Annex 2: Feasibility Study

Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector (BRCCJ)

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I. 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)
EBRD	European Bank for Reconstruction and Development
ECMWF	European Center for Medium-Range Weather Forecasts
EU	European Union
FAO-JO	Food and Agriculture Organization Representation in Jordan
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
GoJ	Government of Jordan
HH	Household
IFAD	International Fund for Agriculture Development
IFI	International Finance Institution
INGO	International Non-Governmental Organization
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
JV	Jordan Valley
JVA	Jordan Valley Authority
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
MWI	Ministry of Water and Irrigation
MoESR	Ministry of Education and Scientific Research
NAP	National Adaptation Plan
NAMA	Nationally Appropriate Mitigation Actions
NARC	National Agriculture Research Center
NCCC	National Climate Change Committee
NDA	National Designated Authority
NDC	Nationally Determined Contribution
ND-GAIN	Notre Dame Global Adaptation Index
NDVI	Normalized Difference Vegetation Index
NC	National Communication
OECD	Economic Cooperation and Development
OP	Operational Partner
PSC	Steering Committee
RCP	Representative Concentration Pathway
PMU	Project Management Unit
RRH	Rooftop Rainwater Harvesting
SD	Sustainable Development
SDG	Sustainable Development Goal
SNC	Second National Communication
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
WAJ	Water Authority of Jordan
WB	The World Bank
WWTP	Waste Water Treatment Plant
WUA	Water Users Association

II. 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.

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.

[1] Sources: IPCC and FAO

III. CURRENCY AND CONVERSION FACTORS

United States Dollar = 0.71 Jordanian Dinar
1 dunum = 1,000 m^2 → 10 dunums = 1 hectare
1 m3 = 1,000 liters

1. PROJECT SUMMARY

Abstract:

1. The goal of the seven-year project titled “Building resilience to cope with climate change in Jordan through improving water use efficiency in the agriculture sector (BRCCJ)” is increased climate resilient sustainable development in the country. The project is designed to further the objectives of the climate change policy (2013-2020) and the National Adaptation Plan (2020) by building the adaptive capacity of vulnerable households, communities and institutions in Jordan, The project is designed increase the resilience of water management systems and the agricultural sector to climate change. 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 deal with the lack of infrastructure, limited capacity of households and weak institutional capacity. They include; (i) Component 1: Climate Resilient Water Systems; (ii) Component 2: Climate Change resilience for Enhanced Livelihoods and Food Security; and (iii) Component 3: Scaling-up climate adaptation. The project builds on the idea of inclusion of Women as Change Agents for Climate Adaptation given that though they are vulnerable to climate risks they have the potential to be leaders and influencers.

2. The Project is the first and only country specific project which the MoE has included in the GCF country portfolio for submission during the first replenishment period of the GCF (2020-23). The investment is expected to reach 212,416 people including 47% women. An analysis of the Value for Money Metrics of the Project shows that the project investment is highly justified based on both financial and economic analysis. The project investments have an Economic Rate of Return of 25.34%. The Net Present Value was estimated to be US$ 86.1 million with a benefit- cost ratio of 3.47. The project is expected to achieve 3% to 3.5% reduction in groundwater overdraft and to contribute up to 4.5% to the water management goals in the National Water Strategy. Cumulative water savings are estimated at around 1.83 MCM in a 10-year period and 5.49 million cubic meters (mcm) for the project´s lifespan. In addition, 10,600 hectares of agricultural land area will be made more resilient with climate-adaptive measures in the project area.

3. The project is expected to have an impact on some key SDG targets by supporting farmers to adopt new technologies and practices that will increase their capacity to produce better and more productive crops and reduce poverty (SDG 1), promoting sustainable agriculture and helping to reduce food insecurity and hunger (SDG 2), helping to empower women and enhance their capacity as agents of change thereby reducing gender inequality (SDG 5), ensuring availability and sustainable management of water by enhancing water-use efficiency and ensuring good ambient water quality (SDG 6), making human settlements resilient and sustainable mainstreaming through climate adaptive planning and green building frameworks to rural areas (SDG 11) and strengthening resilience and adaptive capacity to climate-related hazards (SDG 13) through the range of adaptation strategies and activities that it is undertaking).

4. Total project costs are estimated to be US$ 33.25 million. The current project is based on a request for a grant from the GCF of USD 25 million (75% of total project cost). The Government of Jordan is committed to providing US$ 6.2 million (19%), and FAO and UNDP will co-finance USD 2.06 million (1 million and 1.06 million respectively, representing 6% of total costs). The beneficiaries are expected to provide USD 4.6 million for investments at the household level.

5. The project will be financed over a seven years period with a total budget of USD 33.25 million: **75%**- GCF, **19%**- The Hashemite Kingdom of Jordan, **3%** the United Nation Food and Agriculture Organization and **3%** United Nations Development Program (UNDP). Due to the level of public debt (> 94,6 % of the GDP), the Country is undertaking an important fiscal adjustment. Increasing the foreign currency debt (e.g. from IFIs) would represent an additional source of vulnerability. Therefore, the Country will not be able to provide additional resources to the project and GCF funding is needed to ensure the aimed paradigm shift. The executing entities of the project will be the FAO Representation in Jordan (FAO-JO) via a dedicated project management unit nested in the Ministry of Environment and UNDP Representation in Jordan (UNDP-JO). The project will work under the guidance of the

National Climate Change Committee representing all relevant stakeholders.

Adaptation Benefits

Project Objective	Most vulnerable people, communities and regions	Health and well-being, and food and water security
Increase the resilience of rural communities in Madaba, Karak, Tafilah and Ma'an.	Rural communities in project areas with special focus on women will increase their adaptive capacity by adopting innovative practices and technologies aimed at increasing water availability, agriculture productivity and maximizing the use of available resources	The project will contribute to enhance water security of beneficiaries and support policy makers in scaling up introduced practices and technologies at the national level

Table 1: Project's Benefits 8Y (Adaptation)

Other Expected Co-Benefits: The project will have additional beneficial impacts on the environment, gender, youth and the economy. Table 2 below briefly summarized the major expected impacts on Jordan's sustainable development (SD).

Environment	Reduced pollution from wastewater due to water reclaiming and distribution for irrigation of fodder and other allowed crops. .
Gender	The project will expand women's social and economic freedoms by focusing on their role as change agents, decision-makers and experts as well as increasing their access to resources required to meet their practical needs.
Economic	The project is expected to generate both quantitative and qualitative economic co-benefits for HHs. This will be possible thanks to water saving and rainwater harvesting technologies that will immediately reduce the expenditures of HHs for water and the new climate smart practices and technology that the project will promote.

Table 2: Projects Co-Benefits

Methodology and approach: As mandated by the NDA, FAO as Accredited Entity approached the preparation of the proposed climate investment project by analyzing results deriving – among other - from the following main sources:

a) Comprehensive literature review including ongoing and past projects;
b) FAO Geospatial analysis of target areas and related water basins[2];
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 target areas via field visits, community consultations, focus groups and 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.

Literature Review: FAO and NDA teams collected and analyzed 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.

FAO GeoSpatial Analysis: 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

[2] FAO has developed a new application that allow access to and elaboration of the main international databases on remote sensing and climatic data.

approach not only to support project design but to be accessible in future for monitoring and evaluation activities, as well.

6. FAO deployed Earth Map in Jordan (among other countries) in order 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 institutes[3], allowed for a clear understanding of Jordanian 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 (the Ministry of Environment, the Ministry of Agriculture and the Ministry of Water and Irrigation): Data and analysis produced by FAO experts have been verified with the Ministry of Environment (NDA) and with the focal point for climate change in each of the ministries represented in the National Climate Change Committee.

'Ground-truthing' of climate variables with representative focus groups in target areas: As part of the national engagement process / national ownership and given the importance of community participation in the project, FAO validated project's baselines with communities via meetings with locally active CSOs and institutions. Additionally FAO hired a specialized Jordanian expert with longstanding experience with international organizations such as UNDP, WB, USAID and others to undertake a household socio-economic and climatic survey in target areas so to complement and update the baseline available in literature.

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

2. BACKGROUND INFORMATION

Country Economic Background

7. The Hashemite Kingdom of Jordan is currently classified as an upper middle-income country[1]. However, GDP growth averaged 6.4% during 2000–09 and fell below 2.5 % over 2010–18[2]. In 2018, GDP growth was 1.9% and a modest 1.8 % is estimated for 2019[3]. The unemployment rate raised up from 18.7% to 19.2% between 2018 and 2019 and fiscal deficit accounts is estimated at 2.8% of the GDP showing an increase from 2017 estimates (2.3%) – see Table 3.

	Indicator	Period	Source of information
% GDP growth	1.8%	2019	IMF March 2020
Exchange rate JOD/US$	0.71	2019	IMF March 2020
Unemployment rate	19.2%	2019	EIU December 2019
Inflation rate	0.5%	2019	EIU December 2019
Public debt/GDP ratio	94.4%	2019	Finance Ministry Bulletin 2019
Current-account deficit/GDP	3%	2019	EIU December 2020
Lending interest rates	8.7%	2019	EIU December 2019
Agriculture/GDP	3%	2019	EIU December 2019

Table 3. Key Macroeconomic indicators.

8. The weak performance of growth is a consequence of the sluggish domestic and external demand and the fiscal consolidation efforts which had impacts on unemployment rates (Table 4). The exchange rate is pegged to the US dollar at 0.71 JOD/USD and inflation is expected to be kept under control (between 0.3 and 1.1 percent) given the fall in import commodity prices in 2019. This could change in the future if there is an increase in import commodity prices. The country has a very high public/debt ratio estimated at 94.4% in 2019. Dependence on food and energy imports explains the country´s large structural trade deficit. In 2019, current-account deficit is estimated 3% of GDP.

Annual data	2019
Population (m)	10.6
GDP (US$ bn; market exchange rate)	43.8
GDP (US$ bn; purchasing power parity)	98
GDP per head (US$; market exchange rate)	4,145
GDP per head (US$; purchasing power parity)	9,280
Historical averages (%)	**2015-19**
Population growth	3.7
Real GDP growth	2.1
Real domestic demand growth	1.8
Inflation	1.4
Current-account balance (% of GDP)	-7.9
FDI inflows (% of GDP)	3.5

Table 4. Key Macroeconomic indicators II (EIU; 2020)

9. The country´s classification as a MIC does not consider the burden the country is facing of hosting refugees. The population of Jordan was estimated to be 10.2 million in March 2020[4] including 1.3 million Syrian refugees[5] and refugees from a host of other countries as well[6]. In addition, the country's economy and society have faced significant shocks in the past few years. The regional conflicts in Syria and Iraq,

[1] World Bank June 2019. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
[2] Economic Intelligence Unit- Country Report: Jordan, December 2019.
[3] World Bank estimates.
[4] https://www.worldometers.info/world-population/jordan-population/
[5] Jordan Economic Growth Plan 2018 - 2022 The Economic Policy Council. The Economic Policy Council.
[6] UNHCR Fact Sheet. May 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/69826.pdf

the country's main trading partners, seriously damaged Jordan's trade routes and capital inflows. The influx of refugees continues to exert tremendous pressure on, not only its infrastructure and social services, but also on its labour market and social cohesion. As a result, the country's macroeconomic indicators weakened, the fiscal deficit rose, and financing the external sector became challenging.

10. Jordan was among the first countries in the region to adopt an immediate response to contain the spread of the COVID-19 in February 2019. In addition to sealing off its borders and suspending all flights, giving all public sector employees two weeks of leave and suspending schools and universities, Jordan has imposed a complete nationwide lockdown since March 20, 2020. Since the lockdown duration is unpredictable during the current design, it is difficult to speculate how much the economy will suffer. IMF support to pursue economic reforms (supported by a US$1.3bn IMF programme) was shifted to mitigate the impact of the coronavirus, which will affect consumption and investment. As a consequence, negative GDP growth and a significant widening of the budget deficit in 2020 (EIU; 2020).

11. In March, the International Monetary Fund (IMF) predicted that the kingdom's gross domestic product will grow by 2.1% in 2020. Following the lockdown and amid the global coronavirus outbreak, that figure is no longer realistic. The Central Bank has taken a series of measures to provide relief to the economy. The central bank also called on banks to reschedule loans and offer appropriate grace periods with no additional charge to their clients. The pandemic is likely to worsen the economic pressures on the country[1].

12. Regardless of the efforts made in reforming its economy, challenges increased as a consequence of the impact of the ongoing COVID-19 outbreak, regional conflicts, and the hosting of Syrian refugees weigh on social conditions, public finances, investment, and the external accounts (as it was mentioned in the last IMF press report).

13. Despite its small contribution to national GDP (<6%), the agriculture sector is of critical importance in Jordan, for its socio-economic fabric, and role in political stability, as well as its central role in food security, rural development, providing job opportunities, and the forward and backward linkages it creates. The country has limited land resources and only around 5 percent of its land area is arable. Much of Government of Jordan's (GOJ's) domestic agricultural policy is focused on the management of its scarce and rapidly depleting water resources in an effort to support its traditional livestock owners and develop an export-oriented horticultural sector[2]. Jordan currently imports the vast majority of its basic food crops, including almost all of its cereals. The Jordan Economic Growth Plan has set a target of 5% growth in GDP and the expectation is that agriculture will have to grow by 10% to meet this target. The request for financing to GCF is premised on the GoJ's understanding that it needs to prioritize a series of measures and investments to deal with its vulnerability to climate change which further exacerbates its problems of water scarcity and rural growth and development. In recent years, the impact of flash floods on the all- important tourism sector that was evident in 2018 has also taken a toll on projected growth.

[1] https://www.al-monitor.com/pulse/originals/2020/03/jordan-lockdown-economy-measures-coronavirus.html#ixzz6HrNu9CP8
[2] USDA Foreign Agricultural Service, 2015. Market Overview and Guide to Jordanian Market Requirements.

The water sector

14. Water scarcity in Jordan is absolutely a major and critical challenge that continues to jeopardize all aspects of development with limited conventional water resources, increasing demand due to high population growth, hosting several fluxes of refugees, economic development needs, increasing drought events, climate change, geography and the regional geopolitical environment. It is the main hazard identified to impact Jordan due to climate change.

15. Jordan's conventional, or natural, water resources originate in rainfall, groundwater, and surface waters (Table 5). The country has developed various ways in which to capture, store and distribute these waters, and it has developed some unconventional water resources such as treated wastewater, as well as the utilization of the dam surface water.

Source	Municipal	Industrial	Irrigation	Livestock	Total
Surface Water	103.8	4.8	143	7	258.6
Jordan Rift Valley	91.4	4.8	83	0	179.4
Springs	12.5	0	20	0	32.5
Base and flood	0	0	40	7	47
Groundwater	325	32.2	231.2	0.1	588.5
Renewable	207.2	19.3	189.4	0.1	419.2
Non renewable	107.2	12.9	41.8	0	162.1
Abo Zeighan	10.2	0	0	0	10.2
Treated waste water	0	2	123.3	0	125
Total	429	39	497.5	7.1	972
Total including additional 225 MCM used for irrigation which were estimated using remote sensing techniques					1197

Table 5: Water Supply Sources in Jordan in MCM- 2014[1]

16. The estimated renewable water resource base corresponds to approximately 780 million m3. Of these 275 million m3 is groundwater, the remaining amount comes from surface water sources and runoff stored in wadis[2]. Waste water treatment plants make further available approximately 116 million m3/year of reclaimed wastewater to be stored in Wadi dams and then used for irrigation in the Jordan Valley, and this value is increasing as treatment capacity expands across the country (3).

17. Jordan's water crisis is exacerbated by an observed long-term decline in rainfall (Rahman et al. 2015). This climate change-related decline in rainfall is compounded by increased consumption - influenced by population growth and refugee influx. These two trends mean that the availability of water resources per capita declined dramatically from 3.600 m3 per year in 1946 to 145m3/p/a in 2008 [MWI, 2008]. It fell hence well below the standard water poverty threshold of 500m3/p/a, leading the Kingdom to become one of the most water-constrained countries in the world (14). By 2025 the water demand is expected to exceed available resources by more than 25% and water availability to fall below 90 m3 per capita. Water use is mainly for agricultural purposes (51%), followed by domestic consumption (45%) and industrial use (4%). Agriculture is moreover responsible for 53% of surface water, 39% of groundwater and 91% of treated wastewater consumption. During the 2006-2015 period, groundwater use, treated wastewater and domestic use show a sustained growth (2.5%, 7% and 5.7% per year, respectively), with all other sources and uses constant during that period (37).

18. Despite the enormous pressures on already scarce water resources, in particular through continuous population growth due to forced migration, the country achieved some significant progress in the last decades with regards to the following aspects (16):

- Jordan has a relatively well established network of wastewater treatment plants and the amount reclaimed is increasing steadily, corresponding to 147 million m^3 in 2014. Almost 91% of treated wastewater is reused for agriculture;
- With 94% of the population having access to safe drinking water it has one of the highest coverage rates in the region;
- About 93% of the population have access to improved sanitation;
- Compliance to the microbiological indicators of the WHO for the water supplied in the entire country was 99.7%.

[1] Source: Ministry of Water and Irrigation, Water Reallocation Policy, 2016
[2] The bed or valley of a stream that is usually dry except during the rainy season.

19. Due to the overall water shortage in Jordan, the use of reclaimed wastewater is a key pillar of the country's climate adaptation and water sector strategies. About 90% of the reclaimed wastewater produced is reused directly (direct agreements with farmers) or indirectly (mixing with rainwater and surface water in dams). The collected wastewater is treated in 34 public wastewater treatment plants (Table 6 reporting the major 9). In order to obtain optimal and quick treatment of wastewater, in most of the WWTP the mechanical treatment system is used (28 out of 34)[1].

WWTP	2015/2016 Influent (m^3/day)	2015/2016 Effluent (m^3/day)	2015/2016 Operation Ratio %	2016/2017 Influent (m^3/day)	2016/2017 Effluent (m^3/day)	2016/2017 Operation Ratio %
Tal Mantah	363.2	355.8	90.80	383	377	95.8
Jiza	773	700	17.18	895	868	19.9
Shobak	95	85.5	27.14	153	-	-
Samra	294862	269802	81.01	344549	316832	95.7
South Amman	5000	4500	9.62	16219	15732	31.2
Wadi Shallala	5912	5655.5	43.15	8421	8015	61.5
Mutah-Mazar-Adnaniyyah	1203	1164.4	15.83	1369	1059	18
North Shouna	777	660.7	64.75	655	635	54.6
Za'atari camp	840	780	47.73	1468	-	-
TOTAL	418 000	382 000	62.6%	482 177	449 339	64.64%

Table 6: Development of Influent, Effluent and Operation Capacity for WWT plants in Jordan[2]

20. The overall amount of treated effluent produced by WWTPs in the year 2012 was 118 MCM and the overall area irrigated with treated effluent at the WWTPs was 14.266 Donum that same year (WAJ, 2012), which represents around 6% of the total land irrigated either directly or indirectly with treated wastewater.

21. According to agreements signed with farmers and other official entities, WAJ provides treated water either inside the plant premises or in the vicinities of the plants. The agreements guarantee provision of water in the rate $3m^3$ a day for each dunum. The total cultivated area is estimated to range between 14934 to 14758 dunum (Table 7). Theoretically, according to the signed agreements, the total amount of water supplied to farmers should not exceed 16.02 MCM per year. In addition to the total quantities of water used in agriculture, around 1.83 MCM per year is currently used by Phosphate Mines Co. for cooling purposes. This amount is coming from Aqaba Plant. The reuse of reclaimed water is strictly regulated by the Reclaimed Domestic Wastewater Standard No 893/2006, which affirms that reclaimed water (treated wastewater) can only be used for irrigation of non-edible crops such as forage crops and nurseries and trees.

Treated water consumption in premises and vicinities of WWTP

No.	WWTP	Total cultivated areas irrigated with treated water(dunum)	Actual consumption of treated water (MCM/ Year)
1	Assamra	5103	20
2	Aqaba	2080	4.20
3	Ramtha	1206	1.18
4	Mafraq	387	0.60
5	Madaba	862	1.57
6	Ma'an	205	0.22
7	Kufranja	571	0.63
8	Salt	48	0.05
9	Baq'a	447	0.49
10	Karak	589	0.64
11	Tafila	114	0.12
12	Wadi Al-Seer	62	0.07
13	Wadi Hassan	721	0.27
14	Wadi Musa	1069	0.71
15	Al-Akader	994	1.16
Total		**14758 (Dunum)**	**31.91 (MCM/ Year)**

Source: WAJ, 2009.

Table 7: Treated water consumption per WWT in 2009

22. The reuse of reclaimed water in irrigation is accompanied by water saving irrigation management

[1] Source: Ministry of Water and Irrigation, Jordan Water Sector Facts & Figures -2017)
[2] Source: Ministry of Water and Irrigation, Water Year Book- Hydrological Year 2016-2017

practices and technologies. Farmers mainly use mulch (plastic cover on soil) and drip irrigation in order to avoid excessive evaporation. This practice positively influences microbiological quality of the crops as well. The use of mulch and drip irrigation is considered as very effective barriers for a microbiological contamination. For example, the irrigation system in Wadi Musa (Ma'an governorate) uses pure reclaimed water directly form the WWPT and also applies drip irrigation.

23. The Government is spending between 2% and 4% of the GDP for the management of the water sector, in line with the 1-5% of the MENA countries. Costs for water and sanitations are heavily subsidized and correspond to less than 0.92% of the total household expenditures (16). The MWI is with 1.3 billion highly indebted (2016), which is to a large share attributable to the servicing debt. This substantial burden is of course hampering the abilities to undertake necessary rehabilitations of infrastructure. Non-revenue water reaches 52% (38). Furthermore the National Water strategy itself stated that the gap between expenditure and revenues is continuously growing (16). CC will aggravate already existing problems and act as a multiplier.

The agriculture sector

24. The contribution of the agricultural sector to the Gross Domestic Product (GDP) in the year 2019 amounted to 5.6%[1]. The sector employs officially only 2.7% of the population. Still, these statistics do not include casual labor and small-scale farming. According to IFAD's estimations, about 20% of the population depends directly or indirectly from agricultural and it is the primary source of income for about 7-8% (42). The socio-economic costs for a diminishing sector could therefore be substantial.

25. In spite of its low contribution to GDP and employment, agriculture is one of the most important sectors due to its role in providing the country with large volumes of the domestic food needs, especially fresh fruits and vegetables. Nowadays, Jordan is more than self-sufficient in different types of vegetables and some fruits. Vegetables comprise the major portion of agricultural exports. The major challenge facing the agricultural sector in Jordan is how to satisfy the increasing demand for food supplies (food security) given the economic, policy, environmental, and social/cultural constraints.

26. Arable land shifted from 3.1% (1961) to about 2.7% of the total territory in 2016. The JVA estimated the potential area for irrigated cultivation to be around 840,000 ha but the scarce water availability limits this area currently however to a total of approx. 85,000 ha (33) while about 5% of the agricultural area receives enough rainfall to permit cultivation without irrigation. Most of the irrigated area is in the Jordan Valley, however there are also areas found in the south and south east of Amman and in the upper Dead Sea Basin. Rain fed agriculture is mainly carried out in the northern and western Highlands. Agricultural productivity has greatly increased over the years but water and related technologies remains a decisive limiting factor, Agricultural production and marketing are generally liberalized, but there are some government interventions such as the purchases of cereals at guaranteed prices.

27. As highlighted in the TNC (2014), agriculture depends on water availability as well as on the ability to adopt advanced water harvesting technologies and practices to mitigate the adverse impact of freshwater variability and, increasingly, climate change. Therefore, regions with high potential for agriculture exist (mainly the Jordan Valley and the Highlands). Nonetheless, since these regions experience also pressure from urbanization and other development activities, agriculture is also exposed to growing pressure including from internal migrants from southern and eastern areas of the country. Migration from rural areas has brought urban population from about 51% of 1960 to about 91% of 2018 [WB, 2020]. With the exception of the Jordan valley, efficiency in irrigation is still very low due to insufficient technology and equipment and lack of knowledge. Ultimately, the sector has limited knowledge of specific climate-smart agriculture practices and mainstreaming across institutions and stakeholders of the sector is limited.

28. Field crops such as cereals and legumes are widely produced in Jordan, mainly under rainfed conditions. As indicated in table 8, the total cultivated area of field crops in the Kingdom in 2017 was 737 thousand Dunum (73.7 thousand hectares). The major cultivated field crops are barley, wheat and clover. The table shows that wheat and barley are cultivated in the four governorates of the project area. The cultivated area of field crops in the project area represents 41% of the country's cultivated area (Table 8).

[1] https://data.worldbank.org/indicator/nv.agr.totl.zs

Field Crop	Jordan	Madaba	Karak	Tafileh	Ma'an	Total four governorates
Wheat	121908	14246	28565	2799	22184	67794
Maize	12616	10	1234		10	1254
Sorghum	509		39			39
Barley	564582	18773	142444	15645	46904	223766
Lentils	1237	29	137	2	10	178
Chick-peas	4635	47	159	16	17	239
Garlic	1353		44		442	486
Sesame	86					0
Tobacco, local	3					0
Clover trefoil	23085	190	574			764
Vetch-common	851	15	170		2981	3166
Vetch	4912		3438			3438
Other	955		8			8
Total (Dunum)	**736,732**	**33,310**	**176,812**	**18,462**	**72,548**	**301,132**

Table 8: Cultivated Area of Field Crops by governorate, Jordan, 2017 (Dunum)[1]

29. The main vegetable crops produced in Jordan are tomatoes, cucumbers, eggplants, squash, and potatoes as indicated in table 9. The table also shows the cultivated area of each crop in the four governorates of the project area and in the country[2]. The total cultivated vegetable area in Jordan in 2017 was 377 thousand dunums (37.7 thousand hectare). While the cultivated are in the same vegetables in the project area was 83 thousand dunum, representing 22% of the total cultivated area of Jordan. The major vegetable crops cultivated in the project area are tomato, dry onion, Jew's mallow, watermelon, sweet melon, string beans and potato. The largest cultivated area in the project area is in Karak governorate which occupies two-thirds of the area in the four governorates.

Vegetable crop	Jordan	Madaba	Karak	Tafileh	Ma'an	Total of four Governorates
Potatoes	40082		63	280	1850	2193
Tomatoes	121945	337	37158	795	9758	48048
Squash	27573	70	2169	24	2	2265
Eggplants	19641	42	1759	0	19	1820
Cucumbers	16542	365	414	47	51	877
Cabbages	8328		369	1	62	432
Cauliflower	13844	24	358	0	132	514
Hot peppers	4806	14	717	0	5	736
Sweet peppers	17394	7	696	17	5	725
Broad beans	5662	102	629	0	19	750
String beans	5461	54	2473		370	2897
Peas	1242	1	89		0	90
Cow-peas	687	11	271			282
Jew's mallow	9157		5066			5066
Okra	7669	177	431		40	648
Lettuce	13649	8	38		0	46
Spinach	917		128			128
Snake cucumbers	2394	14	503	3		520
Parsley	2016		7			7
Other	8107	132	403	1	46	582
Radish	1187	8	26			34
Turnip	1059		3			3
Carrots	2716	31	1			32
Watermelons	14882		1781	140	2585	4506
Sweet melons	11941	94	2860	100	867	3921
Onion, green	3613	33	709		2	744
Onion, dry	14446	3	3767		1390	5160
Total (Dunum)	**376,960**	**1,527**	**62,888**	**1,408**	**17,203**	**83,026**

Table 9: Area, Average Yield and Production of Vegetables in Jordan - 2017[3]

30. The total cultivated area of fruit trees in Jordan in 2017 was 780 thousand dunum of which 418 thousand dunum under irrigation and the rest is rainfed. The main fruit trees cultivated in Jordan is olive, which is cultivated under both rainfed and irrigation conditions all over the country. Other main crops include peaches, grape, lemon, banana and dates. Table 10 shows that the major fruits cultivated in the project area are olives followed by apples and apricots. The total cultivated area in the project

[1] Source: Department of Statistics/ Agricultural Census 2017
[2] A detailed crop calendar for the country is available in Appendix 3 of this Annex.
[3] Source: Department of Statistics/ Agricultural Census 2017

area is 81 thousand dunums representing 10.4% of the cultivated area of Jordan. The largest cultivated area is in the project area is in Karak followed by Madaba then Ma'an and Tafelieh.

Fruit Crops	Jordan			Madaba			Karak			Tafelieh			Ma'an			Total four Governorates		
	Rain-fed	Irrigated	Total	Rain-fed	Irrigated	Total	Rain-fed	Irrigated	Total	Rain-fed	Irrigated	Total	Rain-fed	Irrigated	Total	Rain-fed	Irrigated	Total
Figs	607	588	1,195	16	1	17	9	37	46	-	10	10	-	15	15	25	63	88
Bananas	-	7,156	7,156			-	-	1,215	1,215			-			-	-	1,215	1,215
Guava	-	3,102	3,102	-	272	272	-	103	103	-	192	192	-	-	-	-	567	567
Dates	-	32,226	32,226	-	15	15	-	1,114	1,114	-	-	-	-	2	2	-	1,131	1,131
Citrus	-	64,211	64,211	-	71	71	-	160	160	-	43	43	-	2	2	-	276	276
Grapes	5,855	23,084	28,939	587	125	712	192	885	1,077	442	239	681	2	438	440	1,223	1,687	2,910
Olives	348,320	213,821	562,141	17,959	3,216	21,175	14,712	7,946	22,658	4,709	3,037	7,746	480	11,721	12,201	37,860	25,920	63,780
Almonds	2,168	1,159	3,327	52	59	111	30	37	67	45	44	89	-	179	179	127	319	446
Peaches	491	27,005	27,496	9	45	54	-	1	1	1	13	14	-	784	784	10	843	853
Plums, Prune	1,131	1,666	2,797	86	83	169	-	-	-	27	20	47	-	4	4	113	107	220
Apricots	603	14,691	15,294	2	38	40	1	2	3	-	11	11	-	2,049	2,049	3	2,100	2,103
Pomegranates	285	7,600	7,885	26	21	47	6	10	16	2	3	5	1	249	250	35	283	318
Apples	1,348	6,203	7,551	-	21	21	-	21	21	-	4	4	-	4,986	4,986	-	5,032	5,032
Pears	94	2,105	2,199	-	-	-	-	-	-	-	-	-	-	17	17	-	17	17
Nectarines	2	8,595	8,597			-	-	-	-			-	-	50	50	-	50	50
Cherry	432	749	1,181	-	-	-	-	-	-	-	-	-	-	541	541	-	541	541
Other	1,354	3,982	5,336	456	12	468	4	20	24	2	125	127	-	720	720	462	877	1,339
Total	**362,690**	**417,943**	**780,633**	**19,193**	**3,979**	**23,172**	**14,954**	**11,551**	**26,505**	**5,228**	**3,741**	**8,969**	**483**	**21,757**	**22,240**	**39,858**	**41,028**	**80,886**

Table 10: Area of fruits trees cultivated in Jordan and the four governorates under rainfed conditions and irrigation – 2017[1]

31. According to IFAD, a UN organization with over 30 years of experience in the sector in Jordan, agriculture is key to achieve sustainable development in rural areas. Irrigated agriculture is economically more attractive than rainfed agriculture, in fact production from irrigated area represents 90% of the total economic value of the sector. About 46% of the water utilized in irrigated agriculture is abstracted from wells, 28% from surface water and the remaining proportion is reclaimed wastewater.

