
1930	Turco-French Protocol	Turkey and France	Coordinate any plan to use the waters of the Euphrates
1946	Treaty of Friendship and Good Neighbourly Relations	Turkey and Iraq	Extended the principle of mutual cooperation over water development in both rivers. Sharing related data
1950	Ramadi Habbaniya dam on the Euphrates	Iraq	For flood control and irrigation purposes
1960s	Starts the construction of the "Third River"	Iraq	565 km canal between Euphrates and Tigris (completed in 1992)
1970s	Construction of several canals	Iraq	Linking Lake Thartar to the Euphrates, and connecting the lake with the Tigris
1973	Construction of Kevan dam	Turkey	First dam on the Euphrates for Turkey. Construction started in the 1960s. For hydropower purposes
1973	Construction of Tabqa dam	Syrian Arab Republic (with the help of Soviet Union)	First dam on the Euphrates for the Syrian Arab Republic, to meet water and energy needs
1975	Filling of Tabqa dam conflict	Syrian Arab Republic and Iraq (Saudi Arabia and possibly the Soviet Union mediated)	Major sources of conflict between Syrians and Iraqis addressed. Finally the Syrian Arab Republic released more water from the dam to Iraq
1976	Release 350 m ³ /s from the Euphrates downstream	Turkey	Prevented tension between the Syrian Arab Republic and Iraq, regarding the filling of the Tabqa Dam
1977	Southeastern Anatolia Project (GAP)	Turkey	Turkey announced plans for GAP, which included 22 dams and 19 hydropower installations on the Euphrates-Tigris.

Year	Plans/Projects/Treaties/Conflicts	Countries or organizations involved	Main aspects
1983	Establishment of Joint Technical Committee for Regional Waters	Turkey, Iraq, and the Syrian Arab Republic	Dealing with water issues between the basin riparian countries, to ensure principles of consultation and notification as required by international law. This group disintegrated after 1993 without any progress having been made.
1984	Turkey proposed a "Three-staged plan"	Turkey (indirectly Syrian Arab Republic and Iraq)	For optimal, equitable and reasonable utilization of the transboundary watercourses of the Euphrates-Tigris basin. Conforms to the principle of equitable utilization
1985	Haditha dam	Iraq	Dam on the Euphrates river to produce hydropower
1986	Bath dam	Syrian Arab Republic	Second dam on the Euphrates for the Syrian Arab Republic. Small-scale electric generation and small amount of water for irrigation
1987	Informal agreement guaranteed 500 m ³ /s of the Euphrates from Turkey to the Syrian Arab republic	Turkey and the Syrian Arab Republic	The Syrian Arab Republic has accused Turkey of violating this agreement a number of times
1988	Construction of Karakaya dam	Turkey	Second dam on the Euphrates. First dam built under the GAP. For production of hydropower
1990	Agreement between the Syrian Arab Republic and Iraq to share the Euphrates water	Syrian Arab Republic and Iraq	The Syrian Arab Republic agrees to share the Euphrates water with Iraq on a 58 percent (Iraq) and 42 percent (the Syrian Arab Republic) basis. Corresponds to a flow of 9 km ³ /year
1992	Ataturk dam	Turkey	Third dam on the Euphrates for Turkey, the most important of GAP project. Irrigation and hydropower. The filling of the dam, shutting off the river flow for a month, causes conflict with Syrians and Iraqis
2001	Joint Communiqué	GOLD (Syrian Arab Republic), and GAP-RDA (Turkey)	Supporting training, technology exchange, study missions, and joint projects
2002	Bilateral Agreement concerning the installation of a Syrian pump station on the Tigris river	Syrian Arab Republic and Iraq	For irrigation purposes
2008	Cooperation on water issues by establishing a water institute	Turkey, the Syrian Arab Republic and Iraq	18 water experts from each country to work toward the solution of water-related problems

Source. (FAO, 2009)

Annual Average Flow (m^3/s)

Q [m^3/s]

0-100
100-200
200-300
300-400
400-500
500-600
600-700
700-800

Total Dissolved Solids TDS (mg/l)

< 500
500 - 1000
1000 - 1250
1250 - 1500
1500 - 2000
2000 - 2500
> 2500

Annual Average Flow (m^3/s) present state

252

Appendix 3. Water resources of main aquifer zones of Iraq

Aquifer No.	Total Area Km ²	Modulus l/s km ²	Resource l/s	Less than 1 g/s		1 - 3 g/s		3 - 5 g/s		5 - 10 g/s	
				Area km ²	Resource l/s	Area km ²	Resource l/s	Area km ²	Resource l/s	Area km ²	Resource l/s
1	12,300	0.75	9225	0	0	0	0	0	0	0	0
2	1000	0.5	5000	3300	1650	0	0	0	0	0	0
3	43,300	0.5	21,650	6400	3200	0	0	0	0	0	0
4	31,800	0.5	15,900	0	0	6300	3150	5600	2800	0	0
5	61,200	0.35	21,420	0	0	31,700	11,095	900	315	0	0
6	18,400	0.25	4600	7700	1925	0	0	0	0	0	0
7	21,900	0.4	8760	1300	520	13,100	5240	5600	2240	1000	400
8	6400	0.5	3200	0	0	2700	1350	1500	750	2200	1100
9	40,100	1	40,100	0	0	21,700	21,700	11,300	11,300	2900	2900
10	79,300	0.75	59,475	0	0	200	150	23,400	17,550	55,500	41,625
11	37,600	2	75,200	0	0	10,800	21,600	14,600	29,200	1700	3400
12	10,600	3	31,800	3100	9300	1200	3600	1600	4800	0	0
13	40,700	2.5	101,750	24,300	60,750	2000	5000	1200	3000	0	0
14	24,500	5	122,500	24,500	122,500	0	0	0	0	0	0

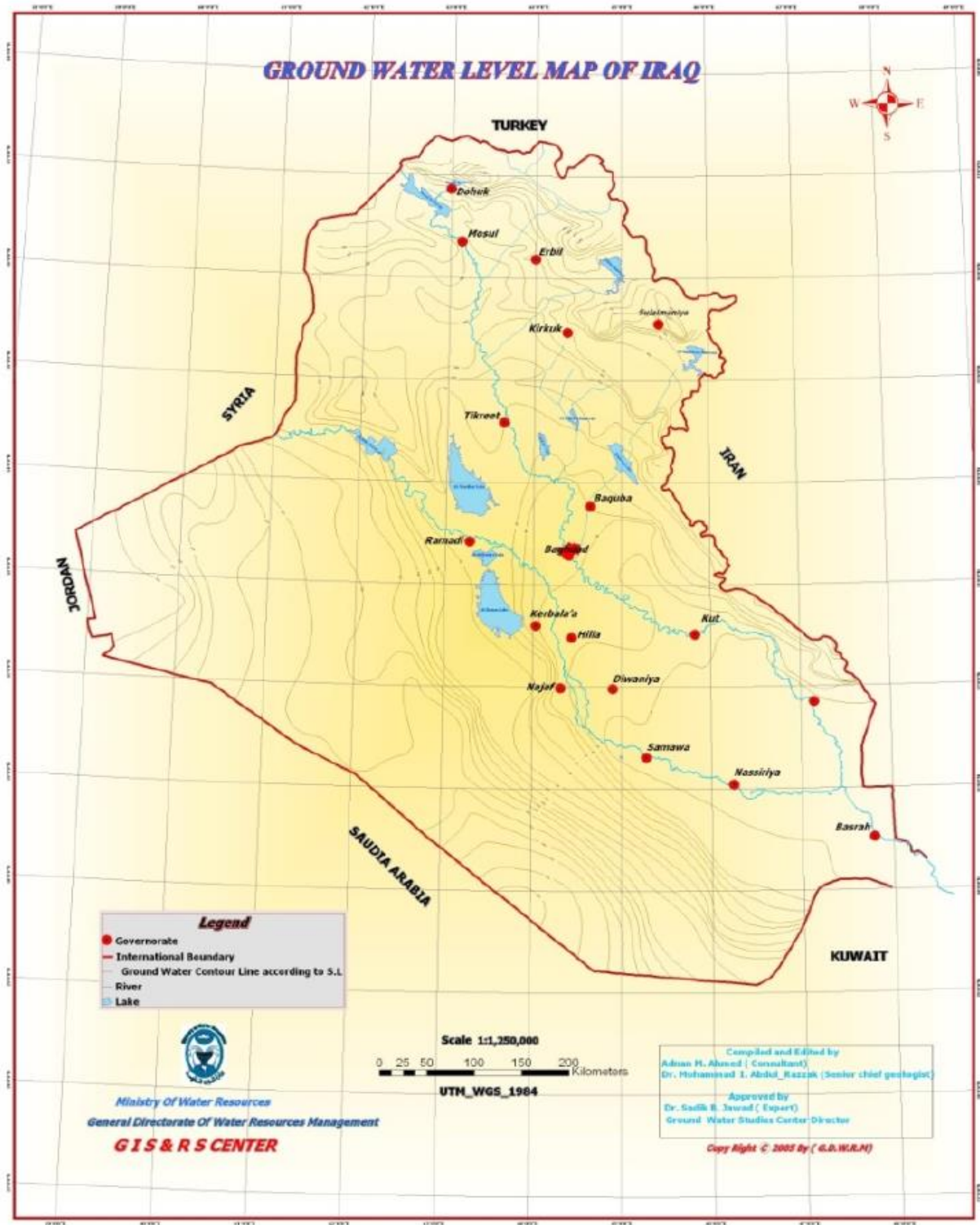
Source. (Nadhir Al-Ansari & al, 2014)

Appendix 4. Total dynamic reserves of water in three categories

Total Amount of Ground Water (Billions of Cubic meters) and Water Use				
Sub Province	Aquifer No	Domestic l g/s	Irrigation & Livestock 1 - 3 g/s	Unusable 3 - 5 g/l
Western desert	1, 2, 3, 4, 5, 7, 8	0.23	1.66	0.63
Jezera	9	0	0.13	0.68
Baiji-Tib	11	0	0.55	0.92
Baghdad Basra	10	0	0	0.004
Foothill zone	12, 13	2.21	1.48	0.270
High folded zone	14	3.86	0	0
Total	-	6.3	3.82	2.504

