Food and Agriculture Organization of the United Nations

Annex 2. Feasibility Study

Ouémé Climate-Resilience Initiative (OCRI) for Benin

Food and Agriculture Organization of the United Nations

April 2022

Contents

Executive Summary

1. This Feasibility Study (FS) is written in support to the Funding Proposal submitted to the Green Climate Fund (GCF), entitled “Ouémé Basin Climate Resilient Initiative” – namely OCRI project, developed for Benin. This FS and Funding Proposal were prepared in agreement with the government of Benin (GoB) and the Food and Agriculture Organization of the United Nations (FAO - Accredited Entity for this project and who provided financial support for the development of these studies and proposal). The development objective of this project is to reduce farmers' vulnerability to increasing climate disturbances and extreme weather events, in the **Ouémé Basin** through implementing a mix of hard and soft climate-resilient measures in the Upper and Middle Ouémé areas. The project will ensure that a sustainable climate-resilience pathway is adopted by systematically addressing the barriers to promoting long-term change. It will develop and scale-up the adaptive and productive capacity of agro-ecosystems and of smallholder farmers in selected rural communities in the Upper and Middle Ouémé river basin. Vulnerability bottlenecks will be reduced by strengthening climate-resilient value chains, and mainstreaming climate change adaptation as part of local and regional development plans. Finance to upscale climate-resilient management in the Oueme Basin will be unlocked through close collaboration with the *Fond National pour l’Environnement et le Climate (FNEC), which is a Direct Access Entity to the GCF.* This will result in the establishment of a resilient agriculture and food production system based on sustainable land and water management in the Ouémé Basin. The project is strongly supported by Benin National Designated Authority who has indicated that OCRI is a flagship project for Benin.

Climate risks and vulnerability in Benin

2. Climate projections indicate that **temperatures in the Upper and Middle Ouémé Basin of Benin have steadily increased since the 1960s, and will continue to rise during the rest of this century, by as much as 5 ºC**. Predictions concerning rainfall vary, but all point toward longer period of droughts and more frequent dry spells, shorter rainy seasons with a late onset and the potential disappearance of the short rainy season in the Middle Ouémé. Shifts in temperature, rainfall patterns, and seasonality require agricultural adaptation with an efficient management of natural resources including soil and water, to reduce risks of damages caused by floods and flash floods, improve agricultural productivity and enhance the climate resilience and adaptation of the 6 million Beninese living in the Ouémé Basin.

3. **The Ouémé Basin is a key area for agriculture, which is Benin's main economic sector**. This sector employs 61% of Ouémé population, out of which 85% are smallholders. The sector is particularly vulnerable to climate change. Increasing intensity and frequency of extreme weather events are impacting the livelihoods of small-scale farmers, agro-ecosystems are becoming more vulnerable and less productive, poverty and food insecurity are increasing. As a result, farmers turn to unsustainable practices like clearing of forest land and natural habitats to establish new fields, slash and burn technique and wood extraction for the production and sale of charcoal – thereby increasing pressure on the biophysical environment, reducing productivity and enhancing exposure to climate-related risks and climate change vulnerability. Without GCF support to implement an integrated climate-resilient management (ICRM) approach in the Upper and Middle Ouémé, the above-mentioned vicious cycle will continue, while climate change increasingly threatens the population of the whole Ouémé Basin.

Request for GCF support

4. The proposed project will address current barriers to enhancing the resilience of the population in the Ouémé Basin. The OCRI project will break the vicious cycle in which vulnerable communities are locked, and catalyze a shift towards integrated climate resilient management (ICRM) in the Upper and Middle Ouémé Basin; this will enhance the climate resilience and improve livelihoods in the whole Ouémé Basin, with benefits in the upstream areas spreading to downstream areas. To initiate this transformative change, the OCRI project is comprised of three complementary Components, which will support the implementation, institutionalization and long-term funding of ICRM in the Ouémé Basin, reduce climate change vulnerability from Upper to Lower Ouémé Basin, reduce emissions and facilitate the replication of ICRM beyond the project's sites.

- COMPONENT 1. Low carbon climate Resilient Crop production enhanced and Ecosystem services restored in the Upper and Middle Ouéme. An integrated climate-resilient management (ICRM) implemented in the Upper and Middle Ouémé Basin provides benefits not only on project sites but in downstream areas as well. Floods are reduced especially in Middle and Lower Ouémé, soil erosion is limited, agricultural productivity is enhanced, water access secured especially in Upper Ouémé, and climate change vulnerability reduced in the whole Basin.
- COMPONENT 2. Climate-resilient and gender-sensitive value chains, supporting farmers' livelihoods in the Upper and Middle Ouémé.The use and planting of diversified high-value adapted crops/ trees and enhanced productivity under Component 1 will be complemented by training in climate-resilient farm planning (FarmTree App), marketing techniques and access to finance through the FNDA. This will secure farmers' livelihoods and diversify income streams despite climate change impacts that can be re-invested in CRA and waterworks. The demonstration of the significant environmental and economic benefits of project interventions will also unlock private investments to sustain CRA in the long-term.
- COMPONENT 3. An enabling institutional and financial environment established to promote and upscale low carbon climate-resilient land and water management in Benin's Basins. Component 3 will unlock public and private finance for climate-resilient management in the Oueme Basin, supporting FNEC's role as financial facility for climate-resilient projects, and ensuring FNEC's resources are sustainable expanded. The establishment of a multi-stakeholder coordination mechanism, to support project implementation and ICRM in the Oueme Basin, supporting regulatory frameworks, and institutional capacity building will ensure the long-term implementation of ICRM in the Ouémé Basin. Moreover, a strong communication and knowledge management strategy to compile, disseminate OCRI results and knowledge products (drawns from the results of Component 1 & 2) beyond the 5 target municipalities will also support the replication of this approach in other areas, and basins of Benin. The upscale of OCRI interventions is also promoted through various awareness raising events, as well as a rigorous M&E system to demonstrate the environmental, social and economic benefits of the project.

Project implementation and budget

5. The proposed OCRI project has a total budget of USD 35, 314,576 over a period of 6 years, with an expected total lifespan of 20 years. It will be executed by FAO, the Ministère du Cadre de Vie et du Développement Durable (Ministry of Livelihood and Sustainable Development - MCVDD) and the Ministry of Agriculture, Livestock and Fisheries (MAEP). The Direct Access Entity FNEC (National Fund for Environment) will aslo act as executing entity and as cofinancier. To implement this project, a GCF grant of USD 18, 453, 795 is solicited. In addition

to the requested funding to the GCF, the MCVDD will contribute USD 3,000,000, FAO will contribute USD 1,039,001. FNEC will contribute 187 500 and MAEP through IFAD will co-finance the proposed project with USD 12,634,280. The economic and financial analysis developed for the proposed project (Annex 3) indicates that high returns on investment can be expected, especially in terms of enhanced agricultural production resulting from climate-resilient water and land management in the Ouémé Basin, climate-resilient agriculture and agroforestry, as well as key support to climate-resilient value chains.

6. In addition to its economic viability, the OCRI project is an innovative initiative in Benin. It will catalize impacts beyond the project's sites and lifespan through an innovative, integrated approach for basin management, which will not only implement concrete, on-the-ground adaptation technologies in selected sites – which is often the case in agricultural development projects – , but also considers the rippling effects of climate change from upstream to downstream basin areas, and how hard and soft adaptation technologies can be combined in the upper and middle catchment to also benefit the lower area. In order to ensure the sustainability of the interventions and to secure a strong exit strategy, the OCRI project will partner with the Direct Access Entity FNEC (National Fund for Environement) to put in place an innovative financial mechanism which will allow the scaling up of climate resilient interventions as well as the strengthening of the capacities of the FNEC. A partnership with FNDA (National Fund for Agriculture) to link farmers to micro-finance institutions to invest in climate resilient agriculture will also be carried out. This comprehensive approach will be combined with the strengthening of climate-resilient value chains and the institutionalizing of ICRM in the Ouémé Basin, to ensure project's sustainability and replication. Moreover, an innovative App will also be used to ensure climate-resilient farm plans that are cost-effective, profitable, while responding to the impacts of climate change.

7. The investment proposed through the OCRI project is sustainable both economically and institutionally, as well as technically feasible as demonstrated in this FS. It will also generate strong economic, environmental and social benefits, and include gender-related considerations (see Annex 8). The GoB and FAO have committed to sustain and maintain the equipment and platform established under the project, including the waterworks, the Farmer Field- and Farmer Business- Schools, and the OCRI multi-stakeholder platform. The proposed project will also secure the livelihoods of many people in the Oueme Basin of Benin, for example directly benefiting those depending on agriculture in the target areas; and indirectly benefiting the whole population of the Oueme Basin through ecosystem restoration and resilient management in a watershed context. Through the project, farmers' cooperatives will be supported and their business capacities increased to ensure long-term, climate resilient income that can also be reinvested in project interventions.

8. In this context, support from the GCF is key to help the GoB support sustained economic growth and improved livelihoods in the Oueme Basin, and possibly other basin areas of the country. The GCF investments will have long-term impacts as the country will be able to sustain and upscale project interventions, which will place Benin in a better position to adapt to the impacts of climate change on their people and economy.

1 The Upper and Middle Ouémé Basin of Benin: key characteristics

9. Benin is a Lower Middle-Income Country (since mid-2020) in West Africa classified as Least Developed Country (as per August 2021)[1]. The country remains one of the poorest countries in the world and ranked, 153rd out of 182 countries in 2019 terms of Gross Domestic Product (GDP) per capita[2]; Benin scores 163rd out of 189 countries in terms of the Human Development Index. Approximately half of Benin's rapidly growing (2.7% per annum) population of nearly 12 million people live under the poverty line of US$ 1.90 per day, and average life expectancy is just under 60 for men and 63 for women[3]. In Benin, 11% of households face moderate to severe food insecurity; these households are especially located in rural areas (15%). Households with moderate/severe food insecurity are often the poorest. Poverty is higher in the rural areas, affecting 35% of people, than in urban areas, affecting 30%[4]. Figure 1 provides a brief overview of Benin.

Figure 1: Overview of Benin

The Republic of Benin is located in West Africa, in the tropical zone between the equator and the Tropic of Cancer, between latitudes 6° 30' and 12° 30' North and longitudes 1° and 3° 40' East. Benin is bordered to the north by the Niger River and the Republic of Niger, to the northwest by Burkina Faso, to the west by Togo, to the east by Nigeria and to the south by the Atlantic Ocean.

The total area of Benin is 114,763 km² and the country extends about 700 km from north to south; its width varies from 125 mm, along the coast, to 325 km at its widest point.

Administratively, Benin has 12 departments divided into 77 municipalities.

The capital of Benin is Porto-Novo, but the seat of government is in Cotonou, the country's largest city and economic capital.

Source: Second National Communication

10. The OCRI project will intervene in five municipalities of Benin, located in the Upper and Middle Basin of the Ouémé, namely Copargo, Djougou (ZAE 4, Upper Ouémé); Glazoué (ZAE 5, transition zone); and Zogbodomey and Zagnanando (ZAE 6 & 7 of Middle Ouémé) – see Figure

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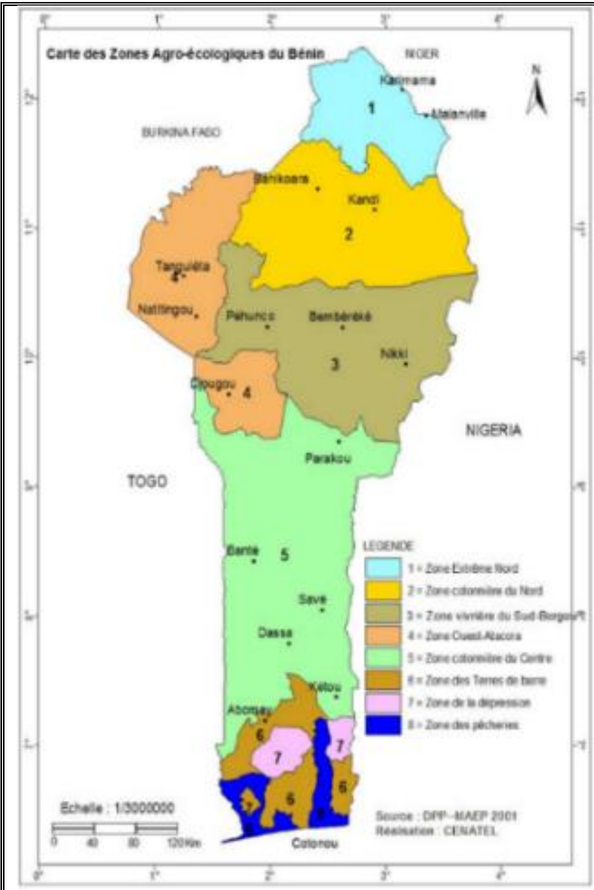
1 https://www.un.org/development/desa/dpad/least-developed-country-category/ldcs-at-a-glance.html
2 https://www.theglobaleconomy.com/rankings/GDP_per_capita_constant_dollars/
3 https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=BJ
4 INSAE EMICoV, 2010

Figure 2: Agro-ecological zones of Benin



Source: Ministry of Agriculture and Fisheries 2011

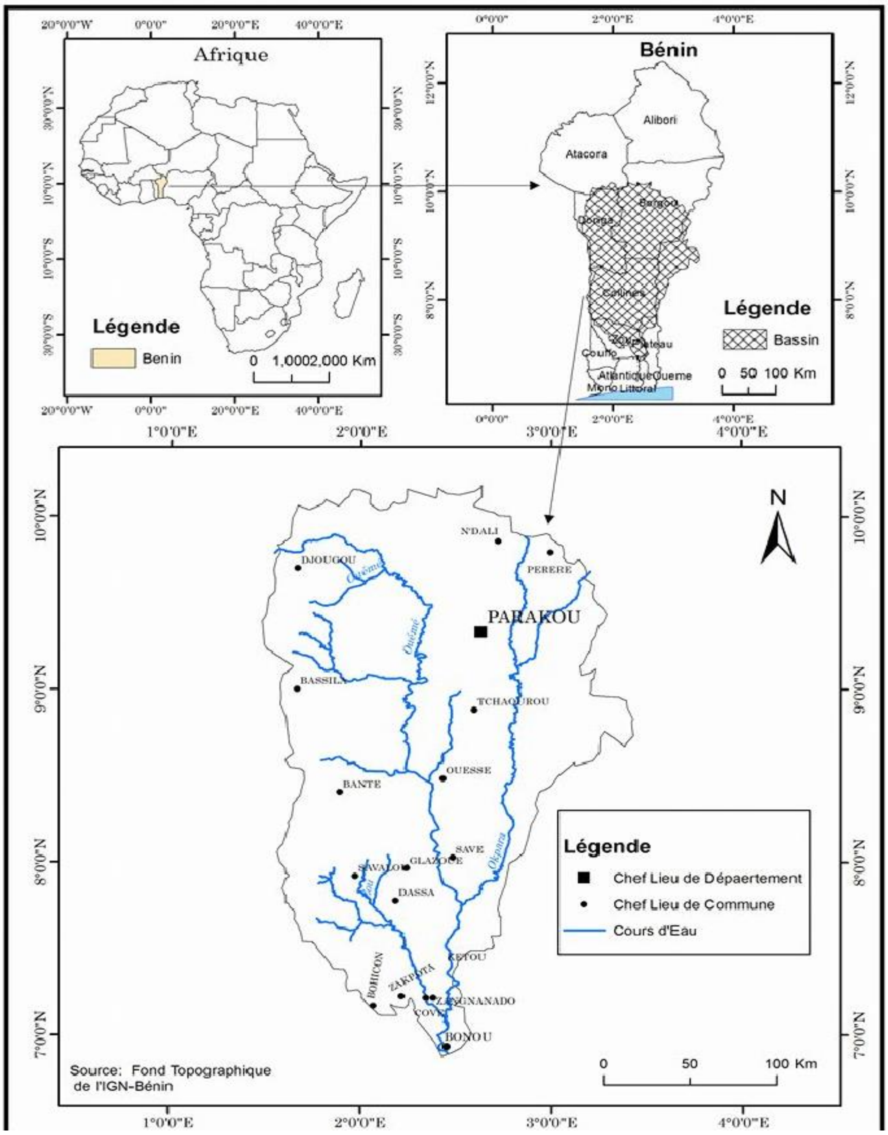
The agro-ecological zones (AEZ) can be grouped following their natural conditions:
In the north, there are two zones with lesser favourable conditions for agricultural production (Zone Extrême Nord Bénin (1) and Zone Ouest Atacora (4) and two zones with more favourable production conditions (Zone Cotonnière du Nord Bénin (2) and Zone Vivrière du Sud Borgou (3). All are characterized by one cropping season per year and by a relatively low population density between 12 and 33 inhabitants per km².
In the centre, a larger zone with favourable agricultural production conditions is found (Zone Cotonnière du Center Bénin (5), also characterized by one cropping season and a low population density with 28 inhabitants per km².
The south has one zone with a high production potential (Zone de la Depression (7), one zone with a medium production potential (Zone des Terres de Barre (6)) and one zone with a low production potential (Zone des Pêcheries (8)). They are characterized by two cropping seasons and a high population density, reaching from 135 inhabitants per km² in Zone 8,267 inhabitants per km² in zone 6 to 416 inhabitants per km² in Zone 7 (including the urban population).