32. Jordan's agricultural sector is vulnerable to climate change. Increased temperature is expected to lead to higher crop evapotranspiration, which in turn will increase irrigation water demand (i.e., it will increase the amount of water needed in agriculture). An increase of temperature by 2ºC would increase irrigation demand by 18% (35). More variable and scarce rainfall under climate change means that water supplies to irrigation through groundwater and surface water sources are projected to become more unreliable. Therefore, considering the described projections (increased temperature and reduced precipitation), climate change is a crucial element to consider in planning and developing the sector as while (35).

33. Providing a sustainable water supply for the agricultural sector will enhance resilience to climate change and strengthen its role in ensuring rural employment and development. Adverse impacts to the agricultural sector could significantly interfere with progress of the country related to poverty reduction, due to the greater dependence of the rural poor on the sector, their lower ability to adapt and the fact that the share of income spent for food is particularly high. Food security and rural economic growth are also expected to be adversely impacted. Lower income from agricultural activities can most likely reduce the ability to adapt to climate change, as agricultural families have to cope with reduced water availability by purchasing new resources (e.g. water tanks and/or purchase of bulk water) that negatively impact household economy.

Direct and indirect agricultural support (subsidies)

34. **Water.** Water consumption is subsidised in different ways depending on the supply source:

- Ground water source for agricultural production in the uplands. Most of these waters are provided thorough privately owned wells across the many groundwater basins in the uplands, Disi and Wadi Araba region. Jordan is heavily dependent on groundwater resources (it is estimated by over 50% of supply). In addition, 10 out of the 12 groundwater basins are over-exploited and agriculture is the largest water consumer with 56% of the water use. The ground water in the highlands is subsidized in two ways: 1) subsidized tariffs for agricultural usage; and 2) famers are not charges for the first 100 thousand cubic meters of water. Those two subsidies do not encourage farmers to save water and certainly, the major cause of depleting the ground water precious resources;
- Surface water: This is the major source of water in the Jordan Valley, the largest agricultural area of Jordan. The water is channeled through King Abdulla channel from the Yarmouk river and

[1] Source: Department of Statistics/ Agricultural Census 2017

other groundwater wells from the Yarmouk basin. The water is distributed by the Jordan Valley Authority the water user's associations (WUA) at a subsidized price. The farmers pay also here a subsidized tariff for the distributed water and receives also a subsidized electricity tariff;

- Treated waste water (reclaimed water). This is the growing water resource in Jordan originating from tens of wastewater treatment plants over the country. The largest is the Samra, which produces large amounts of treated wastewater channeled to King Tala reservoir and then mixed with waters in King Abdulla channel to irrigate certain parts of the Jordan valley in the central and the south. This type of water is also subsidized as in the case of the surface water in the Jordan Valley.

35. **Credit** The major source of formal agricultural credit is the Agricultural Credit Corporation (ACC), which is semi-public corporation provides subsidized credit to farmers in the form of seasonal, mid-term and long-term loan. The current policy of ACC include a zero percent interest rate[1] and a grace period of 5 years. Other informal sources of credit are the private sector such as input suppliers and middlemen at the wholesale markets. Private Banks do not provide any credit or loans to farmers, due to the high risk associated with farming.

36. **Animal feed.** The government provides subsidy to sheep and goat herders in the country. The subsidy to grain barley fed to animals is estimated at $US 100 million[2]. Barley's main use is for animal fodder. Consumption in MY 2018/19 is forecast at 800,000 MT, largely unchanged from the USDA official MY 2017/18 estimate. Imports are forecast in MY 2018/19 to reach 750,000 MT, up50,000 MT from the USDA official MY 2017/18 estimate[3] . Romania remains the main supplier (followed by Russia and Ukraine).

Identified challenges in the latest agricultural strategy

37. Despite the various advancements and increase in productivity, agriculture in Jordan still faces many challenges and most are climate related ones. The country has developed its strategic policy framework to address the following:

- Challenges related to agricultural lands:
  - Urbanization crawling to major agricultural and rangelands.
  - Land fragmentation caused by the inheritance laws and the land tenure system.
  - Desertification caused by climate change, overgrazing and wrong farming practices.
  - The soil salinity resulting from the salinity of the water and the absence or weak drainage.
- Challenges related to agricultural waters:
  - Lack of water resources.
  - Deterioration of water quality.
  - Violations on surface and ground water resources.
- Challenges related to environment and biodiversity:
  - Deterioration of dry lands agrobiodiversity especially in the Badia region.
  - Deterioration of land vegetation cover and forests.
  - Climate changes and its negative impacts on biodiversity.
  - Improper usage of agricultural pesticides.
  - Urbanization expansion to biodiversity habitats.

[1] Being Jordan an Arab-Islamic country, interest rates are a sensitive and political variable. Therefore the ACC does not seem to have a fixed policy concerning interest rate.
[2] https://egyptssp.ifpri.info/2016/01/27/rethinking-food-subsidy-in-jordan/
[3] https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Grain%20and%20Feed%20Annual_Amman_Jordan_3-14-2019.pdf

Natural Resources, climate and climate change

38. Jordan is a relatively small (89,342 km²), semi-arid country in the Middle East, bordered by Syria to the north, Iraq to the east, Saudi Arabia to the east and south, and Israel and the West Bank to the west. The Dead Sea is located along its western borders, and the country has a 26km coastline along the Red Sea at the south-west. The climate of Jordan is mostly arid with a relatively short rainy season between November and April. The topography of the country is highly contrasting; from more than 400 meters below sea level at the Dead Sea to 1,854 meter above sea level (asl) at the southernmost boundary in Um Addami Mountain. There are four main bio-geographical regions in Jordan [GoJ, 2015]:

a. Mediterranean: Limited to the highlands, the Mediterranean region extends from Irbid in the north to Ras Al-Naqab in the south, with some isolated representation in the mountains of Wadi Rum. The altitude ranges from 700 to 1850 m above sea level. Annual rainfall ranges from 300 to 600 mm. Minimum annual temperature ranges from 5 to10º C and mean annual maximums range from 20 to 30º C. Soil is dominated by the red Mediterranean soil (terra rosa) and the yellow Mediterranean soil (rendzina). This region comprises the most fertile part of the Kingdom and hosts 90 percent of the total population.

b. Irano-Turanian: This region is a narrow strip of variable width that surrounds the entire Mediterranean ecozone except in the north. A characteristic of this region is that it is treeless; vegetation is primarily constituted of small shrubs and bushes such as Artemisia herba-alba and Anabasis syriaca. Altitudes range from 500 to 700 m, and annual precipitation ranges from 150 to 300º mm. Mean annual minimum temperatures range from 5 to 2º C, and the mean annual maximum ranges from 15 to 25º C. Soils are mostly calcareous or transported by wind. The vegetation is dominated by chamaeophytes.

c. Saharo-Arabian: This is the eastern desert or Badia and is the largest part of Jordan encompassing, making up approximately 80 percent of the total area. The Saharo-Arabian region is flat except for a few hills or small mountains, the result of volcanic eruptions. Altitudes range between 500 and 700 m. Average annual precipitation from 50 to 200 mm; mean annual minimum temperatures range from 15 to 2º C and the mean annual maximum ranges from 25 to 40º C. Soil is mostly poor: either clay, hamada, saline, sandy or calcareous. Vegetation is dominated by small shrubs and small annuals in the wadi beds.

d. Sudanian: Starting from the northern part of the Dead Sea, the Sudanian region ends at the tip of the Gulf of Aqaba in the south along the Dead Sea depression and Wadi Araba. The most important characteristic of this region is the altitude, considered to be the lowest point on earth (410 m below sea level near the Dead Sea). Annual rainfall ranges from 50 to 100 mm; mean annual minimum temperatures range from 10 to 29º C, and mean annual maximum temperatures range from 20 to 35º C. Soils are mostly alluvial, saline, sandy and granitic. The only inland sand dunes are found in this region. The vegetation is characterized by tropical trees such as Acacia spp. and Ziziphus spina-christi, in addition to some shrubs and annual herbs.

39. About 95% of the country is arid and very-arid while the remaining proportion of country's area is semi-arid (Figure 1). Jordan's orographic diversity and geographical position between the European, Asian and African continents− contributes its variety of bio-geographical regions and ecosystems. As reported in the Aligned National Action Plan to Combat Desertification (ANAPCD) in Jordan (2015-2020), these include:

(i) Deserts (Badia) with poor plant cover; sub-tropical ecosystems, (e.g. Sudanian flora);

(II) Aquatic ecosystems (e.g. rivers, wadies and wetlands);

(III) Highlands (e.g., mountains, hills and plateaus); and

(IV) Steppe, a transitional area where desert biota is gradually replaced by "Mediterranean" biota.

40. Therefore, land cover and land use in Jordan is a complex and diverse mosaic forged by a mixture of rural and urban activities resulting from both climate and socioeconomic drivers. Reportedly (ANAPCD, 2014), about 93% of the country is dominated by rangeland and rooky beds. Agriculture areas cover about 2.7% of the total area with 90% of rainfed agriculture taking place in the northern and western highlands. Irrigation is taking place in Jordan Valley (JV), highlands and desert areas.

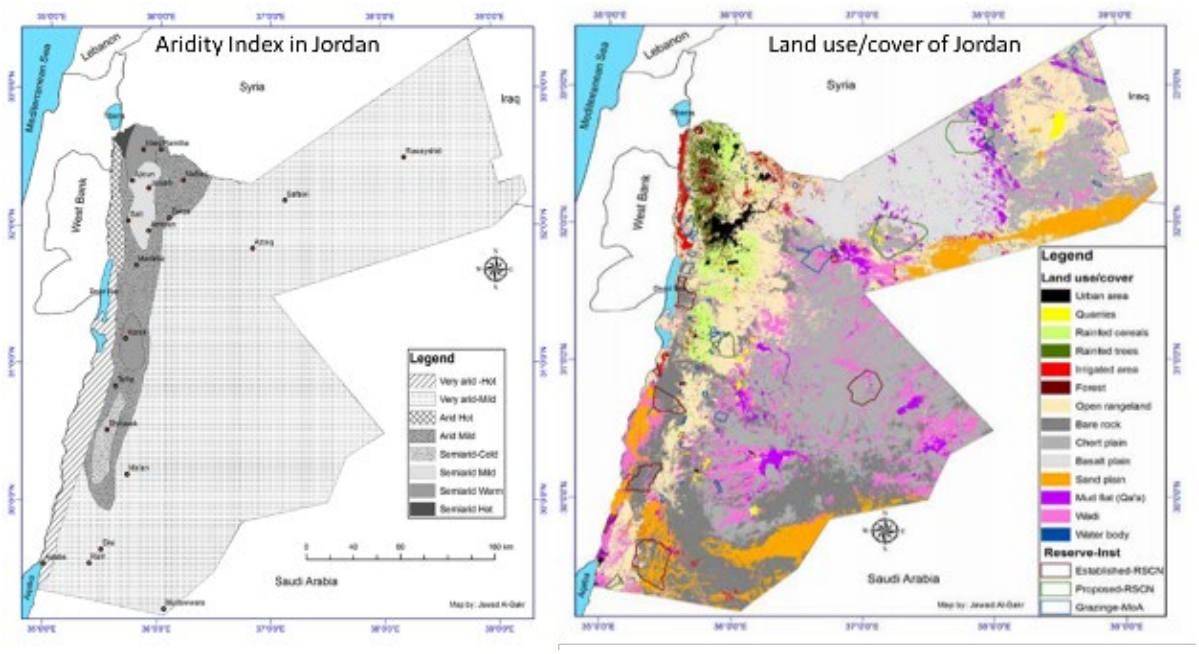


Figure 1: Jordan aridity index and land use/cover

41. The average annual air temperature in the country is 18.6C°, ranging from 13°C in the Southern Badia to 28°C in Aqaba. The Dead Sea basin has an average temperature fluctuating between 16C° and 21 C°, with average minimum temperature ranging from <7C° to 18C°. The maximum temperature is distributed almost uniformly in the whole country and corresponds to an average of 25.3°C (14).

42. Jordan is one of the most water scarce countries in the world. Most of the country (92%) can be considered arid to semi-arid, having an average annual precipitation of less than 200 millimeters (3). The total average annual rainfall volume corresponds to 8.884 MCM (data 2014/2015; 37). The rainy season is taking place from October to May with 80% of the rainfall occurring from December to March and a maximum rainfall in January. There is a significant variation of precipitations between the different climate regions as can be seen in figure 2: the amount is ranging from 28 millimeters at the southern Badia region to a maximum of 570 millimeters at the upper northern highlands of Ras Muneef (14). Potential evapotranspiration typically exceeds rainfall. Approximately 92% of rainfall evaporates, while only 5.4% recharges the groundwater and the remaining 2.4% becomes surface water [Adaileh, 2019].

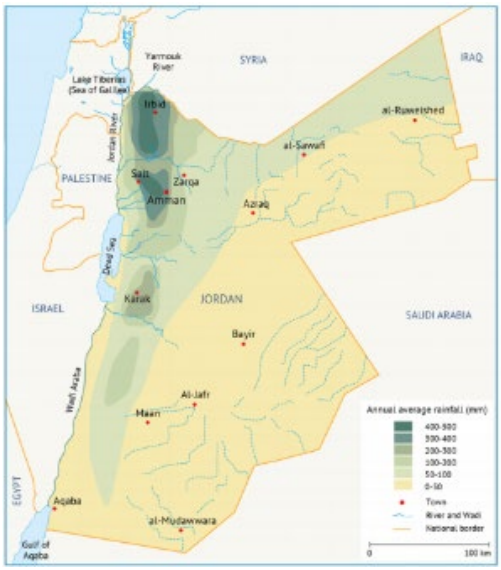


Figure 2: Distribution of average annual rainfall (3)

43. As reported in the third national communication (TNC) and the CC Knowledge Portal, Climate Change has already impacted Jordan. Annual temperatures (MAX and MIN) have increased since 1960

by 0.3-1.8°C and 0.4-2.8°C, respectively. The mean annual temperature has risen by 0.89°C since 1900.

44. The analysis of local data from Jordanian meteorological stations confirms for the period 1990-2019 of trends reported in the national communication (a detailed analysis of local data is available in Appendix 2 of this Annex). FAO analysis of the period 1979 - 2019 (figure 3) confirm trends (40).

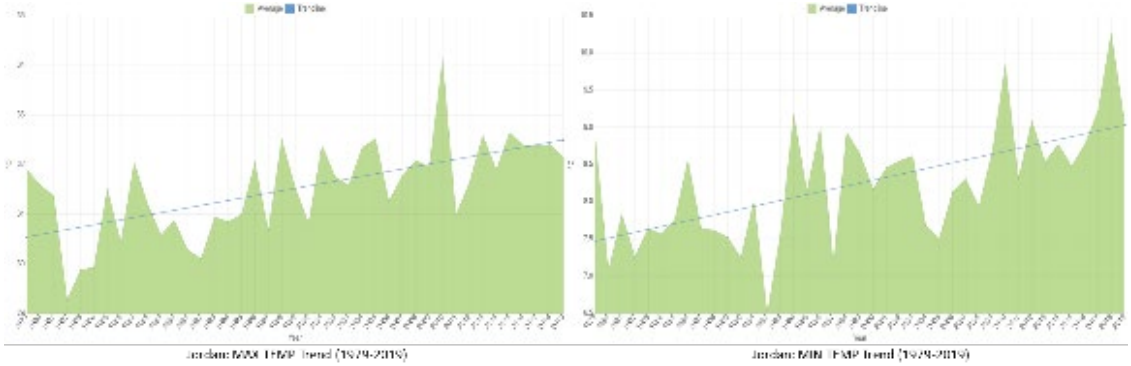


Figure 3 Growing trends for Minimum (left graph) and Maximum temperature **in** Jordan from 1989 -2010 (40)

45. Annual precipitation (rainfall) show decreases at most meteorological stations indicating a drop from 94 mm to 80 mm since 2009, and a 2.92 mm/month per century reduction in average annual participation since 1900 (CC Knowledge Portal for the period 1901-2016), see Figure 4. According to ICARDA (22), in the Dead Sea Basin only, precipitations decreased by up to 20% in the period 1901-2016. The analysis of remote sensing data for the period 1979-2019 (40) can only confirm partially ICARDA's results as the trend for the past 41 years appears slightly less evident with a situation characterized by higher variability.

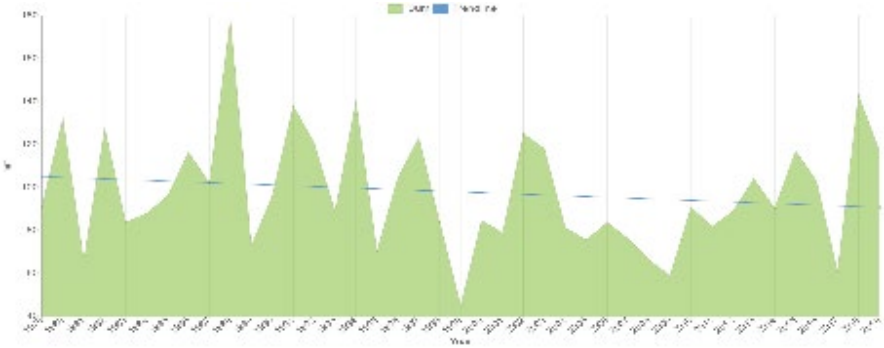


Figure 4: Average annual precipitations (1979-2019)

46. The analysis local meteorological data (1990-2019) as well as from the ECMWF - ERA5 data sets (1979-2019) for country shows an increasing trend for both annual average MIN and MAX temperature and a decreasing trend for annual average rainfall. Additionally, to understand seasonal and monthly changes the datasets for temperatures (MIN and MAX) and for rainfall have been clustered in four decades and progressively compared against each other to identify the months showing constant trends and those with a more variable trend. The analysis (Table 11) highlights the following:

- Max Temperature: constant increasing trend for the months of May, June, August, October and November. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another).
- MIN Temperature: constant increasing trend for the months of March, May, June, August. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another).
- Rainfall: monthly data confirms the high variability of the rainfall values.

Rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019

Jordan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019 (D4)-1979 (D1) Δ
Rainfall(mm)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	-12.20
MAX Temperature (C)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.84	1.82	VARIABLE	1.84	VARIABLE	1.73	1.08	VARIABLE	1.38
MIN Temperature (C)	VARIABLE	VARIABLE	1.95	VARIABLE	2.07	1.99	1.93008	1.91	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.23

Table 11: Jordan rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019[1].

47. Described changes increase the vulnerability of key sectors such as the water and the agriculture ones, which cannot coexist with the described changes in temperatures and the decreasing / erratic rainfall patterns. These matched with the adaptation deficit of rural communities can jeopardize the development efforts of the country and compromise the socio-economic stability of the country. Furthermore, as reported in the third national communication (2014) to the United Nation Framework Convention on Climate Change (UNFCCC) described changes will not improve overtime but worsen.

48. Reportedly (TNC, 2014 and MoE, 2020), "*All models predict a warmer climate with strong confidence e to increase in temperature, and. In 2070-2100, average temperature increase could reach +2.1°C [+1.7 to +3.1°C] under the RCP 4.5 scenario, and +4°C [3.8- 5.1°C] under RCP 8.5." (Figure 5).*[2]

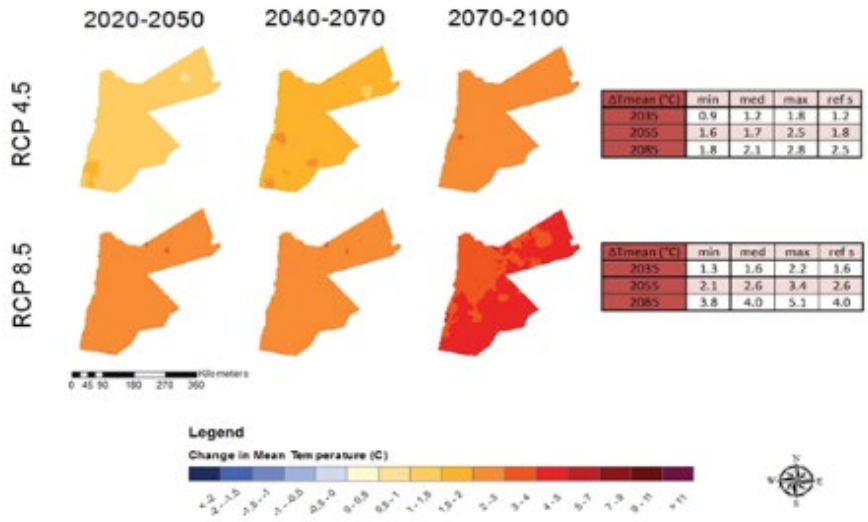
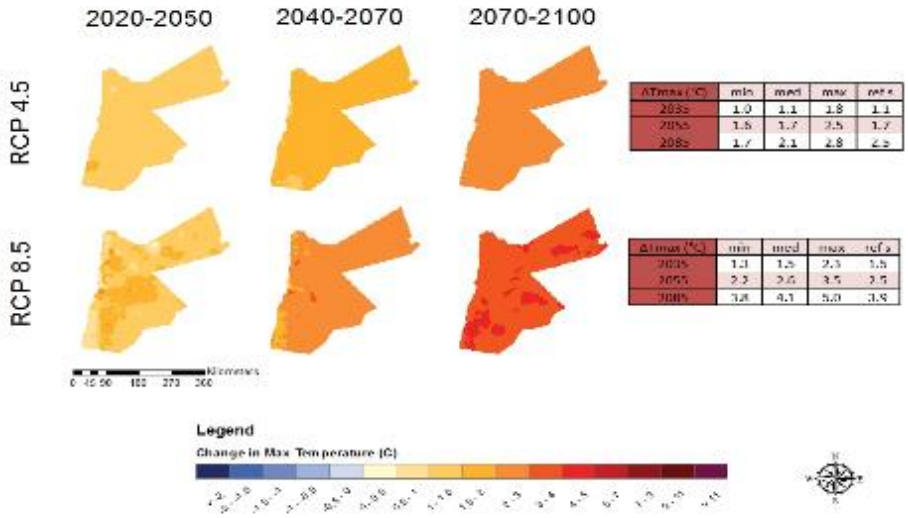


Figure 5: Changes in annual mean temperature (°C) for 2035, 2055, 2085 times-horizons and for RCP 4.5 and 8.5[3]



1 Author elaboration, 2020. Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
[2] The methodology used by the third national communication to produce the reported projections is available in Appendix 4 of this Annex.
[3] Source Ministry of Environment 2020. Draft National Adaptation Plan 2020.

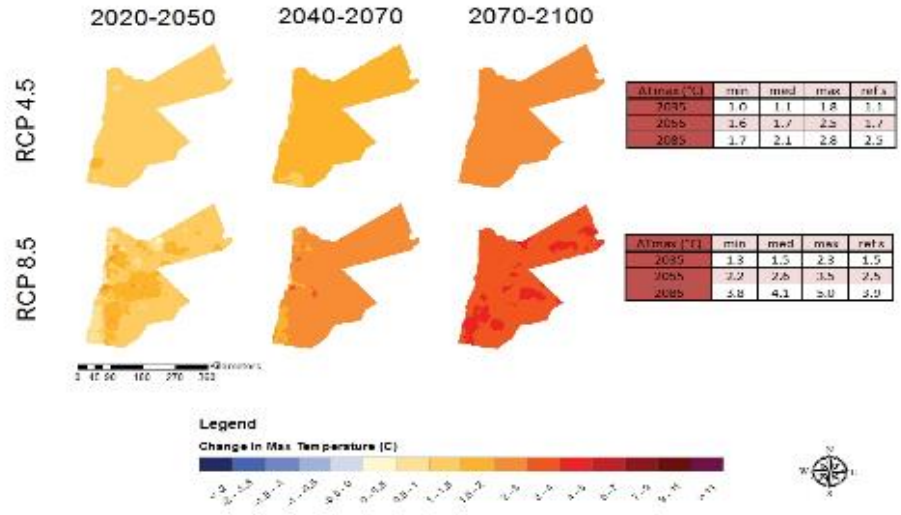


Figure 6: Delta annual minimum and maximum temperature (°C) for 2035, 2055,2085 times-horizons and for RCP 4.5 and 8.5

49. The Ministry of Environment (2020) dynamic projections predict "*a drier climate with medium confidence. In 2070-2100, the cumulated precipitation could decrease by 15% [-6% to -25%] using RCP 4.5 scenario and by – 21% [-9% to -35%] under RCP 8.5. The decrease would be more marked in the western part of the country"* a warmer summer, drier autumn and winter with medium confidence. [..] *The warming would be more important in summer, and the reduction of precipitation more important in autumn and winter than in spring, with for instance median value of precipitation decrease reaching -35% in autumn in 2070-2100. The dynamic projections predict more heat waves with high confidence and the analysis of summer temperature, monthly values and the inter-annual variability reveal that some thresholds could be exceeded. For instance, in pessimistic but possible projections, for a summer month, the average of maximum temperature for the whole country could exceed 42-44°C.The future projections also indicate more droughts, where the maximum number of consecutive dry days would increase in the reference model of more than 30 days for the 2070-2100 period. In contrast, annual values still show possible heavy rainy events at the end of the century. More intense droughts would be (partly) compensated by rainy years, in a context of a general decrease of precipitation. Potential evaporation would increase. […]. Finally, the future projections indicate no trend for intense precipitations or strong winds with low confidence. The number of days with heavy rain (>10 mm) does not evolve significantly, nor does the maximum wind speed or the direction of winds*[1]*, see Figure 7.*

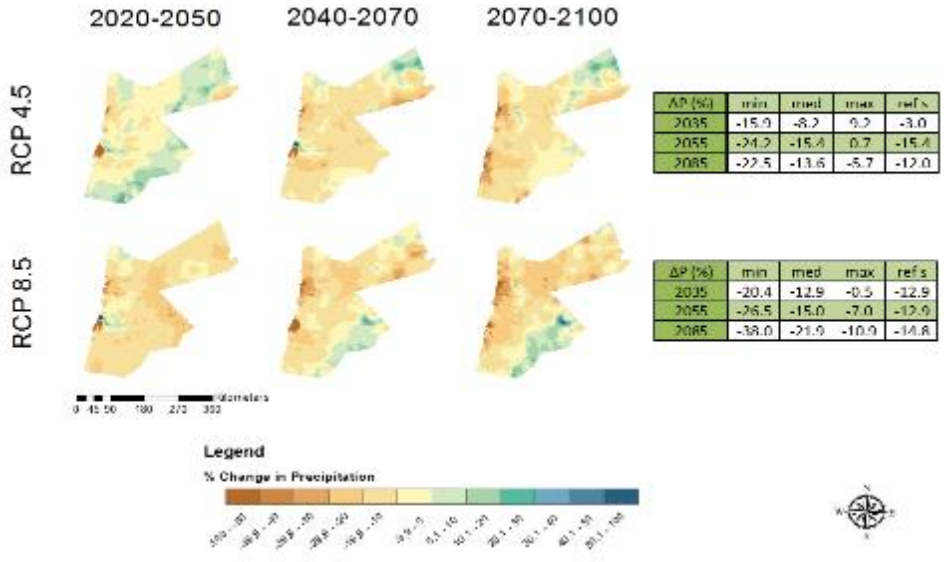


Figure 7: Changes in annual precipitation (mm) for 2050, 2070 and 2100 times-horizons and for RCP 4.5 and 8.5

[1] Description of climate related hazards deriving from changing climate and projections is available in section 2, paragraphs 68 to 80.

Exposure, vulnerability, resilience and DRR

50. Jordan has a ND-GAIN index ranking of 85 out of 181 countries for climate vulnerability (with 1 being the least vulnerable). As reported in the ranking description, *after some years of slight and constant improvement, especially from 1995 to 2008, when the ranking improved from initially 72 to 64, the number dropped again significantly, especially from 2013 to 2017, from 75 to the current 85. Jordan is the 50th least vulnerable country and the 84th least ready country (data 2019).*

51. Climatic factors and described and projected changes in rainfall and temperatures, drought/dry days and evaporation are the main determinants of CC hazards in Jordan (under all RCPs). The impact of these will result in reduced availability of surface water and groundwater reserves as well as lower agriculture productivity due to increased water scarcity and variability, especially in rainfed production.

52. The water sector is considered to be extremely vulnerable to Climate Change and the scarcity of the resource to be one of the significant barriers for the sustainable development of the Kingdom (13). The NDC highlights that water scarcity and quality is having also severe impacts on other domains such as agriculture and food security.

53. Since there is a projected decrease in winter rainfall and an increase in mean annual temperature and evaporation, renewable water recharge and water scarcity will be exacerbated by Climate Change. Already now groundwater in the six main basins is declining at an average annual rate of approx. 1 m (29). It will be challenging to maintain the business as usual scenario with high rates of groundwater over-abstraction as pumping costs and salinity levels will continue to increase and will be further exacerbated by climate change adverse impacts (3). Exact figures on the current water deficit in Jordan and the Dead Sea Basin are currently being identified. However, given the water amount recorded over most Jordanian Governorates in 2015 and considering observed and projected changes in climate and extremes as well as the influx of ~650.000 Syrian (registered) refugees since 2012, it can be assumed that the water deficit across Jordan, including the project locations, has further worsened. To note, there is ~23.000 registered Syrian refugees present in the Governorates of the target region (UNHCR).

54. The overall vulnerability of the sector is considered very high due to high sensitivity and exposure and low adaptation capacities, with the following main factors leading to negative impacts (14):

- Reduced precipitation and increase of irregularity of seasonal rainfall;
- Increased intensity of droughts during which reservoirs are not refilled, groundwater is not recharged, and rain fed agriculture suffers damages;
- Higher irrigation water demand because of higher evaporation due to increased temperature;
- Expected increased abstraction of water flows from upstream neighbouring countries that cover additional needs caused by Climate Change.
- Increased severity of flood events during which water and other infrastructure experiences overflows and damages;

55. The TNC identified temperature increase as the primary exposure risk affecting vulnerability. The above factors could furthermore lead to increased soil degradation and desertification, with additional indirect adverse impacts on agriculture and the ability to adapt of the poor population, which often is dependent on incomes from agriculture and will need to spend more financial resources for water supply (14). The TNC (2014) identified, for the water sector the following vulnerabilities (Table 12):

Table 4.15: Vulnerability Assessment Matrix for Water sector

Climate Change Hazards	Sensitivity Factors Indicators	Exposure level		Sensitivity level	Impact level		Adaptive capacity level	Overall vulnerability assessment	
		RCP 4.5	RCP 8.5		RCP 4.5	RCP 8.5		RCP 4.5	RCP 8.5
Precipitation decrease	Groundwater level decline	High (average score = 3.67)	Very High (average score = 4.33)	High (average score = 3.67)	High (average score = 3.67)	High (average score = 4.0)	1.5	High	High
	Groundwater quality deterioration						1.5		
	Stream flow reduction						2.5		
Temperature increase	Groundwater recharge decrease	Very High (average score = 5)	Very High (average score = 5)	High (average score = 3.50)	Very High (average score = 4.75)	Very High (average score = 4.75)	2.0	Very High	Very High
	Stream flow reduction						2.0		
Drought	Increased water demand	High (average score = 3.67)	Very High (average score = 4.33)	High (average score = 4.0)	High (average score = 3.83)	High (average score = 4.0)	1.5	High	High
Evaporation	Stream flow reduction	High (average score = 3.67)	Very High (average score = 4.33)	High (average score = 4.0)	High (average score = 3.83)	High (average score = 4.0)	1.5	High	High

Table 12: Vulnerability assessment matrix of the water sector (TNC, 2014)

56. Additionally, Jordan as a downstream country is also exposed to cascading effects of other countries. Droughts in upstream Syria from the Yarmouk river for example could have adverse implications for Jordan due to the lower river flow, but also due to higher irrigation demands and hence water extraction from running waters. Similar is the case with Israel that keeps control over the Headwaters of the Upper Jordan and the Golan Heights. Trans-boundary river agreements with these 2 nations are not observed, leaving Jordan with less than 10% of the flows of the crucial water sources. The developments can potentially lead to further regional conflicts/destabilizations (24).