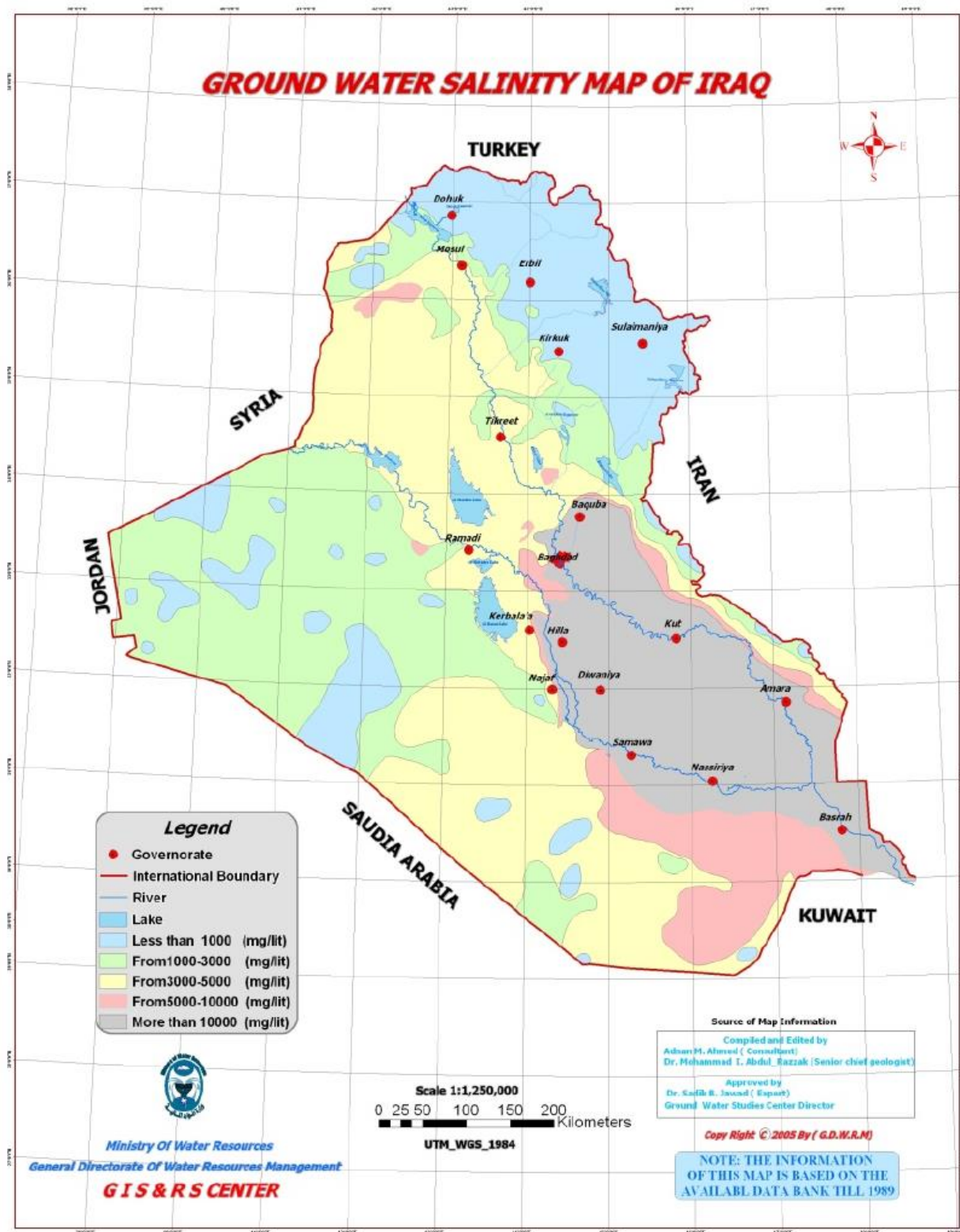
Source. (Nadhir Al-Ansari & al, 2014)