11. Located in Benin, the Ouémé Basin is considered the second most fertile valley in the world after the Nile valley[5]. The Ouémé Basin extends over an area of more than 47,218 km^2, straddling 48 communes in 8 departments of Benin. The Ouémé River and its Basin provide a livelihood for approximately 6 million people[6], mainly engaged in agriculture, fishing, livestock and forestry production. This is the most important river in Benin, with a length of almost 510 km. Situated between 70°00' and 80°30' N and 41°30' E, the Upper and Middle basins of the Ouémé river are part of the Ouémé basin. It is an alluvial plain area, with a gentle slope of the river (5 m of difference in level over 85 km^2) traversed by a dense network of watercourses that feeds Lake Noukoué to the west and the Porto-Novo lagoon to the east. The whole area forms the Ouémé delta, which then flows into the Atlantic Ocean. The middle valley extends over two departments: the Atlantique, composed of eight communes and the Zou, composed of nine communes. The upper valley extends over the department of Donga, which is made up of four municipalities, the department of Borgou, which is made up of eight municipalities, and the department of Les Collines, which is made up of six municipalities (Figure 3).

[5] https://www.afdb.org/fr/projects-and-operations/selected-projects/benin-la-vallee-de-lOuémé-se-transforme-grace-au-paia-vo-23/

[6] Estimation selon le Schema Directeur d'Amenagement et de Gestion des Eaux du Bassin de l'Oueme (SDAGE), 2013.

Figure 3: Ouémé Basin in Benin



1.1 Climate

12. Benin is located in West Africa (Guinea Coast). The climate of Benin is tropical, and strongly influenced by the West African Monsoon. The rainfall seasons of Benin are controlled by the movement of the tropical rain belt (also referred to as the Inter-Tropical Conversion Zone (ITCZ) oscillating between the northern and southern tropics over the course of a year). This oscillation creates both winds from the Ocean (northward) which is most as well as winds from the Sahara region (southward) that are more dusty and warmer (known as the 'Harmattan'). These two opposing wind directions cause the annual West African Monsoon – resulting in a single wet season in the north of Benin from May to November, and two wet seasons from March to July and from September to November in the southern regions, corresponding to the northern and southern passages of the ITCZ across the region. The effects of the monsoon decrease towards the north of the country, while the Harmattan's impact lessens towards the

south of Benin. In general, most of the country experiences transitional tropical conditions, with less rainfall than in other areas at the same latitude – a climate known as the Benin variant[7]. The seasonal rainfall in the region varies considerably on inter-annual and inter-decadal timescales, due in part to variations in the movements and intensity of the ITCZ, and variations in timing and intensity of the West African Monsoon. The most well documented cause of these variations is the El-Niño Southern Oscillation (ENSO). El Niño events are associated with drier conditions in West Africa[8]. Benin has a tropical savanna climate[9] with average monthly temperatures of 26–31˚C [10]. In the far north, the climate is warm semi-arid[11] and temperatures can reach up to 45˚C. Rainfall varies across the country, ranging from 700 mm in the north to 1,400 mm in the south[12].

13. Benin has three climate zones[13] :

1. A Sudanian zone (between 9°45'–12°25'N). This zone is characterised by a unimodal rainfall profile. The rainfall season is from April to October, with a peak between June and September. The period of vegetative growth in this zone is under 145 days, coinciding with the rainfall season. The mean annual rainfall is under 1,000 mm and the mean relative humidity is 54.9%[14]. The mean annual temperature is 27.5°C.

2. A Sudano-Guinean zone (between 7°30'–9°45'N). This zone is characterised by a unimodal rainfall profile peaking between May and October, with a mean annual rainfall of 900–1,100 mm. The period of vegetative growth is about 200 days, during the rainy season. Mean annual temperature varies between 21.2°C and 32.5°C and relative humidity ranges between 45.5% and 87.1%.

3. A Guinean zone (6°25'–7°30'N). This zone has a bimodal rainfall profile and the period of vegetative growth is nearly 240 days. The main rainfall season is from April to June and the short rainfall season is from September to November. The mean annual rainfall is 1,200 mm up to 1,400 mm. Mean temperature varies between 25°C and 29°C and the relative humidity between 69% and 97%.

14. **The Upper Ouémé Basin** is characterised by a Sudanese climate with the presence of a single dry season from mid-October to mid-April and a rainy season from April to October [15] (monomodal). This area is marked by a relative humidity of around 77% in the rainy season and 36% in the dry season[16] in the dry season and an average temperature varying between

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7 Jalloh, A.; Nelson, G.C.; Thomas, T.S.; Zougmoré R.; Roy-Macauley H., (2013): West African Agriculture and Climate Change, A Comprehensive Analysis, IFPRI http://www.ifpri.org/sites/default/files/publications/rr178.pdf

8 McSweeney, C.; New, M.; Lizcano, G. (2010): UNDP Climate Change Country Profiles: Benin, http://www.geog.ox.ac.uk/research/climate/projects/undpcp/UNDP_reports/Benin/Benin.lowres.report.pdf

9 According to the Köppen climate classification. Geography of Benin, Wikipedia. Available online at: https://en.wikipedia.org/wiki/Geography_of_Benin. Accessed on 10 April 2017.

10 World Bank Climate Change Knowledge Portal. Available at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisCCode=BEN#. Accessed on 10 April 2017.

11 According to the Köppen climate classification. Geography of Benin, Wikipedia. Available online at: https://en.wikipedia.org/wiki/Geography_of_Benin. Accessed on 10 April 2017.

12 Government of Benin (2011) Benin: Second National Communication on Climate Change.

13 Aregheore E.M. (2009), Country pasture/ forage resource profiles: The Republic of Benin. FAO Publication available at: http://www.fao.org/ag/agp/agpc/doc/counprof/PDF%20files/Benin.pdf

14 Between 1960 and 2000.

15 PDC 2018-2022

16 Moyennes établies selon les données suivantes : https://planificateur.a contresens.net/afrique/benin/donga/djougou/2394560-avril.html

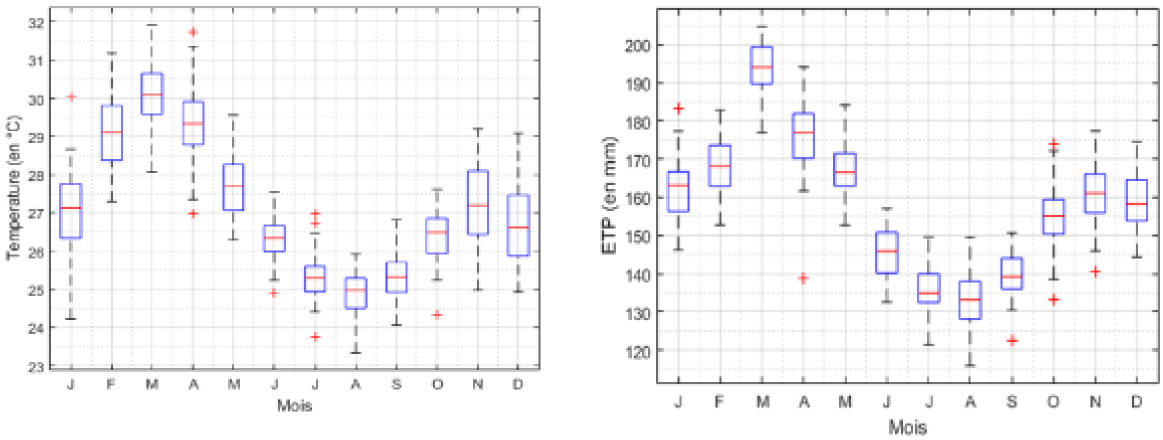
19 and 37.5°C[17]. Rainfall varies between 800 mm and 1,300 mm showing the random nature of rainfall in the area[18].

15. **In-between Upper and Middle Ouémé** is the transition zone, the agro-ecological zone Cotonnière Centre. This area has relatively high temperature variation and a climate characterised by two rainy seasons and two dry seasons. Finally, **the Middle valley of Ouémé** has an average temperature between 22 and 36°C. The bimodal rainfall regime is characterised by with a large dry season from November to February, a large rainy season from March to July, a small dry season from July to August and a small rainy season from September to October.

1.2 Temperature and evapotranspiration

16. The variability of the temperature in Upper Oueme is stronger during the months of the dry season: January, February, March, April, November and December. The average monthly potential evapotranspiration of the municipality of Copargo and Djougou, for example, is shown in Figure 4. It varies on average from 115 mm to 205 mm depending on the month concerned. The most important values of the potential Evapotranspiration (PET) are measured in March, April and February; and the lowest values are measured in July, August, and September. The monthly variability of month-to-month PET is not significant, with the smallest variability observed in September.

Figure 4: Mean profile of the monthly temperature (left) and potential monthly evapotranspiration (right) of Copargo municipality in Upper Oueme from 1970 to 2015.

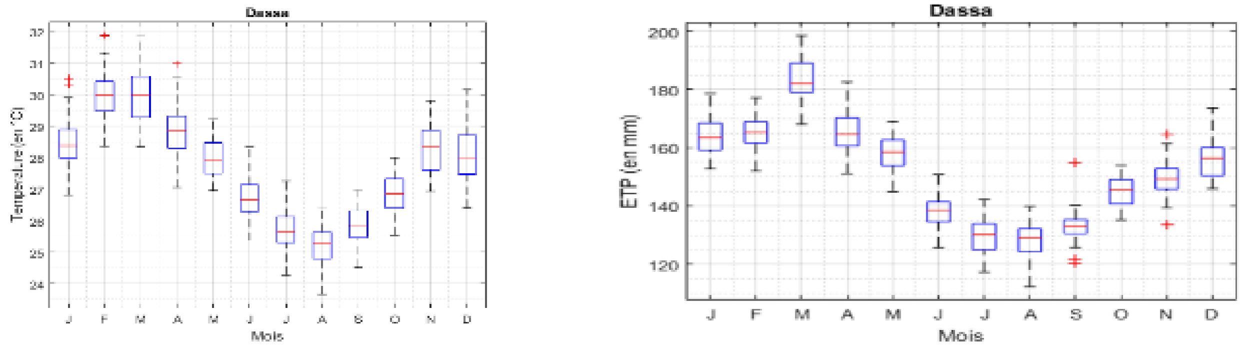


17. In the transition zone between the tropical and the subequatorial type of climate, where Glazoue is located, the temperature varies on average between 23 and 32 ° C during the year with maximum values observed during the dry season in February and March. The minimum values are observed in July, August and September during the rainy season. The variability of the temperature is stronger during the months of the dry season: January, February, March, April, November and December. Extreme temperatures sometimes rise up to 38 °C. Low

[17] https://planificateur.a-contresens.net/afrique/benin/donga/djougou/2394560-mars.html
[18] http://memoiresdubenin.com/wp-content/uploads/2016/12/mono-13.pdf

temperatures are often observed during the night during the harmattan period (December-January). The hottest period is between the months of February and March. The thermal differences vary from 11 ° to 13 °; see Figure 5.

Figure 5: Mean profile of the monthly temperature (left) and potential monthly evapotranspiration (right) of the commune of Glazouè in the transition zone (1970-2015)

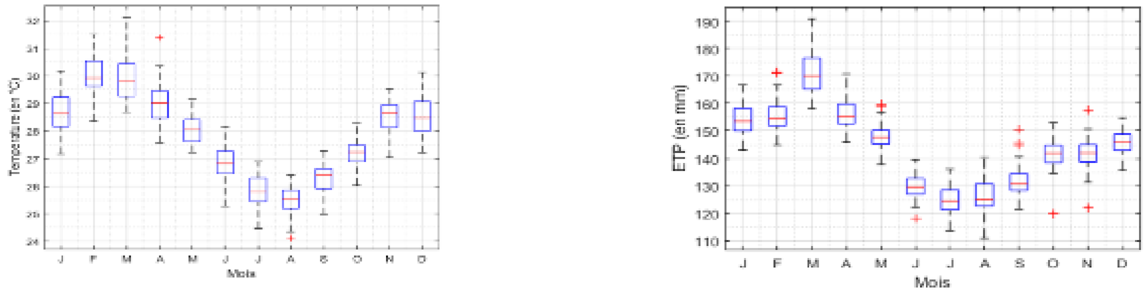


18. The average monthly PET varies from 110 mm to 200 mm on average (Figure 6). The most important values of the PET are measured in January, February, April and March where the highest average value is observed greater than 180 mm; and the lowest values are measured in July, August, September with mean values less than 135 mm. The variability is virtually the same from one month to another. The lowest variability is observed in September.

19. Finally, in the **Middle Ouémé**, which has a subequatorial climate, temperature varies on average between 24 and 32.5 ° C during the year with maximum values observed during the dry season in February and March around 30 ° C. The minimum values are observed in July, August, below 26 ° C, during the rainy season. The variability of the temperature is stronger during the months of the dry season: January, February, March and December.

20. The average PET varies from 110 mm in the month to 195 mm. The average PET profile is close to that of the average monthly temperature (Figure 6). The most important values of the PET are measured in January, February, April and March where the highest average value is observed greater than 170 mm; and the lowest values are measured in July, August, September with mean values less than 125 mm. The variability is virtually the same from one month to another.