57. With regards to irrigation, the TNC identify as adaptive measures drip irrigation systems, storage of water measures, increased exploitation of water springs and planting crops that require less amount of water. In the domestic sector the purchase of extra potable water, additional storage tanks and rainwater harvesting will be the main strategies for adaptation (14). These are also confirmed in the National Adaptation Plan that will be soon released by the MoE.

58. Reduced replenishment of water resources and reduced availability of rainfall will significantly increase the likelihood of soil degradation and hence desertification resulting in adverse effects for agricultural development including: (i) increased water demand of crops (in response to rising temperatures); (ii) shorter growing season; and (iii) degradation of arable land.

59. In a business scenario where no adaptation and planning action is in place the main potential impacts on the water and agriculture sectors will possibly result in: (I) Decreased productivity of both irrigated and rainfed crops; (II) Decreased productivity in livestock production including beekeeping; and (III) Decreased in arable land availability and land fertility. The rural poor, due to their high dependence on agriculture production and high adaptation deficit, are and will be the most vulnerable macro group. Furthermore, the increase in temperature will likely lead to new pests and diseases for crops, livestock's and increase also threats to human health. The TNC (2014) and the National Adaptation Plan (2020), identify the following crops as the most vulnerable (all essential to ensure food security of the country):

- Field crops, such as wheat and barley with a projected decrease in yield ranging from 7% to 21% for wheat and from 18% to 35% for barley due to shorter duration of crop growth.
- Olive and olive oil production, the potential decrease in yield derived from climate change impacts varies from 5% to 10% with high evidence on the oil quality reduction.
- For Orchards on the other hand, adverse impacts of rising temperatures have been observed but it is anticipated that a 1 to 2°C increase in temperature will not have negative implications

on an average year if the right varieties of (native) tree types are used.

60. The TNC reports the agricultural sector to have a relatively low adaptive capacity, given that most of the current land utilized for production is rain fed, which is more exposed to climate change and to the fact that most planned and needed adaptation measures require investments that are not available for farmers and for the sector in general. Strategies for adaptation as recommended by the TNC are reported in table 13.

Table 4.22: Adaptation measures per climate change hazard and the prioritization of the measures in Agriculture

Climate change hazards	Resulting impact	E. Overall vulnerability assessment	Adaptation measures	Priority
Shift in rainfall season	Decrease in reliable cropping days and crop failure	High	Application of conservation agriculture.	2.0
			Modification of planting and harvesting dates	2.0
Increase in average annual temperature	Increase in causes decrease in agricultural productivity	High	Conversion to drip irrigation and increase water use efficiency.	3.0
			Use of supplemental irrigation	2.0
Decrease in average annual precipitation	Decrease in agricultural productivity and revenue	Moderate	Selection of tolerant crop varieties and crop diversification	3.0
Increase in frequency of droughts		Moderate	Integrated watershed management	3.0

Table 13: Identified adaptation measures (TNC, 2014)

61. Additionally, as also reported by the IUCN [IUCN, 2019], the relationship between climate change gender and poverty is due to;

- *Dependence of such vulnerable groups on natural resources that are susceptible to climate change. Twenty percent of the population depends on agriculture for their income. Agriculture vulnerability is high in both rain fed and irrigated areas. This 20% of population – who are also part of the poorest segment – will be most susceptible to climate change impacts.*
- *The dependence of communities on ecosystem services (water springs, rangelands and natural vegetation in medicine, etc.) that is and will be affected by described climate change trends and projections.*
- *Lack of assets, which hinders effective adaptation by the poor segments of population.*
- *Settlements in high-risk areas (i.e. drought-prone) in Jordan are known to be of the lower income groups, a fact which magnifies the potential negative impact of climate change on these groups' poverty levels.*
- *Low levels of education and professional skills that prevent members of poor households from shifting to climate-resilient sources of income.*
- *Women in rural areas are traditionally responsible for the household economy and are active in field work. Any negative impact of climate change will be most sensed by women. Women make crucial contributions in agricultural and rural enterprises in drylands as farmers, workers and entrepreneurs through their indigenous knowledge.*

62. Water and agriculture are also increasingly affected by climate change induced hazards such as flash floods and floods, hail storms, heat waves and droughts (Figure 8). As reported by the World Bank, the average occurrence of natural disasters has almost tripled in Jordan since the 1980s, compared to a doubling worldwide.

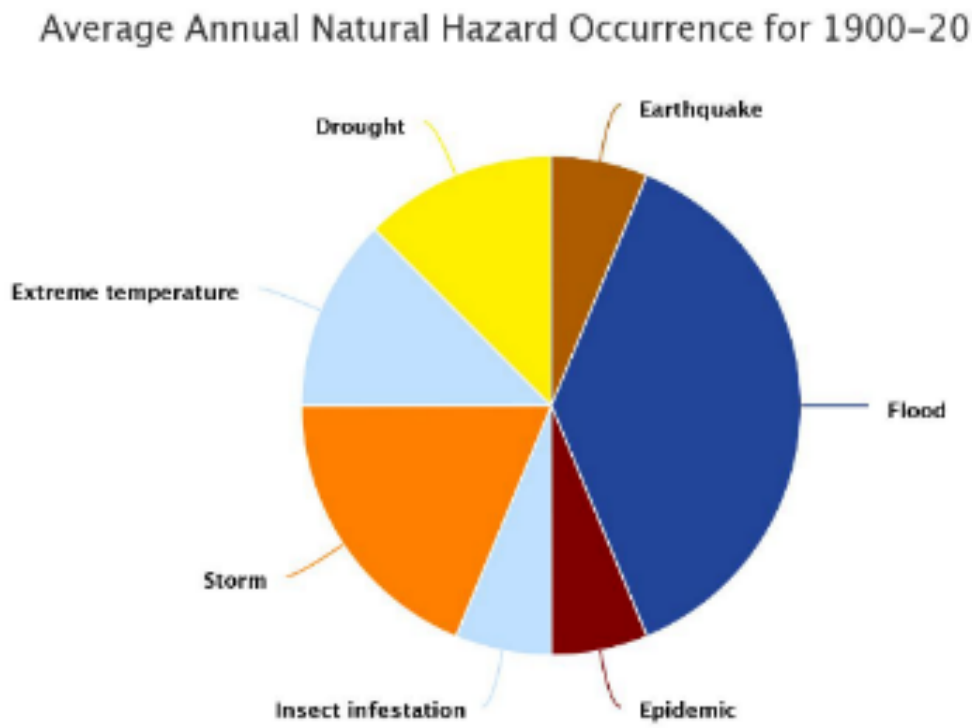


Figure 8:Distribution of Natural Hazard in Jordan (1900-2018)[1]

63. As disaster inventories show, flash floods have been the most impacting events and resulted in the last three decades in 120 deaths and affected several hundreds of thousands with major economic loss destroying infrastructure and agricultural land (61). Episodes of drought are increasing with a frequency of 2.43 per 10 years and affected also several hundred thousands of people in the last decades.

64. The combination of arid conditions and irregular rainfall are identified as direct limiting factors for the agricultural sector. Floods, landslides and erosion problems are reported to become problems, especially in areas with steep slopes of mountains (World Bank) and in the Dead Sea Basin. Especially floods and flash floods are a specific threat to agriculture as these events can destroy investments but mostly remove the limited amount of soil available for agriculture transforming land from arable to unproductive. As reported in the TNC (2014), given the exposure and sensitivity of Jordan to climate change and related hazards, "*the rural poor will be disproportionately affected because of their greater dependence on agriculture, their relatively lower ability to adapt, and the high share of income they spend on food. Climate impacts could therefore undermine progress that has been made in poverty reduction and adversely impact food security and economic growth in vulnerable rural areas. Poor in rural areas in Jordan are expected to face the most severe consequences of climate change through disruption of livelihood options that depend on natural resource management. The expected impacts of climate change, particularly reduced agricultural productivity and water availability threatens livelihoods and keeps vulnerable people insecure. Poor families and households are the most vulnerable group to the impacts of climate change and deserve the priority the in design of appropriate adaptive measures".* Finally, it is worth specifying that among poor the highest cost will be paid by women that are the most vulnerable component of the Jordanian society.

[1] *Source:* World Bank Climate Knowledge Portal

Jordan's climate adaptation targets and related policies

65. Jordan is a very experienced country with regards to water management and international Climate Change diplomacy and, in the framework of the UNFCCC negotiations, the country is part of 2 groups of parties (of the approximately 10 groups identified) that coordinate their positions on a continuous basis: (i) the Arab group consisting of 22 countries that pays particular attention to the required mitigation measures, as some countries of the group are fossil fuel producing and exporting and (ii) the Like-Minded Developing Countries (LMDC) that comprises 24 developing countries. Main unifying principles of these countries are the common but differentiated responsibilities and the historic responsibility for Climate Change assigned to developed countries (10). Jordan has prepared the following strategies, communications and policies focusing on climate change or with climate change identified as a priority sector.

- Initial National Communication to the UNFCCC (1999);
- Second National Communication to the UNFCCC (2009);
- Third National Communication to the UNFCCC (2014);
- Jordan's First Biennial Update Report to the UNFCCC (2017);
- National Strategy and Action Plan to combat desertification (2015-2020);
- Intended Nationally Determined Contribution (INDC) 2015, submitted as its First NDC in November 2016;
- National Climate Change Policy and Sector Strategic Guidance Framework (2013-2020), has been extended to 2030;
- Water for Life: Jordan's Water Strategy (2008-2022);
- The National Water Strategy for 2016-2025;
- Climate Change Policy for a Resilient Water Sector (2016);
- A National Green Growth Plan (2017);
- National Strategy for Agricultural Development (2016-2025)
- Jordan National Vision and strategy 2025.

66. The MoE published the first national climate change policy in 2013 through a participative approach, including policy recommendations and sectorial guidelines for the development of targets for mitigation and adaptation to build a climate risk resilient country with a sustainable low-carbon economy. Among the priority sectors, the country identified water, agriculture, energy, land use and fight against desertification. The purpose of the policy is to provide overarching guidance in implementing national climate change activities, most of the areas dispose however of their own strategy paper and/or action plan.

67. Since 2015, the nationally determined contribution (NDC) is the main policy paper concerning Jordan's contribution to the Paris Agreement on climate change aiming at limiting global warming to 1.5 to 2 degrees °C above pre-industrial levels. Bakhtiari et al. attested Jordan to have extensive capacities for creating the regulatory framework for the implementation of the NDC, while there should be more emphasis on shaping the human capacities for implementation especially for adaptation (36).

68. As reported by the World Bank Climate Change Group, there was no political decision of adoption of the NDC at ministerial or parliament level and the technical development did not foresee the involvement of stakeholders (32). However, multi-sector commissions participated in its elaboration and although not legally-binding, the NDC should influence budgetary, policy, legal and institutional reforms (30).

69. Next to a description of the commitments for mitigation, the NDC outlines also the adaptation strategy. The corresponding measures concerning the **water and agricultural sector** reflect the guidelines of the aforementioned National Climate Change plan and focus on the following:

- The development of methods for groundwater protection, management, monitoring and restoration;
- The implementation of water supply-enhancing measures, including surface and subsurface storage, minimizing surface water losses by evaporation, water harvesting techniques, and protecting surface water supplies from pollution;
- Sustainable management plans for surface water systems and conversion of open canal systems to pressurized pipe system, supplemental irrigation, improving water use efficiency and the

augmentation of drip irrigation and utilization of saline water in the irrigation of crops tolerant to salinity;
- Adoption of climate-smart agriculture practices.

70. The costs related to the necessary adaptation initiatives are not included, however there is a reference to total investments required for the water sector until 2025, corresponding to USD 4 billion. The costs for agricultural measures were not identified yet, nonetheless the NDC communicated that the GoJ has secured pre-2020 about USD 160 mln from its own funds for adaptation measures, including food security.

71. The **2025 National Vision,** is the central national policy-guiding framework for all development actions and includes also chapters related to climate change and adaptation strategies in the sector environment, food security, agriculture, water and energy. It furthermore emphasizes the need of a legislative framework on climate change and called for strengthening the involvement of line ministries.

72. Under the auspices of the MoE the works related to the **National Adaptation Plan (NAP)** started in 2017 are now being finalized and the document should be published in 2020 (4). There is currently a final draft version of the NAP providing a comprehensive and integrated framework and overview of necessary adaptation activities, connected climate finance strategy and a roadmap for implementation of the process The NAP will represent the reference document related to all related efforts and provide a unified and cross-sectorial guideline.

73. A NAP with specific, sectorial, time bound and practical set of measures would represent a significant milestone concerning concerted efforts. So far, the comprehensive aforementioned list of strategic documents/strategies shows the efforts of the administration to tackle the issue and the willingness to integrate it in the different sectors. However, the diversity of documents shows also that so far there is fragmentation. The policies are lacking sometimes also links and unified strategy (24, 28). The update of the NDCs is foreseen in 2020, this represents a great opportunity to link the final NAP to the revised NDCs

Institutional set-up of the climate change sector

74. The Ministry of Environment (MoE) is the responsible entity for Climate Change planning and created the Climate Change Directorate (CCD) to fulfill the provisions of and for transferring the necessary communication to the UNFCCC (Figure 9). The CCD supervises the implementation of CC policy and the National Climate Change Committee on Climate Change (JNCCC), in which the MoE collaborates closely with the Ministry of Agriculture, the Ministry of Health, the Ministry of Water and Irrigation (MWI) and Ministry of Energy and Mineral Resources (MEMR) and other Ministries. The legal mandate and the current structure of the JNCCC needs to be enhanced to become more productive. According to Yasin B, the MoE was working in 2018 on a bylaw requesting the entities to be represented on a high level and foreseeing the inclusion of the Civil Society, the private sector and academia (28).

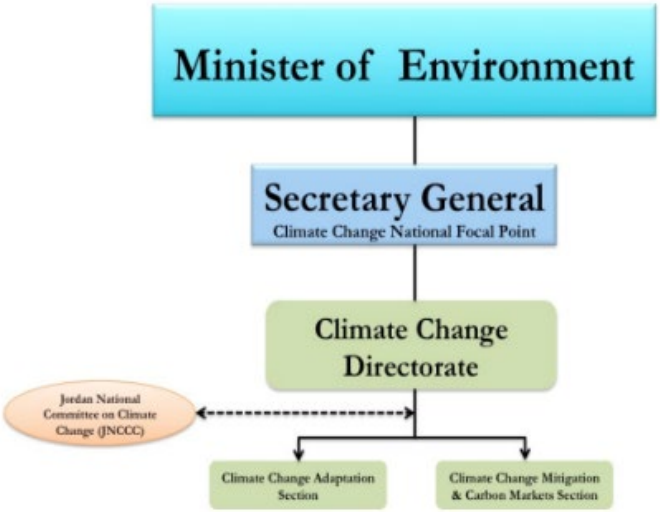


Figure 9 National Climate Change institutional set-up (8).

75. The National Climate Change Committee (NCCC) was established in 2001 and is the highest coordination body for climate policy. The NCCC includes representatives from other Ministries, civil society, the private sector, and the academia. The MoE is the chair and secretariat for the NCCC. The NCCC has the mandate to supervise the implementation of the climate policy framework of the country.

76. A number of other entities also work on environment and climate change:

- The Meteorology Department,
- The Royal Scientific Society,
- The Royal Department for Environment Protection,
- The Greater Amman Municipality,
- The Aqaba Special Economic Zone,
- The Jordan Environment Society,
- The National Agricultural Research Center,
- The Department of Vehicle Licensing, and
- The Jordan Women National Council" (ClimaSouth, n.d.)

Institutional set-up of the water sector

77. **Institutional set-up for the Water sector:** The MWI plays the crucial role in managing the water resources by designing and implementing policies related to irrigation water, wastewater, water allocation and water conservation. MWI is responsible for the overall strategic direction, planning, monitoring, data collection and consolidation and under by-law no 14 of 2014, the Ministry assumes full responsibility for all related water and public sewage projects.

78. **The MWI oversees two secretaries, the Water authority of Jordan (WAJ) and the Jordan Valley authority (JVA) that are autonomous bodies but linked to the MWI.** The WAJ created in 1983 manages municipal water supply and wastewater services and coordinates with the MWI water resources planning and monitoring and the construction, operation and maintenance of related infrastructures. WAJ owns three water companies that manage water and sanitation services in eight governorates. Miyahuna and Aqaba Water Companies are operating as commercial entities to provide water and sanitation services in Amman and Aqaba governorates, respectively. The third one is Yarmouk Water Company, which is responsible to provide water and sanitation services in Irbid, Jerash, Ajloun and Mafraq Governorates. The JVA, created in 1973 as the Jordan Valley Commission, is responsible for water management and conservation and also for social and economic development in the Jordan Valley. The Ministry of Finance and the Ministry of Planning and International Cooperation are responsible for securing the funds for the financing of the projects in the sector.

79. **The overall sector institutional setup is shown in Figure 10.** This institutional set-up will be changed according to the new law merging Water Authority of Jordan (WAJ) and the Ministry of Water and Irrigation (MWI). On 16th of February/2020 the Jordanian Cabinet approved the draft law to be followed by the necessary constitutional steps for its enactment. According to the draft law, the Ministry of Water and Irrigation will exercise all the functions and powers of the Water Authority and its board of directors as stipulated in the Water Authority Law. The JVA supported the creation and development of water users' associations (WUAs) in the Jordan Valley and has transferred some operational functions for secondary and tertiary irrigation water delivery to these WUAs.

80. **Water Management is traditionally relatively centralized**. The creation of Water User Association (WUA) in the 2000s was an essential step towards local management of resource (6). The WUA exist so far exclusively in the Jordan Valley and have entered contractual agreements with the JVA for the management of local infrastructures for water supply (mainly irrigation). WUA are attested to have significant potential for improving efficiency, however, their activities are often difficult to sustain, among others also due to unclear mandates and competencies.

81. **Since the "Water Strategy of Jordan 2008-2022" supports decentralization and privatization, the WUAs should increase their role in the sector and appropriated legislation and regulations should be set up** (7). The JVA assumed in this regard the duty to legalize the establishment of the WUAs under the cooperative law no.18 in 1997 (JCC) and to empower and strengthen the associations by improving their capacity through organizing targeted training courses and by developing cluster networks by region. To the WUA shall in the future also be given more representative authority and water management and O & M related activities (20).

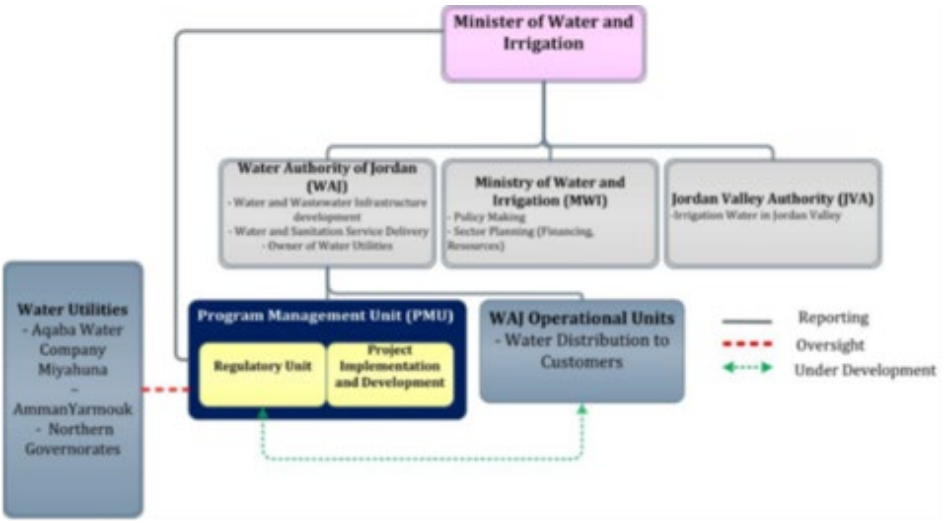


Figure 10: National institutional set-up of the water sector

Institutional set-up of the agriculture sector[29]

82. The Ministry of Agriculture is responsible for the agricultural sector, promoting self-sufficiency and rural development and linking the production to the requirements of the markets inside and outside Jordan. It also aims to promote plant production, control plant pests, preserve forests and pastures, and also regulate the establishment of breeding farms or livestock holdings, poultry farms, fish farms, amphibians, fishing, beekeeping, animal health and veterinary quarantine, as well as the role of the Ministry in the protection of wild birds and wild animals.

83. Organizational structure of the Ministry of Agriculture: The Ministry consists of thirty-eight directorates and a central unit, including two directorates linked to the Minister, the directorate of the Minister's office and Directorate of Information, Communication and Parliamentary Affairs, Internal Control Unit, and Agricultural Risk Management Fund; six Assistance Secretary Generals, directorate of planning and institutional development, legal affairs unit, the directorate of the Secretary General's office, directly linked to the Secretary General in addition to twelve governorate agriculture directorates and thirty directorates of agriculture in the governorate brigades.

84. The Ministry of Agriculture incudes the following entities:

- **National Agricultural Research Center:** Since its early beginnings, the NARC aims at (i) utilizing the outcomes of the agricultural research that is developed locally or devised from other sources for the purposes of increasing agricultural production, both plant and animal production, and improving it and its efficiency; (ii) conserving the agricultural natural resources and optimizing their use; (iii) serving the purposes of agricultural development; and (iv) preserving the environmental balance and climate change adaptation of the sector. The organizational structure of NARC is superintended by the council of this center, whose head is the minister of agriculture, and which includes the general director of the center as deputy of the chief of the council; the general secretary of the Higher Council for Science and Technology; the general secretary of the Ministry of Agriculture; a representative of the Ministry of Planning and International Cooperation; a representative of the Ministry of Water and Irrigation; two of the deans of the agricultural faculties in the public Jordanian universities; dean of the Faculty of Veterinary Medicine in the University of Science and Technology, chief of the Jordanian Agricultural Engineers Association; chief of the Jordanian Farmers Union, and two persons with specialization and expertise in the agricultural field.

[29] The organizational chart is omitted as it is only available in Arabic language.

- **Agricultural Credit Corporation (ACC):** ACC was established to support, develop and improve agriculture as well as increasing production both qualitatively and quantitatively. In addition, ACC seeks to help increase living standards of farmers be means of credit programs especially those targeting certain community members and groups. Such programs include loans of several types, terms and aims; they are rendered in accordance with laws and by-laws ruling over the Corporation mandate. The Organizational Structure of ACC for 2004 comprises the Board of Directors and the executive body including the Director General, his deputy, and the assistants of the Director General. The Structure accommodates several directorates including: Directorate of Administrative Affairs, Directorate of Financial Affairs, Directorate of Loans, Directorate of Islamic Funding, Directorate of Follow up and Collection, Directorate of Implementation Monitoring, Directorate of Internal Control, Directorate of Studies and Planning, Directorate of Public and International Relations, Directorate of Computer and Information, and Directorate of Development and Training.
- **Jordan Cooperative Corporation:** Jordan Cooperative Corporation is an official institution established under the Cooperative Law No. (18) of 1997. It enjoys a legal entity status with financial and administrative independence. In this capacity, it may acquire moveable and immoveable properties, undertake all legal actions, including concluding contracts, accepting gifts and donations, file legal actions and to be sued and shall be represented in legal cases by the procurator general or the district attorney, and it may appoint any lawyer. It has branches in all governorates of the Kingdom. The Corporation is managed by a board of directors. The Corporation works and its financial and administrative staff are managed and supervised by a general manager appointed by the Council of Ministers and such appointment decision shall be approved by the Royal Decree.

85. The project will work prevalently with the NARC and the Ministry of Agriculture directorate of responsible for extension services that is in charge to provide farmers with knowledge and advice in each governorates. Both dispose of at least one center in each of the 4 target governorates. This are currently functioning and staffed.

Strategic climate change and water policy documents

86. The document “Water for Life; Jordan Water Strategy 2008-2022” builds on the first policy paper elaborated in the year 1998 with the title "Jordan water strategy and policies" and defines the roadmap for sectorial efforts until 2022 with the main objective to exploit the full potential of surface water and groundwater; enhance utilization of treated wastewater and lower quality/brackish water for irrigation purposes and desalinated water for towns, industrial and commercial use. The policy furthermore emphasizes the necessity to allocate to drinking water the highest priority, followed by industry and then agriculture.

87. The "National Water strategy 2016 - 2025" focuses on "building a resilient sector based on a unified approach for a comprehensive social, economic and environmentally viable water sector development" (16). The policy is the main current paper for the regulation of the sector. It is aligned with the previous strategies and the "National Vision and Strategy", realigns the priority planning of the sector to the countries changing needs and lays the foundation for the related subsector policies. The strategy focuses on more decentralization, commercialization and consolidation of water and wastewater services as well as increasing private sector participation. Besides, it incorporates among others provisions for climate change, water-food linkages, sustainability of overexploited groundwater resources, and adoption of new available technologies and techniques to reduce the adaptation deficit of the country.

88. Within the broader National Water Strategy, there are five additional sub-sector policies. (1) Water Substitution and Reuse Policy which defines priorities for the wastewater reuse activities and aims to increase the amounts of reclaimed water (treated wastewater) which is reused in agriculture, in order to save freshwater for domestic uses. In relation to wastewater reuse, the Reclaimed Domestic

Wastewater Standard No 893/2006 the key policy document guiding the implementation of any activity involving reuse of reclaimed water in Jordan. This standard specifies the quality of treated effluents allowed to be discharged into wadis or destined for reuse in agriculture. (2) Surface water utilization policy aims to achieve maximum utilization and optimum use of surface water, its protection, its management, and propose measures needed towards successfully integrating all its components. (3) Water Demand Management Policy of 2016, which provides a set of procedures and measures for the development and implementation of water demand management programs across the country. (4) Water Reallocation Policy which establishes use priorities. (5) Water Sector Policy for Drought Management which defines an integrated approach for drought management in the country and calls for the establishment of a legal framework to improve coordination and planning of drought management actions, including through a National Committee for Drought Management.

89. **The Climate Change Policy for a resilient water sector** is a framework in support of the previous policies that provides strategies for mainstreaming climate adaptation and mitigation into existing institutions and for a CC resilient water sector. Moreover, the plan focuses on decreasing demand and on a sustainable use and conservation of resources. In addition, enhancement of water quality and integration of renewable energy, climate proofing of initiatives and integrated water management systems are described as essential parts for the implementation. Lastly, connections to the fulfillments of the SDGs are established, in particular to the SDG 6 that is focusing on Sustainable water use.

90. "Water Resources and Water Security" has been indicated as one of the four priority adaptation sectors for the draft GCF country framework. Included in this sector are activities related to the sustainable use of water resources, intensification of rainwater harvesting techniques and water reuse, improved irrigation for agriculture and desalinization pathways for water supplies.

91. In the last three years, the number of refugees in Jordan is placing tremendous pressure on water supply and systems across the country in particular in the north. At the policies level, MWI issued different policies to further detail the water strategy objectives and goals. These include: The Ground Water Policy which set out the Government's policy and intentions concerning groundwater management aiming at development of the resource, its protection, management and measures needed to bring the annual abstractions from the various renewable aquifers to the sustain-able rate of each. Other policies were prepared are: the Water reallocation Policy, and the Surface Water policy.

Lessons learned from past climate change experiences

92. Although Jordan plays an active role in the climate change international fora and the country is now accredited with important climate funds such as the Adaptation Fund [AF, 2020], Jordan's efforts on climate change, including on water and energy, have remained, limited in ambition and action due to:

- *Climate action is being severely under-funded, and adaptation will require large investments;*
- *The issue is not viewed as a priority (compared to e.g. employment), in part due to a lack of understanding of its implications and costs of inaction and of the benefits of action;*
- *Lack of unified policy framework, instead fragmented plans and institutions that lack consistency, comprehensiveness, links, and common purpose;*
- *Limited application of adopted policies in specific sectors such as water and agriculture;*
- *Lack of technical skills and resources as additional barriers to implementing projects in the agriculture and water projects.*

93. Reportedly [Combaz, 2019], climate adaptation and mitigation have proven challenging and remain highly conditional on the availability of financing and the lack of technical knowledge in the climate change domain. Current lack of finance is likely to impede climate change investments and implementation as Jordan's general budget has chronically been in deficit. *Given the funding gap between Jordan's climate goals and its public finances, climate action will require a shift in national planning and budgeting (alongside international funding)* [Combaz, 2019].

94. Factors hampering effective adaptation towards climate-responsive agriculture and water sectors include the lack of a comprehensive research and knowledge sharing on agricultural adaptation and irrigation technologies [Combaz, 2019; Sixt 2018]. Specifically, literature reports that "Jordanian water harvesting technological innovation system development is hindered by three principal blocking mechanisms: 1) inadequate financial resources to support innovation; 2) lack of a common vision across government ministries; 3) institutional problems that inhibit legitimizing the technology" [Sixt 2018]. Furthermore, notwithstanding the fact that the majority of the rural population remain dependent on agriculture for their livelihoods, very limited action is taken to ensure the adequate technology and knowledge transfer to farming community due to limited and weak extension services. The combination of these factors, including the rapid urbanization observed since the second half of the nineteenth century have led to maintaining inefficient irrigation technologies, a problematic pricing structure for water and wastewater, and water subsidies that do not play in favour of optimization and shift to improved technologies across the country. According to literature [Combaz, 2019, OECD 2017], the MWI's is has debts for over USD 1.3 billion and servicing debt was the largest item on its budget preventing the MWI's ability to undertake essential repairs and construct new infrastructure. Therefore, maintenance of non essential infrastructure appears limited and as communicated by MWI during the preparation of this project not ensured. Furthermore the problem of illegal wells[30] (characteristic of the Jordan valley area) and unsustainable use of water in agriculture is still present in the country.

95. The reduced availability of water due to increased temperatures and decreasing rainfall, is projected (under all RCP scenarios) to make it more difficult to meet domestic needs. This will exacerbate the current conflict with agriculture and industry on water use. Intermittent water supply could lead to destabilization of the socio-economic structure of the country and reducing the agricultural sector's use of Jordan's limited water resources is essential to create a sustainable relationship to the water economy in the future. Nonetheless, the MWI advanced considerably in its work to optimize water management. This is also reflected in the principles that they have developed to guide future water sector planning [IUCN,2019]. These are:

- *Jordanians must recognize that there are limits to the country›s renewable, affordable, traditional, available water supply.*
- *Jordanians must use and reuse water more effectively, efficiently and responsibly.*
- *Citizens and the private and public sectors must share responsibility for water management and protection and work together to improve conditions within their local watersheds.*
- *A deeper knowledge of the availability, quality and protection of water is the foundation for effective decision-making. This includes knowing that there is an increased cost for any new, additional non-conventional resources.*
- *Healthy aquatic ecosystems are vital to a high quality of life for Jordanians and must be preserved in pursuing socioeconomic and community-level development.*
- *Jordan needs to address the impact of climate change on its social, economic and environmental development.*
- *Adaptation measures must ensure institutional response capacity, community education and awareness of the risks.*

Literature highlights also another additional element of fragility of the current efforts to adapt to climate change. IUCN [IUCN, 2019], reports there are still efforts needed to ensure the following:

- *Integrate gender considerations and the interest of vulnerable groups in climate change policies and strategies in all relevant sectors, particularly in national strategies for poverty, childhood and early childhood development in Jordan.*
- *Ensure that financing mechanisms on mitigation and adaptation address the needs and conditions for implementation of poor women and men equally.*
- *Build capacity at all levels to design and implement gender-responsive climate change policies, strategies and programmes.*

96. Lessons learned from previous interventions are very limited and often not available.

[30] The project will not work with farmers who cannot demonstrate the legality of their water sources.