Appendix 5. Groundwater level in Iraq



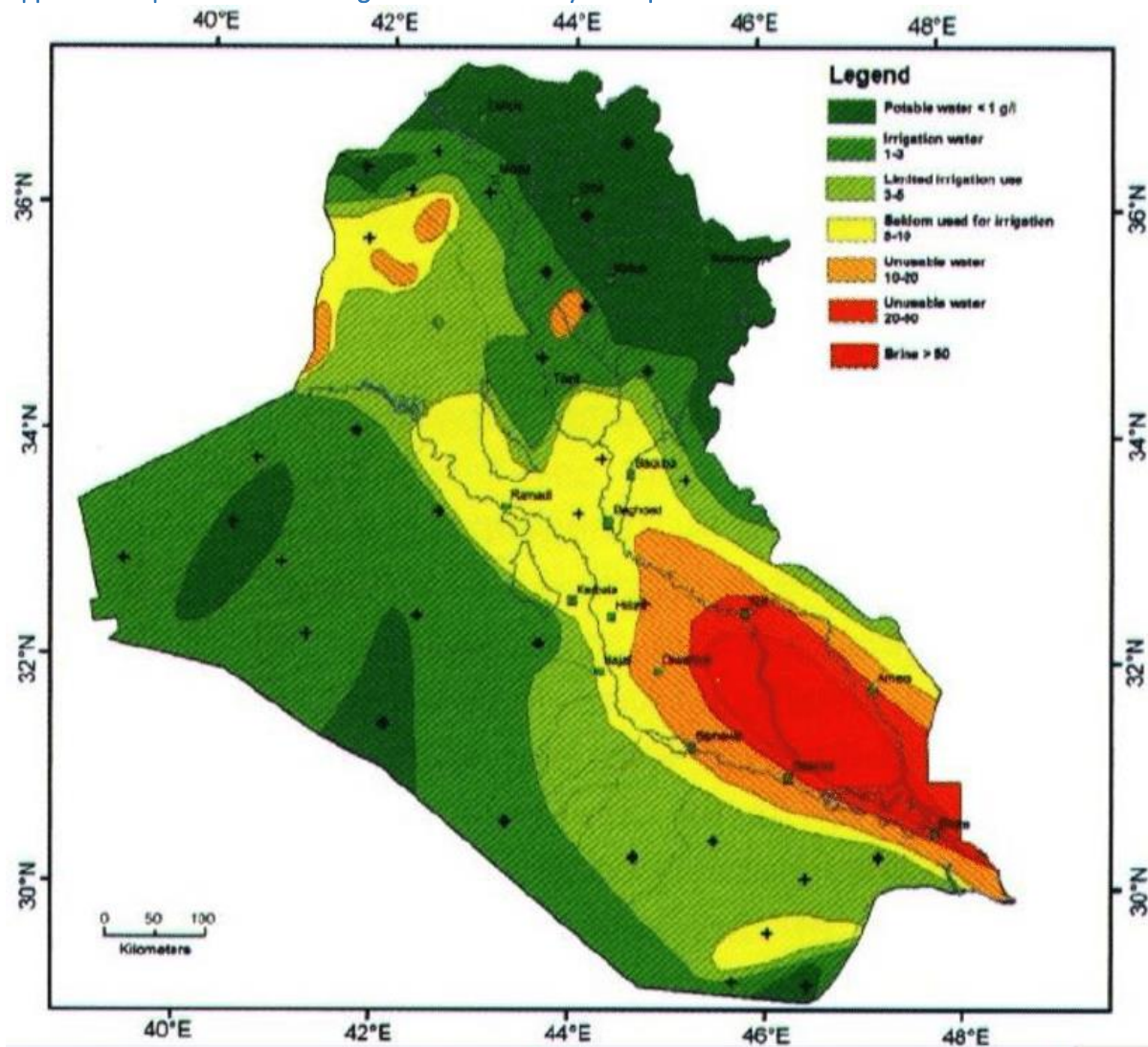
Source. MoWR

Appendix 6: Groundwater salinity maps of Iraq



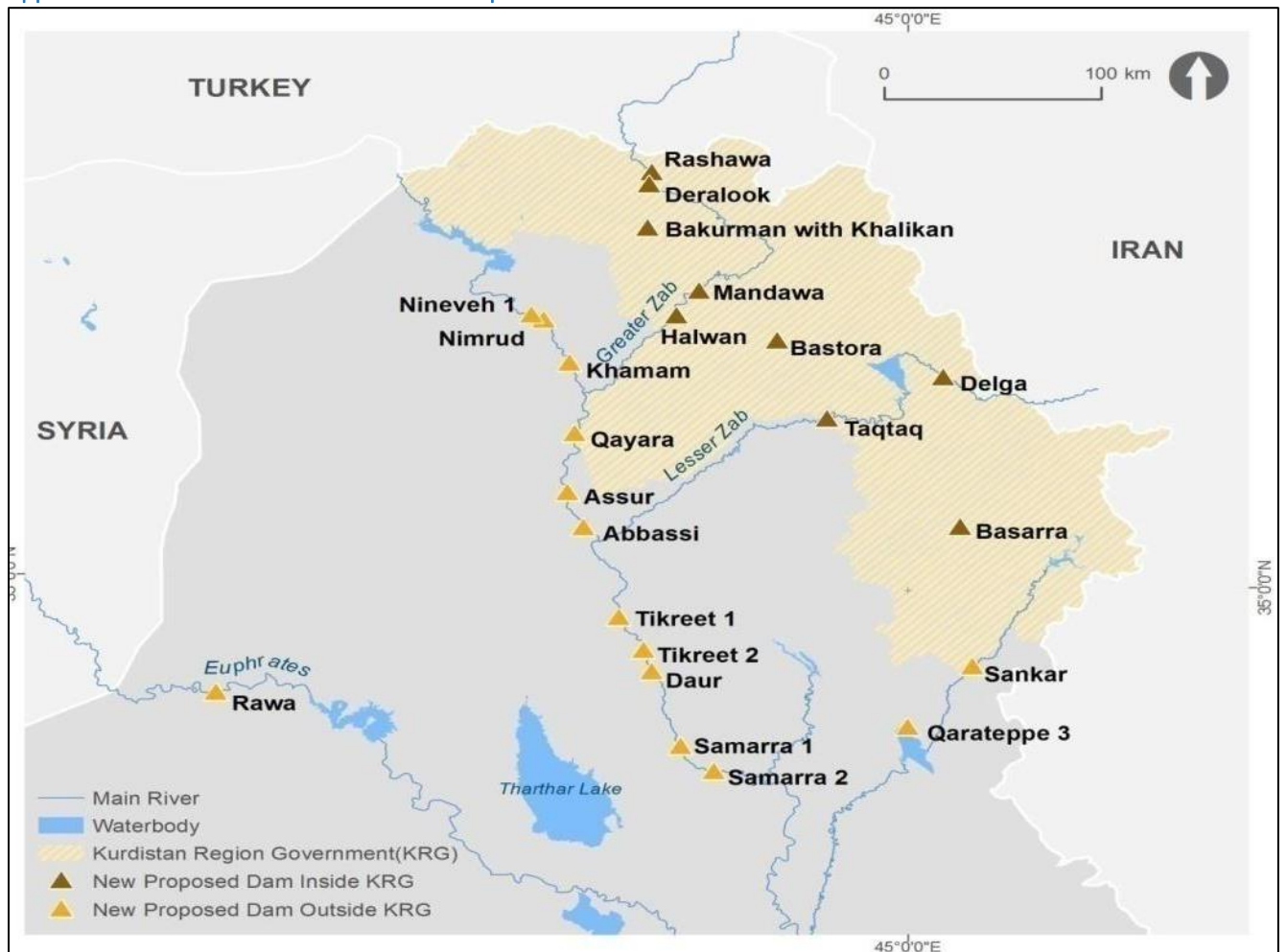
Source. MoWR

Appnedix 7: Spatial variations of groundwater salinity in Iraq



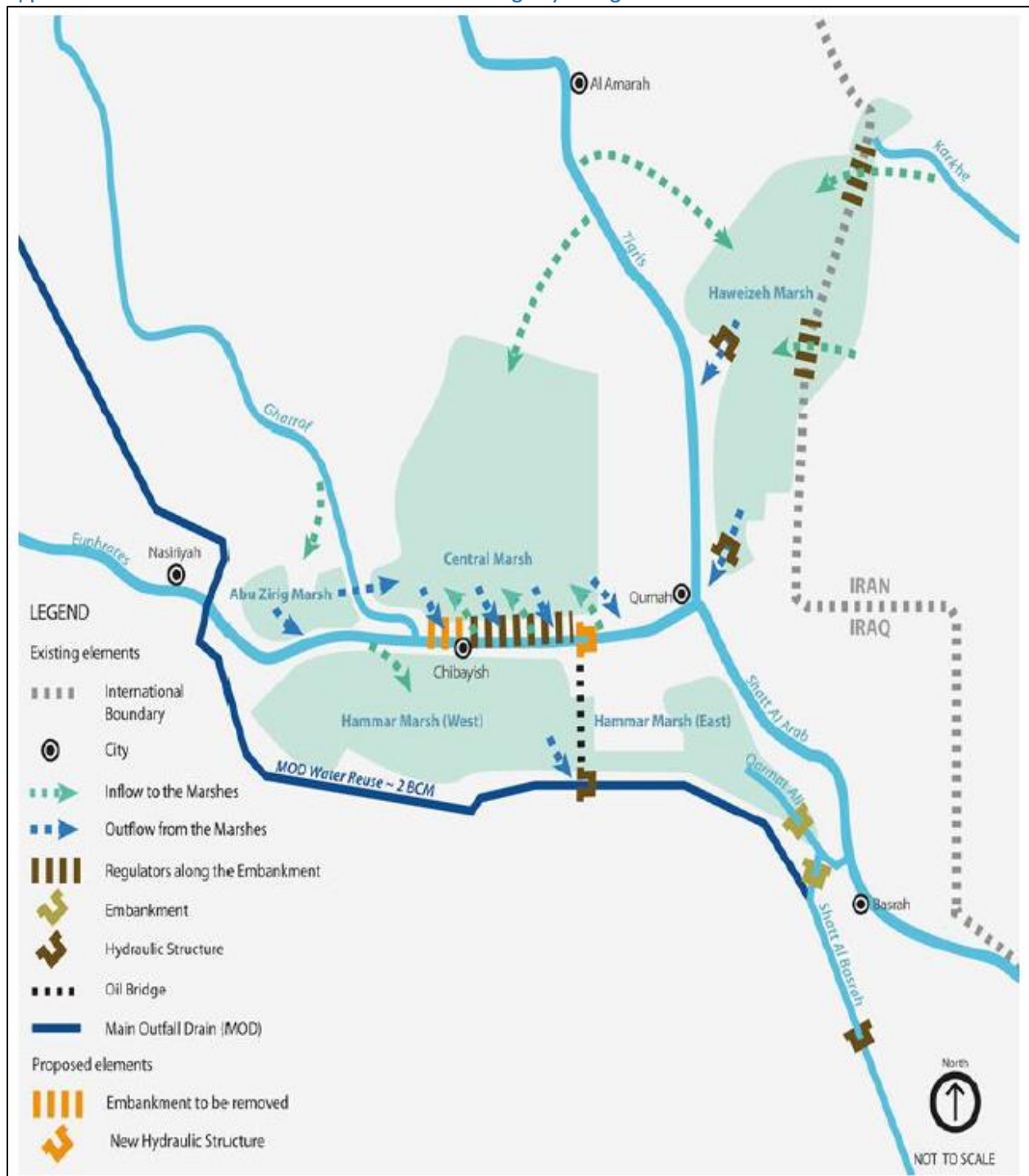
Source: Krasny, J., Alsam, S. and Jassim, S.Z. (2006). Hydrology, in Jassim, S.Z. and Goff, J.C. (ed). Geology of Iraq, Czech Republic, Brno, pp. 251-287.

Appendix 8: Recommended new dams in Iraq



Source: MoWR

Appendix 9: Water balance in the marshes under average hydrologic conditions in 2035



Source. MoWR

Appendix 10: Number of groundwater wells drilled in each Governorate in Iraq

Number of groundwater wells drilled in each governorate in Iraq.	
Governorate	Number of Wells
Duhok	410
Naunawa	1299
Erbil	1286
Sulaymaniah	423
Tameem	1093
Diyala	647
Salahaldin	1118
Baghdad	308
Anbar	608
Muthana	201
Qadisiya	6
Karbala	148
Najaf	286
Wasit	116
Mesan	80
Dhiqar	17
Basra	576
Babil	30
Total	8752

Source. (Nadhir Al-Ansari & al, 2014)

Appendix 11: Details of Irrigation Projects in Iraq

ID	PROJECT NAME	GOVERNORATE	SOURCE	RANKING	Total Area MoWR	Develed till 2013	To Be Developed in the Plan	Final Development	Net area	% DEV	TOTAL DEMAND	Total dem/kdon	Max Monthly demand	Max discharge (l/s)
1	Small farms to hadeetha dam	Anbar	Euphrates	71	59	4	47.3	51.3	45.0	87%	130.3	2895.556	21.5	8.29
2	Small farms from the hadeetha dam	Anbar	Euphrates	81	47	1	46	47	41.2	100%	132.5	3213.83	21	8.10
3	Up to the boundary of the Ramadi project Small farms at springs in the Anbar	Anbar	GW-springs	GW	1		1	1	0.9	100%	2.9	3306	0.5	0.19
4	Ramadi-habaniyah	Anbar	Euphrates	73	135	111	20.4	131.4	115.3	97%	326.8	2835.251	52.1	20.10
5	Faluja-anreah	Anbar-Baghdad	Euphrates	75	56		50.4	50.4	44.2	90%	134	3030.952	21.6	8.33
6	Saqlawiya	Anbar-Baghdad	Euphrates	D	140	140	0	140	122.8	100%	367.7	2994.129	60	23.15
7	Abu ghraib	Anbar-Baghdad	Euphrates	D	206	206	0	206	180.7	100%	576.8	3192	93	35.88
8	Radhwaniyah	Baghdad	Euphrates	D	28	28	0	28	24.6	100%	81	3297.857	13	5.02
9	Yousifia	Baghdad-Wasit	Euphrates	45	125	57	68	125	109.6	100%	360	3283.2	57.8	22.30
10	Latfia	Baghdad-Babil	Euphrates	37	108	88	20	108	94.7	100%	304.8	3217.333	48.8	18.83
11	Iskandariyah	Baghdad-Babil	Euphrates	42	51	44	0	44	38.6	86%	122.3	3168.682	19.5	7.52
12	Faluja al-muahada	Anbar-Baghdad Babil	Euphrates	62	54		54	54	47.4	100%	152.2	3213.111	24.4	9.41
13	Small farms from the boundary of the anbar muhafadha	Babil	Euphrates	72	25		15	15	13.2	60%	42.4	3222.4	6.8	2.62
14	Jarf al sakhr & ruwaiyah	Anbar-Baghdad Babil-Karbala	Euphrates	69	38		38	38	33.3	100%	107.8	3234	17.2	6.64
15	Greater musaiyab	Babil	Euphrates	D	310	310	0	310	271.9	100%	836.1	3074.69	132.5	51.12
16	Husainaia	Babil-Karbala	Euphrates	41	101	80	21	101	88.6	100%	251.9	2843.228	36.9	14.24
17	Small farms; at spring irrigated in karbala	Anbar-Karbala	GW springs	GW	10	10	0	10	8.8	100%	29.7	3385.8	4.9	1.89
18	Bani-hasan	Babil-Karbala Najaf	Euphrates	52	145	43	81.6	124.6	109.3	86%	304.7	2787.785	44.3	17.09
19	Small farms from the Hindiyah barrage	Babil-Karbala Najaf	Euphrates	64	4		3.6	3.6	3.2	90%	8.7	2755	1.3	0.50
20	Iskandariyah -mehaweel & gadwel al-nasiriya	Babil	Euphrates	74	182	11	153.3	164.3	144.1	90%	432.7	3002.301	68.7	26.50
21	Hilla-hashimiyah	Babil	Euphrates	70	240		204	204	178.9	85%	531.2	2968.471	84.2	32.48
22	Huriyah-daghara	Babil-Diwaniyah	Euphrates	12	635	207	428	635	557.0	100%	1,702.50	3056.457	243.1	93.79
23	Hilla-diwanayah	Babil-Diwaniyah Najaf	Euphrates	55	282		273.8	273.8	240.2	97%	643.6	2679.708	100	38.58
24	Diwanayah-shaifiyah	Diwanayah Muthanna	Euphrates	19	380		380	380	333.3	100%	1,031.90	3095.7	157.7	60.84
25	Rumaitha	Muthanna	Euphrates	40	144	30	114	144	126.3	100%	426.6	3377.25	58.4	22.53
26	Hilla-kifil	Babil-Karbala Najaf	Euphrates	D	173	173	0	173	151.8	100%	411.5	2711.618	59.7	23.03
27	Kifil-shnafiyah	Babil-Diwaniyah Najaf	Euphrates	58	494	50	444	494	433.3	100%	1,338.00	3087.692	192.4	74.23
28	Muthanna	Muthanna	Euphrates	27	41	32	9	41	36.0	100%	123	3420	18.7	7.21

29	Shnafiyah-nasiriya	Diwanayah/Dhi-Qar/Muthanna	Euphrates	43	260		260	260	228.1	100%	790.8	3467.354	118.9	45.87
30	Suq al shoyokh	Dhi-Qar	Euphrates	65	75		22.5	22.5	19.7	30%	72	3648	10.4	4.01
31	Small farms in the Euphrates river mouth	Basrah	Tigris	53	35		35	35	30.7	100%	93.1	3032.4	16.2	6.25
32	Zakho	Dohuk	GW-wells	60	15		15	15	13.2	100%	17.3	1314.8	4	1.54
33	Small farms from the boundary up to Mosul dam	Dohuk/Nineveh	Tigris	63	11		11	11	9.6	100%	14.6	1513.091	3.2	1.23
34	Small farms at springs in the dohuk	Dohuk	GW-springs	GW	4		4	4	3.5	100%	5.7	1624.5	1.4	0.54
35	Small farms at wells in the	Dohuk	GW-wells	GW	1		1	1	0.9	100%	1.4	1596	0.4	0.15
36	Dohuk	Dohuk	Tigris	D	2	2	0	2	1.8	100%	2.6	1482	0.6	0.23
37	North jazeera	Nineveh	Tigris	D	264	264	0	264	231.6	100%	477.6	2062.364	98.8	38.12
38	East jazeera	Nineveh	Tigris	26	215	12	203	215	188.6	100%	403	2136.837	90.3	34.84
39	South jazeera	Nineveh	Tigris	8	344		344	344	301.8	100%	670.3	2221.343	118.6	45.76
40	Small farms up to greater zab river	Nineveh	Tigris	33	46		46	46	40.4	100%	86.1	2133.783	19.3	7.45
41	Small farms at springs in the Ninawa	Nineveh	GW-springs	GW	2		2	2	1.8	100%	3.6	2052	0.8	0.31
42	Small farms at wells in the Ninawa	Nineveh	GW-wells	GW	1		1	1	0.9	100%	2	2280	0.4	0.15
43	Small farms at springs in the Ninawa	Nineveh	GW-springs	GW	3		3	3	2.6	100%	5.3	2014	1	0.39
44	Small farms at wells in the Ninawa	Nineveh	GW-wells	GW	4		4	4	3.5	100%	7.4	2109	1.4	0.54
45	Balandah	Dohuk	Greater Zab *	83	1		rainfed		0.0					0.00
46	Khazir-gomel	Nineveh	Khazir *	61	148		rainfed		0.0					0.00
47	Bela-rizan	Dohuk/Nineveh	Greater Zab *	80	1		rainfed		0.0					0.00
48	Diyana-balikiyan	Erbil	Greater Zab	87	6		0.9	0.9	0.8	15%	1.5	1900	0.4	0.15
49	Harir	Erbil	Greater Zab *	78	25		rainfed		0.0					0.00
50	Small farms at springs in the erbil	Nineveh/Erbil	GW-springs	GW	1		1	1	0.9	100%	1.7	1938	0.4	0.15
51	Markaz	Nineveh/Erbil	Greater Zab	39	14		5.6	5.6	4.9	40%	10.2	2076.4	1.9	0.73
52	Shemamuk	Erbil	Greater Zab	30	60		54	54	47.4	90%	101.4	2140.667	18.8	7.25
53	Eski-kalak	Nineveh/Erbil	Greater Zab	D	42	42	0	42	36.8	100%	81.4	2209.429	14.5	5.59
54	Kashaf	Nineveh/Erbil	Greater Zab	14	12		12	12	10.5	100%	25.3	2403.5	4.6	1.77
55	Sallamiyah	Nineveh	Tigris	D	9	9	0	9	7.9	100%	17.2	2178.667	3.2	1.23
56	Small farms at wells in the ninawa	Nineveh	GW-wells	GW	1		1	1	0.9	100%	1.9	2166	0.4	0.15
57	Makhmur	Erbil/Kirkuk	Greater Zab *	54	140		rainfed		0.0					0.00
58	Small farms at well in the ninawa	Nineveh/Salah-ad-din	GW-wells	GW	42		42	42	36.8	100%	107.6	2920.571	19.2	7.41