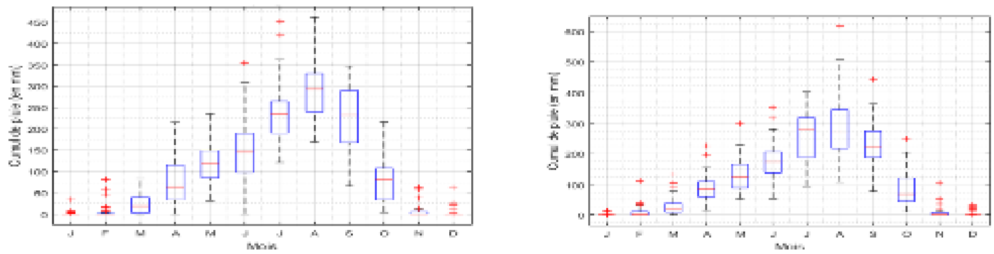
Figure 6: Mean profile of monthly temperature (left) and potential monthly evapotranspiration (right) of Zagnanado municipality (1970-2015).



1.3 Precipitation

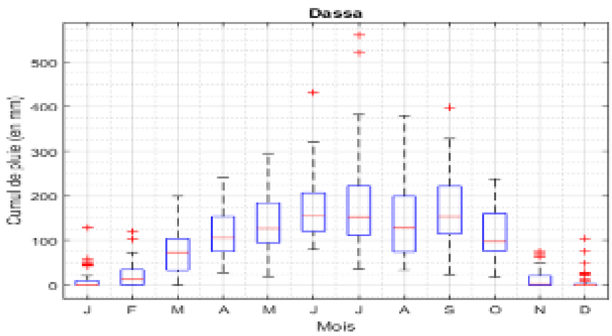
21. In the **Upper Ouémé**, characterized by a tropical climate with a single rainfall season starting in March or April and ending in November, and with a peak observed in July-August, exceptional values are still observed in January, February, November, and December respectively higher than 40 mm, 75 mm, 60 mm and 60 mm[19]. These values are associated with the years of exceptional rainfall observed before the period of recession from 1970 to 1990 (Figure 7).

Figure 7: Average profile of monthly precipitation at Copargo and Djougou from 1960 to 2014



22. In the transition zone between the tropical and the subequatorial, the rainfall regime has two maximum values, in June and in September of respective magnitudes of 160 mm and 150 mm (Figure 8). On average, the rains start in February and end in November. In some years they started in January with monthly accumulations of more than 125 mm observed. Exceptional values are all equally observed in February, June, July, September, November and December respectively greater than 110 mm, 430 mm, 550 mm, 400 mm, 75 mm and 100 mm – see Figure 8.

Figure 8: Monthly precipitation profile in Upper-Middle Ouémé from 1960 to 2014.

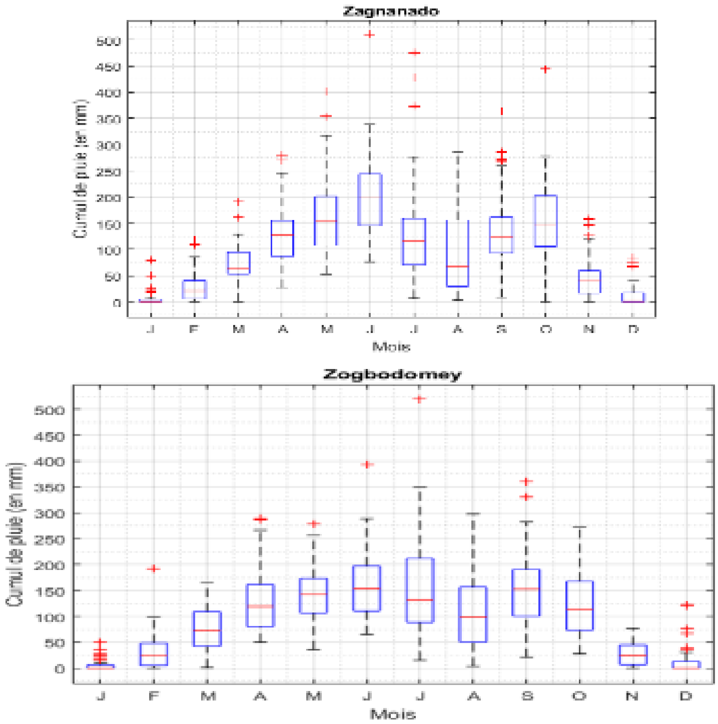


23. Where the climate in the **Middle Ouémé Basin** is subequatorial with two rainy seasons and two dry seasons, the rainfall regime has two peaks, in June and October, with mean values of 200 mm and 150 mm respectively (for Zagnanado) and in June and September, with mean values of 160 mm and 150 mm respectively (for Zogbomey). During the main (longer) rainy season, the rains start in February and end in November. Exceptional values are observed every other month of the year with values greater than 140 mm, 180 mm, 275 mm, 400 mm,

[19] The data considered for the analysis are the daily rainfall (from 1960 to 2014) of the Birni station located in the commune of Copargo and the temperature and evapotranspiration data (from 1970 to 2015) of the Natitingou synoptic station, which is the closest station to Copargo (60 km).

500 mm, 475 mm from February to July, then 360 mm, 440 mm, 160 mm and 80 mm, from September to December[20] (Figure 9).

Figure 9: Average profile of monthly precipitation: Zagnanado and Zogbodomey from 1960 to 2014.



1.4 Geography of the targeted municipalities

Copargo and Djougou (Upper Ouémé)[21]

24. The relief of Copargo is essentially characterised by a mountainous area dominated by the Atacora mountain range with its highest point reaching 654 m at Tanéka-Koko and an area made up of vast wooded plains alternating with valleys. In the mountainous area, the relief is rugged. **It is in this commune, and precisely in the locality of Tanéka-Béri, that the Ouémé has its source and flows towards the Atlantic Ocean.** In the rainy season, the rivers cause submergence, which is favourable to the practice of lowland rice cultivation.

25. The types of soil found in this commune have the same characteristics as those found in the majority of Donga county. They are leaching tropical ferruginous soils that are non-concrete and indurated, light soils with low water retention capacity, ferralitic soils and rare soils with hydromorphic tendency found at the foot of the summits and on the banks of the Ouémé river[22]. These soils have an important need for organic matter inputs for the reconstruction of the humus layer on the cultivated plots.

[20] The data considered for the analysis are the daily precipitation (from 1960 to 2014) of the Zagnanado station in the municipality of Zagnanado. These data were deficient in particular for the years 1993, 2005 to 2009, 2011 and 2014. The temperature and PET data (from 1970 to 2015) used is that of the Bohoicon synoptic station which is the closest station to Zagnanado (20 Km).

21 Plan de développement communal (PDC) 2018 - 2022.
22 Plan de développement communal (PDC) Copargo 2018-2022

26. Copargo is crossed and watered by several rivers over a distance of about 55 km, including one river and three springs. The most important are the Ouémé, Kéran, Yari, Gbangbaré, Saguigui, Pabébou, Baana, Sountchoulou, Danêgué, Sounêgou, N'kouéma and Makoulouhou rivers. These rivers have seasonal flows, except for the Ouémé. Filling, silting, and drying up are the main problems facing these sources.

27. Djougou has a plateau relief dotted with low hills. It slopes from west to east and the heights vary from 295 m in the east to 545 m in the west. In addition to several watercourses, lowlands are also found in the area. The municipality has 557.57 ha of lowlands spread over 76 sites, of which 113.59 ha are developed on 13 sites and 443.99 ha are undeveloped on 63 sites[23].

28. A dense and varied hydrographic network circulates on the Djougou high plateau. Four main rivers with a total length of 21 km irrigate Djougou. The commune also has five water reservoirs. Silting and pollution by pesticides, household waste or by the processing of néré seeds are the main problems noted in relation to these rivers and reservoirs.

Glazoué (transition zone)

29. Glazoué has a very uneven relief with hills (Sokponta, Tankossi, Camaté, Tchakaloké, Tchatchégou, Ma-dengbé, Thio, Ouèdèmè, Assanté and Aklampa). The hills are the major and most visible element within the territory, and complemented by a vast peneplain, which rests on the old pre-Cambian granito-gneissic bedrock[24]. The formed peneplain slopes towards the South and at an average altitude of 130 m. The soils are of tropical ferruginous type on crystalline base with very variable characteristics covered with soils of tropical ferruginous type on crystalline base with very variable characteristics.

30. The municipality of Glazoué belongs to the regional hydrographic network of the Zou and Agbado confluence of the Ouémé River. The hydrographic regime is regular with fairly pronounced low water levels and floods from August to October[25]. Tributaries of the Ouémé (Agbado, Riffo, Tran-Tran, Agbanlin-djetto, Kotobo, Ahokan, Donga, Agba-gbavi, Djololowé, Fèmanou, Klou, etc.) favour the development of off-season market gardening and artisanal fishing activities. However, these watercourses dry up in the dry season with a jagged trend from one year to the next, which is a source of uncertainty and agri-cultural risk for the farmers exploiting the valley of these watercourses.

Zagnanado and Zogbodomey (Middle Ouémé)

31. Zagnanado is characterised by peneplains and plateaus, with a difference in height of approximately 270 m between the highest point in the northern part of the commune and the lowest point in the southern tip. The slopes are generally less than 5%, but almost 4% of the territory is characterised by slopes with a gradient of more than 15%. Almost a third of the commune is located in the valleys of the hinterland, mainly in the southern part. The western part of the commune is covered by plateaus. The peneplains cover about 28% of the municipality, mainly its eastern and northern parts. Finally, the south-eastern part is characterised by the Lama depression and the hills and escarpments cover about 5% of the municipality. Zogbodomey has a similar relief with slopes of less than 5% and several hillsides.

[23] Plan de développement communal (PDC) Djougou 2018-2022

[24] Attiogbé, 2010

[25] Le Barbé, et al, 1993

There are vast valleys of the Zou and Ouémé rivers, low-lying plateau areas and an area of the Lama depression.

32. In the Zou region, the extent of vegetation cover decreased by 34.25% between 1995-2006[26] for the benefit of culture. This process has had important consequences in terms of loss of fertility due to erosion and the vulnerability of areas to heavy rainfall. Zagnanado and Zogbodomey lie on sedimentary rocks with a muddy and slippery appearance after rainy periods. On the whole, this soil is characterised by good physical and hydraulic properties, although water reserves remain low and particularly vulnerable to poor agricultural practices[27]. The three main categories of soil in the Ouémé basin can be found in these communes: Zagnanado has leached tropical ferruginous soils in the arrondissements of Banamè and Don-Tan, ferralitic soils in the arrondissements of Zagnanado, Agonlin-Houégbo, Don-Tan and Dovi which, although originally fertile, are currently being overexploited. Zagnanado also has hydromorphic soils along the rivers, mainly in Dovi and Kpédékpo[28]. Zogbodomey is characterised by ferralitic soils covering most of its territory, which have lost their natural fertility in the north. Hydromorphic soils can be found in the east and extreme west and cover about a third of the commune. Vertisol and ferruginous soils cover about 10% of the area.

33. The soils of the Zou departments were formed in a sub-equatorial climate with two rainy seasons and two dry seasons with dense vegetation. As a whole, therefore, they have good characteristics with greater permeability, high resistance to erosion, greater depth available for root growth and more favourable structural instability. Nevertheless, the water reserve remains limited, making them particularly vulnerable to droughts[29]. These pedological characteristics make it possible to conclude that the soils of the middle valley are well predisposed to agriculture. Nevertheless, their low water retention potential makes them particularly vulnerable to drought episodes with strong repercussions for the agricultural sector.

34. The department of Zou has a relatively developed hydrographic network with several rivers, namely Hounto, Hoho, Da and Dahou (towards Zoukou), Hlan (towards Hlanhonou), Samion (towards Samionta), Koto (towards Kotokpa) and Dèhounta in the surroundings of Kpokissa. The hydrographic network of Zagnanado is made up of several rivers, the most important of which are : Zou, Ouémé, Couffo, Hounto, Koto, Samion, Hlan, Da and Dô. Apart from the Ouémé and its tributary, Zagnanado has 66 lakes and rivers. Zogbodomey comprises several watercourses, the most important of which are the Zou, Ouémé, Hounto, Koto, Samion, Hlan, Da, and Dohou. There are also in the two communes a significant number of lowland areas which are not very highly valued.

[26] http://rgoburkina.org/wp-content/uploads/2015/11/4-Maquette_RGO_00_24_Agoinon_02_01_20131.pdf
[27] http://hydrologie.org/redbooks/a199/iahs_199_0249.pdf
[28] http://ancb-benin.org/pdc-sdac-monographies/monographies_communales/Monographie%20de%20ZAGNANADO.pdf
[29] http://hydrologie.org/redbooks/a199/iahs_199_0249.pdf

1.5 Agriculture

35. Benin is a Lower Middle-Income Country, which economy relies predominately on the tertiary sector, contributing over 50%[30] of the GDP. This sector is dominated by transport and trade activities with the neighbouring countries, particularly Nigeria. The primary sector is the second most important and contributes ~36% of the GDP[31]. Despite a consistent reduction of the contribution of the primary sector to the national economy, an estimated **~70% of the economically active population of Benin relies on agriculture as a main source of income.** Among them, ~45% are formally employed[32] and the rest constitute subsistence farmers. Moreover, agriculture contributes ~80% of export income[33].

36. Although the agricultural sector is identified as a priority by the GoB[34] and although most of Benin's population relies on agriculture as their main source of income, the agricultural sector remains underdeveloped. For example, approximately 63% of Benin's total land area is arable, but only ~20% of the arable land is under cultivation[35]. Crop productivity is low because of, among others, unsustainable practices, a limited access to agricultural inputs, mechanised tools and limited access to credits to invest in agricultural technologies, a lack of irrigation technologies especially for small-scale agriculture, and post-harvest losses. Furthermore, crop production in Benin is mainly rain-fed and thus highly sensitive to shifts in seasonal rainfalls.

37. **The Ouémé Basin of Benin is an area of great economic and ecological importance due to the abundance of its waters and the richness of its soil; the area is a key agricultural hub for Benin, contributing to 65% of the national agricultural production**[36]. Of the 61.1% of Upper and Middle Ouémé's population relying exclusively on the agricultural sector, 85% are smallholders practicing rain-fed subsistence farming on small and scattered plots. The average farm size varies from 0.5 ha in the Middle Basin to 3 ha in the Upper Ouémé Basin[37]. The majority of the farms are family and traditional (semi-homestead slash-and-burn), dominated by food crop production. The main crops and yields produced in the project areas are described in Annex 19: Market Analysis – Section 1.4. and 1.5.

1.6 Water resources

38. Benin's water resources include surface water and groundwater.

<u>Surface water</u>

39. Benin's annual surface water potential is estimated at 13,106 billion m^3 [38]. These resources are distributed between 6 basins (or watersheds) grouped into 4 large hydrographic units that are: the hydrographic units of Niger; Ouémé-Yeah; Volta; and Mono-Couffo (see Figure 10).

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30 The contribution of the tertiary sector to the national economy is much higher if one takes into account the informal economy.