Nonetheless, based on discussions and interviews with partnering institutions as well as from personal communications from involved consultants and experts, the problems highlighted above appear to be affecting projects and their execution. Additionally from the available evaluation provided in the GEF project's data base the following main lesson learned will be taken into due consideration:

- *In project areas where local culture can make full project participation by women problematic, there is a need to carry out thorough assessment of local cultural and other constraints to the achievement of the gender objectives and targets. In this case, the difficulty in fully attaining the gender target as a result of cultural resistance was underestimated and thus, in retrospect, proved to have been overly ambitious [GEF, 2017].*
- *In a community participation project, it is particularly important for success and sustainability to provide adequate resources up front to build beneficiary confidence and participation in project decision making. In this case, the need to build trust was essential and the project's ability to do so was a contributing factor to its successful, if somewhat delayed, implementation [GEF, 2017].*
- *Address all roles and potential administrative barriers at the beginning alongside partners* [GEF, 2016].
- *Setting up a result oriented M&E system that serve as a dynamic management tool, with precise objectives and indicators that adequately reflects results achieved on the ground [GEF, 2014].*

97. A final consideration on lessons learned (given the sever lack of structured analysis on this topic for Joran) is derived from the Paris Agreement: *"governments, development agencies, and the private sector need to collaborate to strengthen knowledge and capacity for managing climate risks (…) and concerted capacity-building, particularly at the local level, is needed to move from improved information to better decisions".* A constant in development and climate project is the limited availability of financial resources to ensure capacity building and capacity development. In these regards the Stockholm Environmental Institute [WA, 2017], jointly with the weadapt platform, identified – among other - the following:

- *Institutional development and strengthening is a focus of all approaches and weakness in this area can undermine approach's effectiveness.*
- *Developing human resources through education, training, and research is key to building national capacity.*
- *Strong financial support for capacity building can increase member nations' compliance to regime provisions.*
- *National ownership of capacity building efforts is key to their sustainability.*
- *Web-based tools can improve capacity building.*
- *International and national support through institutions and financing is critical for successful capacity building.*
- *Capacity building must be designed to be long-term and self-sustaining.*
- *National ownership by recipient countries of capacity building efforts is key to ensuring their success.*
- *Education, training, and awareness-building on human rights is central to sustaining long-term capacity building.*

3. PROJECT AREAS AND TARGET GROUP

Project areas:

98. The most recent assessment of water scarcity and drought risk under climate change, based on a large ensemble of climate model outputs, suggests that the increase in the frequency and duration of meteorological droughts will be larger for the Dead Sea basin than for basins located in the north of the country [Rajsekhar, 2017]. Therefore, the project will prevalently invest its resources there (Figure 11). Target areas have been selected according to the following criteria: a) Included in the Dead Sea basin b) climate change exposure; c) presence of large[31] rural communities; d) vulnerability of communities and livelihood; e) persistent water scarcity. Given the five criteria reported above, participants of the national engagement process, the NDA and FAO convened to execute the project in the governorates of Madaba, Karak, Tafilah and Ma'an (Table 14).

	Criteria				
Governorate	**a**	**b**	**c**	**d**	**e**
Madaba	YES	8/12 months with reduced rainfall (1979-2019). 12/12 months with increasing MAX temperatures (1979-2019). 11/12 months with increasing MIN temperatures (1979-2019).	22%	Poverty rate (15.1%). Dependency from rainfed agriculture (90%) and high adaptation deficit	High
Karak	YES	7/12 months with reduced rainfall (1979-2019). 12/12 months with increasing MIN and MAX temperatures (1979-2019)..	41%	Poverty rate (13.4 %), presence of 3 out of 27 poverty pockets. Dependency from rainfed agriculture (64%) and high adaptation deficit	High
Tafilah	YES	8/12 months with reduced rainfall (1979-2019). 2019). 11/12 months with increasing MAX temperatures (1979-2019). 10/12 months with increasing MIN temperatures (1979-2019).	22%	Poverty rate (17.2%%), presence of 1 out of 27 poverty pockets Dependency from rainfed agriculture (50%) and high adaptation deficit	High
Ma'an	YES	3/12 months with reduced rainfall (1979-2019). 11/12 months with increasing MIN and MAX temperatures (1979-2019).	46%	Poverty rate (26.6%), presence of 6 poverty pockets out of 27. Dependency from rainfed agriculture (85%) and high adaptation deficit	High

Table 14: Brief description of selected target areas[32]

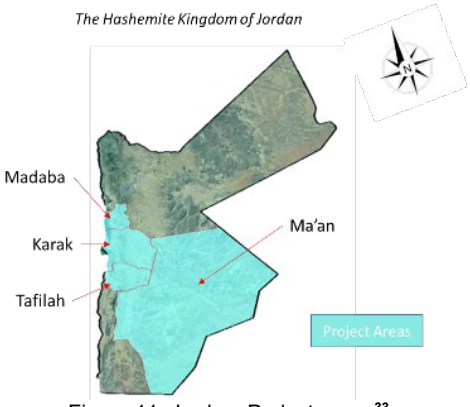


Figure 11: Jordan, Project areas[33]

[31] Compared to the average rural population of the country (10%)
[32] Although the district of Tavush was eligible, due to hig presence of projects, low density of population and extension of protected areas and parks, the marz was not included among project areas to avoid dispersion of funds and reduce risk of duplication.
[33] Not to scale. Detailed Maps are available here: www.earthmapdemo.info (FAO, 2018)

99. The project targets the agricultural areas in the dead sea basin and its sub-basins (figure 12 and 18):

- Mujib Basin (including Wala sub-basin) with a total area of about 6727 Km^2
- Hasa basin with an area of 2603 km^2
- Dead Sea side Wadi with an area of 1508 km^2
- North Wadi Araba basin with an area of 2953 km^2

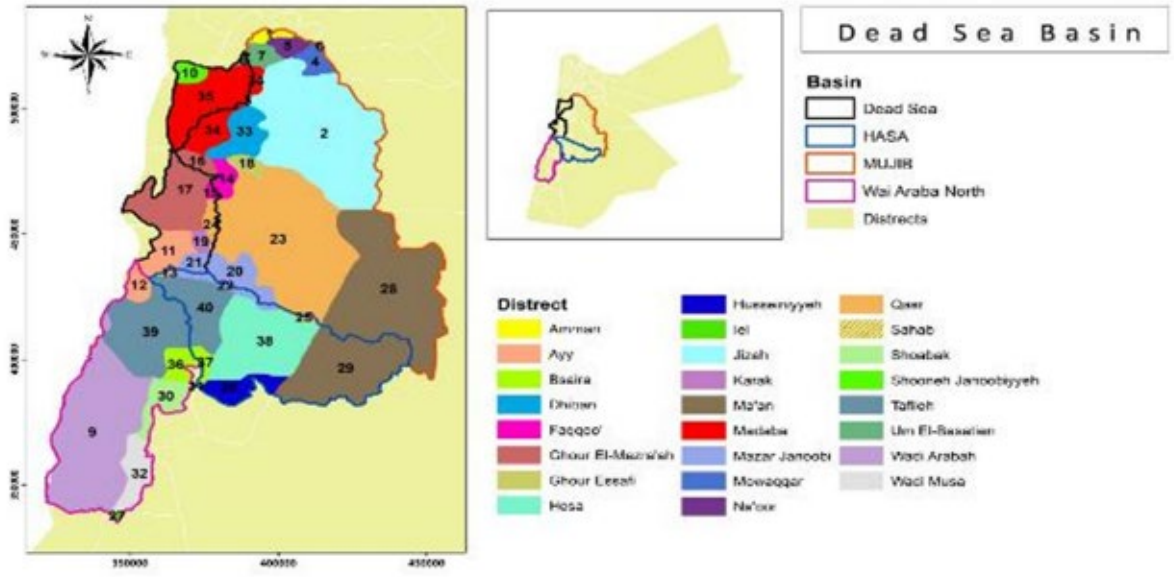


Figure 12: The Dead Sea Basin[34]

100. The main sub-basin is the Mujib basin that encompasses two main catchments - the Wadi Mujib and the Wadi Wala - and comprises an area of 6,727 km^2 of mainly plateau land to the east of the Dead Sea. The altitude level of the plateau ranges between approximately 700 and 1000m asl and drops to approx. 400m below sea level when entering the dead sea. The climate varies between Mediterranean in the western and northern areas to arid to semi-arid in the rest of the region (39) and follows the same patterns as the national climate. Average rainfall can vary significantly and ranges from 300 mm in the eastern part of the basin to below 50 mm in the western part (33).

101. The surface water availability in the project area (Table 15) depends on the average annual rainfall is ranging from 131 mm in Mujib basin to 192 mm in the Dead Sea side Wadis. The runoff coefficient is low in the project area and it is ranging between 0.7% in north Wadi Arba Basin to about 4.0% in Mujib basin. The long-term annual volume of water in the Dead Sea Basin is about 1.911 MCM. The Mujib basin alone contributes to about 46% of the total volume of rainfall in the Dead Sea Basin. Table 16 shows the long-term surface water potential in the project area by basin. The total streamflow in the project area is about 147 MCM of which 67% is base flow and the remaining is flood water. The long-term surface water flow by governorate (Table 17) identifies Karak governorate has the one with the highest total surface runoff which is about 73.44 MCM, while it is the lowest in Tafilah governorate (7.31 MCM). The total surface runoff in Madaba governorate is about 65 MCM.

Basin	Catchment area (km^2)	Average Annual Rainfall (mm)	Estimated runoff coefficient (%)	Long-term (1937-1998) Rainfall average (MCM/yr)
Mujib	6727	131	4.0	884
Hasa	2603	128	2.8	334
Dead Sea side Wadis	1508	192	2.5	290
North Wadi Araba	2953	136	0.7	403

Table 15: Surface water availability in project area

[34] Fayez Abdulla, Jordan University of Science and Technology

Basin	Catchment area (km2)	Average rainfall (MCM/yr)	Baseflow (mCM/yr)	Flood flow (MCM/yr)	Total flow (MCM/yr)
Mujib and Wala	6727	884.0	31.38	33.62	65.0
Hasa	2603	334.0	26.26	5.47	31.73
Dead Sea (southern wadis)	1508	290.0	33.63	6.08	39.71
North Wadi Araba	2593	403.0	8.58	2.55	11.13
Total		1911	99.85	47.72	147.57

Table 16: Long-term surface water potential in project area basins (Jordan National Water Master Plan)

Governorate	River or Wadis	Baseflow (MCM/yr)	Flood flow (MCM/yr)	Total flow (MCM/yr)
Madaba	Wadi wala+wadiMujib	31.38	33.62	**65.0**
Karak	Wadi karak	5.89	1.29	7.18
	Wadi Ibn Hammad&others	10.5	1.84	12.34
	Wadi Hasa	26.26	5.47	31.73
	Wadi khuneizeh	1.43	0.59	2.0
	Wadi Zarqa Ma'in	17.24	2.95	20.19
	Total	61.32	12.12	**73.44**
Ma'an	Wadi Jurdah	0.0	0.22	0.22
	Wadi Fidan	1.64	0.18	1.82
	Qa'aDisi +south Desert	0.0	1.18	1.18
	Jafer	0.0	8.0	8.0
	Sirhan	0.0	7.49	7.49
	Total	1.64	17.07	**18.71**
Tafielah	Wadi Dahel	0.0	0.22	0.22
	Wadi Feifa	3.91	0.39	4.31
	Wadi Mousa	0.0	0.17	0.17
	Wadi Buweirdh	0.8	0.22	1.02
	Wadi Hawwar	0.0	0.28	0.28
	Restricted area	0.8	0.52	1.32
	Total	5.51	1.80	**7.31**

Table 17: Long-term surface water flow by governorate

102. To illustrate the component of the hydrological water budget in the project area, the water balance for year 2017/2018 was considered (MWI, 2018). As can be seen in Table 18, about 92.6% of rainfall is evaporated back to the atmosphere. Groundwater recharge was about 107 MCM (5.5%) while the total runoff is about 40.4 MCM (2%).

Basin	Area (km2)	rainfall (MCM)	Rainfall (mm)	Evaporation (MCM)	Runoff (MCM)	Recharge (MCM)	% of Evaporation	Runoff Coefficient (%)	% Recharge
Mujib	6608	869.2	132.0	793.1	21.5	54.6	91.3	2.5	6.3
Hasa	2530	332.0	131.2	308.6	3.5	19.9	93.0	1.1	6.0
North Wadi Araba	3011	404.1	138.0	384.3	4.4	15.4	95.1	1.1	3.8
Dead Sea	1692	372.5	240.5	344.4	11.0	17.1	92.5	3.0	4.6
Total/ (average)	13841	1977.8	(146.4)	(1830.4)	40.4	107	(92.58)	(2)	(5.5)

Table 18: Water balance for Dead Sea sub-basins for year 2017/2018

103. Climate change scenarios[35] reported in the third national communication expect an increase in air temperature of +1°C by 2030 and of +2°C by 2050, with a significant precipitation decline of -10% by 2030 and -20% by 2050, for all basins. For the latter simulations suggest a decrease in precipitation by -5% and -10% for the years 2030 and 2050 respectively (63)

[35] RCP 8.5, High Emission

Demographic profile of the project areas

104. The total population in the governorates of Madaba, Karak, Tafiela and Ma'an amounted in 2019 to 840,900 representing 8% of the total population of Jordan. Table 19 shows that the percentage of males is higher than the females in all of the four governorates by 10%. In terms of population, Karak governorate is the highest followed by Madaba, Ma'an and Tafiela, respectively.

105. The population is heavily concentrated in the west, and nine out of ten persons reside in urban areas. There is considerable variation in the proportion of rural population between governorates: Karak and Ma'an have close to half their population living in rural areas compared to less than 5 per cent in the Amman and Irbid governorates.

Governorate	Total	Percentage	Female	Male
Madaba	209,200	2%	98,600	110,600
Karak	350,000	3%	167,100	182,900
Tafiela	106,500	1%	50,800	55,700
Ma'an	175,200	2%	83,800	91,400
Total	840,900	8%	400,300	440,600

Table 19: Population as % of the total population distributed by sex in the four governorates in 2019[36]

106. The Department of Statistics (DOS) states that of the 10.55 million population of Jordan, the urban population is 9.53 million representing 90% of the total population. While, as indicated in table 20, of the total population of the four governorate the average percentage of the urban population is 35%. The table shows that the highest percentage of the rural population is in the governorates of Madaba and Tafilah, followed by Karak and Ma'an.

Governorate	Total	Urban	% Urban	Rural	% Rural
Madaba	209,200	45,500	22%	163,700	78%
Karak	350,000	143,000	41%	207,000	59%
Tafiela	106,500	23,500	22%	83,000	78%
Ma'an	175,200	80,500	46%	94,700	54%
Total	840,900	292,500	35%	548,400	65%
Percentage	100%	35%		65%	

Table 20: Population distributed by urban & rural in the four governorates in 2019[37]

107. The project will cover the four governorates, nonetheless priority will be given to the agriculture areas that are geographically located in the Dead Sea Basin. The share of the target basin included in each district was calculated using Geographic Information System (GIS) software.

[36] Source: DOS, Jordan, 2020. www.dos.gov.jo
[37] Source: DOS, Jordan, 2020. www.dos.gov.jo

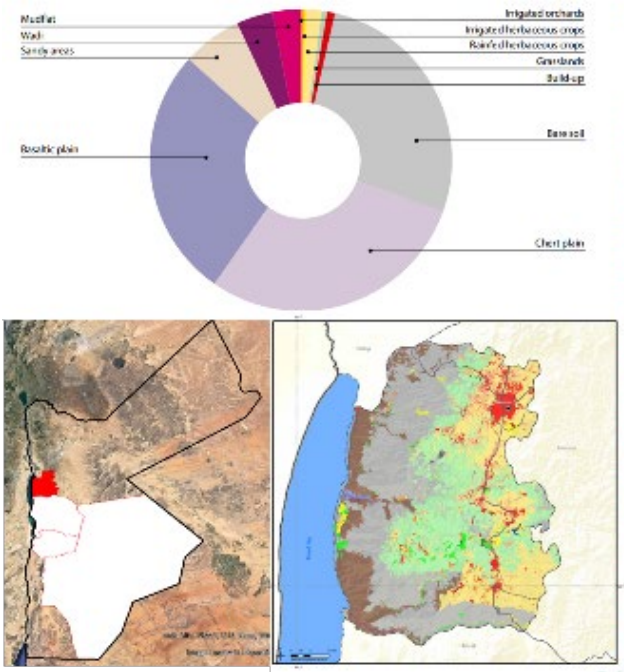
Madaba

108. The Governorate of Madaba is located in the Central Region and southwest of Amman. Its surface is 940 km^2 (1.1 % of the total country area), with 204,300 inhabitants (2 % of the total population), making it the 3rd smallest and the 5th least populated Governorate with a density of 217 persons/km2 (55; 44). The Governorate comprises two districts, Qasabat Madaba including 44 towns/villages and Deeban with 26 towns/villages.

Climate change, natural resources and agriculture:

109. The Northern and Eastern part of the Governorate of Madaba belong to the highlands and have therefore a Mediterranean climate. The Western part connects to the Dead Sea with altitude levels falling to -419 m and a sub-tropical climate, mild winters and very hot summers. Madaba is almost completely congruent with the Zara - Ma`een – Mujib (ZMM) Watershed that comprises an area of 1,019 km2. The Northern and Eastern part of the region belong to the highlands and have therefore a Mediterranean climate. The Western part connects to the Dead Sea with altitude levels falling to -419 m asl and a sub-tropical climate, mild winters and very hot summers. Approximately 10% of the governorate is agricultural land of which 15% has been left fallow in 2015. The rest of the area is used for field crops (55%), vegetables (8%) and fruit trees (23%). Only 0.6 % of the ZMM watershed area is currently used for irrigated cultivations. Agricultural production is therefore very vulnerable to the projected precipitation decrease influenced by CC, especially the field crops that are entirely rain fed and cultivated in flat and semi-flat wadis (54,23). With regards to livestock there are approximately 170,500 sheep, 39,500 goats and 1,700 cattle (58) present and 102 chicken farms that have a production capacity of ca. 12.000 tons of meat per year (43).

110. The WFP Integrated Context Analysis reports a high risk of erosion and a medium risk of land degradation for the whole Governorate. The data is also confirmed by the analysis of the land productivity dynamics (LPD) for the period 2001-2017 also exposing the fact that over 58% of the governorate shows early signs of declining productivity.



LAND COVER CLASSES	DISTRICTS: Al-Badiah Ash-Shamalieh Al-Gharbieh	Al-Badiah Ash-Shamaliyah	Ar-Rwaished	Qasabet Al-Mafraq	TOTAL km^2	TOTAL %
Irrigated orchards	26.36	77.84	0.07	5.30	**109.57**	**0.4**
Irrig. herb. crop	36.56	47.40	6.96	7.54	**98.46**	**0.4**
Rainf. herb. crop	113.18	223.65	0.19	80.73	**417.76**	**1.6**
Rainfed orchards	1.59	0.16	0	46.99	**48.75**	**0.2**
Closed trees	0.01	0	0	2.90	**2.91**	**0**
Open trees	0.01	0	0	3.53	**3.54**	**0**
Woody vegetation	0.09	0.91	50.15	0.01	**51.15**	**0.2**
Grasslands	71.10	0.50	0.03	98.79	**170.42**	**0.6**
Build-up	60.88	73.99	17.03	51.65	**203.55**	**0.8**
Bare soil	345.87	1,319.61	5,156.91	292.39	**7,114.78**	**26.8**
Undif. bare rocks	0	0.61	0	0	**0.61**	**0**
Bare rock granite	0	6.67	0	0	**6.67**	**0**
Chert plain	0	227.67	7,393.12	0	**7,620.79**	**28.8**
Basaltic plain	0	1,442.09	5,666.20	0.02	**7,108.30**	**26.8**
Sandy areas	0	0	1,666.84	0	**1,666.84**	**6.3**
Saline soil	0	0	0	0	**0**	**0**
Extraction site	3.85	22.25	0.71	11.07	**37.88**	**0.1**
Saline waterb.	0	0	0	0	**0**	**0**
Natural waterb.	0.02	0.01	0.06	0.05	**0.15**	**0**
Artificial waterb.	0.89	1.10	3.83	0.06	**5.87**	**0**
Wetlands	1.49	0.32	14.14	0.05	**16**	**0.1**
Wadi	4.17	102.78	913.20	0	**1,020.16**	**3.8**
Mudflat	0	99.98	701.24	0	**801.22**	**3**
TOTAL LAND	**666.07**	**3,667.53**	**21,590.68**	**601.10**	**26,505.37**	**100**

Figure 13: Madaba and its land use (*Source of land use data and map: FAO, 2019*).

111. The analysis of the ECMWF - ERA5 data sets (1979-2019) for the governorate of Madaba shows an increasing trend for both annual average MIN and MAX temperature and a generally decreasing trend for annual average rainfall (Figure 14). Additionally, to understand seasonal and monthly changes

the datasets for temperatures (MIN and MAX) and for rainfall have been clustered in four decades and progressively compared against each other to identify the months showing constant trends and those with a more variable trend. The analysis (table 21) highlights the following:

- Max Temperature: constant increasing trend for the months of May, June, August, October, November and December. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another).
- MIN Temperature: constant increasing trend for the months of March, May, June and August. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another) wit the exception for February when MIN temperature shows a slight decreasing trend.
- Rainfall: monthly data confirms the high variability of the rainfall values. Nonetheless, data show a constant decrease in the months of August and November with a loss of -0.37 mm and – 13.23 mm respectively.

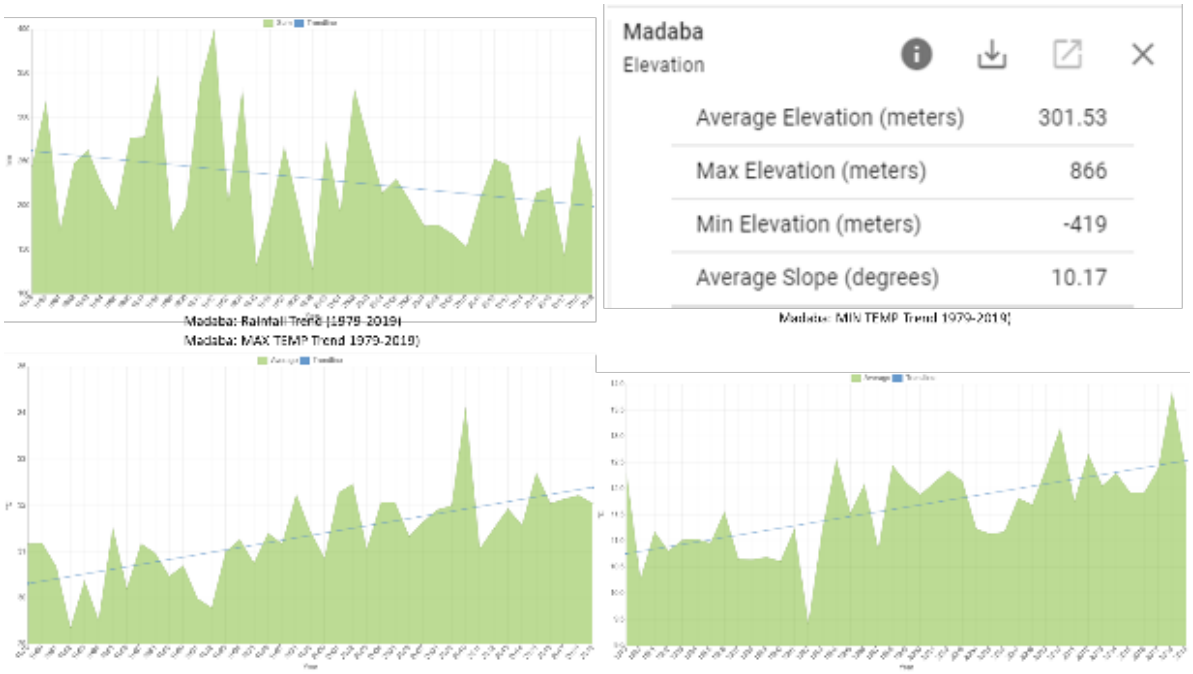


Figure 14: Trend of minimum (left graph) and maximum temperatures in Jordan from 1979 -2019[38].

Rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019													
Madaba	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019 (D4)-1979 (D1) Δ
Rainfall(mm)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	-0.37	VARIABLE	VARIABLE	-13.23	VARIABLE	-50.73
MAX Temperature (C)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.92	1.30	VARIABLE	1.34	VARIABLE	2.15	1.38	0.83	1.39
MIN Temperature (C)	VARIABLE	VARIABLE	2.12	VARIABLE	2.06	1.88	VARIABLE	2.07	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.28

Table 21: Madaba: rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019[39].

112. Described trends demonstrate the high level of exposure of the governorate and its people as increasing trends of temperatures associated with negative trends of rainfall is and will have severe repercussions on water demand for both civil and agriculture purposes.

The Water Sector:

113. Domestic water use in the governorate accounts for a very high share of total water use, about 50%. Agriculture and industry account for 40% and 10% respectively. These high levels of domestic water use can be linked to Madaba's urban growth and associated increases in urban water demands, which force reductions in agricultural water use and reinforce the case for higher use of reclaimed water

[38] Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
[39] Author elaboration, 2020. Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.

in agriculture. Most of residential houses are connected to the Madaba wastewater treatment plant with an average daily treatment capacity of 5000 m3/day and an operating efficiency of 98%. The Mihayouna Company is operating as a government-owned utility providing retail distribution and water and wastewater treatment to the region. Next to Madaba the company covers also Greater Amman area as well as Balqa, Zarqa and in total 550,000 customers (57).

Socio-Economic indicators:

114. Only 1.3% of the employed inhabitants declared in the year 2011 to be part of the sector "Skilled agricultural, forestry and fishery worker" (56). Nonetheless, the national and local statistics might underestimate the real employment in agriculture and farming and the economic impact of the sector. In rural areas many persons carry out casual labor and small-scale farming which often do not find the appropriate representation in official surveys but that plays a major role for livelihood and food security of families

115. Madaba has a total entrepreneurial activity (TEA) of 4.3% which is lower than the national average of 8.2% (52) In addition, the poverty rate of Madaba is 15.1% which is slightly higher than the national average of 14.4%; the percentage of vulnerable households is 22.8%, corresponding to 6330 households (46). Inequality rates show a high 27.2% GINI (47) and the unemployment rate is the 2nd highest with 23.2%, compared to the national average of 18.6% (55). In 2008, 5.7% of the population was recipient of the National Aid Fund (NAF), which is the main poverty reduction programme of the kingdom (53). In this vulnerable group, 76% are either food insecure (17%) or vulnerable to food insecurity (59%) (49).

116. With approx. 22% the share of the rural population is much higher than the average national rate of 9.7% (58). In general, poverty in rural areas is more recurrent than in urban areas and on a national level 19% of the rural population is classified as poor (50). Those employed in the agricultural sector are furthermore poorer than the ones working in other sectors. Smallholders that are dependent on rain fed areas are especially vulnerable to irregular rainfall and droughts (3).

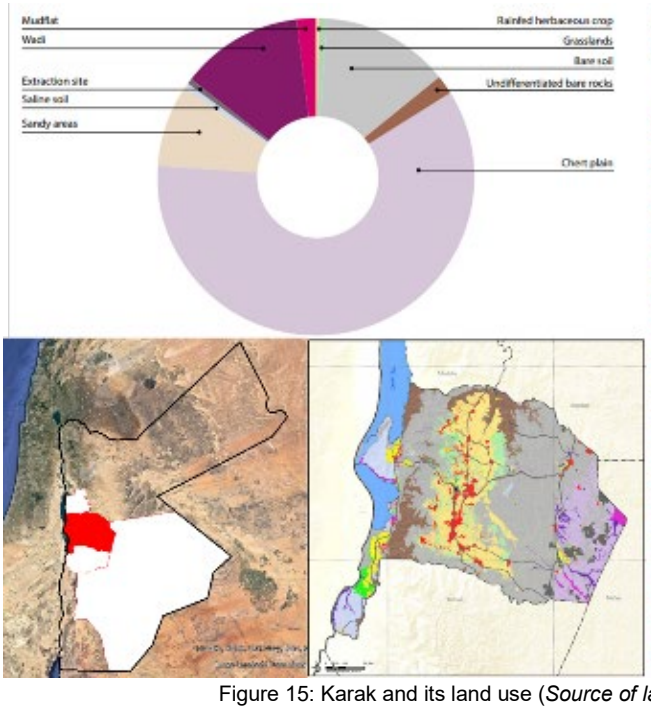
Karak

117. The governorate of Karak is part of the Southern regions and has 341,900 inhabitants (representing 3.3 % of the total population) living on a surface of 3,495 km2 (or, 3.9 % of total area), with a density of 97,8 persons/ km2. Karak is therefore the 6th largest and 6th most populated governorate, and comprises seven districts (55). Currently there are 8.985 refugees registered in the Governorate (1.2% of the national registrations) 44.

Climate change, natural resources and agriculture:

118. Agriculture has been identified as one of the most important economic sectors and approximately 10% of the land is arable (Figure 15). About 76% of the arable land is used for agriculture, the rest is left fallow. Field crops cover 64% and are entirely rain-fed. About 11% of the arable land is currently used for fruits and vegetable orchards (54) Current conditions make farming towards the Dead Sea escarpments less viable as there is no sufficient rainfall present (45). Additional contribution to agriculture is livestock farming with approximately 359,200 sheep, 39,500 goats and 100 cattle (58) and intensive chicken farming with 183 chicken farms with a production capacity of ca. 23,000 tons of meat per year (43).

119. According to the WFP Integrated Context Analysis, exposure to risk varies significantly between the different districts. While the Al Mazar Al Janubi district has - except related to erosion and land degradation - an overall relative low risk rating, the district Faqua is the only one in the whole country that the WFP has assigned the 1a category, indicating therefore both, a high risk of exposure to natural shocks and high recurrence of food insecurity. The data is also confirmed by the analysis of the land productivity dynamics (LPD) for the period 2001-2017 also exposing the fact that over 46% of the governorate shows early signs of declining productivity.



Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	Al-Huseiniya	Al-Petra	Ar-Ramtha	Ma'an	TOTAL km²	TOTAL %
	DISTRICTS					
Irrigated orchards	2.07	1.05	12.09	20.60	**35.80**	**0.1**
Irrig. herb. crop	2.75	0	2.69	98.08	**103.52**	**0.3**
Rainf. herb. crop	4.87	31.72	62.69	76.16	**175.45**	**0.5**
Rainfed orchards	0	0	0.12	0.42	**0.53**	**0**
Closed trees	0	1.12	8.14	0.12	**9.38**	**0**
Open trees	0	2.08	19.95	0.22	**22.25**	**0.1**
Woody vegetation	0.04	7.69	1.80	4.82	**14.34**	**0**
Grasslands	24.33	55.64	91.32	78.20	**249.49**	**0.8**
Build-up	11.06	11.62	10.92	69.70	**103.30**	**0.3**
Bare soil	230.85	70.32	112.93	3,789.57	**4,203.66**	**12.8**
Undiff. bare rocks	0.53	59.08	60.71	562.01	**682.33**	**2.1**
Bare rock granite	0	0	0	18.28	**18.28**	**0.1**
Chert plain	174.42	0	0	19,341.62	**19,516.04**	**59.4**
Basaltic plain	13.70	0	0	25.38	**39.08**	**0.1**
Sandy areas	0	0	0	2,675.20	**2,675.20**	**8.1**
Saline soil	0	0	0	155.80	**155.80**	**0.5**
Extraction site	6.41	0	0.01	211.28	**217.69**	**0.7**
Saline waterb.	0	0	0	0	**0**	**0**
Natural waterb.	0	0.02	0	0.37	**0.39**	**0**
Artificial waterb.	0.22	0.01	0.01	2.34	**2.57**	**0**
Wetlands	0	0	0	2.45	**2.45**	**0**
Wadi	57.16	0	0.36	3,976.38	**4,033.90**	**12.3**
Mudflat	0	0	0	580.05	**580.05**	**1.8**
TOTAL LAND	**528.41**	**240.36**	**383.71**	**31,689.03**	32,841.52	100

Figure 15: Karak and its land use (*Source of land use data and map: FAO, 2019*).

120. The analysis of the ECMWF - ERA5 data sets (1979-2019) for the governorate of Karak shows an increasing trend for both annual average MIN and MAX temperature and a decreasing trend for annual average rainfall (Figure 16). Additionally, to understand seasonal and monthly changes the datasets for temperatures (MIN and MAX) and for rainfall have been clustered in four decades and progressively compared against each other to identify the months showing constant trends and those with a more variable trend. The analysis (table 22) highlights the following:

- Max Temperature: constant increasing trend for the months of May, August, October and December. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another).
- MIN Temperature: constant increasing trend for the months of March, May, June and August. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another).
- Rainfall: monthly data confirms the high variability of the rainfall values. Nonetheless, data show a constant decrease in the months of August and November with a loss of -0.20 mm and – 9.42 mm respectively.

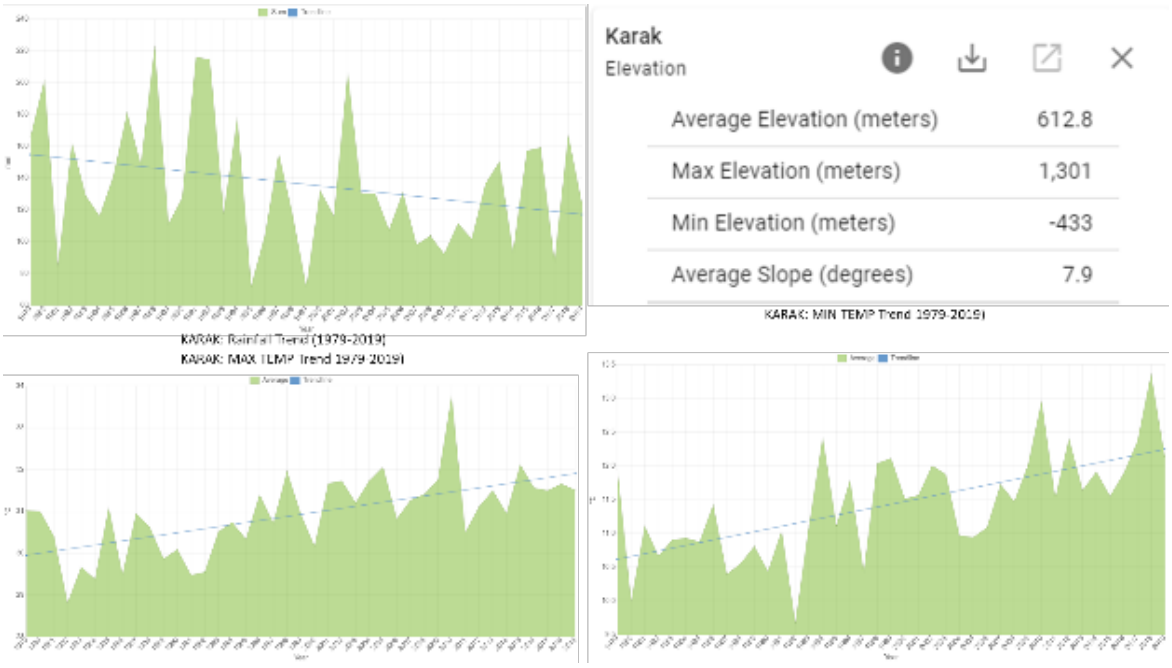


Figure 16: Trend of minimum (left graph) and maximum temperatures in Jordan from 1979 -2019[40].

Rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019													
Karak	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019 (D4)-1979 (D1) Δ
Rainfall(mm)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	-0.20	VARIABLE	VARIABLE	-9.42	VARIABLE	-29.87
MAX Temperature (C)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.85	VARIABLE	VARIABLE	1.27	VARIABLE	2.21	VARIABLE	1.09	1.51
MIN Temperature (C)	VARIABLE	VARIABLE	1.74	VARIABLE	2.57	1.91	2.01	2.21	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.39

Table 22: Karak rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019[41].

121. Described trends demonstrate the high level of exposure of the governorate and its people as increasing trends of temperatures associated with negative trends of rainfall is and will have severe repercussions on water demand for both civil and agriculture purposes.

The Water Sector:

122. Most of the water in this governorate is used in irrigated agriculture, reflecting the demand from irrigators in the Jordan valley and, to a lesser extent, in the highlands (57). Domestic water use is also high (accounting for about 20% of total water use). With an estimated surface water availability of about 70 MCM/yr[42] and an average annual consumption of about 90 MCM/yr, Karak faces a significant water supply shortfall, which is also resulting in significant groundwater depletion[43]. Karak's wastewater treatment plant has a capacity of 1600 m3/day and provides reclaimed water to about 460 dunums,

[40] Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
[41] Author elaboration, 2020. Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
[42] Fayez Abdulla, Jordan University of Science and Technology, (personal communication 2020)
[43] Whitman, E. (2019) A land without water: the scramble to stop Jordan from running dry. Nature.

with potential for expansion.

Socio-Economic indicators:

123. In 2011, 2.7% of the employed inhabitants worked as " Skilled agricultural, forestry and fishery worker". Similar as in Madaba, the main current occupations were "service and sales worker" (31.1%) and "Professionals" (24%) (56).

124. In 2018, the unemployment rate was 15.4% and therefore lower then the national average of 12.2% (55). Interestingly, Karak has the second highest rate of entrepreneurial activity with 11.3%, which is even higher than in the capital and economic center Amman, showing that there is potential among the adult population for creating business and job opportunities (52). Average poverty level of the Governorate in 2010 was 13,4% which is slightly below the average national rate. Also the amount of vulnerable HH is with 20.8% lower than the national average (46).

125. There are however also indicators that show the particular vulnerability of the Governorate: the region has a high inequality rate (GINI = 29.7%) (47) and with 40%, the governorate has one of the highest shares of rural population in the country. (58). As previously pointed out, poverty is a particular recurrent phenomenon in rural areas. In fact areas to the east and west clearly show a high poverty ratio (see figure 15), and are considered poverty pockets[44]. These areas are however also the ones were activities for sustainable agriculture have a high potential for enhancing sustainable development, as the rural poor are highly reliant on the sector.

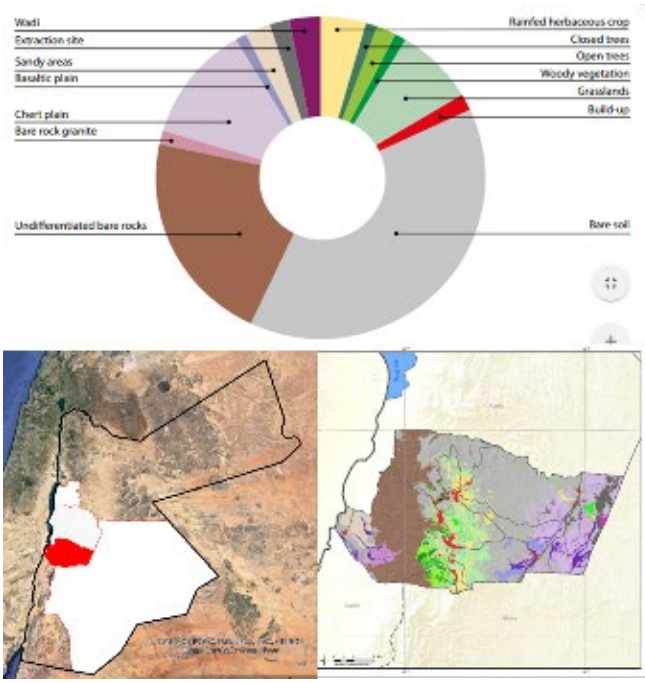
[44] Poverty pockets are areas with a poverty rate higher than 25%.

Tafilah

126. The governorate of Tafilah is part of the Southern region and has 104,000 inhabitants (1 percent of the total population) living on a surface of 6,905 km2 (7.8 percent of total area), and with a density of 47,1 persons/km^2 (55). Tafilah is therefore the 6th smallest and 4th least populated governorate[45] and comprises three districts that are all part of the target regions of the project. The average elevation in the region is 740m, with a maximum elevation of 1 640m, a minimum elevation of -372 m and an average slope of 10.73 degrees. Currently there are 1.959 refugees registered in the Governorate (0.2% of the total) (44).

Climate change, natural resources and agriculture:

127. Only 2.14% of area is arable land. Field crops utilize 53% of the cultivated land, are entirely rain-fed and hence very vulnerable to projected climate change impacts, 25% of the land is dedicated to fruit trees and 19% to vegetable production (54). Additional contribution to agriculture is livestock farming with approximately 99,200 sheep, 21,300 goats and 100 cattle (58) and 31 chicken farms with a production capacity of ca. 3,000 tons of meat per year (43). According to the WFP Integrated Context Analysis the governorate has a high risk for erosion and food insecurity with 3,199 food insecure persons. The data is also confirmed by the analysis of the land productivity dynamics (LPD) for the period 2001-2017 also exposing that over 21% of the governorate shows early signs of declining productivity.



Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS Al-Hasa	Bsaira	Qasabet At-Tafiela	TOTAL km^2	TOTAL %
Irrigated orchards	0.14	0.74	2.95	3.83	0.2
Irrigated herb. crop	1.94	0.17	0.49	2.60	0.1
Rainfed herb. crop	10.47	38.21	53.08	101.76	4.6
Rainfed orchards	0.09	0	2.28	2.37	0.1
Closed trees	0	17.99	3.87	21.85	1
Open trees	3.14	36.42	4.61	44.16	2
Woody vegetation	5.74	7.24	10.87	23.85	1.1
Grasslands	29.15	67.17	76.77	173.09	7.8
Build-up	6.44	11.78	20.32	38.55	1.7
Bare soil	516.42	16.29	320.89	853.59	38.6
Undiff. bare rocks	0.07	29.30	437.09	466.45	21.1
Bare rock granite	1.25	0	27.83	29.08	1.3
Chert plain	255.64	0	0	255.64	11.6
Basaltic plain	28.94	0	0	28.94	1.3
Sandy areas	0	0	52.23	52.23	2.4
Saline soil	0.35	0	2.15	2.50	0.1
Extraction site	38.90	0.98	0.07	39.95	1.8
Saline waterbody	0	0	0	0	0
Natural waterbody	0	0	0	0	0
Artificial waterbody	0.70	0.01	0.65	1.35	0.1
Wetlands	0.02	0	0	0.02	0
Wadi	49.37	0.57	16.13	66.07	3
Mudflat	4.41	0.54	0	4.95	0.2
TOTAL LAND	953.18	227.40	1,032.26	2,212.84	100

Figure 17: Tafilah and its land use (*Source of land use data and map: FAO, 2019*).

128. The analysis of the ECMWF - ERA5 data sets (1979-2019) for the governorate of Tafilah shows an increasing trend for both annual average MIN and MAX temperature and a decreasing trend for annual average rainfall (Figure 18). Additionally, to understand seasonal and monthly changes the datasets for temperatures (MIN and MAX) and for rainfall have been clustered in four decades and progressively compared against each other to identify the months showing constant trends and those with a more variable trend. The analysis (table 23) highlights the following:

- Max Temperature: constant increasing trend for the months of May, June, August and November. During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade

[45] *Ibid.*

and slightly lower in another).

- MIN Temperature: the trend is increasing but variable (e.g. slightly higher in a decade and slightly lower in another) with the exception of January where the trend shows a minor decrease.
- Rainfall: monthly data confirms the high variability of the rainfall values. Nonetheless, data show a constant decrease in the months of November with a loss of - 6.13 mm respectively.

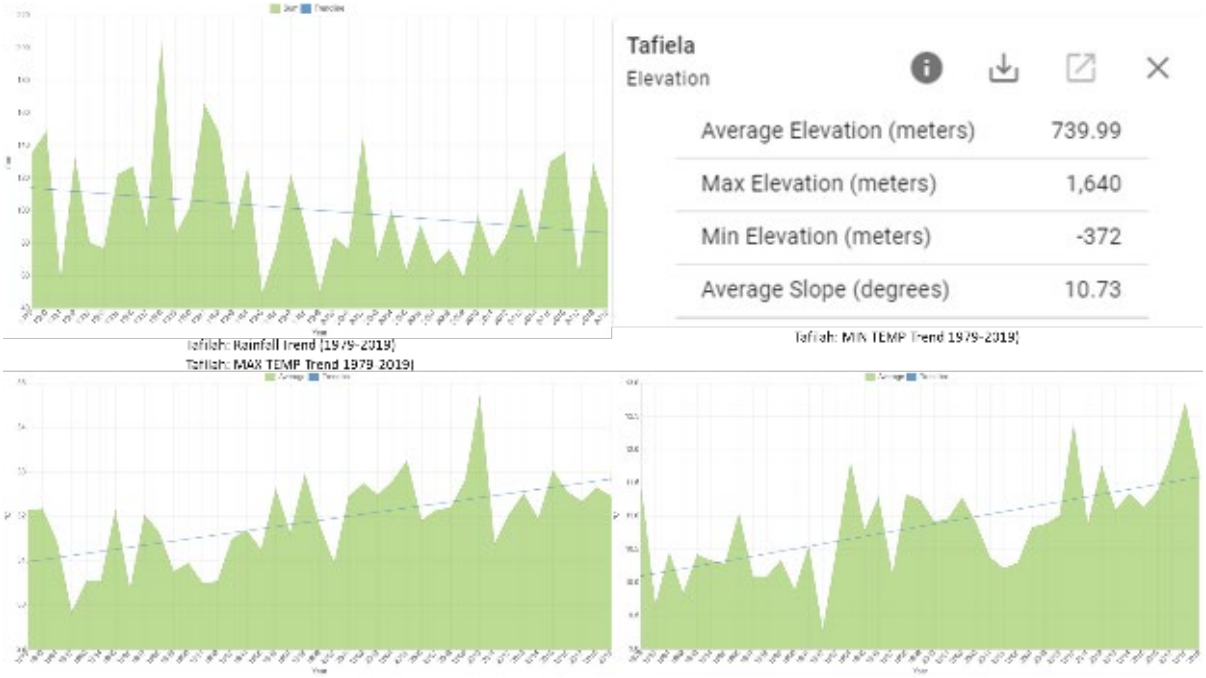


Figure 18: Trend of minimum (left graph) and maximum temperatures in Jordan from 1979 -2019[46].

Rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019													
Tafilah	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019 (D4)-1979 (D1) Δ
Rainfall(mm)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	-6.13	VARIABLE	-20.90
MAX Temperature (C)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.88	1.39	VARIABLE	1.06	VARIABLE	VARIABLE	1.24	VARIABLE	1.30
MIN Temperature (C)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.20

Table 23: Karak rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019[47].

129. Described trends demonstrate the high level of exposure of the governorate and its people as increasing trends of temperatures associated with negative trends of rainfall is having and will have severe repercussions on water demand for both domestic and agriculture purposes.

The Water Sector:

130. Tafilah's water situation is challenging, with growing uses across agriculture, domestic and industry sectors and limited surface and groundwater supplies. About 52% of the governorates scarce freshwater resources are used in agriculture, with the rest equally split between domestic uses and industry. Some estimates suggest that the supply-demand imbalance is large, with at least one-third of the water demand in the governorate going unmet during certain times of the year. The governorate's wastewater treatment plant has a capacity to treat about 2000 m3/day, and already provides reclaimed water to about 341 dunum, with potential for expansion.

Socio-Economic indicators:

131. Tafilah has the highest national unemployment rate with 23.5% (55). Average poverty level of the Governorate in 2010 was 17,2% and the amount of vulnerable HH 26.4%, both values are significant higher than the national average (46). The region has the second lowest inequality rate (GINI = 23.6%)

[46] Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
[47] Author elaboration, 2020. Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.

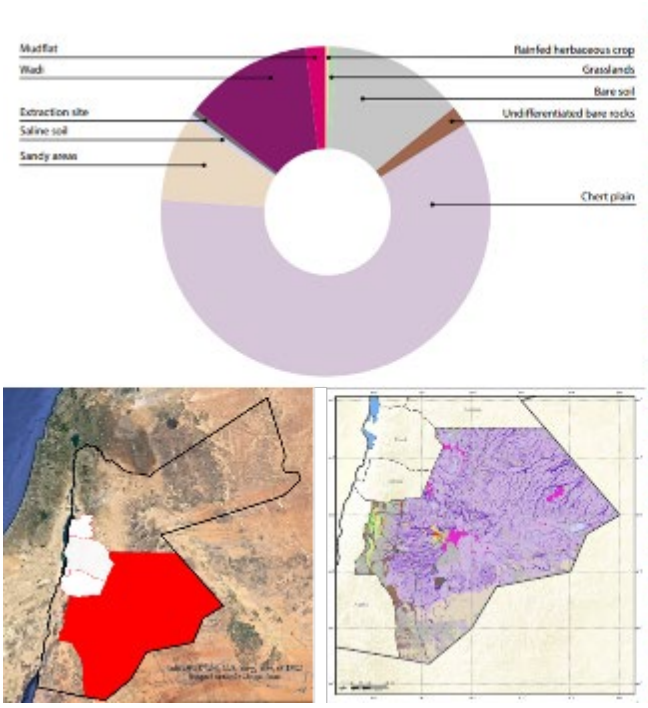
(47) and a rural population of 22%, one of the highest shares in the kingdom (58). As previously pointed out, poverty is a particular recurrent phenomenon in rural areas.

Ma'an

132. The Governorate of Ma'an is part of the Southern regions and has 171,100 inhabitants (1.7 percent of total population) living on a surface of 32,832 km2 (37 percent of total area), with a density of 5,2 persons/km^2(55). Despite being the largest governorate, Ma'an is also the second least populated one, due to a low population density of 5.2 persons/km2.48 The governorate comprises four districts, three of which, and one sub-district, are part of the target areas. Ma'an has and average elevation of 883 m, ranging from a maximum of 1,733 m to a minimum of 284 m a.s.l. Average slope is 2.15 degrees. There are currently 9.731 refugees registered in the Governorate (1.3% of the national registrations) 44.

Climate change, natural resources and agriculture:

133. The governorate is mainly covered by desert and only 0.8% of the land is arable. Of this, 26% is left as fallow. Field crops cover 49% of the arable land and are by 85% rain-fed. About 14% of the land is dedicated to fruit trees and 3% to vegetable production (54). Additional contribution to agriculture is livestock farming with approximately 233,000 sheep's, 103,000 goats and 100 cattle (58) and 5 chicken farms with a production capacity of ca. 1,000 tons of meat per year (43). The WFP Integrated Context Analysis reports for the Al_Husayniyya District a high risk for food insecurity and for the Shobback district a high risk for erosion. In the target districts there are currently 4,196 food insecure inhabitants.



Aggregated land cover statistics of the Governorate by district

LAND COVER CLASSES	DISTRICTS Al-Huseiniya	Al-Petra	Ar-Ramtha	Ma'an	TOTAL km²	TOTAL %
Irrigated orchards	2.07	1.05	12.09	20.60	**35.80**	**0.1**
Irrig. herb. crop	2.75	0	2.69	98.08	**103.52**	**0.3**
Rainf. herb. crop	4.87	31.72	62.69	76.16	**175.45**	**0.5**
Rainfed orchards	0	0	0.12	0.42	**0.53**	**0**
Closed trees	0	1.12	8.14	0.12	**9.38**	**0**
Open trees	0	2.08	19.95	0.22	**22.25**	**0.1**
Woody vegetation	0.04	7.69	1.80	4.82	**14.34**	**0**
Grasslands	24.33	55.64	91.32	78.20	**249.49**	**0.8**
Build-up	11.06	11.62	10.92	69.70	**103.30**	**0.3**
Bare soil	230.85	70.32	112.93	3,789.57	**4,203.66**	**12.8**
Undiff. bare rocks	0.53	59.08	60.71	562.01	**682.33**	**2.1**
Bare rock granite	0	0	0	18.28	**18.28**	**0.1**
Chert plain	174.42	0	0	19,341.62	**19,516.04**	**59.4**
Basaltic plain	13.70	0	0	25.38	**39.08**	**0.1**
Sandy areas	0	0	0	2,675.20	**2,675.20**	**8.1**
Saline soil	0	0	0	155.80	**155.80**	**0.5**
Extraction site	6.41	0	0.01	211.28	**217.69**	**0.7**
Saline waterb.	0	0	0	0	**0**	**0**
Natural waterb.	0	0.02	0	0.37	**0.39**	**0**
Artificial waterb.	0.22	0.01	0.01	2.34	**2.57**	**0**
Wetlands	0	0	0	2.45	**2.45**	**0**
Wadi	57.16	0	0.36	3,976.38	**4,033.90**	**12.3**
Mudflat	0	0	0	580.05	**580.05**	**1.8**
TOTAL LAND	**528.41**	**240.36**	**383.71**	**31,689.03**	32,841.52	100

Figure 19: Ma'an and its land use (*Source of land use data and map: FAO, 2019*).

134. The analysis of the ECMWF - ERA5 data sets (1979-2019) for the governorate of Ma'an shows an increasing trend for both annual average MIN and MAX temperature and a decreasing trend for annual average rainfall (Figure 20). Additionally, to understand seasonal and monthly changes the datasets for temperatures (MIN and MAX) and for rainfall have been clustered in four decades and progressively compared against each other to identify the months showing constant trends and those with a more variable trend. The analysis (Table 24) highlights the following:

- Max Temperature: constant increasing trend for the months of May, June, August and October.

[48] Department of Statistics, 2018. Jordan in Figures.

During the rest of the year the trend is still increasing but variable (e.g. slightly higher in a decade and slightly lower in another).

- MIN Temperature: the trend is increasing but variable (e.g. slightly higher in a decade and slightly lower in another) with the exception of January where the trend shows a minor decrease. The months of March, May, June, July and August show a constant increase across the decades.
- Rainfall: monthly data confirms the high variability of the rainfall values.

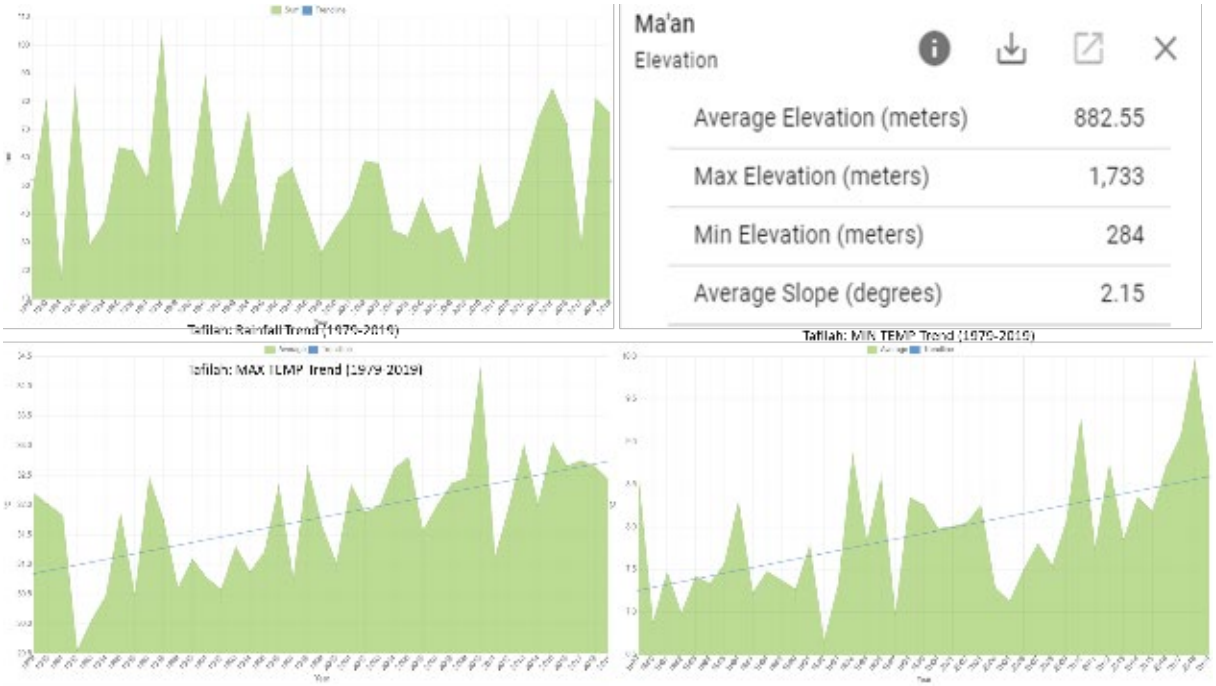


Figure 20: Trend of minimum (left graph) and maximum temperatures in Jordan from 1979 -2019[49].

Rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019													
Ma'an	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2019 (D4)-1979 (D1) Δ
Rainfall(mm)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	VARIABLE	-1.09
MAX Temperature (C)	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.95	1.90	VARIABLE	1.62	VARIABLE	1.71	VARIABLE	VARIABLE	1.31
MIN Temperature (C)	VARIABLE	VARIABLE	1.73	VARIABLE	1.82	2.07	2.11	1.74	VARIABLE	VARIABLE	VARIABLE	VARIABLE	1.09

Table 24: Ma'an rainfall and temperatures (MAX and MIN) comparison of 4 decades in the period 1979-2019[50].

135. Described trends demonstrate the high level of exposure of the governorate and its people as increasing trends of temperatures associated with high variability of rainfall have and will have severe repercussions on water demand for both civil and agriculture purposes. Furthermore, given the overall aridity of the governorate, although minor positive changes are reported, these are not sufficient to counterbalance the reported increases in both MIN and MAX temperatures.

The Water Sector:

136. Ma'an faces a challenging water situation, with high levels of scarcity and variability. Surface water availability is low, with only less than 15% of water demands being met with surface water sources. The remaining water demand either goes unmet or is satisfied by tapping groundwater resources, which are being depleted very rapidly. The MWI estimates a water deficit ranging from 8 to 16 MCM in the key aquifers located in this governorate[51].

[49] Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
50 Author elaboration, 2020. Based on data collected via FAO Earthmap from the ECMWF - ERA5 data sets.
[51] MWI (2017) Jordan water sector- facts and figures.

Socio-Economic indicators:

137. Ma'an has an above national average unemployment rate of 20.5% (58), the poverty rate is with 26.6% the highest in the country. In addition, also the share of vulnerable HH is with 28.4% significantly higher than the national average. (46). The inequality GINI rate is = 26.3% (47) and with 46%, the governorate has the highest shares of rural population in the country (58). As previously pointed out, poverty is a particular recurrent phenomenon in rural areas.

4. KEY TECHNOLOGIES, PRACTICES AND SECTORIAL APPROACHES IDENTIFIED BY STAKEHOLDERS TO ADDRESS CLIMATE CHANGE ADAPTATION

138. A broad range of technologies, practices and sectoral approaches to advance climate change adaptation in Jordan were identified. Just in relation to the water sector, these cover aspects related to farmer trainings on enhancing water-use efficiency, drought-tolerant crop varieties, enhanced water supply, and more reliable water supply in household and agriculture. Given its centrality to Jordanian water and climate policy, the term 'water-use efficiency' was used in the title to capture this diversity of actions. The term should be interpreted in the broadest possible sense as encapsulating issues related to *both* water use and sustainable supplies of water resources, as done in SDG 6.4. The technologies, practices and sectoral approaches are described in more detail in the following sections.

139. The project does not promote groundwater use through irrigation or other means. It will solely focus on increasing water supply through storage of treated wastewater and rooftop water harvesting and reducing household water consumption through the use of water saving devices. To assess the project's benefit, we estimate by how much the proposed interventions will contribute to reducing the existing groundwater overdraft in the Dead Sea Basin. Groundwater overdraft occurs when groundwater use exceeds the amount of natural recharge into an aquifer through rainfall, which leads to a decline in groundwater level and an increased vulnerability to drought.

140. According to the Jordanian Ministry of Water and Irrigation (https://www.nature.com/articles/d41586-019-02600-w), the existing groundwater overdraft in the basin is 26.9 MCM/year. While this value is subject to uncertainty and potential changes as the basin develops and climate change impacts materializes, it provides the best-available benchmark to quantify the project's contribution to reducing groundwater overdraft[1]. This value is compared to the project's interventions in the table below to demonstrate that by increasing water supply through storage of treated wastewater and rainwater (e) and saving water (effectively reducing consumption in households), the project contributes to reducing groundwater overdraft and the pressure on precious groundwater resources. The water balance is calculated on an annual time-step for the last year (year 7) of the project, when all the planned interventions are expected to have been completed, thus providing their full contribution to the region's water balance. To account for the uncertainty around real water savings obtained through water saving devices in households, the table presents the water balance for optimistic (top) and base (bottom) scenarios. As shown in Table 1A/1B, the project is expected to contribute to a 3 to 3.5% reduction in groundwater overdraft in the basin.

Project interventions		
Rooftop rainwater harvesting in private and public buildings	0.31	MCM
Installation of water saving devices in households and public buildings (optimistic – devices lead to 30% reduction)	0.36	MCM
Storage of reclaimed wáter	0.255	MCM
Water balance		
Water saved by the project in year 7 (optimistic scenario)	0.93	MCM
Existing groundwater overdraft	26.9	MCM
Contribution to reduce annual groundwater overdraft by end of the project in year 7		
Achieved reduction in groundwater overdraft (optimistic scenario, where water saving devices lead to a 30% decrease in water consumption in homes)	3.5%	

Table 25: Water balance, optimistic scenario, where the installation of water saving devices in households and public buildings lead to 30% reduction in consumption. All values are annual, assuming that project interventions reach their full planned capacity by year 7.

[1] Whitman, E. (2019) A land without water: the scramble to stop Jordan from running dry. Nature 573, 20–23. doi: 10.1038/d41586-019-02600-w

Project interventions		
Rooftop rainwater harvesting in private and public buildings	0.31	MCM
Installation of water saving devices in households and public buildings (base – devices lead to 20% reduction)	0.24	MCM
Storage of reclaimed water	0.255	MCM
Water balance		
Water saved by the project in year 7 (base scenario)	0.81	MCM
Existing groundwater overdraft	26.9	MCM
Contribution to reduce annual groundwater overdraft by end of the project in year 7		
Achieved reduction in groundwater overdraft (scenario where water saving devices lead to a 20% decrease in water consumption in homes)	3%	

Table 26: Water balance, base scenario, where the installation of water saving devices in households and public buildings lead to 20% reduction in consumption. All values are annual, assuming that project interventions reach their full planned capacity by year 7.