59	Penjween	Sulaymaniyah	Lesser Zab	85	10		10	10	8.8	100%	16.3	1858.2	4.2	1.62
60	Small farms at siprins in the sulaymaniyah	Sulaymaniyah	GW-springs	GW	2		2	2	1.8	100%	3.6	2052	0.9	0.35
61	Sangasar	Sulaymaniyah	Lesser Zab	25	2		2	2	1.8	100%	3.8	2166	0.9	0.35
62	Raniya-sarujawa	Erbil/Sulaymaniya h	Lesser Zab	82	48	10	0	10	8.8	21%	15.7	1789.8	3.4	1.31
63	Sarsiyah	Sulaymaniyah	Lesser Zab *	79	1		rainfed		0.0					0.00
64	Small farms at springs in the erbil	Erbil	GW-springs	GW	1		1	1	0.9	100%	1.8	2052	0.4	0.15
65	Small farms at wells in the kirkuk muhafadha	Erbil/Kirkuk	GW-wells	GW	1		1	1	0.9	100%	1.9	2166	0.4	0.15
66	Kirkuk	Kirkuk Salah-ad-din Diyala	Lesser Zab	D	662	662	0	662	580.7	100%	1,298.40	2235.915	224.7	86.69
67	Resasy-tereshiyah	Salah-ad-din	Tigris	76	60		60	60	52.6	100%	135.9	2582.1	23.5	9.07
68	Al boajeel	Salah-ad-din	Tigris	D	6	6	0	6	5.3	100%	16.2	3078	2.8	1.08
69	Small farms at springs in the salahad din	Salah-ad-din	GW-springs	GW	20		20	20	17.5	100%	47.2	2690.4	8.3	3.20
70	Small farms at wells in the salah addin	Salah-ad-din	GW-wells	GW	16		16	16	14.0	100%	37.6	2679	6.5	2.51
71	Haweeja	Kirkuk	Lesser Zab	23	192	100	92	192	168.4	100%	398.7	2367.281	68.4	26.39
72	Small farms from lesser zab river up to udhaim	Salah-ad-din	Tigris	56	102	0	102	102	89.5	100%	240.9	2692.412	41.6	16.05
73	Small farms at wells in the salah ad din	Salah-ad-din	GW-wells	GW	7		7	7	6.1	100%	15.2	2475.429	2.5	0.96
74	Al-khalij, al aali	Salah-ad-din	Tigris	D	18	18	0	18	15.8	100%	47	2976.667	8.1	3.13
75	Upper naifah	Salah-ad-din	Tigris	48	59		59	59	51.8	100%	150.3	2904.102	25.8	9.95
76	Dour	Salah-ad-din	Tigris	D	8	8	0	8	7.0	100%	20.4	2907	3.5	1.35
77	Al-aoja & dujail	Salah-ad-din	Tigris	D	24	24	0	24	21.1	100%	63.4	3011.5	10.9	4.21
78	Al-nai	Salah-ad-din Diyala	Tigris	D	33	33	0	33	28.9	100%	69.5	2400.909	11.2	4.32
79	Ishaqi	Salah-addin Baghdad	Tigris	D	317	317	0	317	278.1	100%	753.7	2710.467	127.6	49.23
80	Shahrzoor	Sulaymaniyah	Diyala *	84	74		rainfed		0.0					0.00
81	Kalar	Sulaymaniyah	Diyala	57	12	4	0	4	3.5	33%	8.6	2451	1.9	0.73
82	Kaolas	Sulaymaniyah	Diyala *	86	17		rainfed		0.0			#DIV/0!		0.00
83	Small farms at springs in the sulaymaniyah	Sulaymaniyah	GW-springs	GW	1		1	1	0.9	100%	1.6	1824	0.4	0.15

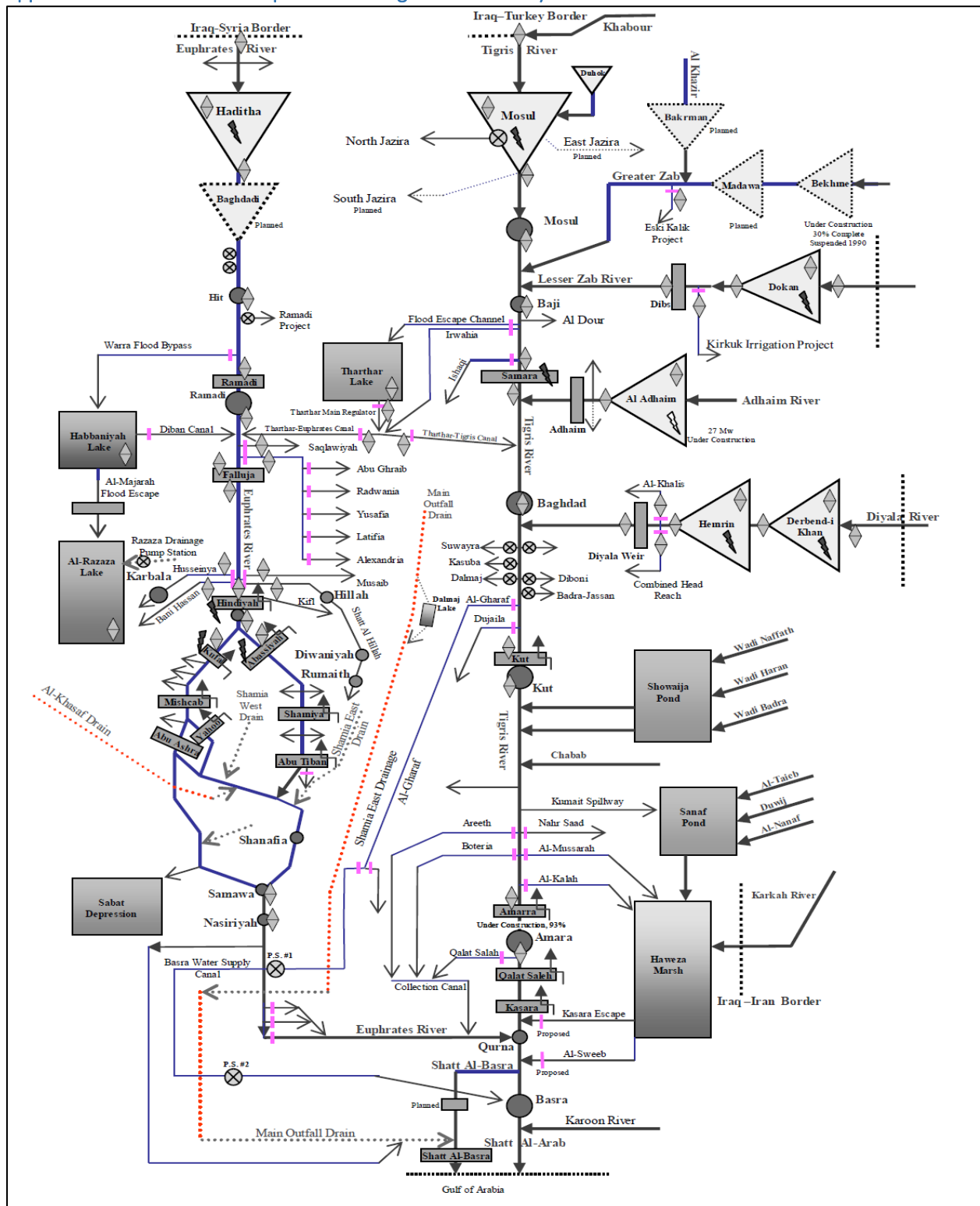
84	Shekh-langar	Sulaymaniyah	Diyala	67	1		1	1	0.9	100%	2.1	2394	0.5	0.19
85	Balajo-khanaqeen-wind	Sulaymaniyah Diyala	Diyala	68	89		89	89	78.1	100%	167.1	2140.382	29.9	11.54
86	Qara teppe	Diyala	Diyala	17	62		62	62	54.4	100%	117.2	2154.968	20	7.72
87	Jalawlaa & al-sa'diyah	Diyala	Diyala	18	24		24	24	21.1	100%	47.7	2265.75	8	3.09
88	Small farms at wells in the diyala	Diyala	GW-wells	GW	4		4	4	3.5	100%	7.6	2166	1.3	0.50
89	Upper khalis	Salah-ad-din Diyala	Diyala	D	216	216	0	216	189.5	100%	467.1	2465.25	74.9	28.90
90	Lower khalis	Diyala Baghdad	Tigris	D	230	230	0	230	201.8	100%	587.7	2912.948	98.8	38.12
91	Mandeli	Diyala	Diyala	13	29	3	26	29	25.4	100%	64.9	2551.241	10.1	3.90
92	Haruniyay+combined head reach (sudour)+muqdadiah	Diyala	Diyala	D	93	85	8	93	81.6	100%	188.1	2305.742	28.7	11.07
93	Ruz	Diyala	Diyala	D	230	230	0	230	201.8	100%	541.7	2684.948	82.6	31.87
94	Mahrut	Diyala	Diyala	38	190	10	100	110	96.5	58%	283.1	2933.945	48.1	18.56
95	Khoraisan (sareah) + tel asmar	Diyala/Baghdad	Diyala	31	93.4		93.4	93.4	81.9	100%	238.8	2914.69	40.3	15.55
96	Small farms in the low course of diyala river	Baghdad	Diyala	47	3		3	3	2.6	100%	7.4	2812	1.2	0.46
97	9th april project (nehrawan) "previously 7th of april project"	Baghdad	Diyala	D	78	78	0	78	68.4	100%	227.1	3319.154	37.4	14.43
98	Small farms on left bank of the diyala	Baghdad	Tigris	51	17	0	12.8	12.8	11.2	75%	37.1	3304.219	6	2.31
99	Wihda (nehrawan)	Baghdad/Wasit	Tigris	D	85	85	0	85	74.6	100%	251.5	3373.059	40.8	15.74
100	Hour-rijab	Baghdad/Wasit	Tigris	D	95	95	0	95	83.3	100%	275.9	3310.8	44.4	17.13
101	Suwairah (hafria)	Diyala/Baghdad Wasit	Tigris	D	148	148	0	148	129.8	100%	398.9	3072.608	59.3	22.88
102	Qusaiba	Wasit/Babil	Tigris	D	55	55	0	55	48.2	100%	141.1	2924.618	20.5	7.91
103	Shihaimiyah	Wasit/Babil	Tigris	D	72	72	0	72	63.2	100%	185.7	2940.25	25.9	9.99