31 http://www.indexmundi.com/benin/gdp_cSDAGEosition_by_sector.html

32 *Ibid.*

33 Gain Report (2014), Benin: Agricultural situation. USDA Foreign Agricultural Servce. Available at: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Agricultural%20Situation_Lagos_Benin_3-20-2014.pdf

34 Programme d'Actions du Gouvernement (PAG) 2016-2021

35 Government of Benin (2008) National Adaptation Programmes of Action (NAPA).

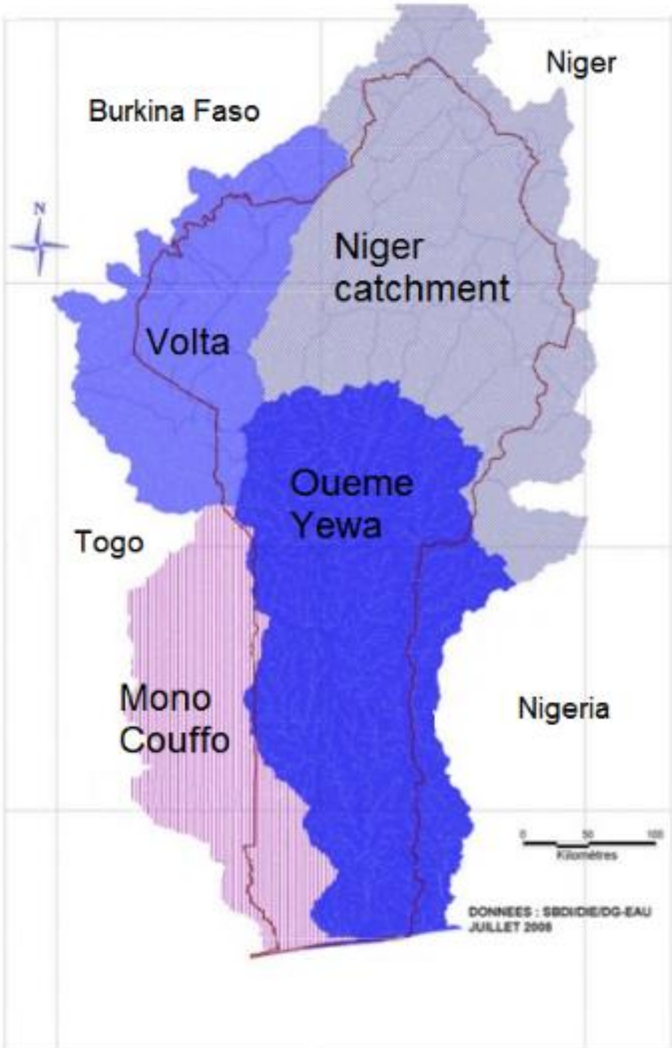
36 Estimation selon le Schema Directeur d'Amenagement et de Gestion des Eaux du Bassin de l'Oueme (SDAGE), 2013.

37 *Ibid.*

38 FAO Aquastat – Benin.

The basins are divided into sub-basins which are the primary hydrological units. In total, 86 sub-basins are identified.

Figure 10: The four main basins in Benin: Niger; Volta (or Pendjari); Mono-Couffo; and Ouémé-Yewa .



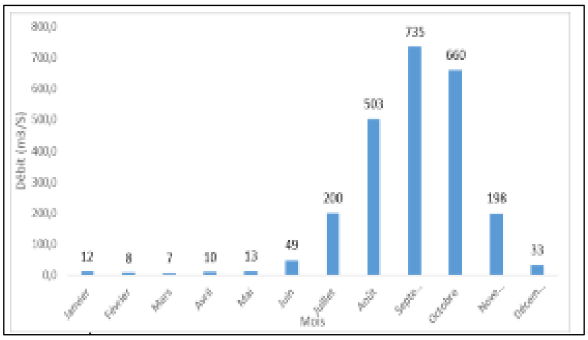
40. The Ouémé basin has significant water resources with a surface water potential estimated at 10 billion m^3 / year; this corresponds to a potential of 250,000 ha of irrigable land. The recharge capacity of groundwater in the Ouémé basin is estimated at around 755 million m^3 / year[39]. Despite this significant potential to support economic growth and development of the region, a chronic lack of mobilization of water resources is noted across the whole Ouémé Basin, with presence of limited irrigated agriculture. The water mobilization difficulty is especially pronounced in the basement regions where surface water losses are observed as a result of the siltation of the stream and its tributaries. Moreover, the hydrological regime of the river and its tributaries is characterized by a great seasonal variability and non-controlled interannual irregularity.

[39] SDAGE 2013

41. In terms of water dynamics, studies by Bossa (2012)[40] demonstrated that the geology factor seems to be the major driver of the Ouémé catchment's hydrological response, while the slope controls (i) the conductivity of the water channels, (ii) the groundwater threshold (for base flow generation) and (iii) soil evaporation compensation. On the other hand, the author explained the observed surface runoff lag and the extreme retrained sediments in the Oueme catchment by the dominant type of soil (lixisol) found in the basin, while the presence of the lateritic consolidated soil explained the vulnerability of the basin to soil erosion and the considerable fraction of aquifer percolation justified by the drainage density.

42. In its current state, these water resources are mobilizable through 131 water reservoirs (including dams, pools and marsh overburden) with a cumulative storage capacity of 32.213 million cubic metres of water. Specifically, the five (05) Communes (municipalities) of the OCRI project, have approximately twenty-three (23) dams/water retention/pools with a total storage capacity of 759,200 m^3 of water. However, most of these water reservoirs are used for pastoral purposes (promotion of livestock). Moreover, the diagnosis of the state of these water reservoirs revealed a high level of degradation and therefore need urgent rehabilitation. With regards to the inflows water in the Oueme Basin, analysis of the rainfall data and hydrological water balance from 1987 to 2016 by Cocker et al. (2018)[41] in the lower valley, revealed inflow water rate varying from 7 to 735 m^3/s, with the peaks (503-735 m^3/s) observed in August-September-November (fig. 11). In general, for the last 5 decades, the mean annual daily water flow of the Oueme river at Bonou station is around 170 m^3/s (Biao, 2017)[42].

Figure 11: Dynamics of the inflows water in the Oueme Basin (lower valley).



Source of data: Historical data from Benin-Meteo
Period: 1987 to 2016
Source of graph: Cocker et al., 2019

Ground water

[40] Bossa, Y.A.Multi-Scale Modeling of Sediment and Nutrient Flow Dynamics in the OuéméCatchment(Benin)—Towards an Assessment of Global Change Effects on Soil Degradation and Water Quality; University of Bonn: Bonn, Germany, 2012; p. 130.

[41] Cocker F., Vodounou J-B., Zodekon R.et Yabi J., 2018. Disponibilité de la ressource en eau et variabilité climatique dans la basse vallée de l'Ouémé, au sud Bénin (Afrique de l'Ouest) Int. J. Innov. Sci. Res. 38pp. 289–300

[42] Biao, E.I. Assessing the Impacts of Climate Change on River Discharge Dynamics in Oueme River Basin. Hydrology 2017, 4, 16.

43. The groundwater resources in Benin include two large hydrogeological complexes, presented as discontinuous aquifers from the basement region and continuous aquifers of sedimentary regions, covering respectively 80% and 20% of total area of Benin respectively. The total annual recharge of the different aquifers is estimated at 1.87 billion meters^3 of water.

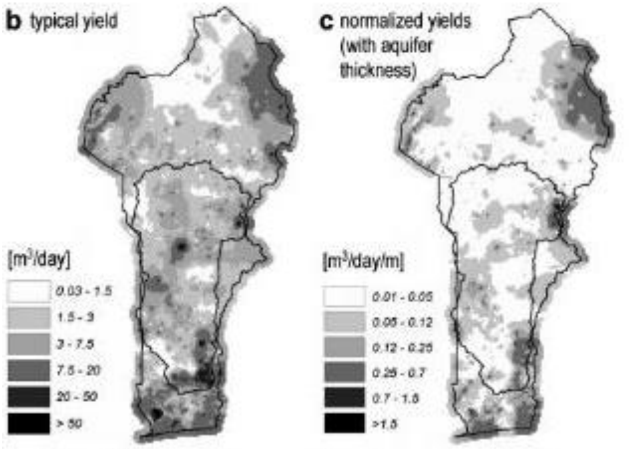
44. Discontinuous aquifers are present at the level of the crystalline basement that covers nearly 80% of the Ouémé Basin territory. These discontinuous aquifers are generally divided into two distinct strata: the first stratum is at the top level of the upper layers and is exploitable through large wells which are likely to dry up during the dry seasons; the second stratum is located at a deeper level of the underlying rock and its flow is less vulnerable to seasonal variations. Continuous aquifers are between 45 m and 150 m deep and are particularly vulnerable to saline intrusion on the Continent Terminal. A detailed analysis of water availability, current uses and potential, is presented in Annex 17 Feasibility Waterworks.

45. Groundwater is one of the major sources of water used in Benin, yet, only 2% of the available recharge water is currently used (Barthel et al., 2009)[43]. As for the whole country, groundwater availability and accessibility in the Oueme basin can be shared into two, based on the hydrogeological properties: (i) coastal sedimentary basin in the south, dominated by weakly consolidated sand, sandstone, clay and claystone and (ii) the crystalline basement in the northern regions, with a Precambrian crystalline basement, covered by a tertiary Regolith and a lateritic weathering zone. Hence, the southern part of the Basin is easily rechargeable, mainly due to the existence of shallow water tables (including artesian wells), with good flow rates, exceeding 50 m^3/hour (Barthel et al., 2009). Cocker et al. (2019)[44], recently mapped the groundwater potential and availability of the lower Ouémé Valley. The authors concluded with 34.5% excellent groundwater availability, 51.87% excellent exploitability and 38.43% excellent groundwater accessibility within the studied area. Example for the Northern part of the Ouémé basin, include the analysis of groundwater recharge capacity from 1990 to 1999 in the Okpara sub-basin (upper Oueme) by Barthel et al. (2009). The authors found a variation of 0.2 to 1.2 mm/month as recharge capacity, with the maximum recharge usually observed in July-August. Groundwater exploitation is usually done for drinking and agricultural purposes, through boreholes and different types of wells. In general, there are about 5000 drilled wells in the Ouémé catchment (Barthel et al., 2008), with a total annual abstraction estimated at 0.34 mm/year, i.e. 13,500 m^3/day (Vouillamoz et al., 2014). The typical and normalized yields from these wells vary from 0.03 to more than 50 m^3/day and 0.01 to 1.5 m^3/day, respectively, with the highest yields observed in the extreme South-east of the basin and some few other parts in the centre and extreme North-east (fig. 12). Even though groundwater recharge capacity is related to rainfall variabilities (Kotchoni et al., 2018), this annual abstraction (0.34 mm/year) seems to be relatively low (0.02 – 14%) compared to the recharge capacity (2.4 to 14.4 mm/year). In regards to the water quality, Tossou et al. (2017) stated that the inadequate management of the generated solid wastes and the excess used of pesticides are the potentials sources of pollution of the groundwater in the basin.

[43] Barthel R., B.G.J.S. Sonneveld, J. Götzinger, M.A. Keyzer, S. Pande, A. Printz, T. Gaiser 2009. Integrated assessment of groundwater resources in the Ouémé basin, Benin, West Africa. Physics and Chemistry of the Earth 34 (2009) 236–250.

[44] Cocker Fêmi, Jean-Bosco K. Vodounou, Jacob A. Yabi 2019. Évolution récente des débits dans la basse vallée de l'Ouémé, Sud-Benin. J. P. Soaphys, 1 (2019) C19A1

Figure 12: Typical and normalized yields from the spatial distribution of wells in the Oueme basin



Source of data: Observed climate data (Meteo-Benin) and underground water data collected from Direction Generale de l'Eau
Period: Past (1990-1999)
Source graph : Barthel et al., 2009[45]

Inland-valleys surface and ground water

46. The wetlands in Benin and generally in Sub-Saharan Africa include coastal plains (deltas, estuaries and tidal flats), inland basins (comprising extensive drainage depressions), river floodplains (consisting of recent alluvial deposits bordering rivers) and inland valleys. Inland valleys are defined as flat-bottomed, relatively shallow valleys; they are widespread in the undulating landscape. They are known as dambos in eastern and central Africa, as fadamas in northern Nigeria and Chad, bas-fonds or marigots in francophone African countries, and as inland-valley swamps in Sierra Leone[46]. Inland valleys are endowed with important surface and ground water depending the specific climate zone. The exploitation of inland valleys constitutes another alternative to the water scarcity problem in the Oueme basin and Benin in general. Indeed, Benin has about 322,000 ha of inland valleys (wetlands endowed with little sub-catchment) with high potential for agricultural production that needs to be valorised. For example, Giertz et al. (2012) identified 817 inland valleys in the communes located at the Upper Ouémé catchment, out of which 67% is used traditionally managed for agricultural purposes. From this inventory, the commune of Djougou, one of the OCRI project area, has the highest number of inland valleys, covering a total of 2100 ha (fig.13). Another example is the study conducted by Chabi et al. (2010), that identified 181 inland valleys covering a total surface of 1123 ha in Dassa (centre Benin), a commune closed to Glazoue (one of the OCRI Project site). Due to the high-level of fertility of the inland valley sols, crops production is highly beneficial to farmers in these ecosystems. For example, Hounsou et al. (2020)[47]

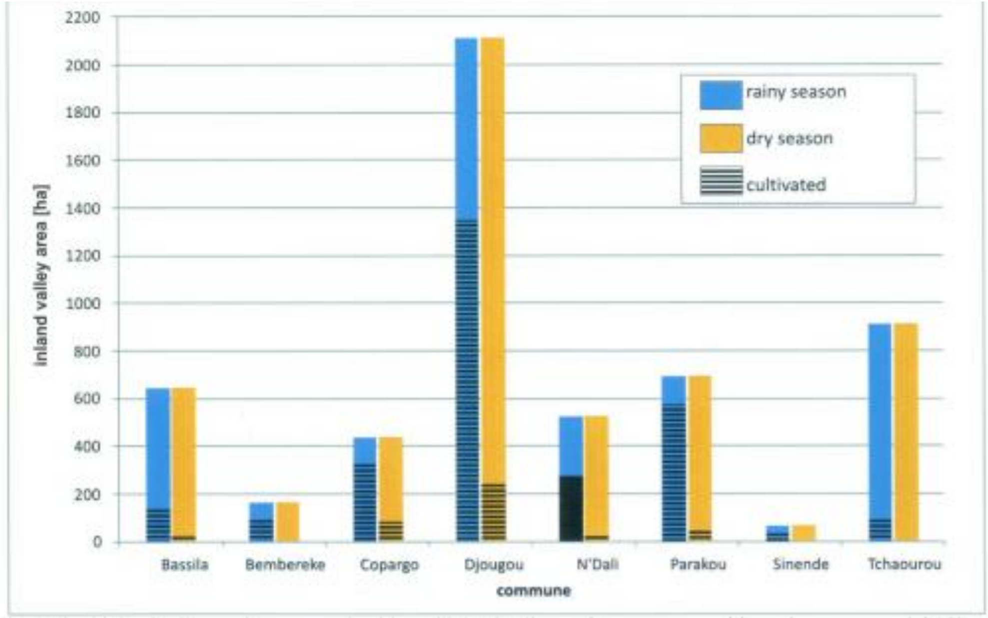
45 Barthel, R., Jagelke, J., Gaiser, T., Printz, A., Götzinger, J., 2008. Aspects of choosing appropriate concepts for modelling groundwater resources in regional Integrated Water Resources Management – examples from the Neckar (Germany) and Ouémé catchment (Benin). Physics and Chemistry of the Earth, Parts A/B/C, 33 (1–2), 92–114.