141. Finally, according to the goals set in the National Water Strategy (2016-2025), 7 MCM of additional water supplies will be provided through household's rainwater water harvesting by 2025 (National Water Strategy, table 5). The investments on rainwater harvesting systems supported by the project will contribute to 0.31 MCM or 4.4% to close the gap towards this goal and support the expansion of its impacts at the national level thanks to the extensive training and capacity development of communities, civil society organizations, academia, private sector actors and institutions (central and local).

Investments in rooftop rainwater harvesting and water saving devices for public/private buildings

142. Rainwater harvesting (RWH) at the household level is listed by the National Water Strategy for 2016-2025, the National Adaptation Plan and by National Climate Change Policy and Sector Strategic Guidance Framework (2013-2020) among the specific adaptation measures that the water sector in Jordan needs to undertake to cope with future climate change. At present, there is limited application of RWH in the study area (Table 25), despite its high potential for alleviating the impacts of climate change on water security in many areas of Jordan. This is possibly due to the high level of poverty registered in the area as well as in the lack of appropriate awareness.

Governorate	Number of households	Number of people
Madaba	327	1516
Karak	350	1642
Tafila	8	28
Ma'an	47	165

Table 27: Existing rooftop water harvesting systems in the project area[1].

143. The rooftop rainwater harvesting systems are cost effective and easier technical method of providing additional supplies to bridge dry spells and conserve water. It is popular as a household option as the water source is close to people, so it is convenient and requires a minimum of energy to collect it. An added advantage is that users own, maintain, and control their system without the need to rely on other members of the community or other stakeholders. Furthermore, the country disposes of a specific standard – the Unified Plumbing Code of 2015 - that also includes type of tanks and technical specification. The objective is to collect rainwater using appropriate infrastructure (e.g. cisterns) and citizen expertise to increase the volume of freshwater available for livestock watering and households' gardens irrigation. Finally, at the community level, rainwater harvesting reduces the volume of surface water discharged to drainage and may contribute to reducing flood risk and the load on combined sewer overflows (thus improving ambient water quality). Multiple studies show that installation of rooftop rainwater harvesting systems, especially in urbanized areas, can be an efficient support to reduce flood risk (Freni and Liuzzo, 2019)

144. Table 26 lists the number of rural single households in the project. Only the households with rooftop areas greater than 100 sqm are included, because that's the requirement for a minimum water harvest yield of 10 m3 below which the intervention is not economically feasible (Abdulla, 2019). The potential rooftop water harvesting yield for each governorate was estimated using the traditional supply-

[1] Source Jordanian Department of Statistics, 2018

side approach (Abdulla 2019). The volume of water that can be harvested from roofs equals the annual volume of rainfall in each governorate (mm/yr), times the roof area in each governorate (sqm), times the runoff coefficient (non-dimensional) – which is set to 0.8 following Jordanian best practice (Abdulla and Al-Shareef 2009). Table 26 shows the water yield potential (i.e., the volume of water that can potentially be harvested from roofs in target households and public buildings in the project area) estimated with this approach. Data on roof areas are taken from the Jordanian Department of Statistics and grouped into categories to facilitate the estimation. The water harvested through this technology will contribute to the irrigation of at least 800 dunum (80 ha) of household's gardens (see example of house gardens identified in Figure 21) and will provide drinking water for a total of at least 20,000 animal heads (cattle and small ruminants).

	Madaba		Karak		Tafilah		Ma'an		
	Households								
Roof area (sqm)	100-149	150-200	100-149	150-200	100-149	150-200	100-149	150-200	Total (m3)
Average annual rainfall (mm/yr)	325.7	325.7	355.6	355.6	255.4	255.4	270	270	
Total number of households	1777	1619	3630	3657	988	461	1245	508	
Target households (36% of total)	640	583	1307	1317	356	166	448	178	
Potential water yield (m3)	20844	26583	46476	65565	9092	5935	12096	6728.4	193323
	Public buildings								
Roof area (sqm)	500		500		500		500		
Target buildings (number)	266		629		235		84		
Potential water yield (m3)	34645		89421		24021		9069		157156

Table 28: Water yield potential for households and public buildings Madaba, Karak and Tafila Governorates[1].

Figure 21: Sample of identified household and public infrastructures suitable for the activity.

145. Rainwater harvesting tanks can be constructed above ground or underground. For underground structures, construction challenges are greater as location of supply and sewage lines needs to be checked, damage to building foundation needs to be avoided. Nonetheless, underground cisterns tend to have greater storage capacity and also have the advantage of providing relatively cooler water during the hot months (PennState, 2016).

146. According to the Jordanian standards established by the Unified Plumbing Code (2015) for the rooftop rainwater harvesting systems, the project will use 4 types of tanks: concrete, fiberglass, steel and ferrocement. Selection will be made based on site, land availability, emissions associated with tank type and technical feasibility. Plastic tanks are increasingly popular; if constructed from food-grade plastic material to prevent leaching of harmful compounds; these tanks are a good solution and also

[1] Source: data on number of households and public buildings from Jordanian Department of Statistics, 2018, all other data from Dr Fayez Abdulla, Jordan University of Science and Technology using a runoff coefficient of 0.8 and the median roof areas.

tend to have lower emissions compared to concrete tanks (MetaMeta, 2017).

147. Therefore, this activity aims to build climate resilience through improved access to water and efficient water use at the household level for both domestic use and for crops planted in the homestead gardens that do not require constant irrigation and that are drought tolerant. To this end, the project considered that households would use about 23% of the stored water for domestic purposes and the rest for crops (e.g. olive oil trees, zaatar and vegetables). From the simulations made by the project, the following pattern for a 20 m3 system that included irrigation of crops equivalent to about 20 m2 planted with olive oil trees (2-3) and about 50 m2 planted with mixed vegetables, the system will always be filled with water.

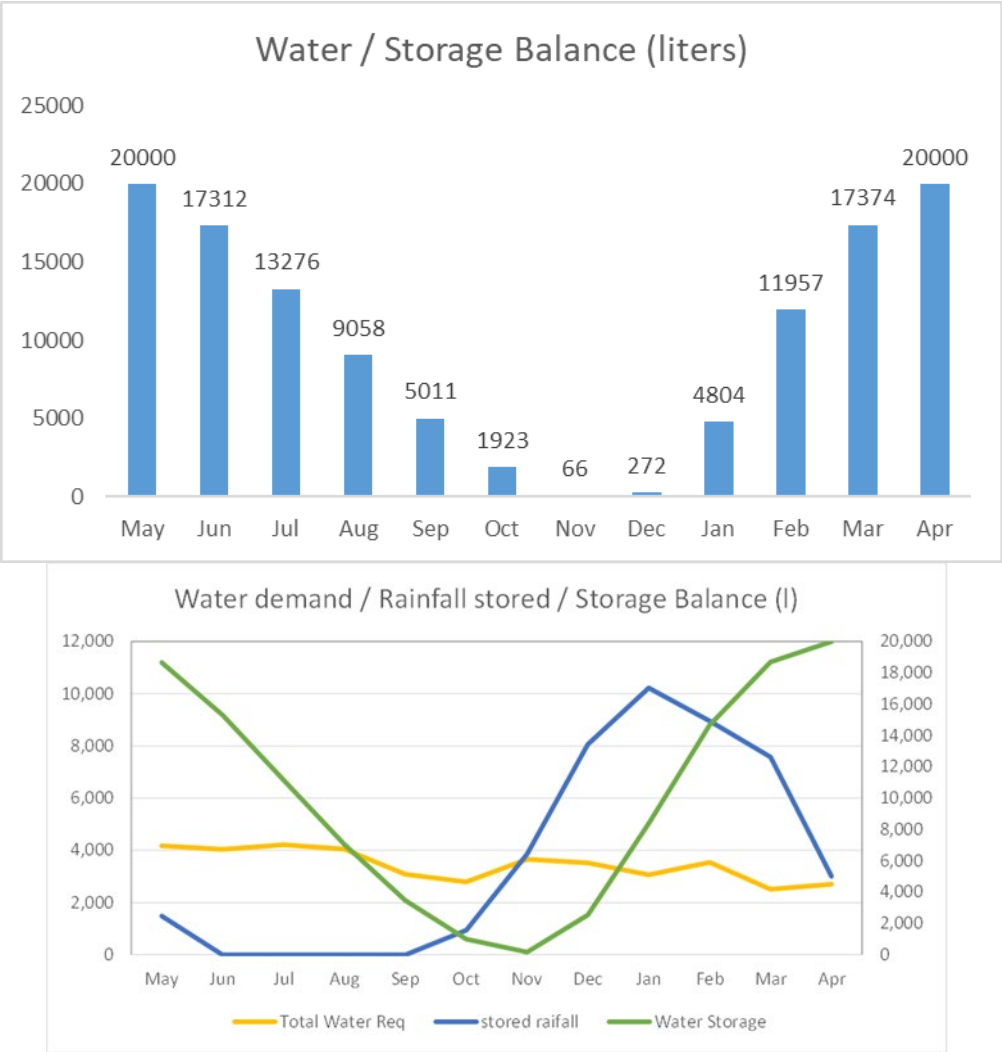


Figure21: Rainwater Storage tanks water balance.

148. Furthermore, households will also have access to the activities designed to increase water productivity, adopt new irrigation technologies and learn new practices that will minimize water requirements both in house and outside (i.e. home garden) [Component 2]. Therefore, the provision of rainwater harvesting systems is not planned to substitute rainfed irrigation in open fields but to optimize the use of potable water from the public system also climate proofing home gardens productions.

149. The type of rainwater storage method will depend on site specific constraints, including space and slope constraints (Sharma et al. 2015). Concrete tanks are thought to be the most cost-effective for sizes between 2.5 m^3 and 16 m^3, with high-density polyethylene (HDPE) recommended for smaller tanks, due to its low weight, cost-effective durability and ease of maintenance (Silva et al. 2015). Research on the cost-benefits of rainwater tanks type shows that material type is not a fundamental in determining economic feasibility (Morales-Pinzon et al. 2012).

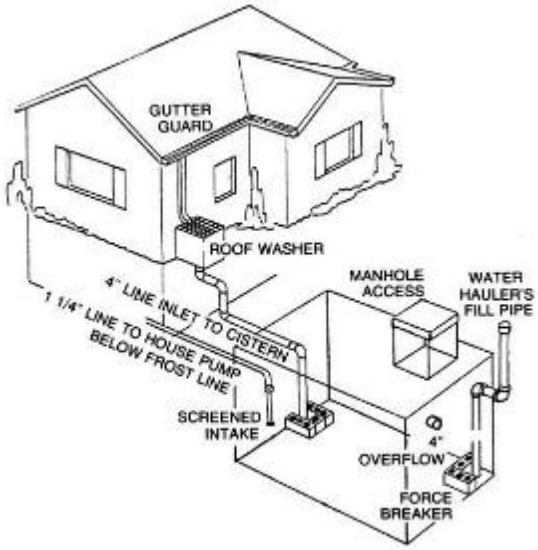


Figure 22: Schematic sketch of a simple rooftop rainwater harvesting system with underground cistern.[1]

150. Groundwater recharge will be considered in the design stage of the system if there is an oversupply of collected rainwater compared to demands (Water Aid 2011). This will be often the case in public buildings, where roof areas are large and demands low. The rainwater harvested in public buildings is expected to be used for building cleaning and water services and – in some buildings- food preparation. If the quantity of rainwater collected exceeds demand for a good part of the year, then groundwater recharge can take place through a few options, including: (1) deep well recharging (2) unused dug wells (3) recharge pits (UN Habitat 2012). Deep well recharging works by simply channelling the collected rainwater to the well through a pipe, and is particularly suite for areas where aquifers are deep and overlain by impermeable strata. Unused dug wells can be used as recharge structures by guiding pipes from the rainwater collection systems, though this requires periodic cleaning and chlorination to avoid bacterial proliferation. Groundwater recharge pits are dug in areas where geological maps indicate the presence of permeable layers which favour percolation (alluvial deposits). In these areas, pits are constructed in proximity to the building, filled with pebbles, gravels and other permeable materials and connected to the collection system. A schematic of a groundwater recharge pit fed by a rooftop rainwater harvesting system in shown in Figure 23.

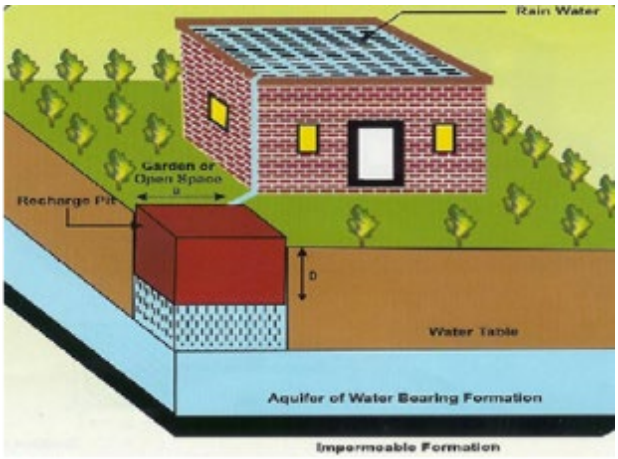


Figure 23: Schematic representation of a groundwater recharge pit fed by collected rainwater[2].

151. The supply of the rooftop rainwater harvesting systems should be awarded using a bulk tendering process. This is because it will be practically difficult for service providers, government agencies and FAO to supervise widely scattered construction for the 5000 plus beneficiaries targeted in the project. This bulk tendering process is likely to target large national contractors capable of manufacturing, transporting and installing standardized tanks and structures. To minimize project supervision and

[1] Source: PennState Extension (2016)
[2] Source: Hyderabad Water, available from: https://www.hyderabadwater.gov.in/en/rainwater1/aboutus.aspx

tendering risks, rooftop rainwater harvesting system designs with the following characteristics should be favored:

- Standardized with minimal testing requirements
- Able to store 10-20 m^3
- Can be transported and delivered easily to multiple sites
- Require minimal site pre-survey and minimal inspection/supervision during installation
- Have a lifespan of at least 30 years
- Have low greenhouse gas emission of material production
- Do not require maintenance services from government agencies/service providers, but do have a guarantee from the manufacturer if defects emerge.

152. Mass-produced, above ground tanks respond to these requirements. These are typically made from plastic (high-density polyethylene or glass reinforced plastic) or precast concrete (Thomas and Martinson, 2007). These tend to be easy to transport and install then custom-made tanks. Some indicative prices are provided in Table 27.

Type	Advantage	Disadvantage
Concrete tanks	Cooler water storage Can be customized	High building cost Long building time High maintenance cost Spatial restrictions Building permits Tend to have high greenhouse gas emissions
Plastic tanks	Easy and quick to install Low cost for small structure Easy maintenance Easy transportation	Risk that beneficiaries sell it Limitation in pipe connections High cost for larger sizes
Metal tanks	Easy transportation Easy/quick installation Modular/variety of sizes Easy maintenance	Tank stability Corrosion

Table 29: Simplified SWOT analysis of identified tank options[1].

153. While the standardized approach is recommended to facilitate tendering and implementation, it comes with its downsides. Experts argue that this approach minimizes the scope for local employment (i.e., tanks are manufactured elsewhere) and participation of stakeholders in siting and maintain the tanks (Thomas and Martinson, 2007).

154. The above mentioned activities will require private sector entities specialized in designing, implementing and supervising civil engineering works. In addition, the implementation process will require an effective supply of inputs needed for conducting the activities. Table 28 below, shows the active establishments in the field of construction, civil engineering, and many other specializations related to implementing the project activities in the four governorates. Finally, there are many input suppliers in the four governorates who can supply all the needed irrigation fittings, tanks, pipes, pumps and all other needed tools or equipment to construct the needed structures in the activities.

Economic activity	Ma'an	Tafiela	Karak	Madaba	Project Area	Kingdom Total
Construction of buildings	6	1	8	2	17	473
Civil engineering	**0**	**0**	**4**	**0**	4	**64**
Construction of roads and railways	0	0	3	0	3	21
Construction of utility projects	0	0	0	0	0	25
Construction of other civil engineering projects	0	0	1	0	1	18
Specialized construction activities	**4**	**2**	**12**	**6**	24	**527**
Site preparation	0	0	0	0	0	3
Electrical installation	0	1	2	0	3	86
Plumbing, heat and air-conditioning installation	2	0	4	3	9	262
Other construction installation	0	0	1	0	1	18
Building completion and finishing	2	0	4	3	9	139
Other specialized construction activities	0	1	1	0	2	19
Wholesale on a fee or contract basis	0	0	0	2	2	334
Wholesale of agricultural raw materials and live animals	3	7	10	11	31	205

[1] Source: Authors when not specified in the table.

Table 30: No. of Active Establishments by Economic Activity and Governorate 2018[1]

155. Additionally, as part of the identified priority selection criteria, involved households and institutions will have to acquire and install water saving devises that appear to be still scarcely used in rural areas. The project aims to promote water-use efficiency through uptake and diffusion of water saving devices in households and public buildings. Water saving devices include spray taps, faucet aerators, pressure reducing valves and low-flow shower heads with shut-off valves (Figure 24). In Jordan, existing evidence suggest that water saving devices has proved to save 30% of water used in buildings (USAID 2005). The government – often with support from international donors- has already embarked on a campaign to promote the uptake of these devices, so this activity is well aligned with existing policies (USAID 2018).

156. While the cost of water saving devices is fairly low, their benefit in terms of saved water is significant. The estimated cost of installation of water saving devices at a typical household with roof area between 100-200 m2 is only around 100 JOD[2]. Assuming a conservative household consumption of about 300[3] litres per day, this leads to about 0.36 million cubic metres of water saved across all beneficiary households and public buildings[4].

Figure 24: Water saving devices available in Jordan. Source: USAID.

Specific Execution Modalities[5]

157. The activities related to rainwater harvesting (private households[6]) will be executed by UNDP-Jordan. UNDP Jordan owns the in-house capacity with a team of engineers and procurement experts to design of BOQ and process procurement of roof top harvesting activities at the large scale in a short time line. In addition, the capacity from the regional hub in Amman and procurement team in Copenhagen can be seconded to accelerate the process when necessary. UNDP will apply its Social and Environmental Screening procedures (SESP) to identify potential social and environmental risks and opportunities associated with the proposed interventions and determine the appropriate type and

[1] Source: Department of Statistics/Establishments Census 2018.
[2] Estimate provided by Dr Fayez Abdulla, Jordan University of Science and Technology based on a search of suppliers of water saving devices
[3] Estimate provided by Dr Fayez Abdulla also includes public buildings, where we assume that water consumption per capita in public buildings is lower than in private buildings, but that overall number of users is higher so that overall consumption per building remains the same
[4] The full cost of the water saving devices will be ensured by beneficiaries.
[5] When execution modalities are not explicitly reported, these will be executed directly by FAO.
[6] Rainwater harvesting systems in public buildings will be under FAO responsibility.

level of social and environmental assessment.

158. UNDP will encourage and promote effective public, public-private and civil society partnerships, building on its experience and resourcing strategies of partnerships. UNDP will engage key stakeholders including governmental authorities in the targeted areas, national leaders, civil society, research centers and universities to ensure ownerships of the project interventions. UNDP will benefit from similar interventions already implemented in different parts (although small scale) and the lessons learned out of these interventions.

159. UNDP will target youth and female leaders and affected populations through active engagement in climate action, policy dialogue, awareness raising and advocacy in all stages of the project. UNDP will establish an internship programmes targeting youth to ensure knowledge sharing amongst local communities given that Jordan has one of the youngest population in the region with 63% of the population under 30 (DOS, 2019).

160. UNDP will ensure strengthening the role the local NGOs/ CBOs with a focus on women association in the targeted governorates in executing some of the activities including outreach and awareness activities.

Investments in hydraulic structures to maximize use of reclaimed water

161. Reuse of reclaimed water is central to Jordan's climate adaptation efforts. Jordan's Third National Communication on Climate Change (The Hashemite Kingdom of Jordan, 2014) and Intended Nationally Determined Contributions both identify water recycling and reuse of reclaimed water as a key adaptation action in the water sector. These climate-related strategies are accompanied by sector specific policies and legislation regarding reuse of reclaimed water. The two key documents are the Jordanian standard no. 893/2006 " Reclaimed domestic wastewater" which sets the water quality parameters that have to be met to irrigate different types of crops (Jordanian Reclaimed Wastewater Standard-JS 893\2006) and the 2016 Water Substitution and Reuse Policy. Here the terms treated wastewater and reclaimed water are used interchangeably to indicate effluent from a wastewater treatment plant which is suitable for reuse in irrigation according to national legislation.

162. The project aims to maximize reuse of reclaimed water from three existing wastewater treatment plants (WWT). The main characteristics of the three WWT plants are shown in Table 31.

WWTP	Design capacity (m^3/d)	Type of treatment
Al Tafila	7,500.0	Trickling filters
Al Karak	5,500.0	Trickling filters
Madaba	7,600.0	Activated sludge

Table 31: Design capacities, influents and effluents of WWTPs.[1]

163. During the field visits, it emerged that in the rainy season the wastewater treatment effluent is unused and discharged into the environment, while in the dry season demand for reclaimed water goes unmet. Therefore, it was proposed that the unused reclaimed water during the rainy season be stored in reservoirs to maximize its utilization in irrigated agriculture in the dry season. This concept is shown in Figure 25. The proposed reservoirs act as a seasonal storage for the effluent and, in addition, provide additional stabilisation for the effluent, enhancing its water quality. This proposed activity upgrades the existing systems, ensuring that they are aligned to international best practice on the sustainable treatment and reuse of municipal wastewater, which recommends that every wastewater reuse for irrigation project includes a reservoir to regulate effluent flow (Libhaber and Jaramillo, 2012, pg. 341). In addition to the reservoir, the activity aims to rehabilitate and expand of the reclaimed water distribution systems to maximize its efficient utilization.

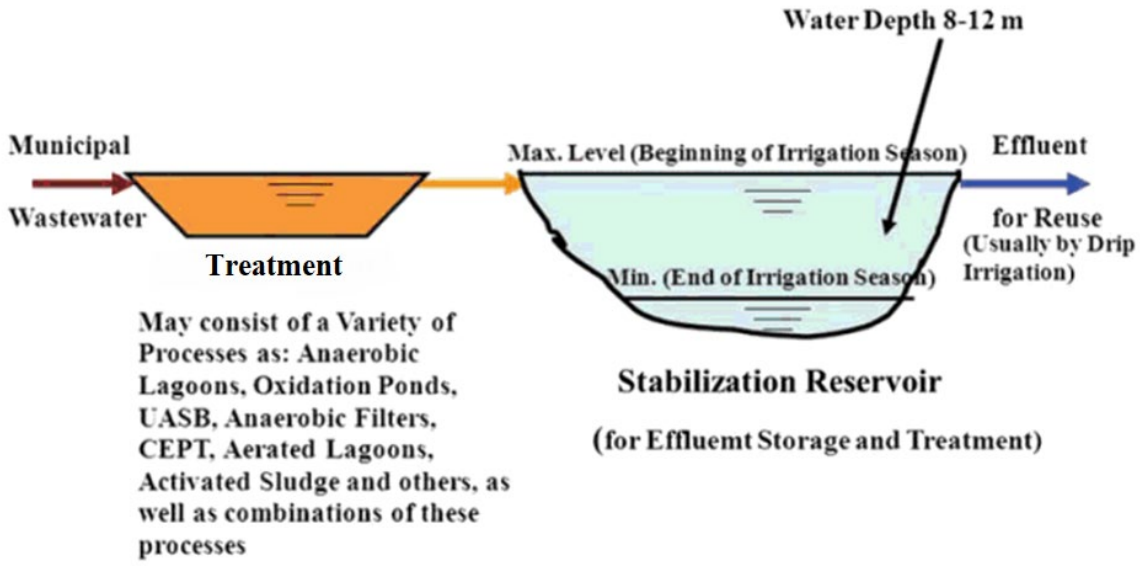


Figure 25: The effluent storage and stabilisation concept and schematic diagram of its functioning[2].

[1] Source: Eng. Ahmed Al-Uleimat, ASG For Labs & Quality Affairs, Ministry of Water & Irrigation (personal communication, March 2020).
[2] Note: water depth is indicative and will vary depending on site conditions and quantity of effluent to be stored. Source: Adapted from Libhaber and Jaramillo. Sustainable treatment and reuse of municipal wastewater. IWA publishing, 2012. The full set of design studies including the construction technical details will be provided with the

164. A preliminary spatial evaluation using Google Earth Pro (Figure 26) and field visits was used to estimate the size of the proposed storage and distribution infrastructure. This evaluation takes into account (1) the land around the wastewater treatment facilities available for storage structures, (2) the surplus reclaimed water currently spilled and (3) typical size for storage ponds for reclaimed water (as discussed in Libhaber and Jaramillo, 2012). The results for the three wastewater treatment plants are shown in Table 30. Reservoir design and construction needs to take into account greenhouse gas emissions associated with construction and material, favouring options with minimal emissions such as lined ponds.

Name	Number of agreements	Land (existing) [dunum]	Land potential [dunum]	Effluent [m3/day]	Storage (m3)	Assumption
Madaba Station	22	966.208	1600	3083.62	90,000	30 days of effluent go unutilized in the winter and can be stored
Karak Station	11	460.175	2337	780.525	25000	30 days of effluent go unutilized in the winter and can be stored
Tafilah	N/A	N/A	341	2189	30000	Size determined by land available on site
Total	**33**		**4278**	**5964.145**	**255,000**	
Source	MWI (see annex for original)	MWI	Google Earth	MWI	Authors estimate	Authors estimate

Table 32: Characteristics and interventions for the target WWTPs.[1]

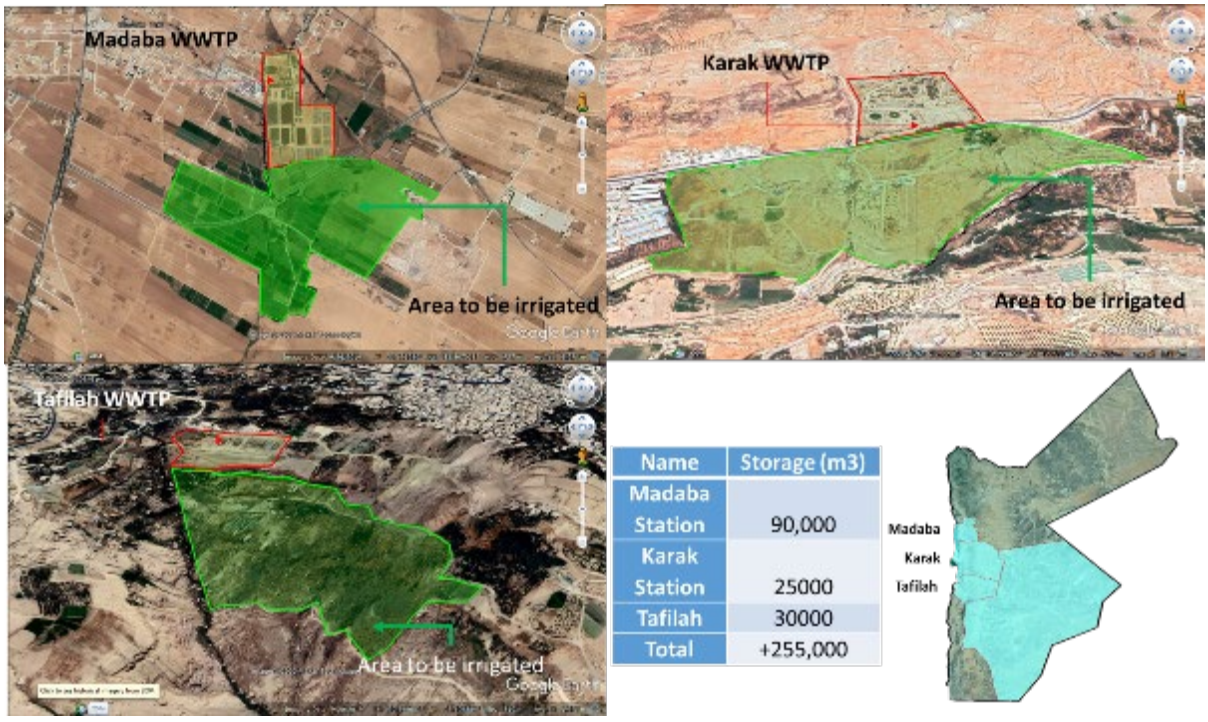


Figure 26: WWTP location and additional irrigation areas.

165. The project involves the reuse of treated wastewater to irrigate field crops according to national laws and international standards through water efficient irrigation technologies. In Jordan the reuse of treated wastewater is regulated by Jordanian Standard 893/2006 for Discharge of Treated Domestic Wastewater. This standard establishes the water quality standards for treated wastewater which is to be utilized for irrigation purposes (Table 31).

support of the Ministry of Water and Irrigation at start up. These will also include all the specification to design, build and manage reclaimed water to reduce and mitigate possible contamination risks.

[1] Source: Eng. Ahmed Al-Uleimat, ASG For Labs & Quality Affairs, Ministry of Water & Irrigation (personal communication, March 2020).

Parameter	Unit	Jordanian Standards 2006		
		Crop Category A	Crop Category B	Crop Category C
BOD	mg/l	30	200	300
COD	mg/l	100	500	500
DO	mg/l	> 2	-	-
TSS	mg/l	50	150	150
TDS	mg/l	1500	1500	1500
PH	UNIT	6 – 9	6 – 9	6 – 9
Turbidity	NTU	10	-	-
Nitrate	mg/l	30	45	45
Total Nitrogen	mg/l	45	70	70
Total PO4-2	mg/l	30	30	30
Escherishia Coli	MPN/100 ml	100	100	Not Applicable
Intestinal Nematodes	Egg/l	< 1	< 1	< 1

Table 33: Jordanian standard for reuse of treated wastewater in irrigation. Note that this project's target crops in category C.

166. In 2019, the effluent from the target wastewater treatment plants complied with the Jordanian Standard for category C. As shown in Table 32, the three plants pass the standards for category C, but fail the standard for Crop Category B because of the high levels of faecal coliforms. This means that the effluent from the target plants can only be used to irrigate field crops, industrial crops and forest trees. The high level of faecal coliforms is known to the authorities because it is not included in the limits for category C crops and because of the limited persistence and no relevant accumulation of *E. coli* in soils, as also suggested by the scientific literature (Vergine et al. 2015).

167. To ensure compliance, activity 1.1.2.2. under this component will provide technical assistance to MWI and Ministry of Health. This aims to assure compliance with environmental standards and monitor soil and water quality at sites where reclaimed water is used to irrigate field and industrial crops. In addition, a third activity will aim to build capacity among farmers, to ensure that safety standards are met and that there is no negative perception of wastewater reuse. The full set of design studies including the construction technical details will be provided with the support of the Ministry of Water and Irrigation at start up. These will also include all the specification to design, build and manage reclaimed water to reduce and mitigate possible contamination risks.