104	Middle tigris	Baghdad/Wasit Babil/Diwaniyah	Tigris	35	528.2		528.2	528.2	463.3	100%	1,442.50	3113.309	196.6	75.85
105	Daboni (al-julfams)	Wasit	Tigris	D	68	68	0	68	59.6	100%	196.5	3294.265	27	10.42
106	Badra-jassan	Wasit	Tigris	21	75	47	28	75	65.8	100%	198.3	3014.16	30.3	11.69
107	Karmashiyah	Wasit	Eastern Tributaries	77	1		1	1	0.9	100%	2.6	2964	0.4	0.15
108	Dalmaj	Wasit	Tigris	D	296	296	0	296	259.6	100%	848.9	3269.412	114.5	44.17
109	West gharaf	Wasit/Dhi-Qar	Tigris	15	337	60	277	337	295.6	100%	999.3	3380.421	138.6	53.47
110	Al-mghashe "previously 17th july"	Dhi-Qar	Tigris	D	56	56	0	56	49.1	100%	167.2	3403.714	23.2	8.95
111	East gharaf	Wasit/Dhi-Qar	Tigris	24	475	55	400.7	455.7	399.7	96%	1,367.50	3421.001	193	74.46
112	Dawaiyah "previously 30th july"	Misan/Dhi-Qar	Tigris	11	183	123	60	183	160.5	100%	567.9	3537.738	79.9	30.83
113	Dujailah	Wasit	Tigris	D	186	186	0	186	163.2	100%	556.4	3410.194	81.7	31.52
114	Kut-butaira	Wasit/Misan	Tigris	20	133	16	117	133	116.7	100%	393.3	3371.143	60.1	23.19
115	Abu-bshoot	Misan	Tigris	D	29	29	0	29	25.4	100%	88.7	3486.828	12.9	4.98
116	Taib	Misan	Eastern Tributaries	2	1		1	1	0.9	100%	2.8	3192	0.4	0.15
117	Duwairij	Misan	Eastern Tributaries	1	3		3	3	2.6	100%	7.2	2736	1.1	0.42
118	Nahar-saad	Misan	Tigris	D	75	75	0	75	65.8	100%	215.7	327.64	31.1	12.00
119	Amara	Misan	Tigris	7	400		400	400	350.9	100%	1,118.40	3187.44	159.3	61.46
120	Shatt al-arab & swaib	Basrah	Tigris	66	290	20	130	150	131.6	52%	404.8	3076.48	70.3	27.12
121	Zubair (irrigated from wells)	Basrah	GW-wells	GW	35		35	35	30.7	100%	99.5	32400.857	18.4	7.10
122	Modern village 1 and 2	Baghdad	Tigris	50	60		60	60	52.6	100%	156.1	2965.9	23.3	8.99
123	Basroukiya	Diwaniyah Muthanna	Tigris	10	94		94	94	82.2	100%	273.9	3321.766	38.4	14.81
124	Mdalel, mrezeja and fao	Diwaniyah Muthanna Wasit Diwaniyah Dhi- Qar	Tigris	9	12		12	12	10.5	100%	35.5	3353.5	4.9	1.89
125	Abbasi	Kirkuk Salah-addin	Tigris *	34	60		rainfed		0.0					0.0
126	Sader	Erbil/Kirkuk Salah-ad-din	Tigris	28	150		20	20	17.5	13%	44	2508	7.6	2.93
127	Ali gharbi and ali sharqi	Misan	Tigris	3	137		137	137	120.2	100%	403.4	3356.759	6207	24.19
128	Boghaylat	Misan Dhi-Qar	Tigris	6	30		30	30	26.3	100%	93.4	3549.2	13.2	5.09
129	Jazeera (island) sayed ahmad	Misan Dhi-Qar	Tigris	5	40		40	40	35.1	100%	123.3	3514.05	17.4	6.41
130	Southern ez river	Misan	Tigris	4	17		17	17	14.9	100%	45	3017.647	7.7	2.97
131	Khozaimiya	Salah-ad-din	Tigris	29	5		2	2	1.8	40%	4.9	2793	0.8	0.31

132	Jazeera western samarra	Salah-ad-din	Tigris	49	89		89	89	78.1	100%	220.9	2829.506	37.5	14.47
133	Upper resasy	Salah-ad-din	Tigris	44	18		18	18	15.8	100%	45.8	2900.667	7.8	3.01
134	Southern haseeba al baghouz	Anbar	Euphrates *	59	4		rainfed		0.0					0.0
135	Expanding hilla hashimiyah	Babil Diwaniyah	Euphrates	46	150		150	150	131.6	100%	361.8	2749.68	50.5	19.48
136	Extension sewaer	Muthanna	Euphrates	16	43		43	43	37.7	100%	129.3	3427.953	18.8	7.25
137	Extension Middle Tigris-	Wasit	Tigris	36	137		137	137	120.2	100%	374.1	3112.949	51	19.68
138	Al Gharbia	Wasit	Tigris *	32	40		rainfed		0.0					0.0
139	Kirkuk Phase 3	Salah-ad-din/Diyala	Udhaim	22	160		160	160	170.4	100%	313.8	2235.825	54.3	
140	Dhalouia	Salah-ad-din Diyala	Tigris	22	32		32	32	28.1	100%	62.8	2237.25	10.9	
141	Farms in the north of Saqlawiya	Anbar	Euphrates	26			26	26	22.8	100%	68.3	2994.692	11.2	
142	Is'haqi farms from Balad up to the confluence with Tigris arm	Salah-ad-din Baghdad	Tigris		62		62	62	54.4	100%	147.4	2710.258	25	

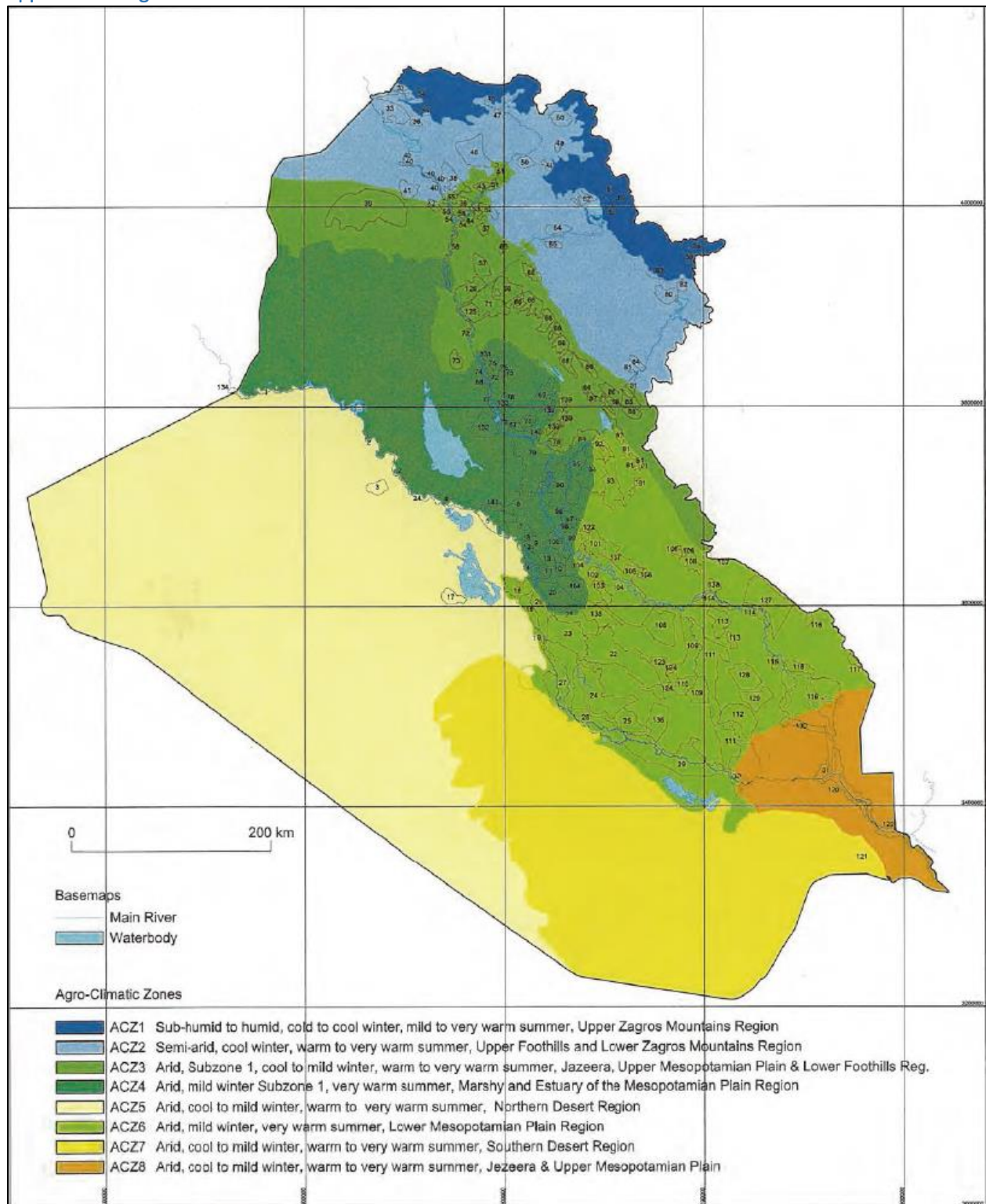
Source. JICA, 2016a

Appendix 12: Schematic of Iraq's water storage and control system



Source: MoWR

Appendix 13: Agro-climatic zones



Source. (JICA, 2016a)

Appendix 14: Iraq crop yields (2019)

Crop	t / ha (2019)
Almonds, with shell	1,47
Apples	3,16
Apricots	4,97
Barley	1,69
Beans, dry	6,76
Beans, green	5,92
Broad beans, horse beans, dry	1,26
Cabbages and other brassicas	7,05
Carrots and turnips	7,43
Cauliflowers and broccoli	7,27
Chick peas	1,05
Chillies and peppers, green	7,08
Cow peas, dry	5,36
Cucumbers and gherkins	8,61
Dates	1,46
Eggplants (aubergines)	15,79
Figs	7,66
Fruit, fresh nes	4,36
Garlic	6,71
Grapefruit (inc. pomelos)	5,25
Grapes	15,32
Groundnuts, with shell	3,48
Lemons and limes	1,70
Lentils	1,25
Lettuce and chicory	7,03
Linseed	0,38
Maize	4,70
Melons, other (inc.cantaloupes)	12,55
Millet	0,84
Nuts nes	1,84
Okra	5,40
Olives	3,55
Onions, dry	7,73
Onions, shallots, green	8,61
Oranges	1,34
Peaches and nectarines	5,18
Pears	6,65
Plums and sloes	7,68
Potatoes	27,96
Pumpkins, squash and gourds	10,60
Quinces	5,43
Rice, paddy	4,50
Seed cotton	0,29
Sesame seed	0,79
Sorghum	1,57
Soybeans	0,80
Spinach	6,92
String beans	5,43
Sugar beet	1,96
Sunflower seed	2,54
Tangerines, mandarins, clementines, satsumas	10,82
Tobacco, unmanufactured	0,84
Tomatoes	27,06
Vegetables, fresh nes	4,83
Vegetables, leguminous nes	6,15
Vetches	0,67
Walnuts, with shell	1,37
Watermelons	15,23
Wheat	2,81

Source: Author's elaboration using FAOSTAT data.