46 http://www.ricehub.org/RT/land-development/inland-valleys/

47 Hounsou B. Mathieu, A. C. Sandra Boko, S. Prudence Badjito, M. Voltaire Alofa et K. Euloge Agbossou 2020. Incidences socio-économiques et sanitaires de la mise en valeur durable des bas-fonds de la commune de Zagnanado (département du Zou, Bénin). Int. J. Biol. Chem. Sci. 14(5): 1786-1799, June 2020. ISSN 1997-342X (Online), ISSN 1991-8631 (Print).

concluded that the use of the inland valley doubled vegetable crops yield and smallholders revenue, at Zagnanado, one of the OCRI project's site.

Figure 13: Total number of inland valleys in communes located at the Upper Ouémé catchment.



1.7 Vegetation, forests and natural resources

47. Benin's landscape is characterized by forest, gallery forest, savanna, woodlands, and agriculture as well as pastureland. The spatial variation in climate and different soil properties influence ecological processes. As a result, Benin is divided into three vegetation zones[48]:

- North Benin is comprised of wooded savanna and riverine forests. The vegetation in these parts is broadly categorised as West Sudanian Savanna – typically a hot, dry, wooded savanna composed mainly of large tree species and long "elephant" grass (*Hyparrhenia* spp.)[49].
- North-central Benin is comprised of dry dense forests, open savanna and riverine forests. The most common tree species in central and north Benin are *Isoberlinia doka, Afzelia africana, Khaya senegalensis, Parkia biglobosa, Danielia oliveri, Anogeissus leiocarpus,* and *Pterocarpus erinaceus*.
- South Benin is comprised of a highly dynamic mosaic of forest, savanna and grassland habitats[50]. The dense forests of this region include species such as *Mitragyna spp., Vachillia sieberiana, Terminalia spp., Borassus aethiopum, Triplochiton scleroxylon, Vachillia seyal, Balanites aegyptiaca* and *Tamarindus indica*.

[48] Government of Benin (2011), Second National Communication on Climate Change.
[49] WWF Terrestrial Ecoregions. Western Africa: Stretching from Senegal through Niger. Available online at: http://www.worldwildlife.org/ecoregions/at0722. Accessed on 11 April 2017.
[50] WWF Terrestrial Ecoregions. Western Africa: Stretching from Nigeria to Senegal. http://www.worldwildlife.org/ecoregions/at0707. Accessed on 11 April 2017.

48. On a finer scale, the vegetation of Benin is classified into ten different phytogeographical districts, namely Coastal, Pobé, Plateau, Ouémé Valley, Bassila, Zou, South Borgou, North Borgou, Atacora mountains and Mékrou-Pendjari[51].

49. The country has no undisturbed primary forest and has lost 29 % of its forest cover since 1990 despite having more than 22 % of the country under protected area[52]. At 2.5 %, Benin has one of the highest annual deforestation rates in the world. Land cover statistics indicate that the total forest cover of the Ouémé Basin decreased from 3.3 million ha to 2.1 million ha in the period 1972-2008, a total loss of about 1.2 million ha in 36 years. The annual loss of forest cover in the basin is at 33,162 ha. This is because of climate change leads to slash and burn agricultural practices and clearing of land in search for fertile agricultural fields and uncontrolled extractions of the natural resources.

1.8 Land tenure

50. With regards to land ownership, starting in 2005, the Millennium Challenge Account (MCA), Benin and the Ministry of Urban Planning and Land Reform led to a comprehensive land reform aimed at modernizing and standardizing the legal framework. To facilitate private investment through the formalization of land rights and the development of a land market, the project promotes the unification of land tenure and simplification of registration procedures. Individual land title, managed by a future "National Agency of Domains and Land", are generalised. This reform project is accompanied by support for the massive transformation of land tenure permits in urban areas, and the establishment of 300 LICs in rural areas. A draft Land Code and Land Code is in the National Assembly, which should endorse this option, contested by those who think it does not meet the challenges of the rural world.

51. Currently, cultivated land is under personal property (63%); family property (46%) and rental (14%). Two tenure systems are applied: modern law (developed perimeters and urban areas and peri-urban) and customary law. The majority of land is still managed under customary law and / or religious law. Customary law consists of a set of traditional rules determining the position of populations with regard to the allocation, management and exploitation of land and its accessories (water, pasture, forests. etc.). The management of land and other natural resources cannot be separated; it is the responsibility of the owner of the land.

52. In 2013, according to the results of the AGVSA survey (Global Analysis of Vulnerability and Food Security), between 35% and 62% of farmers in the upper and middle valley of Ouémé are owners of areas they cultivate; and between 46% and 64% work on family properties. Between 15% and 40% of family farms grow on rented land. In all the municipalities of the upper and middle valley, there are non-native farmers, who in most cases work on land made available, and who are therefore in a situation of land insecurity in a context of unrestricted land sales. The case of the Holli ethnic group, which is significantly represented in the populations of the communes of the middle valley of Ouémé, is essentially itinerant farmers. Their dispersed way of housing and socio-political organization makes them more vulnerable

[51] Adomou, A.C., Sinsin, B. and Van der Maesen, L.J.G., 2006. Notulae Florae Beninensis 12: Phytosociological and Chorological Approaches to Phytogeography: A Meso-Scale Study in Benin. *Systematics and geography of plants*, pp.155-178.

[52] https://rainforests.mongabay.com/20benin.htm

to the vagaries of transhumance and marginalized in the management of the resulting conflicts.

53. With regards to river banks, as well as watercourses and water bodies, including humic zones and lowlands, these come under the public domain of the State and directly under the supervision of the town halls of the communes following the country’s decentralisation process (see Law No. 2013-01 on the land and state code in the Republic of Benin, Article 264, Water Code-Benin LAW 2010-44 of November 24, 2010 on water management in the Republic of Benin, Article 20 and 21). The development of river banks, and of the lowlands by farmers and communities require to obtain a right of use permit from the town councils. The upper basin are defined as national forest reserves, under the management of the Water and Forest Administration (under the Ministry of Living Environment and Sustainable Development MCVDD.

54. The OCRI project is planning resilient agricultural developments such as soil and water conservation techniques within the fields belonging to the producers (based on traditional, custom laws, which has the same legal value than formal land ownership titles); while the degraded river banks on which reforestation will take place are managed under the MCVDD - which is the key executing entity for the project. The commitment of town halls, national and regional associations of producers was confirmed during the field missions, and in the annexed letters, and serve as guarantee for the maintenance and sustainability of the planned developments of OCRI.

2 Emission profile of Benin

55. Benin has published its Intended National Determined Contribution (INDCs) under the Paris Agreement in June 2017, which highlights the country's emission profile and intentions in terms of decarbonising its economy and investing in climate change resilience. The INDC indicates that Benin's total GHG emissions amounts to approximately 14.1 Mega ton CO2 Equivalent (Mt CO2 eq), that is approximately 1.5 ton CO2 eq per capita in 2012, without Land Use, Land-Use Change, Lands and Forestery (LULUCF). These emissions come from the sectors of energy (47.4 %), **agriculture (45.9%),** waste (5.0 %) and industrial processes (1.6 %). Considering LULUCF, the balance of GHG emissions (14.9 Mt CO2 eq) and absorptions (50.3 Mt CO2) shows globally that Benin remains a GHG sink with a net absorptive capacity of 35.4 Mt CO2 in 2012, this means that its GHG emissions are largely offset by the absorption of CO2 on the level of its forest cover. Even tough Benin remains a sink, its capacity of carbon sequestration is declining falling from (52.0) Mt CO2 eq in 1995 down to (41.3) Mt CO2 eq in 2005, that is a decrease of 20.6 %, and to (35.4) Mt CO2 eq in 2012, that is a decrease of 32.0 %.

56. In terms of projection of greenhouse gas emissions, in the BAU case, the tendency of overall emissions (without LULUCF) reveals an increase rate of 172.8% over the period 2012-2030 rising from 14.1 Mt CO2 eq to 38.5 Mt CO2 eq.The total of aggregate cumulative GHG emissions without any intervention over the period 2021-2030 is close to 306.1 Mt CO2 eq (without LULUCF).They would come up to 27.4% from the agriculture sector. Benin is committed to reduce its GHG emissions. Overall, excluding the forestry sector, Benin plans to reduce cumulative greenhouse gas emissions by 49.49 Mt CO2e, a reduction of 16.17% compared to the status quo scenario on the period 2021 to 2030. This could be achieved through: i) implementing improved farming techniques; ii) implementing soil fertility-maintaining techniques on a cultivated area; and iii) promoting sustainable irrigation schemes.

57. Furthermore, the implementation of the measures envisaged in LULUCF would contribute to increase its cumulative sequestration capacity of 32 Mt CO2 eq over the period 2021- 2030 including 76.6% of conditional contribution, by limiting deforestation (23.9 Mt CO2 eq) and creating planted forests (8.1 Mt CO2 eq). Lowering the annual rate of deforestation would make it possible to reduce the cumulative emissions due to the sector of forestry by 110 Mt CO2 eq over 2021-2030 period including 80% of conditional contribution and 20% of unconditional contribution. This could be achieved through: i) Protecting and preserving existing natural and planted forests to reduce deforestation rate; and ii) implementing reforestation.

58. To achieve its emission reduction targets or potential, Benin will need support in terms of technology transfer, capacity building, National resources (public funds and private investments) will also need to be supplemented by the external financial support (bilateral or multilateral). The estimated overall cost for the implementation of the mitigation-related measures is of USD 6,042.33 million.

3 Climate hazards identification

59. This section identifies the current and future weather-related hazards that are likely to affect natural resources, agricultural systems and the population in the project locations. Hazards may include short-term, or extreme weather events (e.g. storm, fire or flood), and slow-onset (chronic) events that occur over a longer period (e.g. drought)[53].

Historical data

Historical data used originate from the national meteorogical service (precipitation, temperature, evapotranspiration) and the hydrological service (run-off, discharge).

Models, validation and Projections

Models and projections data derive from the Coordinated Regional Downscaling Experiment (CORDEX) initiative (Region 5: Africa). The Representative Concentration Pathways (RCP 4.5 and RCP 8.5) were used.

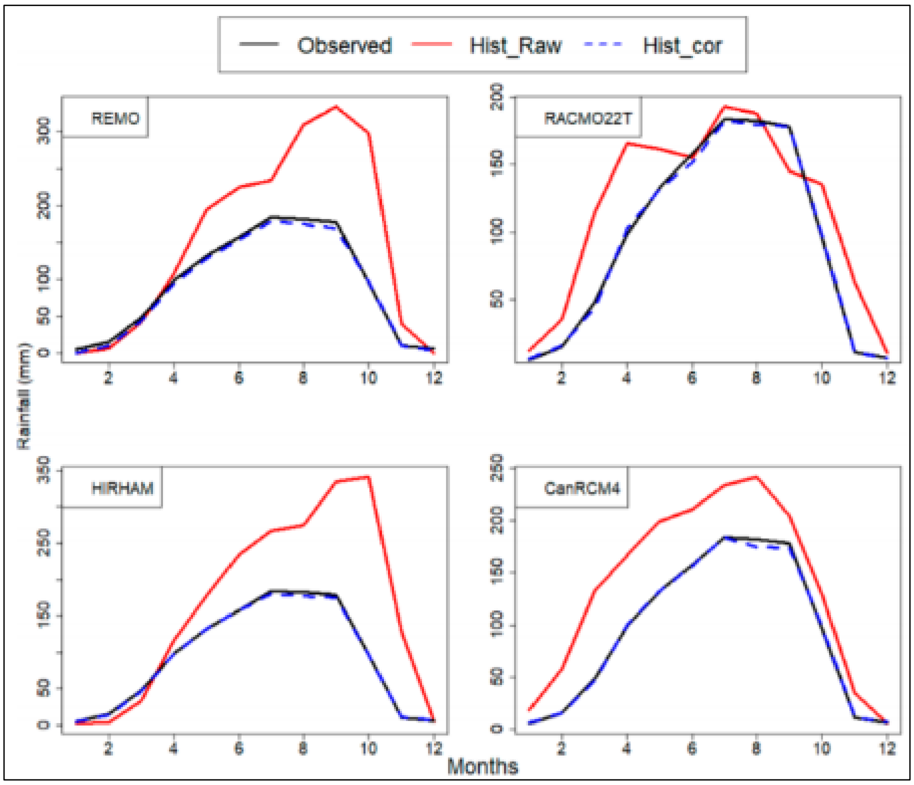
60. Models used for future and current climate simulations were all well evaluated (calibration-validation) to analyse their performances and effectiveness of reproducing the observed trends for Benin context. In the case of the future rainfall and temperature simulations, raw datasets from four GCMs/RCMs (REMO, RACMO22TT, HIRHAM and CanRCM4) were used in their bias-corrected forms. These two types of datasets (raw and bias-corrected) were compared to the historical observed dataset. Figure 14 shows the results from this comparison. In general, bias-corrected datasets better reproduced the observed datasets. Indeed, the agreement between observed and corrected data is confirmed by the efficiency coefficients (KGE and PBIAS) with the results summarized in the figures below (Lawin et al., 2019). Therefore, the bias-corrected datasets were used as well as for subsequent future climate analysis.

61. Also, they are different approaches for bias-correcting climate data, and the performance of a given method depends on the rainfall gauge station and the RCM in used. M'po et al. (2016) compared 6 of these methods to the observed data and to the raw GCMs/RCMs datasets for 8 stations in the Oueme basin out of which the three major stations in concern (Djougou, Save for Glazoue and Zagnanado) are used in this study. In general, the results showed that at daily scale, Delta, Scaling, EQM, AQM reduce the bias of REMO, CRCM, CCLM and RACMO models. In most stations, the AQM method outperformed than the other for correcting the bias of the four RCMs (REMO, RACMO22TT, HIRHAM and CanRCM4). In the specific case of the REMO and in regards to the three main stations used in this study, the EQM method has a successful bias correction than the others and therefore was used in the subsequent simulations, including for the spatial distribution analysis.

[53] Based on FAO approach for climate risk screening, available: http://www.fao.org/3/cb2669en/cb2669en.pdf

62. In the case of the hydrological models SWAT and HEC-HMS models were used, For the SWAT model, the calibration and validation were rated satisfactory based on the performances of the model for streamflow simulations (R2 and NSE mostly higher than 0.5) (Danvi et al., 2018)[54], with an overestimation of discharge that was suspected to relate to the low potential

Figure 14: Comparison of raw and bias corrected rainfall data with observation at seasonal scale over the historical period 1971–2005



evapotranspiration simulated. Before applying the SWAT model, the authors overcame this challenge by computing the potential evapotranspiration outside SWAT model (Danvi et al., 2018). For HEC-HMS model calibration, simulated discharge better reproduces that observed (figure 15[55]) with an efficiency of 0.94 based on the KGE and 7% overestimation based on the PBIAS, while in validation, the efficiency was 0.91 based on the KGE with 1.3% of underestimation of observation (Lawin et al., 2019)[56]. Therefore, the authors confirmed the high performance of the HEC-HMS model for simulating discharge (figure 16) and flow duration (figure 17) over the Ouémé catchment.