Plant performance with respect to 2006 Jordanian Standards for reuse in irrigation										
C - Field Crops, Industrial Crops and Forest Trees										
	pH	BODF	COD ب	TSS ب	TDS	NH4	NO3	PO4	T-N ج	E.coli
Tafilah	Pass	Pass	Pass	Pass	-	-	Pass	-	Pass	-
Karak	Pass	Pass	Pass	Pass	-	-	Pass	-	Pass	-
Madaba	Pass	Pass	Pass	Pass	-	-	Pass	-	Pass	-
B-Fruit Trees, Sides of Roads outside city limits, and landscape										
	pH	BODF	COD ب	TSS ب	TDS	NH4	NO3	PO4	T-N ج	E.coli
Tafilah	Pass	Pass	Pass	Pass	-	-	Pass	-	Fail	Fail
Karak	Pass	Pass	Pass	Pass	-	-	Pass	-	Pass	Fail
Madaba	Pass	Pass	Pass	Pass	-	-	Pass	-	Pass	Fail

Table 34: Plant performance with respect to 2006 Jordanian Standards for reuse in irrigation.

Landscape resilience investment plans

168. While water-related investments are a key climate priority in Jordan, there is a lack of a clearly articulated investment plans that take into account the specific characteristics of the project area[1]. More specifically, landscape water harvesting, water-use efficiency, groundwater recharge and flash flood mitigation are all priorities expressed in Jordan's key climate policy documents. While the usefulness of these measures to adapt to climate change is clear, there is a lack of understanding of suitable sites for these interventions in the project area. For example, during the field visits, MWI provided a list of water springs and ponds that are seemingly in need of rehabilitation. However, this list lacked clarity on key feasibility aspects, including social and environmental feasibility. After a closer review, it appeared that MWI was not able to justify on technical grounds why certain interventions had been prioritized. By the end of the visit, it became clear that the existing information on water interventions at the landscape level (e.g, flood protection, groundwater recharge, earth dams) was largely insufficient to develop any type of investment proposal, and the need to develop more holistic and integrated investment plans was recognized.

169. This lack of granularity hinders long-term investment planning, as it prevents donors and governments from having a clear and articulated picture of well-justified and feasible investment projects. To address this key information gap, the project proposes the development of landscape investment plans. This activity emphasizes the 'landscape' dimension of all climate change adaptation actions. This is the key novelty of this activity, which aims to step-up the capacity and information base available to MWI. Thanks to this activity, MWI will move away from ad-hoc investment decisions towards holistic water planning for adaptation in the project area.

170. The landscape resilience investment plans have three main objectives. (1) Set measures and objectives for developing, and protecting the water resources of the project area, with a key focus on groundwater recharge and efficient water use; (2) Set measures and objectives for protecting the population from the impacts of flash floods; (3) Set measures and objectives for harnessing water's potential for agricultural production – especially in relation to water-use efficiency - while protecting the health of aquatic ecosystems; (4) produce the needed technical documents to allow the MWI to execute the plan and/or fundraise resources from international donors.

171. To achieve the above-mentioned objectives, this activity will employ the following key analysis techniques, following international best practices[2]: (1) Stakeholder consultation and validation; (2) Social and economic analysis of the uses of water, and its impacts on agricultural production, social dynamics and inequality; (3) Strategic environmental assessment; (4) Scenario planning, to assess the role of climate uncertainties in the performance of the proposed investments and identify no-regret measures; (5) Full project technical documents including drawings, environmental impacts assessment and water accounts (if needed); bill of quantities, and budget.

172. The landscape resilience investment plans will cover three major themes. First, they will provide a water diagnostic, including an assessment of the status of water resources, their quantity, quality and variability. This theme will also assess existing uses for water. Second, they will discuss disaster risk, with an emphasis on flash floods and droughts, paying particular attention to the potential for groundwater recharge to mitigate both risks. Third, they will examine interventions, assessing their institutional, social, economic and environmental feasibility. This theme is key, as it provides empirically-grounded and transparent information with which to make the case for investments and guide any future MWI activity in the project area. These three themes will feed into a landscape resilience plan, which will detail a set of priorities to be validated with stakeholders and chart a path towards financing and implementation.

Specific Execution Modalities

173. UNDP will complement and benefit from the work of its current programmes (i.e development of 2BUR and 4NC, strengthening drought governance in Jordan, etc) to mainstream climate resilience in national sectors with a focus on strengthening linkages between planning, budgeting and financing to address Jordan`s climate resilience priorities as well as strengthening institutional capacity on integrating climate resilience in budgeting and planning to ensure sustainability and advance climate

[1] Ministry of Environment, 2013, pg.25; Jordan's INDC 2015, pg.11
[2] ADB (G. Pegram, Y. Li, T. Le. Quesne, R. Speed, J. Li, and F. Shen) 2013. River basin planning: Principles, procedures and approaches for strategic basin planning. Paris, UNESCO and Asian Development Bank, Manila.

financing for all sectors in a gender responsive way.

174. UNDP is currently leading the updating process of its National Climate Change policy which provides an entry point to engage in effective policy dialogue and understand implications of climate change for budgeting and financing.

175. UNDP will actively engage with national leaders and stakeholders from different backgrounds- women, youth, refugees, civil society, government, private sector and the parliament (budget and finance committee and the economic and investment committee of the House of Representatives) to influence national resource allocation on climate resilience priorities. UNDP will ensure that activities are in line with the relevant national and local policies, strategies and plans so as to make the proper contribution and not to duplicate the efforts of others. UNDP will benefit from existing relevant coordination mechanisms (locally and nationally e.g. the National Committee on Climate Change and the national DRR platform) to support the implementation of the different activities and in advocating the importance of the project.

5. Identified actions to transfer technologies and practices and to scale up results nationally

176. Building on available lessons learned, the project will invest via component 1, 2 and 3 in ensuring knowledge transfer and capacity development of stakeholders, beneficiaries and private sector. This will be ensured via the following methods:

Trainings

177. Trainings will be executed by national and international experts or national NGOs. Trainings will be on the job and will be done in each of the governorates to ensure and facilitate the highest participation of farmers (men and women), institutions and private sector actors. Details of trainings are provided in the funding proposal section E.

Field conferences

178. Via the support of NARC, the project will ensure at least 12 field days per years per governorate showing and demonstrating to farmers and farming communities available adaptive technologies and practices in Jordan. Field days constitute in are a short one-or-two- hour sessions held at a public. Promoted technologies and practices include:

a) Drip irrigation and other irrigation technologies tailored according to the needs of project areas;
b) Protected agriculture in home gardens and small farms;
c) Soil less home gardening for improved and increased production;
d) Hydroponic home gardens; and
e) Mulching and on farm water management.
f) Rainwater irrigated productions in home gardens and small farms.

Awareness

179. Awareness campaigns will be outsourced to specialized companies/NGOs. Awareness campaigns will be done door by door (i.e. in schools and other public gathering sites in target areas) as well as via social networks, visual media, newspapers and radio. The project will ensure constant information in target areas and at national level on various topics including:

a) Water management in agriculture;
b) Rainwater harvesting at the household and field level;
c) Water savings;
d) Climate smart approaches.

E-Knowledge diffusion

180. Digital agriculture is now advancing in Jordan and – although perfectible – the ICT sector of the country (5.8 million active social users [GCI, 2019; Aburumman, 2018] is ensuring the possibility for remote farmers to connect with research centers such as NARC and with the Ministry of Agriculture. There are already 7 websites providing different types of support (mostly bureaucratic) to farmers. Of these, 6 are managed by the Ministry of Agriculture and 1 by NARC. As stated by the World Bank in a recent technical paper: "*The digital revolution in agriculture, including information and communication technologies (ICT), has large potential to increase agricultural productivity in general and TFP [Total Factor Productivity] in particular. In Jordan*" [WB, 2018]. The Ministry of Agriculture has developed a series of media contents to reach out farmers via the mobile network and computers. The ministry as well as NARC are developing a series of contents related to climate smart agriculture and other climate

adaptive practices. The project will support this activity of the MoA with the development of a specific application and online platform where such contents will be uploaded and where the farming community will be able to access produced knowledge. The application and platform will be managed and maintained by the MoA (extension services directorate). Additional contents will be provided from the field farming schools and trainings funded by the project. Finally, the application/platform will be used by the MoE to disseminate to the beneficiaries key climate information such as weather forecasts and alert on climate hazards. The application will follow the rules and regulations of Jordan and will include a registration form. Users will be able to leave comments on products' quality. As reported by the world bank in a recent technical report for Jordan: "*The digital revolution in agriculture, including information and communication technologies (ICT), has large potential to increase agricultural productivity in general and TFP [Total Factor Productivity] in particular. In Jordan*" [WB, 2018]

Update of the national curricula

181. The project will coordinate and collaborate with the Ministry of Education and the main national Universities to ensure that introduced practices and technologies as well as best practices from others are included in the national curricula of vocational schools and universities. This will allow the project to expand its impact well beyond it life. The activity will be executed by national and international experts in collaboration with the MoE and the MoEd. The project will support the update of at least the following curricula:

a) Agriculture / Water management (Vocational schools and universities). The project will introduce in the national curricula of agriculture studies key concepts of climate change adaptation, climate smart agriculture, climate adaptive water management and climate adaptive technologies.
b) Masonry / hydraulics / electricity (Vocational schools). The project will introduce in the national curricula of vocational schools: (I) principles and elements of rainwater harvesting from building; (II) irrigation technologies; (III) water saving devices and water saving techniques in construction.

Private Sector Involvement

182. The project will secure that private sector currently involved in the provision of agriculture inputs/machinery (e.g. irrigation equipment, pumps, tractors and fertilizers) and in the construction sectors (e.g. masons, plumbers and related companies, input providers) is constantly involved in project's activities to ensure technology transfer and to stimulate the relation between demand and offer directly in the field. The project will not discriminate companies based on their size and/or volume of business. Companies involved in the agriculture inputs and equipment market as well as companies and workers involved in construction and provision of building equipment and inputs will be invited to participate the activities of the project with:

a) Participation in the field farming schools, field days and update of the national curricula.
b) Dedicated trainings, workshops and conferences on introduced technologies and practices.
c) Dedicated awareness and communication campaigns and events.

Civil Society Organizations

183. During the design phase the civil society of Jordan greatly contributed to the identification of problems and in defining the baseline of the project. The project recognises the potential of such organizations and their role in supporting beneficiaries in overcoming the adaptation deficit. Nonetheless, the knowledge and technical skills of Jordanian civil society organization and community based organization appears still under capacitated and requires further support before their contribution can effectively and efficiently deployed in assisting rural communities in their path to adaptation and resilience. Therefore the project will support this transition and capacity development process via:

a) Dedicated trainings, workshops and conferences on introduced technologies and practices including among others:
    a. Climate Smart Agriculture Practices;
    b. Field farming school principles and procedures;
    c. Climate adaptive technologies and practices in agriculture. In these regards the project will replicate for civil society organization and community based organization the same set of trainings designed for the staff of the MoA.

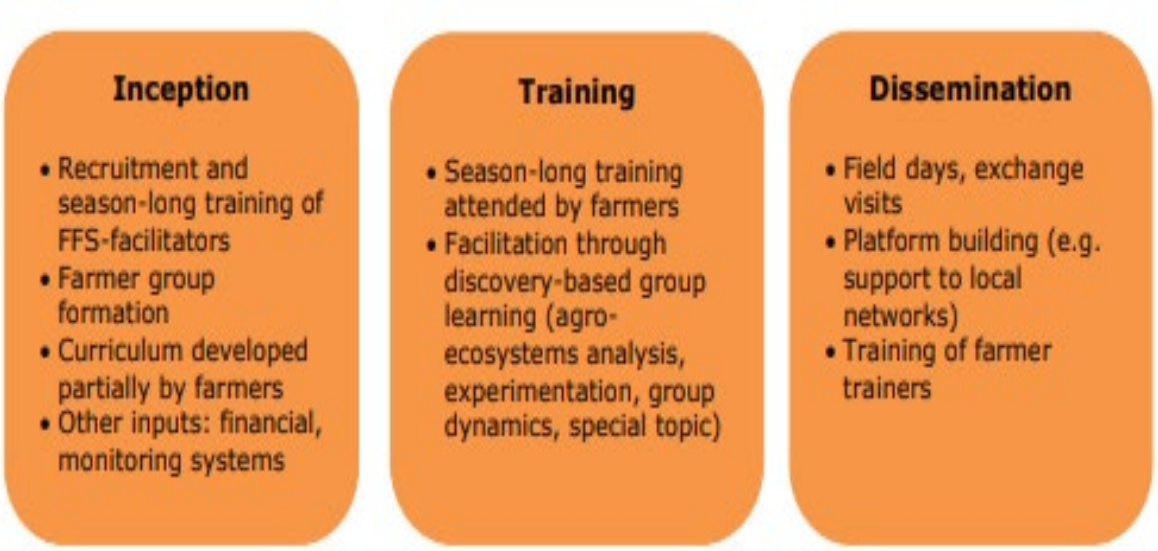
Climate wise women

184. Activities related to climate wise women are detailed in Annex 8 and in the funding proposal.

Farmer Field Schools

185. As reported in the TNC, the National climate Change Adaption Policy of the Hashemite Kingdom of Jordan (2013-2020), the NAP as well as in literature [Sixt, 2016] one of the main cause of vulnerability of farming communities in project areas is the high adaptation deficit. Reportedly, such deficit is caused mostly by high dependency from rainfed agriculture, poverty, and limited access to innovation as well as by the limited capacity of local extension services to transfer knowledge and technologies to farmers and local administrations. Therefore, under a business as usual scenario, if knowledge will not be transferred to both public and private extension operators as well as farmers, communities will hardly be able to cope with the identified adverse climate change impacts. In addition, farmers and communities will not be able to use water more efficiently, as many are not trained on water-saving agricultural water management practices. Coherently with the objectives of reported climate change policies and action plans as well as those reported in the Green Growth Plan for Jordan, the project will address such deficit throughout the three components to ensure a clear paradigm shift at all level of the Jordanian society. In particular, within the activities identified in component 2, the project will adopt the field farming schools approach following the guidelines agreed in 2016 between the Jordanian ministry of agriculture and the FAO [FAO/MOA, 2016; FAO, 2016]. As reported by FAO: "*Farmer Field School (FFS) is an approach based on people-centred learning. Participatory methods to create an environment conducive to learning: the participants can exchange knowledge and experience in a risk free setting. Practical field exercises using direct observation, discussion and decision making encourage learning-by-doing. The field is the space where local knowledge and outside scientific insights are tested, validated and integrated, in the context of local ecosystem and socio-economic settings. Community-based problem analysis is the entry point for a FFS group to develop a location specific curriculum. A growing range of technical topics are being addressed through FFS: soil, crop and water management, seeds multiplication and varietal testing, IPM, agropastoralism, aquaculture, agroforestry, nutrition, value chain, and link to markets, etc*." Therefore, the project will ensure – among other - the following phased approach to inform and train farmers on topics reported in table 33:

a)**The preparatory phase** (precondition survey, selection and training of facilitators, ground working and FFS group formation). This activity will be done jointly with the MoA and NARC with the support of local administrations and CSO/CBOs.
b) **The first basic FFS cycle** (hands on training and follow up of farmers). This activity will be done jointly with the MoA and the NARC.
c) **The post-graduation phase** (continuous follow up of involved farmers to provide advice, monitor absorption rate and address issues). This activity will be done jointly with the MoA and NARC with the support of local administrations and CSO/CBOs.



FFS Main Topic	Priority Target	Main Objective	Main Climate Change Adaptation Benefit (CCAB) and coherence with national priority adaptation measures (CAM)
Shift to drought tolerant barley varieties[69]	Rainfed barley producers.	Reduce water needs of plants and ensure higher resilience of crops to temperature and prolonged water deficit.	**CCAB:** Farmers will be able to cope with the increased evapotranspiration caused by increasing temperatures and water deficit. This will potentially allow for increased productivity per unit of water and more stable income for households. **CAM:** (I) Improving soil water storage to maximize plant water availability by maximizing infiltration of rainfall; (II) minimizing unproductive water losses (evaporation, deep percolation and surface run-off); (III) increasing soil water holding capacity; and maximizing root depth; (IV) Application of conservation agriculture; (V) Use of supplemental irrigation from harvested rainwater in the critical stages of crop growth; (VI) Modification of planting and harvesting dates; (VII) Support the adoption of Best Available Technology (BAT) and Best Environmental Practices (BEP); (VIII) Take measures to increase the labor productivity of rural women through improved access to training, extension services and technology.
Water harvesting land structures (on farm contour bunds/gully plugs)	Rainfed crop producers (e.g. pulses and grains).	Increase water availability at the farm level and increase soil moisture available for productive evapotranspiration[70].	
Water harvesting land structures (on farm contour bunds/gully plugs)	Rainfed fruits producers (e.g. plums and cherries).	Increase water availability at the farm level and increase soil moisture.	
Conservation Agriculture (no/minimum tillage, crop rotation and restorative fallow practices)[71]	Rainfed crop producers.	Increase soil moisture, reduce land erosion due to rain washing and enhance the soils physical properties. Minimize greenhouse gas emissions from soils through zero tillage[72].	
Adapting the crop calendar to changing temperature and rainfall patterns: modification of planting and harvesting dates.	Rainfed crop producers (e.g. pulses and grains).	Reduce risks of water shortage and increase chances of water availability in the critical phases of growth of the plants.	
Protected and semi-protected cultivation' practices for home gardens and irrigated lands	All farmers with irrigation and households with home gardens.	Increase productivity per water unit and allow for higher production with limited water and land inputs.	**CCAB:** Farmers will be able to cope with the increased evapotranspiration caused by increasing temperatures and water deficit. Farmers will be able to produce for more cycles, reduce the amount of inputs and water needed. This will allow for increased productivity per unit of water and more stable income for households.
Fertigation of crops	All farmers with irrigation and households with home gardens		
Wicking beds		Increase productivity per water unit and allow for higher production in limited space,	

[69] Such varieties – old and under used varieties of barley - are available at the National Center for Agriculture Research (NARC). These are not OGM.
[70] Rockström, Johan, et al. "Managing water in rainfed agriculture—The need for a paradigm shift." Agricultural Water Management 97.4 (2010): 543-550.
[71] Based on findings and recommendations from TNC/NAP and from available literature [Shakhatreh, 2018]
[72] Mangalassery, Shamsudheen, et al. "To what extent can zero tillage lead to a reduction in greenhouse gas emissions from temperate soils?." Scientific reports 4.1 (2014): 1-8.

		reduced risk of soil contamination (chemical and biological).	**CAM:** (I) Support the adoption of Best Available Technology (BAT) and Best Environmental Practices (BEP); (II) Use of supplemental irrigation from harvested rainwater in the critical stages of crop growth; (III) Take measures to increase the labor productivity of rural women through improved access to training, extension services and technology; (IV) Development and adoption of adaptive technologies and innovations; and (V) Communication about climate risk management and effective adaptation strategies
Container and soilless cultivation (aquaponics and hydroponic)		Increase productivity per water unit and allow for higher production in limited space, reduced risk of soil contamination (chemical and biological), reduce the level of pesticides needed and reduce the risk of soil borne diseases.	
Irrigation and cultivation with reclaimed water	All fodder producers	Shift from rainfed barley to better-irrigated crops such as alfa alfa. Provide supplemental irrigation in key stages of crop growth. Increase productivity per water unit and increase of fodder available for livestock. Reduce use of freshwater resources to irrigate fodder.	

Table 35: Proposed field farming schools' structure and topics to address identified climate changes adverse impacts and compliance with nationally identified adaptation priorities for agriculture.[73]

Policy Dialogue

186. As reported in the Jordan Economic Growth Plan (2018-2022), "*capitalizing on new agricultural technologies such as hydroponic systems as well as digitizing the input and output of agricultural decision-making would strongly enhance the efficiency of this sector in Jordan*" [GoJ, 2017]. The project will work with partners and stakeholders to ensure that the bottlenecks currently hampering Jordan's agriculture and water sector development are addressed at the policy and institutional level. Therefore, based on identified lessons learned, the project will support partnering institutions and the national climate change committee with the creation of mechanisms for the establishment of climate change adaptation incentives/subsidies/standards to support and scale-up the adoption of:

- Adoption of drought tolerant grains and fruits and changes in the grain related subsidies to progressively shift from production based subsidies/incentives to climate adaptive incentives/subsidies based on adoption of climate smart field and water management.
- Adoption of water efficient technologies to obtain premium water and agriculture subsidies to progressively shift from production based subsidies/incentives to climate adaptive incentives/subsidies based on adoption of climate smart field and water management. This will contribute to the various policy framework objectives of promoting the efficient use of water in irrigation and high-yield agricultural products.
- Adoption of building rules that will incentivize: (I) the use of rainwater harvesting systems for rooftops in rural areas; (II) the integration of water saving devices. A timed incentive based (e.g. tax benefits, subsidies, priority in the approval process) strategy will be developed and agreed with stakeholders (including the private sector). At the end of the strategy identified devices and technologies will become mandatory. The strategy will also include the upgrade of public building standards to include and enhance the minimum requirements for water saving and water harvesting technologies and construction practices. The adoption of adaptive incentives will also contribute in: (I) increasing the participation of the private sector in national adaptation strategies and will contribute to the national objective of engaging the private sector in the implementation of strategic projects and management of the water sector; and (II) setting national standards for plumbing.
- Upgrade of standards for the use of reclaimed water in agriculture. As reported in the main strategic frameworks of Jordan, one of the higher priorities of the country is to increase the supply of water to the agriculture sector by replacing fresh water from surface and groundwater sources with treated wastewater from wastewater treatment plants. As farmers can only

[73] The image included in this table orginate from FAO/MOA, 2016

produce fodder due to the quality of effluent from WWTP, the project will support stakeholders in enhancing standards to allow a more efficient and effective monitoring process of farms irrigated with reclaimed waters.

187. The project will hire national and international experts to support stakeholders in the process. Since year one of execution the project will organize conferences and workshops to ensure the highest possible participation of all involved actors and will deliver to the country specific paradigm shift strategies including specific adoption mechanism to ensure adoption of the proposed changes and to ensure non exclusion approaches.

6. PROJECT FEASIBILITY ASSESSMENT

188. The feasibility of the project derives from a series of analysis executed by national and international experts. Analysis are contained in a series of specific working papers[74] 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 Relevance,** 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 how the project will comply with the national environmental legislation and how the project will respect of the safeguards agreed between the GCF and FAO.

189. 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.

190. The main elements of the feasibility are reported in table 34, 35 and 36. 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 6 and 7 of this document.

[74] These are: The Water Sector in Jordan and project areas, Jordan Natural Resources Management and Climate Change, and Socio Economic description of project areas. Each is available on demand.

Component 1: Climate Resilient Water Systems						
Project Component/Sub-component	**Climate Relevance[75]**	**Coherence with National Policies and Standards[1]**	**Technical Feasibility**	**Economic Feasibility[76]**	**Social Feasibility[77]**	**Environmental Feasibility[78]**
Output 1.1.1 By year 7 at least 8250 buildings retrofitted with water harvesting structures	Water scarcity is already affecting rural communities in target areas and projections expect further increases in temperature (MIN – MAX) associated with additional reductions in rainfall by 2030, 2060 and 2100. Rural communities and rural poor are the most vulnerable in Jordan and water security is a specific adaptation target of the NDC. The TNC and the NAP identified the water sector as one of the most vulnerable sectors in Jordan and rooftop rainwater harvesting technology water saving and increase in the use of reclaimed water for agriculture as some of the most cost effective interventions to increase water security of the country.	Increased harvesting of rainwater from roofs is considered a priority by: The National Water Strategy (2016-2025) as well as by the National Adaptation Plan (2020) The National Climate Change Policy of the Hashemite Kingdom of Jordan (2013-2020) The Water Sector Policy for Drought Management 2018. The Climate Change Policy for a Resilient Water Sector 2016. The Water Demand Management Policy 2016. The Water Reallocation Policy 2016. Proposed activities are also compliant with: Water Authority Law No 18/1988 amend. 16/1998, 62/2001 Water Regulations for	The technology is known in Jordan. Although in need of capacity development (addressed by the project) existing private sector companies dispose of the needed skills to execute contracts according to the timeframe identified by the project. The number of identified target buildings is coherent with the availability of single houses and public buildings. Identified technologies for rooftop retrofitting is based on studies and best practices from the Jordanian context.	EIRR: 14% NPV: $ 14,071,220 B/C Ratio: 2.2 Water Saving (MCM): 0.55	The activity is recognized as a strategic priority for the country as it will benefit rural households – especially the poor and the women – guaranteeing increased water availability/reduced water expenditures. Technical feasibility studies at the HH level will be executed following gender oriented approaches to ensure the in the positioning of the outlets. The project will guarantee technology access grants for the poor and for single women headed households. To avoid misuses of the collected water, beneficiaries will be trained on management practices to optimize water and to respect	The activity will not have adverse impacts on the environment.

[75] Details on climate change and climate change adaptation are available in Annex 2, pages 9→27.
[76] Details of the economic and financial feasibility are available in Annex 3
[77] Details on social feasibility are available in Annex 6 and Annex 8
[78] Details on environmental feasibility are available in Annex 8.

		Connection to public sewer system Wastewater Management Policy of 1997 Reclaimed Domestic Wastewater Standard No 893/2006 Revised and updated 'National Water Strategy (2016-2025) Water Substitution and Reuse Policy, 2016 Water Demand Management Policy 2016 Water Reallocation Policy 2016 Jordan Economic Growth Plan (2018-2010)			the norms related to water consumption.	
Output 1.1.2 By year 7, reuse of reclaimed water from 3 Waste Water Plants is optimized			All identified WWTP are existing and operational. Each is managed by the MWI via specific public/private companies. Identified WWTP have the required volumes of water as well as the needed space to store the reclaimed water and distribute it to downstream farmers.	EIRR: 7% NPV: $977,735 B/C Ratio: 1.3 Water Saving (MCM): 0.255	Activities will include the development and or enhancement of Community-based water resources management (WUAs) as recommended by the Revised and updated 'National Water Strategy (2016-2025). Providing reclaimed water via WUAs will allow to ensure the highest possible inclusion of farmers including women.	Reuse of reclaimed water will be compliant with the Reclaimed Domestic Wastewater Standard No 893/2006 and WHO international standards. The activity will prevent contamination in the rivers reducing the volumes of effluents from WWTP.

Output 1.1.3 By year 4, Landscape Resilience Investment Plan for part of the Dead Sea Basin	Water related infrastructures play a major role in reducing the risk of climate related hazards (i.e. flash floods) as well as in providing rural communities with supplementary water resources. The investment plan will be developed with these two objectives and will provide stakeholders with a strong preparedness and planning tool to enhance water management in project areas..	The activities respond to the priorities identified by key climate change related policy frameworks such as: Climate Change Policy for a Resilient Water Sector 2016 Water Reallocation Policy 2016 Revised and updated 'National Water Strategy (2016-2025) Jordan National Adaptation Plan (2020) Jordan Economic Growth Plan (2018-2010)	N/A	EIRR:N/A NPV (US$): N/A B/C Ratio: N/A Water Saving (MCM): N/A The activity will allow the MWI to cover the current gaps related to the identification and design of key landscape resilience investments favoring the financing from IFIs and international donors.	As recommended by the Revised and updated 'National Water Strategy (2016-2025) the plan will also include among stakeholders community representatives, local institutions and civil society organizations.	The activity will limit itself to the planning and costing phases. Nonetheless, it will include specific environmental impact surveys and if needed (depending on local regulations) assessments.

Table 36: Component 1 main elements of feasibility.

Component 2: Climate Change resilience for Enhanced Livelihoods and Food Security;						
Project Component/Sub-component	**Climate Relevance[79]**	**Coherence with National Policies and Standards[1]**	**Technical Feasibility**	**Economic Feasibility[80]**	**Social Feasibility[81]**	**Environmental Feasibility[82]**
Output 2.1.1 By year 7, 6,000 Farmers trained in climate resilient production practices through FFS (4050) and field days (1950)	Climate adaptation deficit of farmers is reported by the TNC as one of the main drivers of vulnerability. Proposed activities will reduce the adaptation deficit and will support farmers (men and women) in adapting their farming practices against increases in temperatures and reduction of rainfall. Climate Smart agriculture and increased knowledge across farming communities about water savings practices and technologies is one of the strategic objectives of NAP and of the NDC.	Activities will be executed jointly with the MoA and NARC that are the two national institutions with specific mandate on extension services and knowledge management in the agriculture sector. Proposed approaches and topics are aligned with: The National Strategy for Agricultural Development (2016-2025). The National Climate Change Policy of the Hashemite Kingdom of Jordan (2013-2020) Proposed e-extension activities are in line with the Jordan's digital Economy Action Plan (2018-2022). Jordan Economic Growth Plan (2018-2010)	Activities will be executed following the FFS guidance document developed by FAO with the MoA and NARC in 2016. Activities will be implemented via the MoA and NARC supported by FAO experts. Tools and inputs required for the FFS are available in target areas. Introduced practices and technologies are good practices in use by the private sector in other countries. The MoA and NARC dispose of the technology needed to broadcast the e-contents created by the project,	EIRR: 76% NPV: $79,698,448 B/C Ratio: 8.2	The project will target the most vulnerable households in rural areas and will adopt techniques and approaches that are gender sensitive and that will allow the participation of women active in farming.	The technologies and practices promoted by the project will not have adverse impacts on the environment. On the contrary they will support farmers in increasing productivity per unit of water and reduce the use of inputs.
Output 2.1.2 By year 7, 30 000 Farmers reached through e-extension				EIRR:N/A NPV (US$): N/A B/C Ratio: N/A	E-contents will be transmitted by the MoA via Internet, radio and state tv. This will allow a multigenerational approach and ensure a higher permeability of produced messages within communities and across generations.	

[79] Details on climate change and climate change adaptation are available in Annex 2, pages 9→27.
[80] Details of the economic and financial feasibility are available in Annex 3
[81] Details on social feasibility are available in Annex 6 and Annex 8
[82] Details on environmental feasibility are available in Annex 8.

Output 2.1.3 By year 3, 400 Women trained as Change Agents for Climate Adaptation	Women make crucial contributions in agriculture and rural enterprises in dry lands as farmers, livestock herders, workers and entrepreneurs, and that negative impacts of climate change will be the most felt by them (NCCP, 2012)	National Strategy for Women in Jordan (2020-2025) The National Poverty Reduction Strategy (2013-2020) The National Climate Change Policy (2013-2020). National Strategy and Action Plan to Combat Desertification 2015-2020. The National Strategy for Agricultural Development (2016-2025). National Biodiversity Strategy and Action Plan 2015-2020 Revised and updated 'National Water Strategy (2016-2025) National Green Growth Plan 2013	The change agents for climate adaptation will be trained in partnership with Jordanian universities and vocational training institutes. These will be supported by international experts as well as experts from the MoE, the MoA and NARC.	EIRR: NPV (US$): B/C Ratio: Water Saving (MCM):	The activity is designed to ensure higher participation of women (traditionally excluded). As detailed in the Gender Assessment and Gender Action Plan (Annex 8).	The activity will promote technologies and practices that do not have adverse impacts on environment. On the contrary their mainstreaming will allow for more sustainable management of water and other natural resources.
Output 2.1.4 By year 7, 15.000 Persons sensitized for climate adaptive measures	Kindly refer to Output 2.1.4.	Kindly refer to Output 2.1.4.	The technology available in the country and in use at the MoA allow the broadcasting and posting of contents prepared by the MoE.	EIRR: NPV (US$): B/C Ratio: Water Saving (MCM):	E-contents will be transmitted by the MoA via Internet, radio and state tv. This will allow a multigenerational approach and ensure a higher permeability of produced messages within communities and across generations.	The activity will promote technologies and practices that do not have adverse impacts on environment. On the contrary their mainstreaming will allow for better management of water and other natural resources.