Appendix 15: Top 20 imported agricultural products in Iraq (2019)

Item	tonnes
Flour, wheat	1.381.436
Rice, paddy (rice milled equivalent)	1.290.036
Rice, milled	1.289.465
Sugar Raw Centrifugal	970.896
Maize	822.819
Cake, soybeans	614.933
Wheat	570.646
Tomatoes	478.000
Watermelons	413.000
Potatoes	387.000
Eggs, hen, in shell	298.000
Apples	270.000
Oranges	230.000
Bananas	227.827
Onions, dry	196.000
Cucumbers and gherkins	182.000
Tomatoes, paste	164.762
Tangerines, mandarins, clementines, satsumas	159.930
Fruit, fresh nes	152.144
Lemons and limes	143.155

Appendix 16: Top 20 exported agricultural products in Iraq (2019)

Item	tonnes
Dates	717.103
Beans, dry	1.697
Potatoes	1.219
Wool, degreased	870
Wheat	847
Olives preserved	841
Spices nes	634
Apricots, dry	370
Flour, wheat	238
Eggs, hen, in shell	211
Fat nes, prepared	198
Pastry	195
Vegetables, preserved nes	184
Meat, chicken, canned	183
Lentils	182
Juice, fruit nes	176
Flour, maize	158
Vegetables in vinegar	138
Potatoes, frozen	136
Fruit, cooked, homogenized preparations	134

Appendix 17: Preliminary design

Hydraulic design for Left Alkamalia DC7a+ (DC7a-1)

Starting Station	Ending Station	Starting Location	Starting Station Information				Nominal Dia. (in)	Pipe Material (4)	Actual Pipe I.D. (mm)	Inflow/Outflow (l/s)	Q (l/s)	Q (cms)	Manning's n (4)	Velocity (m/s)	Vel Head (m)	Length (m)	Fric. Rate (m/m)	Friction Loss (m) ⁵⁾	Sum of K's (6)	Minor Losses (m) ⁷⁾	Total Head Loss (m)	Pump Head (m)	End Station HGL (m)
			Obs. HW Elev. (m)	HGL (m)	Elev. (m) ³⁾	Pres. (m)																	
0+00	1+90	Canal Turnout	29.77	29.45	29.05	0.4	900	STEEL	900	316.00	316.0	0.316	0.012	0.50	0.01	190	0.00004	0.01	0.80	0.01	0.0		29.4
1+90	2+40	WC1		29.43	29.01	0.4	900	STEEL	900	(23.00)	293.0	0.293	0.012	0.46	0.01	50	0.00004	0.00	1.00	0.01	0.0		29.4
2+40	8+80	WC3		29.42	29.00	0.4	900	STEEL	900	(6.00)	287.0	0.287	0.012	0.45	0.01	640	0.00003	0.02	1.18	0.01	0.0		29.4
8+80	11+30	WC5		29.39	28.87	0.5	630	PVC	630	(13.00)	274.0	0.274	0.011	0.88	0.04	250	0.00017	0.04	1.30	0.05	0.1		29.3
11+30	12+30	DCF7A-1		29.29	28.82	0.5	630	PVC	630	(123.00)	151.0	0.151	0.011	0.48	0.01	100	0.00005	0.01	1.30	0.02	0.0		29.3
12+30	13+80	WC7		29.27	28.80	0.5	630	PVC	630	(8.00)	143.0	0.143	0.011	0.46	0.01	150	0.00005	0.01	1.20	0.01	0.0		29.3
13+80	16+80	WC2		29.25	28.77	0.5	500	PVC	500	(13.00)	130.0	0.130	0.011	0.66	0.02	300	0.00013	0.04	1.00	0.02	0.1		29.2
16+80	22+20	WC9 & WC4		29.19	28.71	0.5	500	PVC	500	(24.00)	106.0	0.106	0.011	0.54	0.01	540	0.00009	0.05	2.18	0.03	0.1		29.1
22+20	25+50	WC11		29.11	28.66	0.4	500	PVC	500	(18.00)	88.0	0.088	0.011	0.45	0.01	330	0.00006	0.02	1.88	0.02	0.0		29.1
25+50	36+00	WC13		29.07	28.63	0.4	400	PVC	400	(18.00)	70.0	0.070	0.011	0.56	0.02	1050	0.00013	0.13	0.00	0.00	0.1		28.9
36+00	36+00	FO		28.93	28.52	0.4	300	PVC	300	(7.00)	63.0	0.063	0.011	0.89	0.04	0	0.00048	0.00	0.00	0.00	0.0		28.9
36+00	39+00	WC15		29.11	28.52	0.6	300	PVC	300	(46.00)	60.0	0.060	0.011	0.85	0.04	300	0.00043	0.13	1.88	0.07	0.2		28.9
39+00	--	Discharge Pipeline		28.91	28.49	0.4																	

NOTES:
1) Inputs are in BLUE
2) Calculations are done from upstream to downstream
3) Elevations are at center of pipe
4) Manning's N Values
PVC 0.011
RCP 0.015
STEEL 0.012
5) Manning's Equation

$$h_L = L \times V^2 n^2 / (1.49 R_h^{4/3})$$

6) K Values for Minor Losses:
0.5 Square Entrance, "Hydraulics" Daugherty & "Hydraulics" Schoder & Dawson
1.0 Exit Loss, "Hydraulics" Schoder & Dawson
2.0 Tilting Disc Check Valve, Tent. Stds. Hydr. Inst.
0.5 Butterfly Valve, Russell, "Public Water Supplies," p. 236.
"Handbook of Appl. Hydr." Davis
0.3 90-degree elbow, "Handbook of Hydraulics" Brater & King
0.2 45-degree elbow, "Handbook of Hydraulics" Brater & King
1.5 Standard Tee, "Hydraulics" Schoder & Dawson
0.2 Gate Valve Wide Open
7) Minor Loss = $\sum K(V^2/2g)$

Starting Station	Ending Station	Starting Location	Starting Station Information				Nominal Dia. (mm)	Pipe Material (4)	Actual Pipe I.D. (mm)	Inflow/ Outflow (l/s)	Q (l/s)	Q (cms)	Manning's n (4)	Velocity (m/s)	Vel Head (m)	Length (m)	Fric. Rate (m/m)	Friction Loss (m) ⁽⁶⁾	Sum of K's (6)	Minor Losses (m) ⁽⁷⁾	Total Head Loss (m)	Pump Head (m)	End Station HGL (m)
			Obs. HW Elev. (m)	HGL (m)	Elev. (m) ⁽³⁾	Pres. (m)																	
0+00	4+50	Canal Turnout	29.29	29.29	28.82	0.5	500	PVC	500	123.00	123.0	0.123	0.011	0.63	0.02	450	0.00012	0.05	0.80	0.02	0.1		29.2
4+50	9+80	WC1 & WC2	29.22	28.73	28.73	0.5	500	PVC	500	(16.00)	107.0	0.107	0.011	0.54	0.02	530	0.00009	0.05	1.00	0.02	0.1		29.2
9+80	10+40	WC4	29.16	28.62	28.62	0.5	500	PVC	500	(15.00)	92.0	0.092	0.011	0.47	0.01	60	0.00007	0.00	1.08	0.01	0.0		29.1
10+40	14+90	WC3	29.14	28.61	28.61	0.5	500	PVC	500	(13.00)	79.0	0.079	0.011	0.40	0.01	450	0.00005	0.02	1.38	0.01	0.0		29.1
14+90	21+70	WC6	29.11	28.52	28.52	0.6	400	PVC	400	(7.00)	72.0	0.072	0.011	0.57	0.02	680	0.00013	0.09	1.38	0.02	0.1		29.0
21+70	21+70	FO1 & FO2	28.99	28.39	28.39	0.6	400	PVC	400	(10.00)	62.0	0.062	0.011	0.49	0.01	0	0.00010	0.00	1.20	0.01	0.0		29.0
21+70	24+20	WC5	28.98	28.39	28.39	0.6	300	PVC	300	(18.00)	44.0	0.044	0.011	0.62	0.02	250	0.00023	0.06	1.00	0.02	0.1		28.9
24+20	27+50	WC8	28.90	28.34	28.34	0.6	300	PVC	300	(13.00)	31.0	0.031	0.011	0.44	0.01	330	0.00012	0.04	2.08	0.02	0.1		28.8
27+50	36+50	WC10	28.84	28.25	28.25	0.6	300	PVC	200	(20.00)	11.0	0.011	0.011	0.35	0.01	900	0.00013	0.11	1.70	0.01	0.1		28.7
36+50	--	Discharge Pipeline	28.72	28.07	28.07	0.6																	

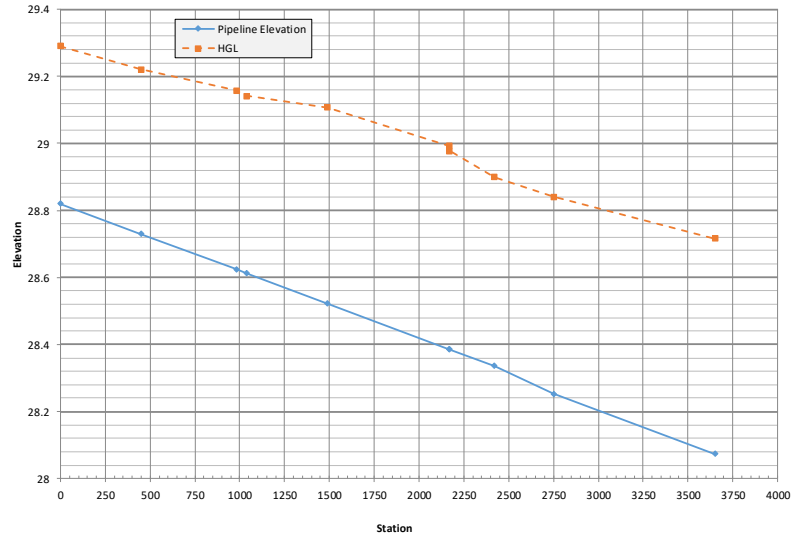
NOTES:

- Inputs are in BLUE
- Calculations are done from upstream to downstream
- Elevations are at center of pipe
- Manning's N Values

PVC	0.011
RCP	0.015
STEEL	0.012
- Manning's Equation

$$h_L = L \times V^2 n^2 / (R_h^{4/3})$$
- K Values for Minor Losses:

0.5	Square Entrance, "Hydraulics" Daugherty & "Hydraulics" Schoder & Dawson
1.0	Exit Loss, "Hydraulics" Schoder & Dawson
2.0	Tilting Disc Check Valve, Tent. Sids. Hydr. Inst.
0.5	Butterfly Valve, Russell, "Public Water Supplies," p. 236.
	"Handbook of Appl. Hydr." Davis
0.3	90-degree elbow, "Handbook of Hydraulics" Brater & King
0.2	45-degree elbow, "Handbook of Hydraulics" Brater & King
1.5	Standard Tee, "Hydraulics" Schoder & Dawson
0.2	Gate Valve Wide Open
- Minor Loss = $\sum K(V^2/2g)$



DC7A	PICKET	Irrigated Area		DESIGN DISCH.(l/s)	DC7A1	PICKET	Irrigated Area		DESIGN DISCH.(l/s)
		GROSS	NET				GROSS	NET	
DC7A	0+00	473.08	413.00	316.00	DC7A	0+00	191.29	167.00	8.00
WC1	0+190	33.22	29.00	23.00	WC1	0+450	12.60	11.00	8.00
WC3	0+240	10.31	9.00	6.00	WC2	0+450	27.49	24.00	15.00
WC5	0+880	20.62	18.00	13.00	WC4	0+980	24.05	21.00	13.00
DC7A-1	1+130	191.29	167.00	123.00	WC3	1+040	11.45	10.00	7.00
WC7	1+230	12.60	11.00	8.00	WC6	1+490	2.29	2.00	5.00
WC2	1+380	20.62	18.00	13.00	FO1	2+170	4.58	4.00	5.00
WC9	1+680	24.05	21.00	15.00	FO2	2+170	34.36	30.00	18.00
WC4	1+680	14.89	13.00	9.00	WC5	2+420	24.05	21.00	13.00
WC11	2+220	29.78	26.00	18.00	WC8	2+750	37.80	33.00	20.00
WC13	2+550	29.78	26.00	18.00	WC10	3+650	29.78	26.00	18.00
FO1	3+600	11.45	10.00	7.00	SUBTOTAL		191.29	167.00	-
WC15	3+900	74.46	65.00	46.00					
SUBTOTAL		473.08	413.00	-					