63. For the SWAT model, the calibration and validation were rated satisfactory based on the performances of the model for streamflow simulations (R2 and NSE mostly higher than 0.5) (Danvi et al., 2018), with an overestimation of discharge that was suspected to relate to the low potential evapotranspiration simulated. Before applying the SWAT model, the authors

[54] Danvi Alexandre, Simone Giertz, Sander J. Zwart and Bernd Diekkrüger 2018. Rice Intensification in a Changing Environment: Impact on Water Availability in Inland Valley Landscapes in Benin. Water 2018, 10, 74; doi:10.3390/w10010074.

[55] *Lawin et al., 2019*

[56] Lawin A.E., Houngué R., M'Po N. Y., Hounguè N. R., Attogouinon A. and Afouda A.A. 2019. Mid-Century Climate Change Impacts on Ouémé River Discharge at Bonou Outlet (Benin). Hydrology 2019, 6, 72; doi:10.3390/hydrology6030072.

overcame this challenge by computing the potential evapotranspiration outside SWAT model (Danvi et al., 2018).

Figure 15: Rainfall intensity for validation period 1994-2005 as observed (black) and simulated raw (red) by REMO and corrected using Delta approach (yellow), Scaling(blue), AQM (green), EQM(cyan) GQM(magenta) and GPQM (blue dash) for the three stations in Ouémé

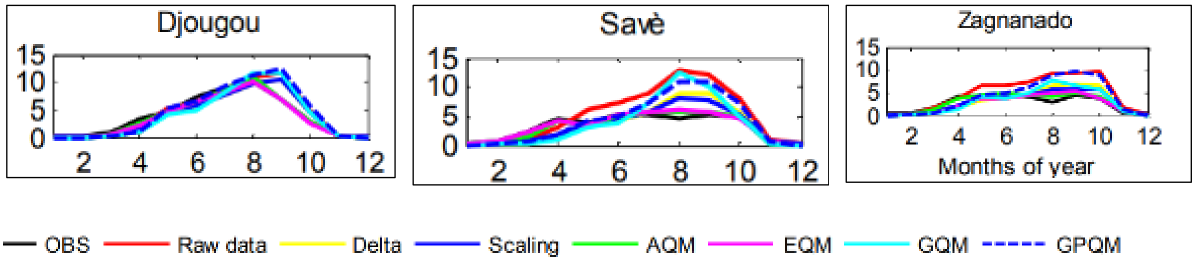
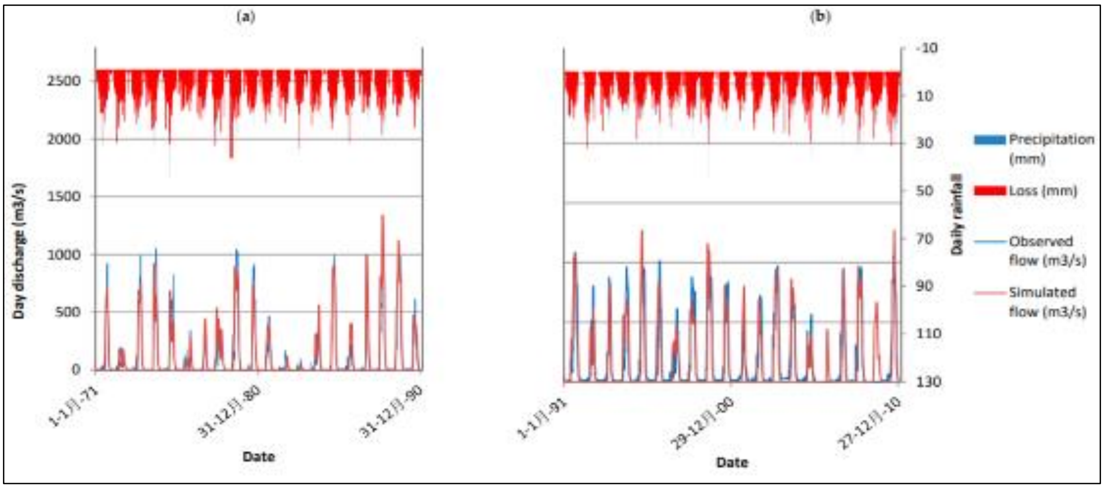
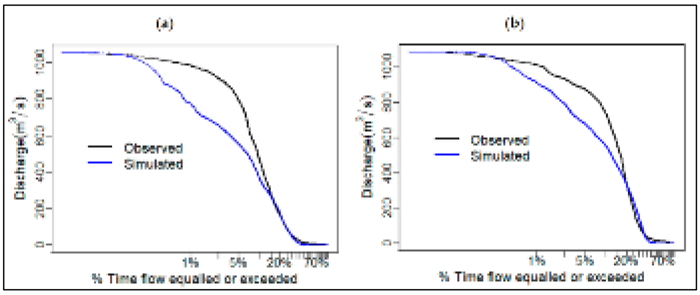


Figure 16: HEC-HMS Hydrological model calibration from 1971–1990 (a) and validation over 1991–2010 (b)



Model Calibration-Validation for HEC-HMS model, Observations (1971-2005) data
Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44).*
Period: *Past (1971-2005) and future (2020-2050)*
Source graph: *Lawin et al., 2019*

Figure 17: Flow duration of daily observed and simulated discharge in calibration over 1971–1990 (a) and validation over 1991–2010 (b), HEC-HMS hydrological model

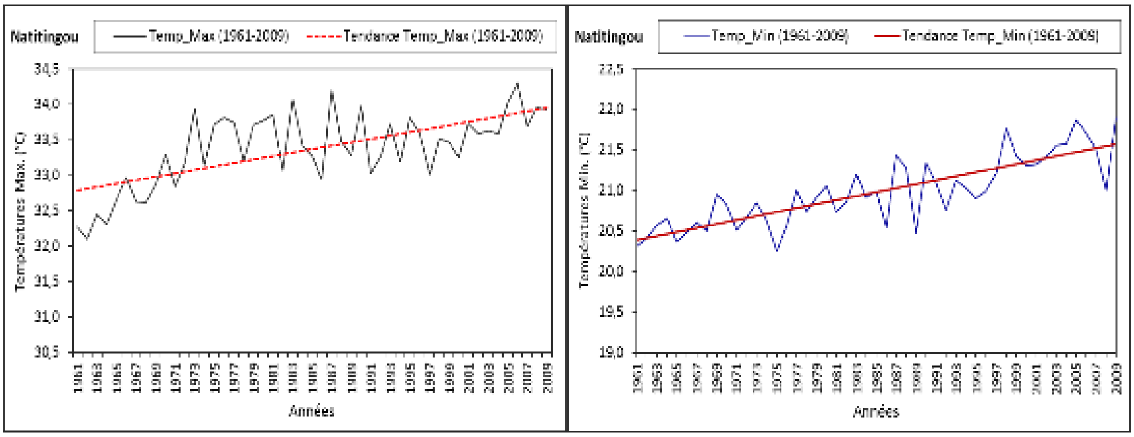


Observations (1971-2005) data
Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44)*
Period: *Past (1971-2005)*
Source graph: *Lawin et al., 2019*

3.1 Historical trends in temperature

64. The mean annual temperature in Benin has increased by 1 ˚C since 1995. Changes in temperature have been higher in the northern parts of the country than in the rest. This includes the **Upper Ouémé Basin**, where the trends in maximum and minimum temperatures over the last forty years in the synoptic station (Natitingou – Figure 18) show that temperatures have steadily increased. The observed increase average is 0.96 ° C. Maximum temperatures have risen from 32.1° C to 34.3° C, with an overall increase of 2.2° C, and minimum temperatures increased from 20.3 ° C to 21.9 ° C, with overall increase of 1.6° C over the period 1961 to 2009 (Figure 18).

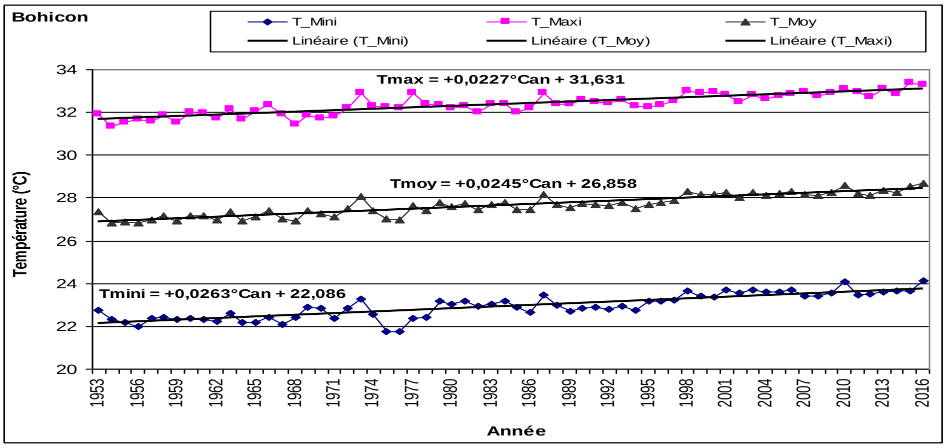
Figure 18: Annual temperature trend at Djougou and Copargo, in the Upper Ouémé Basin



65. In the Middle Oueme, the analysis of observed thermal values trends (maximum, mean and minimum) over the last sixty years at the synoptic station (Bohicon. -Figure 19), indicates an overall trend of increasing temperatures. Between 1953 and 2016, the maximum temperatures increased from 31.8 to 33.23° C, showing an increase of 1.40° C; and the minimums ranged from 21.5 to 24 ° C, with an increase of 2.5 ° C. Moreover, analysis of the decennial mean variability of average temperature values which allow better observation of warming trend shows that the tendency of thermal warming is unequivocal. The most relevant increases began in the 1970s and continued steadily until the 2000s (Figure 20).

66. Overall, in the Middle Oueme, the analysis of observed thermal values trends (maximum, mean and minimum) over the last sixty years, indicates an overall increasing temperature trend of 0.025°C/year (linear regression). In the Upper Oueme Basin, a higher temperature increasing trend of 0.039°C/year was observed over the last forty years in the synoptic station
67. Changes in temperature parameters (heat and cold/harmattan) is also perceived by farmers in all the five communes of the Oueme basin[57]. According to the respondents, temperature has increased during dry seasons, leading to more frequent and severe heat waves and drought than historically observed. The respondents confirmed that the temperature has increased between 1 and 3° C in all the communes but with higher temperatures in Copargo and Djougou (Upper Oueme), followed by Glazoue, then Zogbodomey and Zagnanado (Middle Oueme – see Figure 21).

Figure 19: Annual temperature trend in the project areas in the Middle of Ouémé (Zogbodomey and Zagnanado)



68. Benin has 6 synoptic stations, with 3 falling within or very close to the Upper and Middle Oueme area: Parakou, Save, Bohicon and Natitingou. All the communes/municipalities of OCRI intervention have at least one precipitation weather station from where the observed rainfall data were collected from. For others parameters such as Tmin, Tmax and PET, observed data were taken from the closest synoptic weather stations in a range of (15-60 km). For Copargo and Djougou' data were taken from Natitingou synoptic station (about 60 km and 30 km respectively); for Zagnanado we used Bohicon synoptic station data (about 25 km); for Glazoue, we used Save synoptic station data (about 15 km). Please see map of synoptic stations (fig 20.)

Figure 20: Map of synoptic stations

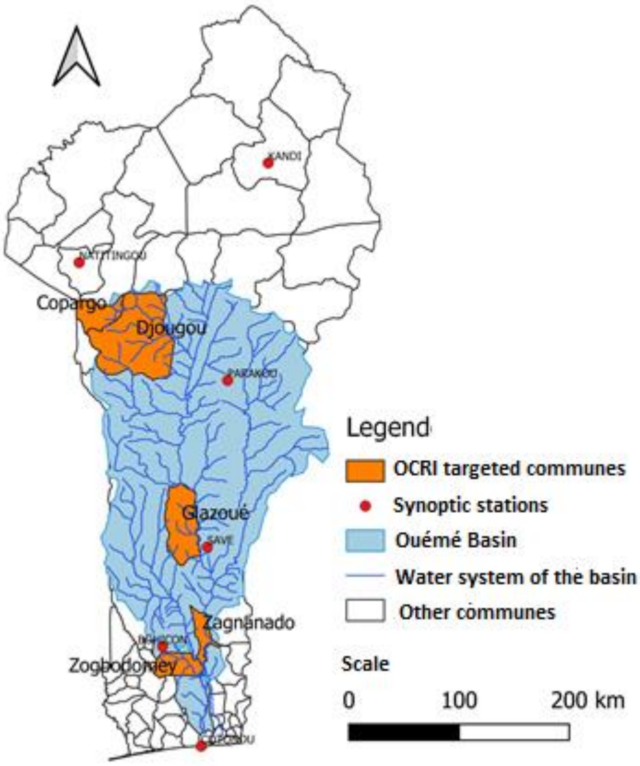
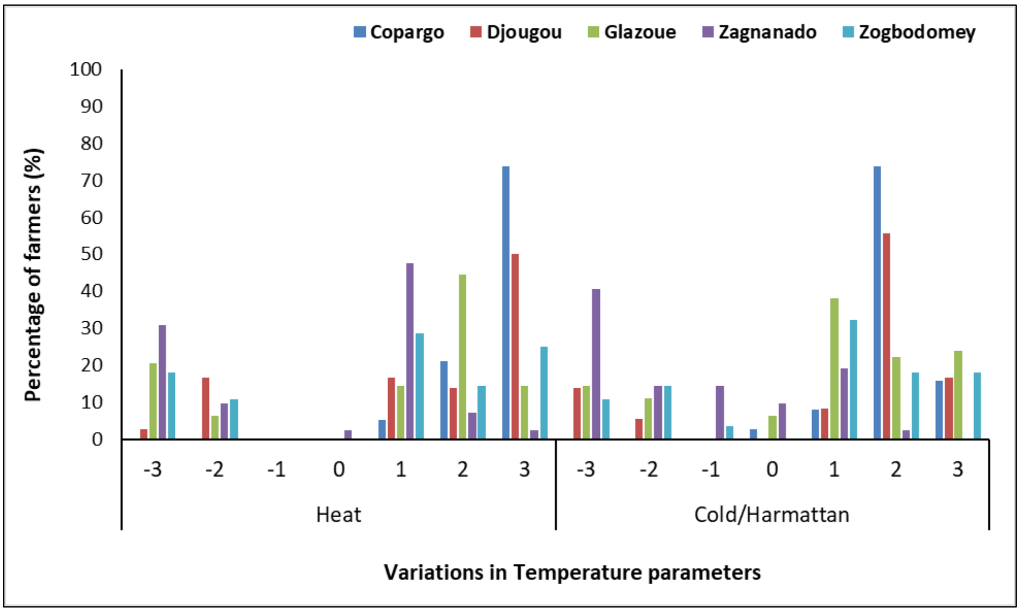


Figure 21: Farmers perceptions on the changes in temperature parameters[57]



69. In agreement with scientific trend analysis, evidences were extensively provided by farmers[57] on how progressively the climate has changed.