Table 37: Component 2 main elements of feasibility.

Component 3: Scaling-up climate adaptation						
Project Component/Sub-component	**Climate Relevance[83]**	**Coherence with National Policies and Standards[1]**	**Technical Feasibility**	**Economic Feasibility[84]**	**Social Feasibility[85]**	**Environmental Feasibility[86]**
Output 3.1.1. By year 6, specific policy and regulatory bottlenecks are identified and reforms initiated	As highlighted in the TNC (2014), the activity will contribute to develop policy instruments at all levels of government to implement the National Framework Strategy on Climate Change and the National Adaptation Plan. This will include the creation of mechanisms for the establishment of climate change adaptation incentives/subsidies to support and scale-up the adoption of (i) introduced drought tolerant grains and fruits[87]; (ii) the expansion to rural areas of building rules that make mandatory the adoption of rainwater harvesting from rooftops;(iii) the integration of water saving devices in the building code of Jordan (iv) the upgrade of public building standards to include water saving and water harvesting technologies; (v) the upgrade of standards for the use of reclaimed	Revised and updated 'National Water Strategy (2016-2025). Jordan Economic growth Plan (2018 – 2022) The National Strategy for Agricultural Development (2016-2025). Reclaimed Domestic Wastewater Standard No 893/2006 Jordan Economic Growth Plan (2018-2010)	Identified needs and bottlenecks are already highlighted in the national communications to the UNFCCC and included in key national documents such as the National Adaptation Plan. The creation of the National Committee on Climate Change and of the inter-ministerial technical working group on adaptation provide for a solid and fertile ground to allow national and international climate policy experts to prepare and present the identified policy reforms.	EIRR:N/A NPV (US$):N/A B/C Ratio:N/A	Activities will develop mechanism and safeguards to neutralize the risk of exclusion of small farmers and the poor. Consultations are planned with the national and local expressions of the civil society as well as with farming communities.	The activity will promote technologies and practices that do not have adverse impacts on environment. On the contrary their mainstreaming will allow for better management of water and other natural resources.

[83] Details on climate change and climate change adaptation are available in Annex 2, pages 9→27.
[84] Details of the economic and financial feasibility are available in Annex 3
[85] Details on social feasibility are available in Annex 6 and Annex 8
[86] Details on environmental feasibility are available in Annex 8.
[87] The adoption of drought tolerant varieties is a national priority also identified in the National Green Growth Plan for Jordan.

	water in agriculture; and (vi) the adoption of water optimization technologies to access water subsidies (blocked by Lack of incentives and high taxation and customs on modern technology)					
Output 3.1.2 By year 6 at least 6 national curricula of vocational schools (masonry, plumbery and agriculture) and of specialized universities (agriculture, architecture, water engineering) are updated to include climate smart agriculture, water efficiency and precision agriculture.	Training and capacity development of young generations is one of the adaptation objectives of the country. Activities will allow to address the severe adaptation deficit of the country. Activities will allow to mainstream across institutions and private sector key climate change adaptation technologies and practices that will increase water security of the country and resilience of the agriculture sector.	The National Strategy for Agricultural Development (2016-2025). The National Climate Change Policy of the Hashemite Kingdom of Jordan (2013-2020). Jordan Economic Growth Plan (2018-2010)				
Output 3.1.3 By year 7 at least 6440 persons (4 governorates, 16 provinces, 324 municipalities) and private sector engaged in climate change adaptation practices						

Table 38: Component 3 main elements of feasibility.

Project Beneficiaries Calculations and Accounting

Component 1	Units	People	Women
Roof-Top water harvesting public buildings	municipal staff and students	10,000	5,000
Roof-Top water harvesting at homes	citizens	43,175	21,328
Waste Water Treatment plants	Farmers	968	
		54,143	**26,328**
Component 2			
FFS Climate -Smart	farmers	4,050	1,200
Persons reached through E extension	farmers	30,000	10,000
Farmer Field Days	farmers	6,000	1,800
Climate Wise Women	farmers		400
Persons sensitized to climate adaptive measures	farmers	15,000	10,500
		55,050	**23,900**
Component 3			
Policy in the agriculture sector [a]	Farmers	167,818	82,902
Climate Smart Agricluture in Unversities [c]	Students	5,000	1,500
Climate Smart Agricluture in Vocational Institutes [d]	Students	14,000	4,200
Local Engagement and Dissemination[e]	citizens	4,800	2,400
Engagement of Local administration [f]	municipal staff	640	192
Engagement of private sector[g]	private sector	1,000	100
Civil Society Organizations [h]	CSO staff, CBOs and Community Members	1,000	500
		194,258	**91,794**
	TOTAL	**303,451**	**142,023**
Reduced by 30% to compensate for double counting	**ADJUSTED TOTAL**	**212,416**	**99,416**

	Direct		Indirect	
	People	women	People	women
50%	10,000	5,000		
49%	43,175	21,328		
	968			
30%	4,050	1,200		
33%	30,000	10,000		
30%	6,000	1,800		
		400		
80%			15,000	10,500
43%				
49%			167,818	82,902
30%	5,000	1,500		
30%	14,000	4,200		
50%	4,800	2,400		
30%	640	192		
10%	1,000	100		
50%			1,000	500
47%				
	119,633	48,120	183,818	93,902
47%	83,743	33,684	128,673	65,732
		40%		51%
Total (direct and Indirect)	**212,416**	**99,416**		

a: Based on the assumption that of the 101,708 Individual farm holders in the country 30% are expected to benefit by at least one of the policy measures proposed and each household has 5.5 members
b: Based on the assumption that all of the 7 WWT plants will be impacted by this policy which will on average benefit 50 households with an average of 5.5 hh members.

c: Based on the assumption that JUST will introduce modules of climate change adaptation and mitigation in 3 of its 10 faculties which will be introduced to 25% of its 25,094 under-graduate students and 2020 masters students over the next ten years
d: Based on the assumption that of the 35,000 or so enrolled in one of the TVT institutions and community colleges in Jordan 50% of these will have introduced the climate smart module which will be relevant for 20% of the trades and students will benefit from these over the next 7 years

e: Based on the assumption that each Governorate will sponsor one event annually for four years in which 300 citizens will be invited
f: Based on the assumption that at least 40 local administrative staff from key agencies in each of the four Governorates will be made aware of the adaptation measures related to their area of work each year for four years
H: based on the assumption that once staff of CSOs are trained they will also extend the knowledge to CBOSs they deal with and their target group in the communities. Each CSO will train at least 10 o their own staff, 2 staff each from 50 CBOs and include the modules to spread awareness among 500 community members each year for 4 years
g: Based on the assumption that a seminar will be organized for the private sector annually in Amman in which they will exhibit climate smart devices, technologies and inputs. This can be combined with the olive festival
Number of males and females benefiting from the adoption of diversified, climate resilient livelihood options (including fisheries, agriculture, tourism, etc.) It is assumed that 4050 of those in FFS and 50% of those in the field days and 25% of those receiving e-extension and 40% of those reached by climate wise women adopt a practice or technology that helps in their resilience
Number of males and females with year-round access to reliable and safe water supply despite climate shocks and stresses. It is expected that 10,000 of those using public buildings, all those receiving support from RWH, WWT benefit from year round access plus baseline of 3767

Table 39: Calculation of Number of Beneficiaries

7. PROJECT COORDINATION AND COLLABORATION

191. The project via the PMU and the NCCC will establish collaboration 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 catalyzer 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.

192. 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 catalyzer of the different actions ongoing in project areas to connect communities with other projects that could extend and/or scale up impacts (table 37). Lesson learned and best practices are and will be derived from the following:

- Increasing the resilience of poor and vulnerable communities to climate change, the overall objective of this project financed by the UNFCCC- Adaptation Fund is to "adapt the agricultural sector in Jordan to climate change induced water shortages and stresses on food security through piloting innovative technology transfer, policy support linked to community livelihoods and resilience". The initiative targets mainly the Jordan Valley and the "Wadi Moussa" and is composed by different projects aiming at (i) enhancing adaptation of the agricultural and water sector through the introduction of innovative technology and (ii) at Capacity Building, Knowledge Dissemination, Policy and Legislation Mainstreaming.

- The Rural Economic Growth and Employment Project (REGEP), builds up on the lessons learned of the decades long experience of the IFAD and in particular of the ARMPII and has a total budget of USD 15+ mln. The project started in the year 2015 with the aim to create productive employment and income generating opportunities for the rural poor. In this regard, the activities will enhance the technical capacity and competitiveness of rural farmers and MSMES, provide access to finance and will provide models for integrating stakeholders in value chains. It is a national initiative with focus on rural areas of the Governorates of Ajloun, Jerash, Balqa, Madaba and Mafraq.

- Agricultural Resources Management Project-Phase II (ARMPII), implemented by IFAD over a period from 2004-2015 and with a total financing of 41.97 mln USD adopted community based participatory approaches to develop strategies for a sustainable soil and water resource use. Furthermore, it included activities for promoting microfinance and capacity development finances in the target regions Karak, Tafilah and Ma'an.

- MENARID: Mainstreaming Sustainable Land and Water Management Practices. This 2009-2015 GEF cofinanced project implemented by IFAD expanded the ARMP II project. The objective of the project was to "reduce land degradation and promote the integration of an ecosystem-based approach into public-supported productive and poverty reduction activities; the latter designed to improve economic productivity of land, increase water use and irrigation efficiency and support communities affected by land degradation and water scarcity, supporting Sustainable Land Management (SLM) and Integrated Water Resources Management (IWRM) best practices at the local level".

- The FAO has implemented in Jordan several projects like the Reduce Vulnerability in Jordan in the Context of Water Scarcity and Increasing Food/Energy Demand financed by Switzerland and implemented for a total volume of approx. USD 2 mln from 2015-2019. The initiative concentrated on the development of an integrated sustainable approach to agriculture and an efficient

combination of water harvesting, groundwater use and solar-powered drip irrigation. The regional project Coping with water scarcity - The role of agriculture Phase III: Strengthening national capacities financed by the Italian Cooperation on the other side concentrated on mitigating the contribution of agriculture to water scarcity and on enhancing the necessary national and regional ability for water management. The lessons learned from these projects will be beneficial for the implementation of the GCF project that can scale up and extend the activities of the FAO in the country.

- Climate change adaptation to protect human health, implemented by the WHO from 2010 - 2014 and financed by the GEF SCCF fund, investigated the effects of Climate Change on the increasing use of wastewater for irrigation from a human health perspective. The aim was to define monitoring systems and provide institutional framework for mitigating health effects on farmers and consumers.

- The GIZ is supporting the country by creating development opportunities for both Jordanians and Syrian refugees by assisting in particular host communities. In this regard also the management of water and climate change are vital issues. Currently the agency is implementing the following series of projects that are of interest for the GCF project:

    - Increasing energy efficiency in the water sector
    - Promoting renewable energy in the water sector
    - Cash for work: protecting reservoirs in Jordan
    - Decentralised collection, treatment and effective reuse of wastewater
    - Avoiding water losses, improving supply
    - Climate Smart Water and Wastewater Companies
    - Improving the performance of water utilities
    - Religious leaders support water conservation
    - Managing water resources in Jordan

- Establishment of an effective NDC-Governance for the NDC revision and implementation. This project, implemented by GIZ has the objective to enhance the technical abilities of the competent authorities to update infomration and targets of the NDC and to report data in a transparent way.

- Jordan Response Plan (JRP) 2017-2019: The JRP identifies infrastructure projects and strategic sectors for funding to respond to the impacts of the Syrian crisis. Among others, the objectives of the platform are to "*foster the resilience of the service delivery system, at the national and local levels […] and mitigate the negative impacts […] in a cost-effective and sustainable manner; Create new employment and livelihood opportunities for vulnerable Jordanians and Syrian refugees, […] strengthen the coping mechanism of the most vulnerable segments affected by the crisis; […] Mitigate pressures on the natural resources, environment and ecosystem services*; As pointed out by Lahn et al., Jordan has exceptional capacities for preparing national plans in response to the presence of refugees (27). The GCF initiative should therefore try to establish contacts with this Donor platform to create synergies, to exchange know how and to promote the inclusion of projects related to the water-agriculture-nexus as a means of job creation and local sustainable development for the benefit of hosting communities and refugees.

- Irrigation Technology Pilot Project to Face Climate Change, implemented by IFAD in coordination with NCARE with funds from the GEF and local sources for a total of USD 4.5 mln from 2014-2018. The initiative promoted innovative, efficient and economically sustainable irrigation technologies, like fertigation, hydroponics, aquaponics, desalination, computerized irrigation systems and solar energy water pumps in different climatic production areas on 300 hectares of farm land, together with capacity development and awareness raising activities. Target areas were the regions Al Mafraq, Madaba, Wadi Araba, Wadi Musa and Ash Shobak.

- USAID is implementing projects in the water sector since 60 years in Jordan and achieved among others policy reforms for the water companies that increased cost recovery and the installation of wastewater treatment plants that provide 120 million cubic meters of reclaimed water for the agriculture sector. Besides, the capacities of competent entities, in particular the WUAs have been enhanced and from 2015-2018 9,600 smart meters have been installed that resulted in 2.4 mln cubic meters of water saved. The current areas of focus are:

- Improving water and wastewater infrastructure through projects like the Zara Ma'in Water Treatment Plant, the construction of the Na'our Wastewater Network, and the development of the Jerash and North Aqaba Wastewater Treatment Plants;
- Strengthening Governance of the MWI for water sector policies, staff training, reforms for water utilities, and by continuing to introduce smart metering and rapid leak detection;
- Promoting water conservation by scaling up the use of water-saving technologies by farmers and households and by fostering behavioural change

- **AFD and KFW** are currently carrying out the second phase of the Water Sector Policy Loan (WSPL) program that builds up on the first phase, financed solely by AFD and concentrating on promoting reforms for an efficient supply and demand management of the water sector and an enhancement of its distribution companies. The WSPL2 focus on the improvement of financial management, operational efficiency, cost recovery and policy dialogue. Future phases of the WSPL could address in particular also the agriculture-water nexus and represent therefore attractive potentials for coordination synergies.

- The First and Second Programmatic Energy and Water Sector Reforms Development Policy Loan of the World Bank aims at improving the technical and financial efficiency and viability of the water and energy sectors. In particular the program worked on the energy-water nexus and provided a series of activities in support of reforms for costs recovery, smart energy use and renewable energy integration and optimizing water allocation resources and wastewater treatment.

- Also other investment banks provide financing to Jordan: the European Investment Bank (EIB) is currently carrying out the Deir Alla and Al-Karamah project, focusing on the improvement of the water supply and wastewater treatment in the aforementioned regions. The European Bank for Reconstruction and Development (EBRD), with EU and GCFF support, on the other hand provides sanitation services for West Irbid. Last but not least, the Japanese International Cooperation Agency has a long-standing cooperation with Jordan focusing in particular on investments in infrastructure for fresh water supply.

	Title	Donor	Executor	Info	Areas of collaboration/coordination
1	Increasing the resilience of poor and vulnerable communities to climate change	Adaptation Fund of the UNFCCC	MoPIC	start date: 07/13/2016 duration4 years Budget: USD 9.2 mln	Contribute to the diffusion, testing, capacity development of innovative technologies for irrigation. Identification of possibilities for integrated water management in arid climates and substitution of fresh water through wastewater. Training, capacity development on climate resilient water usage in agriculture; Develop and test innovative solutions to implement participatory water & agriculture development and management and to support the rural poor to make informed choices.
2	Rural Economic Growth and Employment Project	IFAD plus local co-financing	Jordan Enterprise Development Corporation	from 2015 - 2021 budget; USD 15.2 mln	Support community-driven development to promote self-organizing of targeted farming communities and possibilities to integrate climate smart/resilient agriculture into value chains. Information sharing on sustainability aspects and policy support in the agricultural field. Identify possibilities for rural communities/farmers to access finance for climate smart agriculture investments.
3	Water Program of the GIZ	mainly German Government	line ministries and entities	n.a.	Coordination in the activities to support capacity development of the WUA, MWI and other line entities and in the testing of innovative water management systems for agriculture.
4	Jordan Response Plan	International Donor community	MOPIC	n.a.	Bring the importance of investment in the sustainable development of the water-agriculture-nexus to the attention of the donor community as a means to support host communities and refugee population.
5	Water Sector Policy Loan	AFD and KFW		start date: 2017 Budget: EUR 450+ mln	Future phases of the WSPL are planned to address the agriculture-water nexus. Coordination to accommodate climate smart agricultural practices, in particular diffusion of water harvesting and distribution technology.
6	Establishment of an effective NDC-Governance for the NDC revision and implementation	GIZ	MoE and RSS	from 2018 - 2020 Budget: EUR 2 mln	Coordinate to ensure necessary updating of the NDC for removing barriers to Climate Change Adaptation of the water and agriculture sector.
7	Water Program of the USAID	US Government	different entities	n.a.	Ensuring good governance and implementation of efficient technologies for water harvesting and utilization in the agricultural sector. The exchange of know how will also be particularly important with regards to the experience of USAID with the WUA and other competent entities.

Table 40: Project's planned coordination and collaboration with ongoing projects in Jordan

8. PLANNING, M&E AND KNOWLEDGE ANAGEMENT

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.

193. 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) Georeferenced[88] 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.

194. **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.

195. **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.

196. **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.

197. **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.

198. **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.

199. **Budget.** The AWPB will contain a detailed budget built following the one presented in Annex 3 of the project document and will include cofinanciers. The budget will contain all planned expenditures according to FAO rules and procedures or else according to covenants of the project financial agreement.

200. **Procurement Plan:** The procurement plan will be prepared according to FAO rules and

[88] *Georeferecing* 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.

procedures and will relate to Annex 10 of the project document.

201. Planning and approval of the AWPB will be done at the end of each fiscal year and will require formal approval of both the SC and FAO (Figure 27).

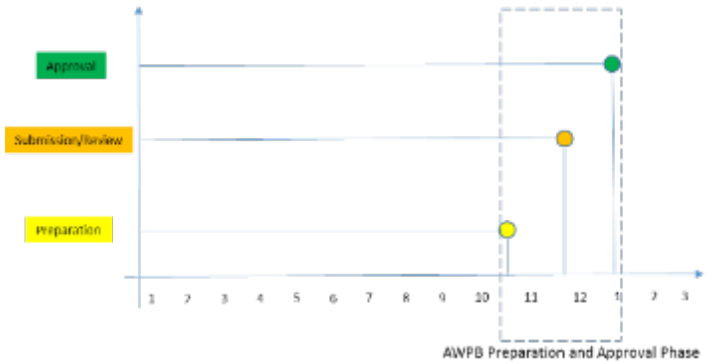


Figure 27: Timeframe Scheme of the Planning and Approval phase of the AWPB

Monitoring and Evaluation: The project will apply FAO's M&E standard procedures and will be compliant with the GCF performance measurement framework as reported in the full funding proposal. FAO will manage and coordinate reporting to the GCF according to agreed standards and procedures. The project will follow an Evidence Based Management (EBM) approach, which is intended to aid decision-making towards the explicit goal, outcomes and outputs identified as part of the Theory of Change reported in Sections 8, 9 and 10 of this Annex.

202. Project's achievements towards approved targets will be monitored via identified indicators and against the project baseline as reported in the logframe matrix (Section 9). As described in the next sections, the project will ensure georeferencing of activities including trainings and capacity development so to allow constant follow up via FAO newly developed Remote Sensing application "Earth Map". The combination of georeferencing, groundtruthing with partners and communities plus the remote sensing analysis via FAO/Earth Map will allow the M&E unit, the NDA, FAO and the GCF to have a clear understanding of project's effectiveness and efficiency. Additionally, the described approach will allow the M&E unit to advise and support the PMU management and the MONP with evidence enhancing project's capacity not only to deliver but also to support stakeholders and beneficiaries in their decision-making processes.

203. The project cycle will be monitored using a combination of tools based on: **(i)** field data collection, **(ii)** georeferencing and **(iii)** geospatial analysis.

(i) Field data Collection: field data will be collected by the M&E unit via dedicated activities planned with communities according to the monitoring exercises planned by the Project. To this end, the M&E unit will collect data from communities following the HH survey methodological approach and specifications. Additionally the project has planned to have two additional households and institutions survey at mid-term and project completion. Finally, the project will be assisted by the Forest Monitoring Center of the MoNP that will ensure (high resolution orthophoto maps and surface models) acquired by drones in year 1, 3, 5 and 7.

(ii) Georeferencing: Georeferencing will ensure a unique relation between project's activities and geographical coordinates collected according to a specific procedure (Ref: Georeferencing Procedures). This will allow the project and the Country to ensure clear identification of activities and beneficiaries in the precise context identified during project identification and design. Georeferencing will allow the project to profit from the vast geospatial data set available for the Country and will support involved institutions in sharing and mainstreaming geospatial data.

(iii) Geospatial analysis: the M&E unit will monitor activities and processes thanks to a series of remote sensing and photointerpretation analysis that have been made accessible to the Country via

the newly FAO developed application Earth Map. The application will allow the project to factor in climate change variables as well as socio-economic and environmental data into the planning and decision making process. The integration of 'geo-spatial' elements will allow stakeholders to overlay different classes of data such as climate trends, hydrography, erosion, flood risks, land cover, land use, distribution of population and livelihoods that are a non-negligible part of an evidence based and informed decision making process. Finally, the process will contribute in enhancing national and regional data collection activities that will support the understanding of Climate Change impacts at local level.

204. Having georeferenced investments as well as soft activities (i.e. trainings, capacity development[89]) will allow the project to answer indicators with objective elements of evaluation. In the specific case of this project, the PMU as well as all the other stakeholders - including GCF- will be able to understand if activities have been executed, if these have been successful and finally if there is a specific impact that could be objectively linked to project's theory of change. The use of such approach will not require special technologies, equipment or advanced IT skills. Basic software are available under license (i.e. ArcGis/ESRI) or in open source (i.e QGIS) and most of the currently available smart phones/tables, regardless of their operative systems, can execute most of the processes required to ensure georeferencing and data management. Additionally, FAO will provide dedicated training to PMU, M&E unit and project's partners/stakeholders during the stat-up phase of the project.

M&E Unit Composition and Functions: The M&E process will be under the responsibility of the PMU. The M&E unit (Figure 28), will consist of one team leader and of three officers (M&E/GIS/KM-COM). The team leader will respond directly to the PMU director and to the NCCC (SC) in case of internal disputes.

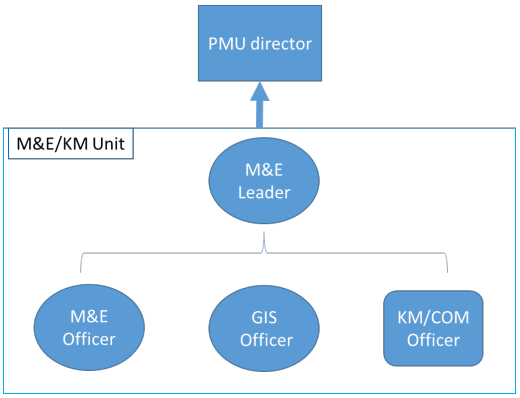


Figure 28:M&E Unit Composition

205. 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

[89] Georeferencing trainings and other activities with communities will allow the project to understand the level of permeability of activities within communities. Thanks to georeferencing the project will be able to clearly report not only on gender, age and other socio-economic characteristics of beneficiaries but also on their distribution in target areas.

others, and will be georeferenced. Data will be stored in a database accessible to the CCC 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 10 and Annex 4.

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 ecosystem based forest management, the M&E unit will ensure annual consultations in target areas so to support planning and monitor execution of activities. Thanks to the described georeferencing 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: Project's baseline is the resultant of data collected in project areas via: (i) literature review; (ii) questionnaire-based household survey[90] to assess vulnerability of rural communities and to collect socio-economic data on target population; and (iii) geospatial analysis[91].

206. Goal of the baseline is to collect socio-economic and biophysical data (including climate) in project areas. Main objectives of the baseline is: **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. Madabaa
2. Karak
3. Tafila
4. Maán

207. Baseline data reported in Section 6 and 7 are fully georeferenced and available in both Earth Map and Google Earth Pro. A summary of existing baseline data is presented below (table 38).

Data	Origin	Hierarchy	Verification period	Extension	Location
Socio Economic Baseline	FAO / National Statistics / Literature / HH focus groups	Outcome 1/2/3	Annual	PDF, KMZ, HTML	NDA FAO PMU GCF
Water availability / distribution and Efficiency	FAO / National Statistics / Earthmap remote sensing repository / Literature	Outcome 1/2	Annual	PDF, KMZ, HTML	
Policy Framework Mainstreaming and Community Participation Baseline	FAO / Institutional stakeholders / Literature	Outcome 3	Interim / Final Evaluation /	PDF	

Table 41: Baseline Summary according to LFM

[90] HH report and focus group findings are available up on request.
[91] Geospatial analysis are available on demand.

Description of Selected Indicator: 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.

208. 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 (UNDP) and service providers (Table 39).

#	Means of Verification
1	Geospatial Analysis
2	Household Survey
3	Institution Survey
4	Private Sector Surveys
5	Jordanian Department of Statistics
6	Project's Database
7	Institutional Partners Databases

Table 42: Project's means of verification

209. 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: 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.

210. 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 were geospatial algorithms are already available and fine-tuned for Jordan 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.

211. 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.

212. 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, AE as well as donors. FAO will provide stakeholders with at least 9 training session to secure full mastering and

ownership of the promoted process.

213. 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 GIZ, the WB, IFAD and USAID.

Reporting, Supervision and Evaluation: FAO as accredited entity of the project will ensure annual reporting to the GCF. The report will include as well the audit report 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**. QR will present the work and achievements of activities presented in the AWPB. It will include among the others data, comments and information from the beneficiaries and other involved stakeholders. QR 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[92]" 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 CCCC and the PMU for comments and after finalization sent to the Green Climate Fund at midterm (MTE) and within six (6) months from project's closure (FE). In accordance to FAO procedures for the evaluation of initiatives funded by voluntary contributions,[93] the project will undertake:

a. **An independent Interim Evaluation**, when delivery will reach 50% 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.

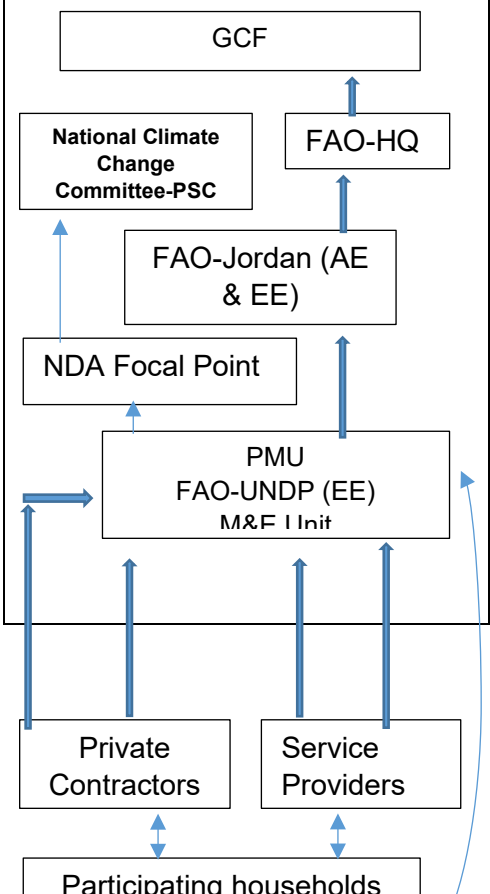
b. **An independent Final Evaluation**, within six months prior to the actual completion date (NTE date) of the project. It will aim at identifying project outcomes, their sustainability and actual or potential impacts. It will also have the purpose of indicating future actions needed to assure continuity 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 40).

[92] The project implementation atlas will be available as well via Google Earth so to appreciate in real time changes induced by the project. Its preparation will start with the baseline and will evolve with the project.
[93] This report is available in electronic format at: http://www.fao.org/evaluation.

Report Type:	Prepared by:	Approved by:	Proposed Timeframe:	Diffusion:
Technical Report	Service provider/Partners	PMU-M&E	Upon conclusion of activities	Internal
Quarterly Report	PMU-M&E	PMU	3 reports per year	Internal
Supervision Report	FAO	FAO	1 report per year	Public
Audit Report	External Independent Auditor	FAO	1 report per year	Internal
Annual Report/AWPB	PMU-M&E	NCCCC-FAO	1 report per year	Public
Interim Evaluation	External Independent Auditor	FAO	Fourth year	Public
Completion Report	PMU-M&E	NCCCC-FAO	Seventh year	Public
Terminal Evaluation	External Independent Auditor	FAO	Seventh year	Public
Impact Evaluation	GCF/FAO	GCF	To be determined	Public

Table 43: Project Reporting Framework

214. 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 analyzed during the whole project, stakeholders and general 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. Thanks to a pressing communication activity and key formal events at Start-up, Mid Term and Completion the project will ensure a constant flow of knowledge that will as well increase ownership of stakeholders and enhance its capacity to support an effective and efficient change into the policy making environment of Jordan. Figure 29 below presents the combined flow of reporting and knowledge sharing.

Reporting Relationships	Types of Reports	Reporting Timeline	Responsibility
	Baseline Survey	First Year	Third Party
	Annual Work Plan and Budget	Two months prior to the start of the relevant PY.	PMU-CTA
	Geo-Referencing of all activities using FAO's Remote Sensing application "Earth Map".	Real time sex-disaggregated tracking and recording of all participants	PMU- M&E Unit
	Benefciary Feedback Analysis with both men and women.	On a regular basis at the completion of key project investments.	PMU- M&E Unit
	Monthly statistical reports on physical and finncial progress.	At the end of the first week of the relevant month.	EEs-UNDP and FAO, Service providers and contractors.
	Quarterly Statistical and Narrative Reports on physical and financial progress.	Two weeks after the end of the relevant quarter.	PMU- M&E Unit

	Environmental & Social Safeguards Quarterly Report	Two weeks after the end of the relevant quarter	Environmental and Social Safegaurds Specialist
	Policy notes and briefs to highlight the project progress with policy and regulatory reform.	On a periodic basis at each signficant point of reform.	Techncial Assistance
	Anuual Progress report on outputs and key performance indicators.	One month after the end of the relevant PY.	Service providers and contractors.
	Annual Performance Reports.	Two months after the end of the relevant PY.	PMU- M&E Unit
	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.	PMU-Financial Specialist and MWI, MoA and MoE.
	Geospatial analysis through thematic maps.	The first quarter of PY 2 and therefater annually.	PMU- M&E Unit
	Leaning and Knowledge Products	Periodically	TA
	Mid-Term Evaluation	The first quarter of PY 4.	Independent Third Party
	Final Evaluation	Three months prior to end of the project in PY 7.	Independent Third Party

Figure 29: The project reporting flow

215. FAO will support the NCCCC and the PMU in reviewing and analyzing progress reports and assessing performances against baseline and targets. In addition to the support provided from FAO-Jordan, FAO-HQ will organize two or more (depending on needs) supervision mission per year.

M&E Outputs and budget: 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 dedicate M&E unit that will work under the direct supervision of the PMU Project's Director.Budget of the M&E function is dully 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: 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).

216. 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. To ensure sound and effective management of learning and knowledge processes the project will hire a communication and KM specialist (external service provider ad hoc) that will be assigned to the M&E unit of the project. The specialist will ensure – among the others - socialization of project's data and information, communication with the media, and coordination of the national engagement process