		Length	Q	WL		Diam		FO					Length	Q	WL		Diam	FO	
		m	l/s	US	DS	mm		One way	Two way				m	l/s	US	DS	mm	One way	Two way
		880.00	316.00	29.45	28.91	900.00	STEEL	1		3,650.00	DC7A1	1,490.00	123.00	29.29	28.72	500.00	1		
		500.00				630.00	PVC					200.00							
		1,170.00				500.00	PVC					400.00							
		1,050.00				400.00	PVC					300.00							
		300.00				300.00	PVC					200.00							
3,900.00	DC7A	2,100.00	23.00	29.43	29.29	300.00	PVC		12		WC1	320.00	8.00	29.22	29.20	200.00	3		
	WC3	640.00	6.00	29.42	29.39	200.00	PVC	5			WC2	300.00	8.00	29.22	29.20	200.00	3		
	WC5	600.00	13.00	29.39	29.28	200.00	PVC	5			WC4	480.00	15.00	29.16	29.04	200.00		4	
	WC7	430.00	8.00	29.27	29.24	200.00	PVC	3			WC3	300.00	13.00	29.14	29.08	200.00		3	
	WC2	300.00	13.00	29.25	29.19	200.00	PVC		3		WC6	450.00	7.00	29.11	29.08	200.00		4	
	WC9	500.00	15.00	29.19	29.06	200.00	PVC		4		WC5	1,100.00	18.00	28.98	28.59	200.00		9	
	WC4	750.00	9.00	29.19	29.12	200.00	PVC	6			WC8	850.00	13.00	28.90	28.74	200.00		8	
	WC11	420.00	18.00	29.11	28.95	200.00	PVC		4		WC10	670.00	20.00	28.84	28.54	200.00			5
	WC13	460.00	18.00	29.07	29.90	200.00	PVC		4									18.00	22.00
7,300.00	WC15	1,100.00	46.00	29.11	28.81	300.00	PVC		9										
								20	36										

Cost estimation based on the Left Alkamalia DC7a+ (DC7a-1) preliminary design

Implementation works of distributary pipelines (DC7-a-1), (DC7-a) / 18 watercourses						Implementation works of distributary pipelines (DC7-a-1), (DC7-a)					
Pipe Type	Pipe size mm	Length m	Unit price USD	Total Cost USD		Pipe Type	Pipe size mm	Length m	Unit price USD	Total Cost USD	
STEEL	900.00	880.00	420.00	369,600.00		STEEL	900.00	880.00	420.00	369,600.00	
PVC	630.00	500.00	175.00	87,500.00		PVC	630.00	500.00	175.00	87,500.00	
PVC	500.00	2,660.00	105.00	279,300.00		PVC	500.00	2,660.00	105.00	279,300.00	
PVC	400.00	1,730.00	66.00	114,180.00		PVC	400.00	1,730.00	66.00	114,180.00	
PVC	300.00	4,080.00	42.00	171,360.00		PVC	300.00	880.00	42.00	36,960.00	
PVC	200.00	9,470.00	25.00	236,750.00		PVC	200.00	900.00	25.00	22,500.00	
FO simple		38.00	2,739.07	104,084.64		FO simple		1.00	2,739.07	2,739.07	
FO double		58.00	3,423.84	198,582.53		FO double		2.00	3,423.84	6,847.67	
Supplying, laying and connecting pipes				1,561,357.17		Supplying, laying and connecting pipes				919,626.74	
Earthworks			4%	62,454.29		Earthworks			4%	36,785.07	
Other structures			10%	156,135.72		Other structures			10%	91,962.67	
				1,779,947.17						1,048,374.49	
Temporary construction site preparation			3%	53,398.42		Temporary construction site preparation			3%	31,451.23	
				1,833,345.59						1,079,825.72	
Unexpected expenses			15%	275,001.84		Unexpected expenses			15%	161,973.86	
				2,108,347.43						1,241,799.58	
Engineering design			7%	147,584.32		Engineering design			7%	86,925.97	
Construction supervision			5%	105,417.37		Construction supervision			5%	62,089.98	
Environmental and social safeguards			2%	42,166.95		Environmental and social safeguards			2%	24,835.99	
				295,168.64						173,851.94	
				2,403,516.07						1,415,651.52	
Targeted area (ha)			473.08			Targeted area (ha)			473.08		
Unit cost for implementation (USD/ha)				5,080.56		Unit cost for implementation (USD/ha)				2,992.41	
Total targeted area (ha)			4,681.56			Total targeted area (ha)			4,681.56		
Total budget for canal upgrade (USD)				23,784,915.64		Total budget for canal upgrade (USD)				14,009,122.92	
Targeted distributary (km)			57.76			Targeted distributary (km)			57.76		
Targeted watercourses (km)			55.78			Targeted watercourses (km)			-		
Targeted Households			1,518.00			Targeted Households			1,518.00		
Number of beneficiaries			9,715.20			Number of beneficiaries			9,715.20		
The preliminary design cost estimates are subject to significant uncertainty especially for Nejaf where rice irrigation requires larger discharge (2 l/s/ha instead of 0.8 l/s/ha).											
hence the reason why we applied a 15% uncertainty for unexpected expenses											

Category a where distributary canals and their watercourses are upgraded

						Distributaries		Watercourses		
	Name	Net area		Gross area		Q	length	length	FO	
		donum	ha	donum	ha	l/s	km	#	km	#
≥	Albachai	1091	273	1,250	313	1000	2.0	26	5.0	119
⋈	Left Alkamalia DC7a+ (DC7a-1)	1652	413	1,892	473	316	7.6	18	11.8	154
≤	Alhumadi canal	2000	500	2,291	573	400	2.5	2	4.1	180
		4,743	1,186	5,433	1,359		12.1		20.9	453

	Name	ND (mm)	Unit Cost (USD/ml)	Total cost (USD)	FO	Pipes	Earthworks	Other structures	Temporary site preparation	Unexpected expenses	Sub-total 1
≥	Albachai	700	277.57	555,130.43	366,692.55	921,822.98	36,872.92	92,182.30	31,526.35	216,480.91	1,298,885.46
⋈	Left Alkamalia DC7a+ (DC7a-1)	630	175.00	1,321,250.00	474,543.30	1,795,793.30	71,831.73	179,579.33	61,416.13	421,724.10	2,530,344.59
≤	Alhumadi canal	630	175.00	437,500.00	554,661.00	992,161.00	39,686.44	99,216.10	33,931.91	232,999.09	1,397,994.54
						3,709,777.28	148,391.09	370,977.73	126,874.38	871,204.10	5,227,224.59

	Name	Design	Supervision	Safeguards	Sub-total 2	Total cost
≧	Albachai	90,921.98	64,944.27	25,977.71	181,843.96	1,480,729.42
⋈	Left Alkamalia DC7a+ (DC7a-1)	177,124.12	126,517.23	50,606.89	354,248.24	2,884,592.83
≧	Alhumadi canal	97,859.62	69,899.73	27,959.89	195,719.23	1,593,713.77
		365,905.72	261,361.23	104,544.49	731,811.44	5,959,036.03
						5,959,037.00

Note	The preliminary design cost estimates are subject to significant uncertainty especially for Nejaf where rice irrigation requires larger discharge (2 l/s/ha instead of 0.8 l/s/ha). hence the reason why we applied a 20% uncertainty for unexpected expenses					
	Total Project Targeted area (ha)	1,359.00				
	Total budget for canal upgrade (USD)	5,959,037.00				
	Targeted distributary (km)	12.00				
	Targeted watercourses (km)	21.00				
	Targeted Households	418.00				
	Number of beneficiaries	2,863.00				

Category b where only distributary canals are upgraded

		Distributaries						
	Name	Net area		Gross area		Q	length	FO
		donum	ha	donum	ha	l/s	km	#
≧	Kata'at Alzarfaat	400	100	458	115	600	2.5	39
	Kata'at Almarashdah	172	43	197	49	300	2.6	15
	Tabr Alkhan	294	74	337	85	380	3.8	28
	Tabr Alshaib	189	48	216	55	390	3.3	18
	Alajda'a	275	69	315	79	372	4.3	26
⋈	Fraiha canal DC1	518	130	596	149	250	4.3	49
	Um Gamal DC1	4120	1030	4,719	1,180	520	4.3	384
≧	project Alkadeer (/Um Alrigaif)	1000	250	1,145	286	300	3.5	90
	Alaksha	2400	600	2,749	687	220	7.0	216
		9,368	2,344	10,733	2,685		35.5	865

	Name	ND (mm)	Unit Cost (USD/ml)	Total cost (USD)	FO	Pipes	Earthworks	Other structures	Temporary site preparation	Unexpected expenses	Sub-total 1
≧	Kata'at Alzarfaat	500	105.00	262,500.00	120,176.55	382,676.55	15,307.06	38,267.66	13,087.54	89,867.76	539,206.57
	Kata'at Almarashdah	300	42.00	109,200.00	46,221.75	155,421.75	6,216.87	15,542.18	5,315.42	36,499.24	218,995.46
	Tabr Alkhan	400	66.00	247,500.00	86,280.60	333,780.60	13,351.22	33,378.06	11,415.30	78,385.04	470,310.22
	Tabr Alshaib	300	42.00	137,928.00	55,466.10	193,394.10	7,735.76	19,339.41	6,614.08	45,416.67	272,500.02
	Alajda'a	400	66.00	283,800.00	80,117.70	363,917.70	14,556.71	36,391.77	12,445.99	85,462.43	512,774.60
⋈	Fraiha canal DC1	400	66.00	280,500.00	150,991.05	431,491.05	17,259.64	43,149.11	14,756.99	101,331.36	607,988.15
	Um Gamal DC1	900	420.00	1,818,600.00	1,183,276.80	3,001,876.80	120,075.07	300,187.68	102,664.19	704,960.75	4,229,764.49
≧	project Alkadeer (/Um Alrigaif)	500	105.00	367,500.00	277,330.50	644,830.50	25,793.22	64,483.05	22,053.20	151,431.99	908,591.97
	Alaksha	700	277.57	1,942,956.52	665,593.20	2,608,549.72	104,341.99	260,854.97	89,212.40	612,591.82	3,675,550.90
						8,115,938.77	324,637.55	811,593.88	277,565.11	1,905,947.06	11,435,682.37

	Name	Design	Supervision	Safeguards	Sub-total 2	Total cost
≥	Kata'at Alzarfaat	37,744.46	26,960.33	10,784.13	75,488.92	614,695.49
	Kata'at Almarashdah	15,329.68	10,949.77	4,379.91	30,659.36	249,654.83
	Tabr Alkhan	32,921.72	23,515.51	9,406.20	65,843.43	536,153.65
	Tabr Alshaib	19,075.00	13,625.00	5,450.00	38,150.00	310,650.03
	Alajda'a	35,894.22	25,638.73	10,255.49	71,788.44	584,563.04
⋈	Fraiha canal DC1	42,559.17	30,399.41	12,159.76	85,118.34	693,106.49
	Um Gamal DC1	296,083.51	211,488.22	84,595.29	592,167.03	4,821,931.51
≤	project Alkadeer (/Um Alrigaif)	63,601.44	45,429.60	18,171.84	127,202.88	1,035,794.84
	Alaksha	257,288.56	183,777.54	73,511.02	514,577.13	4,190,128.03
		800,497.77	571,784.12	228,713.65	1,600,995.53	13,036,677.90
						13,036,678.00