Table 1: Farmers stories on how the climate has changed overs the Oueme basin

Evidences	Farmers	Localities	Sub-basin
"Before, the rains were regular and we had very good harvests. But from about 25 years ago, I noticed that the rains are getting more and more odd and unpredictable. Sometimes they start very late, sometimes they start well but stops early. Two years ago I did market gardening and there was no rain until April, then some rain came and then nothing until September, I harvested nothing."	A.H., Corn, vegetable crops farmer (male)	Zonmon , ZAGNANADO	Middle Ouémé
"12-13 years ago the rains became uncertain. Some years there is flooding, some years it is drought and hot temperatures. Last year (2021), there was a drought and in the same season there was a flood in September"	A.M., Corn, rice farmer (male)	Zounnon , Dovi , ZAGNANADO	
"In 2016 we made corn, but there was a long spell of drought and we harvested almost nothing."	M.C., market gardening farmers (male)	Cana2, ZOGBODOME Y	
"Seven (07) years ago (2015), we had only six (06) rains during the months of February until May, all our crops dried up in the fields, we lost all our crops."	B. A., Maize farmer (male)	Aklamkpa , GLAZOUE	
"Before, when I was young (like twenty years back) we sowed here in Aklamkpa (Glazoué) in February, March at most. Now we have to wait until April or May or move closer to the lowlands to sow early, but the big risk is that the floods very quickly drown the crops towards the end of the season."	B.A. Maize farmer (male)	Aklamkpa , GLAZOUE	
"We had two rainy seasons, gradually over the past fifteen years they have been reduced to just one with the delay in the first rains and the early ending of the season."	D. L., Cereals farmer (male)	Gotho , Wèdèmè , (GLAZOUÉ)	
"More than twenty years ago (20), the rains began in the fourth month (April). Gradually and from year to year they began to come late so that currently we have the first rains in the fifth (May) and even sixth month (June). In addition to this, the drought spells follow the late onset of the rains. What is even more serious is that the rains cease quickly in September whereas they fell until October in the past."	A. R, Corn, cashew, market gardening farmer (female)	Foumbéa , Kolokonde , DJOUGOU	Upper Ouémé
"When I was little in the 2000s, the wetlands (inland-valleys) remained wet until February. Gradually, this has receded and our inland-valleys are already drying up in December. All this hampers our vegetable production"	B. I., orn, market gardening farmer	Dangoussar , DJOUGOU	

3.2 Historical trends in precipitation

70. In the country as a whole, a general trend towards a decrease in annual rainfall and a shortening of rainfall events can already be observed[58]. The analysis of the interannual variability of rainfall observed during the period 1951-2010 and 1980-2016 in Benin reveals

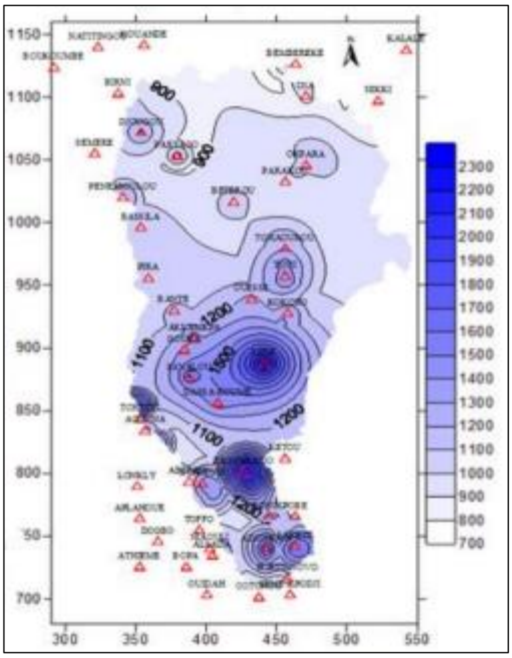
[57] Akponikpè PBI (2022) Climate change and Environmental Impact study in the Oueme-basin (Benin): Update of literature and Analysis of the perceptions of climate change and farmers adaptive strategies. FAO Consultancy report, Fev-March 2022.

[58] Diagnostic de l'environnement institutionnel national relatif aux changements climatiques et à l'AIC, Bokonon-Ganta Bonaventure Eustache, Cotonou, février 2017.

periods of deficit alternating with a few surplus years[59]. Overall, since the end of the 1960s climate perturbations have increased in Benin, which has manifested in reduced annual amplitude of rains by 180 mm[60]. The annual count of wet days as well as the annual maximum 30-day total rainfall showed a substantial decrease over the 1960-2000 period.

71. The historical (1963-2000) analysis of the Simple precipitation intensity index (SDII) from the CLIMDEX database (https://www.climdex.org/access/) shows that the SDII varies in average from 13 to 16 mm/year in the Upper part of the basin (Djougou), from 13-15 mm/year for Glazoue and from 13-15 mm/year for the middle part of the basin. In general, the historical trend of the SDII is not fix and show a sinusoidal pattern. M'po et al. (2017) found no trend of the SDII over the Oueme basin, except at the Bonou outlet (lower basin) and other few stations where an increasing trend is observed, while much decreasing trends of the annual total precipitation (PRCPTOT) in the basin is observed (fig. 22-27).

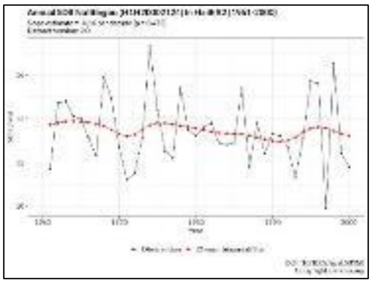
Figure 22: Spatio-temporal variability of the annual rainfall over the Oueme basin



59 Second National Communication Benin, 2011; Third National Communication Benin, 2019

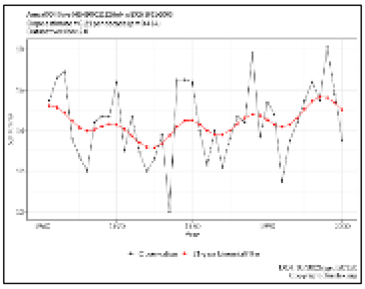
60 UNDP; Beninese Ministry of Environment and Nature Protection (2008): Convention-cadre des Nations Unies sur les changements climatiques (PANA-Benin).

Figure 23: Evolution of the simple precipitation intensity index (SDII) in Copargo/Djougou, based on Natitingou Synoptic station (Upper Oueme)



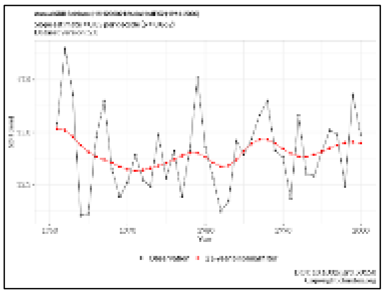
Source of data: *CLIMDEX HadEX2*
Period: *1963-2000*
Source graph: *Climdex.org*

Figure 24: Evolution of the simple precipitation intensity index (SDII) at Glazoue, based on Save Synoptic station (Upper Oueme)



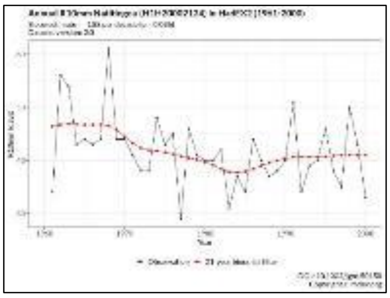
Source of data: *CLIMDEX HadEX2*
Period: *1963-2000*
Source graph: *Climdex.org*

Figure 25: Evolution of the simple precipitation intensity index (SDII) at Bohicon (Middle Oueme)



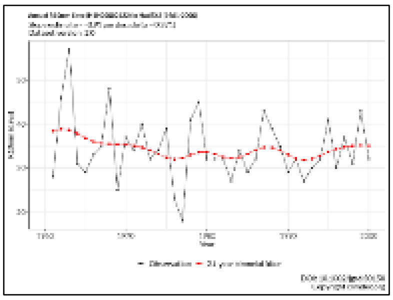
Source of data: *CLIMDEX HadEX2*
Period: *1963-2000*
Source graph: *Climdex.org*

Figure 26: Evolution of the annual count of days when precipitation PRCP ≥ 10 mm (R10mm) in Copargo/Djougou, based on Natitingou Synoptic station (Upper Oueme)



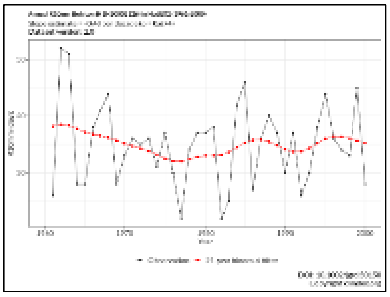
Source of data: *CLIMDEX HadEX2*
Period: *1963-2000*
Source graph: *Climdex.org*

Figure 27: Evolution of the annual count of days when precipitation PRCP ≥ 10 mm (R10mm) at Glazoue, based on Save Synoptic station (Upper Oueme)



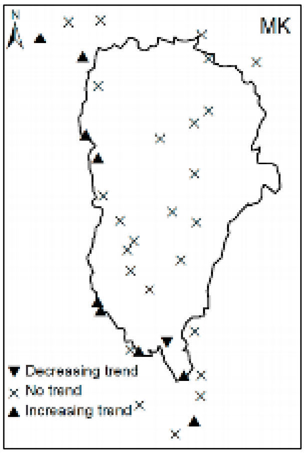
Source of data: *CLIMDEX HadEX2*
Period: *1963-2000*
Source graph: *Climdex.org*

Figure 28: Evolution of the annual count of days when precipitation PRCP ≥ 10 mm (R10mm) at Bohicon (Middle Oueme)

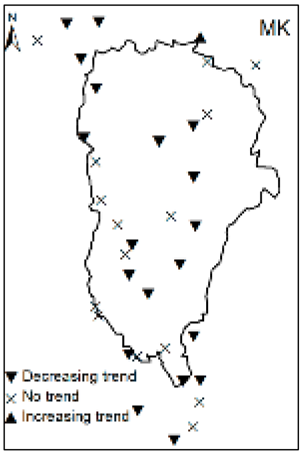


Source of data: *CLIMDEX HadEX2*
Period: *1963-2000*
Source graph: *Climdex.org*

Figure 29: Spatial distribution of the observed (1950–2014) simple precipitation intensity index (SDII) over the Oueme Basin (left) and of the observed (1950–2014) annual total precipitation (PRCPTOT) over the Oueme Basin (right). Trends detected using Mann-Kenda



Source of data: *Observed climate data from Benin Meteo*
Period: *1950-2014*
Source graph : *M'po et al. 2017*



Source of data: *Observed climate data from Benin Meteo*
Period: *1950-2014*
Source graph : *M'po et al. 2017*

3.3 Historical trends in dry spells, evapotranspiration, run-off and flooding

72. In Benin, an observed increased frequency of climate extremes since 1951, has caused more frequent droughts and flooding[61]. Droughts have intensified, particularly in 1970-1980s, and rains have intensified by 100 mm/h enhancing soil erosion and intensifying the impacts of floods[62]. In particular, erratic violent rains increase the frequency and magnitude of flash floods with significant losses and damages. The increased frequency of extreme weather events in Benin has negatively impacted livelihoods and damaged infrastructure. Indeed, the years 1985, 1988, 1991, 1995, 1997, 2008, 2009, 2010, 2012, 2013 and 2019 were characterized by major floods: the 2010 floods have been particularly devastating given their spatial extent (55 communes affected out of the 77 of the country) and the number of people affected (680,000 people). This depicts a highly increased flooding frequency reaching one flooding event every three years during the last three decades.

73. In the upper valley, Olivier et al. (2017)[63] on the basis of a frequency analysis of the flows of the Oueme at Béterou showed that the maximum rains responsible for the frequent floods are rain events with a return period greater than five years, with amount values greater than 39.2 mm. The corresponding flows are of the order of 459 and 628 m3/s.

[61] Project GCP/GLO/207/ITA, Project for the Strengthening of National Capacities for Monitoring Water Resources with a Focus on Agricultural Management, 2009

[62] UNDP; Beninese Ministry of Environment and Nature Protection (2008)

[63] Olivier, K., Wilfrid, V. E., & Jean-Marie, D. Caractérisation Des Risques Hydroclimatiques Dans Le Bassin Versant De L'Ouémé A L'exutoire De Bétérou Au Bénin (Afrique De L'ouest). European Scientific Journal May 2017 edition Vol.13, No.15 p 101-118

74. In the middle valley, the recurrent floods observed are caused by maximum daily rainfall amounts between 25.0 and 38.2 mm with respective return periods of 2 years and 3 years. Similarly, the frequent river floods are caused by floods with peak flows between 746 and 1160 m3/s, i.e. flows with return periods between 2 and 5 years[64].

Fig 29 Fitting of the Gumbel's law to daily maximum flows in Beterou (Upper Oueme)[65]

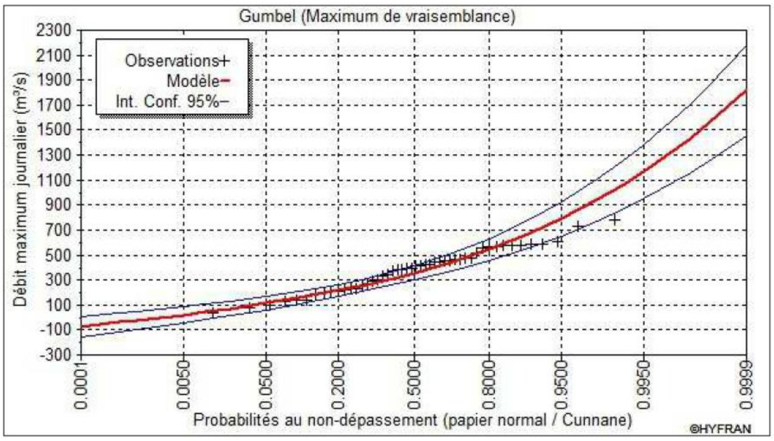
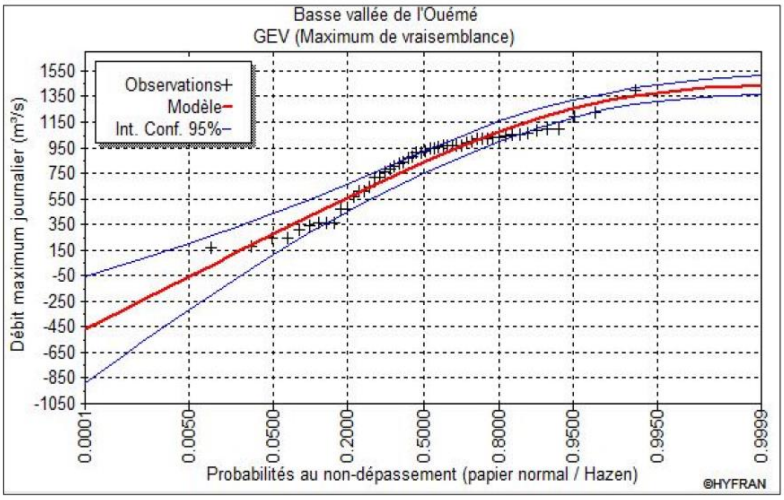


Fig 30 Fitting of the Generalized Extreme Value or GEV to daily maximum flows in Bonou (Lower/Middle Oueme)[66]



64 Seidou, S., Ouassa, P., Atchade, G. A., & Vissin, e. W. (2021). Caracterisation Des Risques Hydroclimatiques Dans La Basse Vallee De L'Oueme Au Benin (Afrique De L'Ouest). *International Journal of Progressive Sciences and Technologies*, *25*(2), 334-348.