Note	The preliminary design cost estimates are subject to significant uncertainty especially for Nejaf where rice irrigation requires larger discharge (2 l/s/ha instead of 0.8 l/s/ha). hence the reason why we applied a 20% uncertainty for unexpected expenses					
	Total Project Targeted area (ha)		2,685.00			
	Total budget for canal upgrade (USD)		13,036,678.00			
	Targeted distributary (km)		36.00			
	Targeted watercourses (km)		-			
	Targeted Households		826.00			
	Number of beneficiaries		5,594.00			

Summary total cost for canals upgrade

Total Project Targeted area (ha)	4,044.00
Total budget for canal upgrade (USD)	18,995,715.00
Targeted distributary (km)	48.00
Targeted watercourses (km)	21.00
Targeted Households	1,244.00
Number of beneficiaries	8,457.00

Appendix 18: Preliminary Maintenance Plan PV pumping system²⁷¹

Continuous maintenance activities (Daily/Weekly)

Regular inspection and preventative care activity sheet		
System component	Preventative care and maintenance	Activity
General	Follow the official pumping schedule of the scheme	As indicated by scheme management
Pump (over and above regular operation procedures provided by manufacturer's operating manual)	Maintain a clean facility at all times	Remove and dispose of rubbish and debris, sweep area
	Record pump pressure when running	If there is a change in foreseen pressure, request technical support to check panels
	Record pumping times	If there is a change in foreseen times, request technical support
	Is pump or discharge piping leaking	If yes, request technical support to fix leaks
Pumphouse/ Pump enclosure	Record pump pressure when running	If there is a change from normal range in pressure, request technical support
	Check enclosure for cracks and damage	If cracked, repair cracks with cement
Controllers/ inverters, etc.	Is the enclosure locked?	If not, lock enclosure and/or repair locking hardware as necessary
	Record electrical power Record electrical discharge Check any warning lights or alarms Read volt and ampere meters	If there is a change in electrical discharge, request technical support to check panels
Solar array	Check solar array for any immediate needs	Trim or remove any vegetation around the solar panels as well as any structures that will block sunlight: <ul style="list-style-type: none"> - Leaves or sticks that have been blown or fallen onto the panels - Bird droppings or major dirt build-up - Breakages from storms or other means - Wiring - Check area around solar panels for rubbish, debris, and spider webs or any other insect nesting
	Wash panels	Do during early hours when it is not yet hot. Use a soft sponge and water only
	Are there any cracks in the panels?	If yes, request technical support

²⁷¹ Maintenance plan is adapted from [“Solar Pumping for Water Supply Harnessing solar power in humanitarian and development contexts”](#) and needs to be updated in the frame of the project.

	Is there any exposed or loose or disconnected wiring? Check for any damage from rodents or animal	If yes, request technical support
	Is the panel mounting strong and well attached? Are there cracks or any other signs of weakening?	If yes, request technical support

Preventive maintenance plan

The abbreviations describe the importance and frequency of the maintenance tasks related to each component of the solar plant:

Q: quarterly

SA: semi-annual

Y: yearly

nYr: every n years

Equipment	Task	Importance	Frequency
Modules	Integrity inspection and replacement	Minimum requirement	Y
	Check cleanliness of modules	Minimum requirement	Y
	Electrical measurement inspections	Minimum requirement	Y
	Thermography inspection	Recommendation	Y
	Checking clamps/bolts panel structure	Minimum requirement	Y
	Internal inspection of junction boxes	Recommendation	Y
Electrical boards and switches	Integrity check and cleaning	Minimum requirement	SA or Y
	Check labelling and identification	Minimum requirement	Y
	Electrical protections (including fuses, surge and others) visual and functional tests	Minimum requirement	Y
	Checking integrity of cables and state of terminals	Minimum requirement	SA or Y
	Measurement inspection	Best practice	Y
	Thermography inspection	Recommendation	Y
	Check cable tightening	Minimum requirement	Y
	Monitoring operation test	Best practice	Y
Cables (DC and AC)	Integrity inspection	Minimum requirement	SA or Y
	Check labelling and identification	Minimum requirement	Y
	Check cable terminals	Minimum requirement	Y

Equipment	Task	Importance	Frequency
	Measurement inspection	Best practice	Y
Control box/ Inverter	Integrity check and cleaning	Integrity check and cleaning	SA or Y
	Document inspection	Document inspection	Y
	Check labelling and identification	Minimum requirement	Y
	Check correct operation (on/off) by operator	Minimum requirement	SA or Y
	Check fuses and surge protections	Minimum requirement	Y
	Thermographic inspection	Best practice	Y
	Sensor functional verification	Minimum requirement	Y
Generator (for emergency back-up or in hybrid systems)	Integrity check and cleaning	According to manufacturer recommendations	According to manufacturer recommendations
	General maintenance		
	Check correct operation		
	Replacement of filters		
Lights and electrical sockets	Integrity check and cleaning	Minimum requirement	Y
	Check correct operation	Best practice	Y
	Check conformity to local security standards	Best practice	Y
Water supply system	Integrity inspection of pipeline and reservoir (if any)	Minimum requirement	SA or Y
	Check water meter correct operation	Minimum requirement	SA or Y
	Check water readings are properly taken by operator	Best practice	SA or Y
Lighting protection (if applicable)	Integrity inspection	Minimum requirement	Y
Fences and gates	Integrity inspection	Minimum requirement	Y
Vegetation	Vegetation clearing	According to local conditions	Q, SA or Y
Drainage system	General cleaning	According to local conditions	Q, SA or Y
Buildings	Integrity check and cleaning	According to local requirements	According to local requirements
	Documentation inspection	Best practice	Y
	Check earthing	Minimum requirement	3Yr
PV support structure	Integrity inspection	Minimum requirement	Y
	Check tightening	Minimum requirement	Y
Irradiation sensors	Integrity check and cleaning	According to manufacturer	Q
	Calibration		2 Yr

Equipment	Task	Importance	Frequency
	Monitoring operational test	specifications and local conditions	Y
Communication board/Remote monitoring	Functional communication check	Minimum requirement	Q
Intrusion detection system	Integrity check and cleaning	According to manufacturer specifications	Y
	Functional verification of intrusion detection		Y
	Functional verification of alarms/cameras		Q
	Specific maintenance		Y
Stock of spare parts	Inventory of stock	Minimum requirement	Y
	Visual inspection of stock conditions	Minimum requirement	Y
	Stock replenishment	Minimum requirement	Q

Appendix 19: Irrigation efficiencies for current and future scenarios in the target governorates

	Initial	Future (a)	Future (b)					
E _c	0.72	0.90	1.00					
E _s	0.85	1.00	1.00					
E _t	0.85	0.90	1.00					
E _{op}	0.95	0.98	0.98					
E _a	0.55	0.65	0.65					
Future (a)	for the sites where distributary canals with their watercourses are targeted by the upgrades							
Future (b)	for the sites where only distributary canals are targeted by the upgrades							

E_c = Conveyance efficiency

E_s = Efficiency secondary canal

E_t = Efficiency tertiary canal

E_{op} = Operation Efficiency

E_a = Efficiency Field application

$$E_c = E_s \times E_t$$

Appendix 20: Preliminary feasibility and cost estimations

Site name	District	GPS location	Canal Width	Required width	Max required canal length	Canal direction	Azimuth	Existing pump power (kw)	Total power required on site	Possibility of capacity installation (kWp)	Annual Solar Energy production (kWh)	Preliminary cost estimation USD/system ²⁷²
Al Haydariya - Al Wasmiya	Najaf	32.307744, 44.314765	12.5 m	16 m	350 m	South-East	163°	200	200 kW	250	361,456	477,750
Al Safi	Mouthana	31.212750, 45.606213	9 m	13 m	125 m	South	178°	280	280 kW	320	451,902	611,520
			9 m	13 m	56 m	South - West	190°					
			9 m	13 m	185 m	South - West	200°					
2C Canal	Mouthana	31.551817, 45.136876	10.5 m	12 m	120 m	South - East	135°	160	160 kW	220	305,860	420,420
			10.5 m	12 m	60 m	South - East	145°					
			10.5 m	12 m	100 m	South - East	155°					

²⁷² Based on conservative price estimations. Considering significantly changes in component prices over time, the price estimations will be updated during the detailed design phase in Year 1.

Item No	Preliminary cost estimation for 250 kWp solar system on water canals in Al Haydariya - Al Wasmiya/Najaf ²⁷³	UNIT	QTY	RATE USD	AMOUNT USD
1	Solar PV Module				
1.1	Supply, install, test and commission of Solar module of a Crystalline technology 580Wp or higher	Pcs	432	240	103,680
2	Metallic support Structure				
2.1	Supply, install, test and commission of the metallic support structures , with all needed accessories for a complete installation, including site clearing, excavations, concrete slabs, metallic structure installation, complete with all accessories needed.	LS	1	100,000	100,000
3	Solar drive				
3.2	Supply, install, test and commission of solar variable frequency drive as per technical specifications and drawings including all required accessories.	Pcs	1	60,000	60,000
4	Cable Tray				
4.1	Supply, install, test and commission of Hot dip galvanized covered cable tray for DC combiner box cables, totalizer cabling and for all connections inside the technical room	LS	1	10,000	10,000
5	DC Combiner Boxes				
5.1	Supply, install, test and commission of waterproof IP65 metallic enclosure DC combiner Box as per technical specifications and drawings including accessories	LS	1	8,000	8,000
6	DC Solar Cable				
6.1	Supply, install, test and commission of solar PV and solar connectors	LS	1	8,000	8,000
7	AC Main Cable				

²⁷³ Based on conservative price estimations. Considering significantly changes in component prices over time, the price estimations will be updated during the detailed design phase in Year 1.

7.1	Supply, install, test and commission of AC power cable stranded type, TUV certified, double insulation material XPLE/PVC/ CU	LS	1	4,000	4,000
8	DC Totalizer Box				
	Supply, install, test and commission of waterproof IP65 metallic enclosure DC Totalizer Box as per technical specifications and drawings including accessories	LS	1	3,020	3,020
9	Technical Room BOS				
9.1	Supply, install, test and commission of all necessary components for a fully functional and safe system operation. BOS components should be installed in indoor enclosures with forced ventilation.	LS	1	15,000	15,000
10	Monitoring, logging and control	LS	1	12,000	12,000
11	Earthing and Lightning Protection System	LS	1	18,000	18,000
12	Poles				
12.1	Construct 2 or 3 poles elevated 6 meters over the ground level from PV array (totalizer box) to inverters room including all required civil works	LS	1	6,000	6,000
13	PV Field Fence and CCTV	LS	1	22,000	22,000
14	Water cleaning network system	LS	1	6,000	6,000
15	Labelling	LS	1	5,500	5,500
16	Testing & commissioning	LS	1	6,000	6,000
17	O&M manuals and training, including as built drawings	LS	1	11,000	11,000
18	Contingencies/unexpected expenses (20%)	LS	1	79,640	79,640
FINALT TOTAL per 250 kWp				477,840	
FINALT TOTAL for 1MWp				1,911,360	