65 Olivier, K., Wilfrid, V. E., & Jean-Marie, D. Caractérisation Des Risques Hydroclimatiques Dans Le Bassin Versant De L'Ouémé A L'exutoire De Bétérou Au Bénin (Afrique De L'ouest). European Scientific Journal May 2017 edition Vol.13, No.15 p 101-118

66 Seidou, S., Ouassa, P., Atchade, G. A., & Vissin, e. W. (2021). Caracterisation Des Risques Hydroclimatiques Dans La Basse Vallee De L'Oueme Au Benin (Afrique De L'Ouest). International Journal of Progressive Sciences and Technologies, 25(2), 334-348.

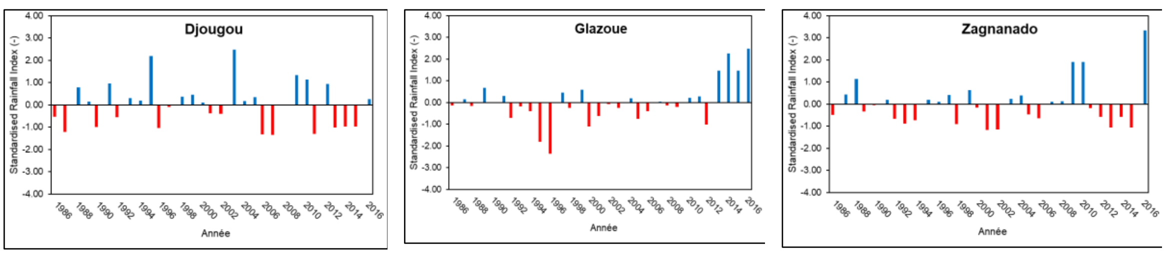
75. In economic terms, the impact of the 2010 floods was estimated at more than 127 billion CFA francs and a decline in the GDP growth rate of around 0.8 points (Benin, 2011). It is estimated that the **floods resulted in a drop of the GDP growth rate of around 0.8 points**[67].

Dry spell periods

76. The historical (1986-2016) rainfall data were analysed for three different locations/regions of the basin: (i) Djougou (Upper Oueme), (ii) Glazoue (upper Oueme) and (iii) Zagnanado (middle Oueme). Rainfall anomalies (Standardised Rainfall Index, SRI) for these locations were calculated. In agro-climatology, a positive SRI indicates a wet or humid year or period, while a negative SRI, indicates a dry period. The severity of the drought or wetness can also be classified, such that: -1<SRI<0 is equivalent to moderate drought period, -2<SRI<-1 to a high drought period and SRI≤-2 is equivalent to extreme drought period. The analysis reveals that about 50% (15-17 over 31) of the years were found to be dry in all the three regions. Glazoue (south upper Oueme basin) was found to have the highest number of dry years and the lowest SRI (hottest year). In general, all the three regions shared at least 1992, 1996, 2000, 2002, 2006 and 2006 as dry years (fig. 31).

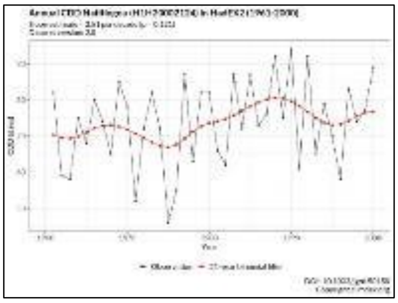
77. The historical (1963-2000) analysis of the consecutive dry days from the CLIMDEX database (https://www.climdex.org/access/) shows that the CDD varies in average from 62 to 75 days in a year in the northern Upper oueme (Djougou-Natitingou), from 42-57 days/year for the south upper oueme (Glaoue-Save) and from 54-62 days/year for the middle basin (Zagnanado-Bohicon). Additionally, M'po et al. (2017) analysed historical and future spatial distribution of the Consecutive Dry days (CDD) and the Consecutive Wet days (CWD) over the Oueme basin. The authors observed an increasing trend of the past CDD trend in the south-east and an increasing trend in the Ouest. The future did not show any trend under the RCP. 4.5 scenario, while an increasing CDD trend will be observed in the future according to the RCP. 8.5. In opposite, a decreasing trend of the CWD will be observed in the future under that same RCP. 8.5 (fig. 32-36).

Figure 31: Rainfall anomalies in the Oueme basin based on observed data from Meteo-Benin. Upper Oueme (Djougou on the left; Glazoue in the center, based on observed data from Dassa, the closest synoptic station) and middle Oueme (Zagnanado on the right).



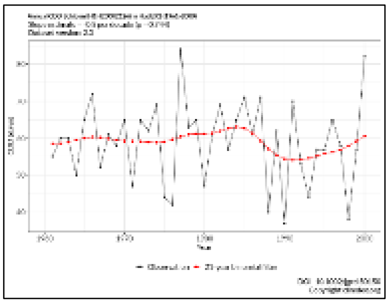
67 UNDP ; Beninese Minitry of Developement and economic analysis 2014 https://info.undp.org/docs/pdc/Documents/BEN/SAP%20Rapport_Provisoire_cc_ressources_eau.pdf

Figure32 : Evolution of the consecutive dry days (CDD) index in Natitingou synoptic station near Djougou (North Upper Oueme)



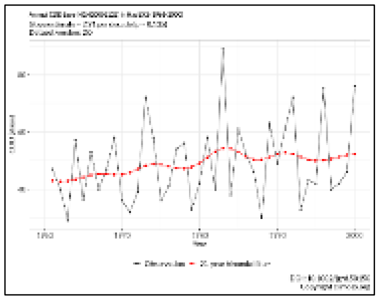
Source of data: CLIMDEX HadEX2
Period: 1963-2000
Source graph: Climdex.org

Figure33 : Evolution of the consecutive dry days (CDD) index at Save synoptic station, near Glazoue (South Upper Oueme)



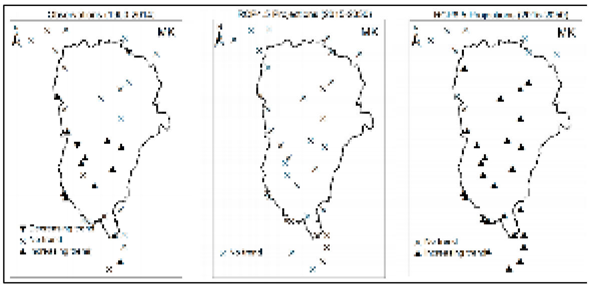
Source of data: CLIMDEX HadEX2
Period: 1963-2000
Source graph: Climdex.org

Figure34: Evolution of the consecutive dry days (CDD) index at Bohicon synoptic station, near Zagnanado (Middle Oueme)



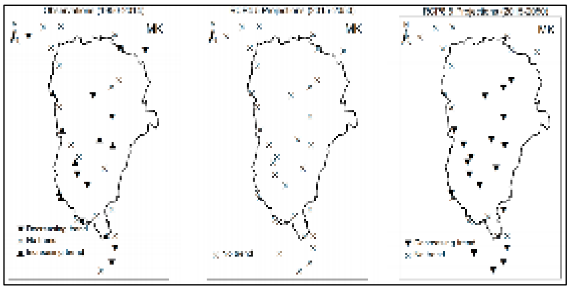
Source of data: CLIMDEX HadEX2
Period: 1963-2000
Source graph: Climdex.org

Figure 30: Spatial distribution of the past (1950-2014) and future (2015-2050) consecutive dry days (CDD), over the Oueme basin.



Source of data: *Simulated climate data using the regional climate model REMO, forced with data from MPI-ESM-LR (GCM). REMO data available in the CORDEX for Africa at 0.44^0 resolution.*
Period: *past (1950-2014), future (2015-2050)*
Source graph : *M'po et al. 2017*

Figure 36: Spatial distribution of the past (1950-2014) future (2015-2050) consecutive wet days (CWD) over the Oueme basin.



Source of data: *Simulated climate data using the regional climate model REMO, forced with data from MPI-ESM-LR (GCM). REMO data available in the CORDEX for Africa at 0.44^0 resolution.*
Period: *past (1950-2014), future (2015-2050)*
Source graph : *M'po et al. 2017*

Runoff and evapotranspiration

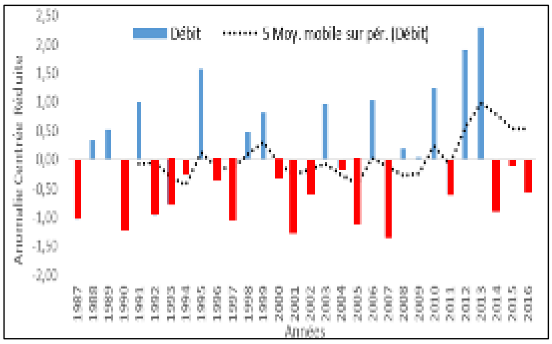
78. Danvi et al. (2018) analysed the water balance of the Oueme basin in three different sub-catchment (Kounga, Tossahou and Kpandouga) located around Djougou (Upper Oueme), using historical data (1985–2003) under the SWAT model. The authors found the highest evapotranspiration to be 832 mm, while the highest surface runoff was around 125 mm per year.

79. In the project intervention area, there is a more arid climate, with frequent late rains and heavy rains, long periods of heat, and prolonged periods of drought[68]. The Upper Ouémé Bassin is affected by more irregular rainfall with an increase in climate events such as torrential rains. In downstream Glazoué, the growing seasons are reduced from two seasons to one season per year; in which crops are regularly destroyed by floods caused by extreme rainfall events.

Water resources

80. Analysis of the inflow water anomalies in the lower Oueme showed high variations with the extreme negative observed in 1990, 1997 and 2007, and the extreme positive ones in 1995, 2012 and 2013 (fig. 37).

Figure 37 : Anomalies of the inflow water rates at the Oueme basin (lower basin).



Source of data: Historical data from Benin-Meteo
Period: 1987 to 2016
Source of graph: Cocker et al., 2019

3.4 Future trends in temperature

81. The Upper and Middle Ouémé Basin have experienced steady increase in temperatures since the 1960s; and this trend will continue under climate change conditions. Climate projection models in Benin predict an increase in the maximum normal temperature for the whole country, ranging from 1-1.5 ° C to 2.5-5.0 ° C. The average annual temperature is forecast to increase from 1.0 ° C to 3.0 ° C by the 2060s and from 1.5 to 5.1 ° C for the 2090s. The magnitude of projections for the 2090s in all the emission scenarios are of the order of 2.0-

[68] INE (2018), "Analyse de la vulnérabilité et de l'adaptation au changement climatique des communautés et agroécosystèmes aux variations actuelles du climat et aux phénomènes météorologiques extrêmes", Rapport Final, 80p.

2.5 ° C. According to Essou and Brissette[69], all models for the months of April to November and in all greenhouse gas emissions scenarios considered, the monthly distribution of temperature change factors shows a general upward trend by about 1 to 3°C for daily temperatures for the 2035- 2064 periods[70]. For the 2070-2099 period, all the models predict a rise in temperatures from 1 to 5°C. It is indicated a general upward trend in daily temperatures, of 1 to 3°C for the 2035- 2064 period, and 1 to 5°C for the 2070-2099 period, with higher temperatures affecting the Upper Ouémé area .

82. Kodja et al. (2019)[71] analysed the future trends (2021-2080) of temperature as compared to the historical trends (1981-2010) in the Oueme basin at two outlets/stations (Bonou, the Lower Oueme and Beterou, Upper Oueme). As reported by the authors, the future data were obtained from the CORDEX program, using two RCMs (MPI-M and MIROC). The changes in temperature are shown in Figure 38-39.
83. According to them, temperature over the Oueme basin will increase over the 21st century and will be persistent from year to year. In general, during that period, the average temperature will increase by 1.5 degree, the minimum temperature by 1.4 and the maximum temperature by 1.7 degree compared to the baseline period (1981-2010). Average long-term monthly mean temperature comparison shows that the hottest month in the future (2021-2080) are May and August for both stations (figure 38-39).

Figure 3138: Projected changes average temperature (°C) from the reference period (1981- 2010) to future periods (FP1=2021-2050, FP2= 2031-2060, FP3= 2041-2070, and FP4= 2051-2080) at Bonou.

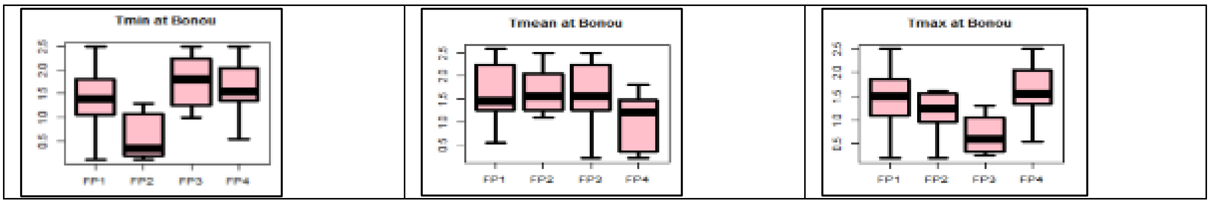


Figure39 : Projected changes average temperature (°C) from the reference period (1981- 2010) to future periods (FP1=2021-2050, FP2= 2031-2060, FP3= 2041-2070, and FP4= 2051-2080) at Beterou

[69] Gilles RC Essou and Francois Brissette, 2013, ''Climate Change Impacts on the Ouémé River, Benin, West Africa''

[70] That was also the case for the months of December to March, with the exception of a very slight decrease (less than 1°C) forecast for December, February and March by a single model, and by 1°C to 2°C forecast for January by just two models (Essou and Brisette 2013).

[71] Kodja D.J., Batablinle L., Akognongbe A., Amoussou E., Mahe G., Vissin E.W., Paturel J.E., Houdenou C. (2019) Rainfall and temperature changes in Oueme watershed by 2080 in West Africa. in Climatic Change, Variability and Climatic Risks XXXIIème Colloque Internationale de l'AIC Thessaloniki - Grèce 29 mai au 1 juin 2019

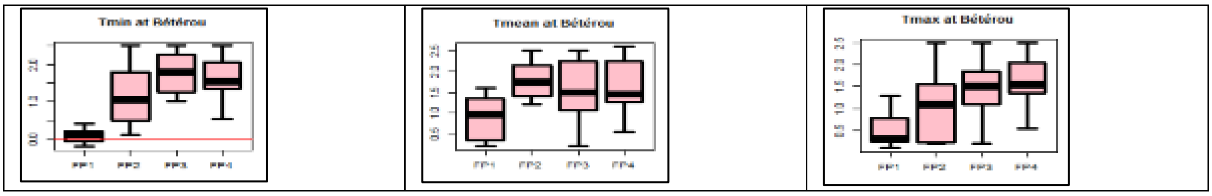
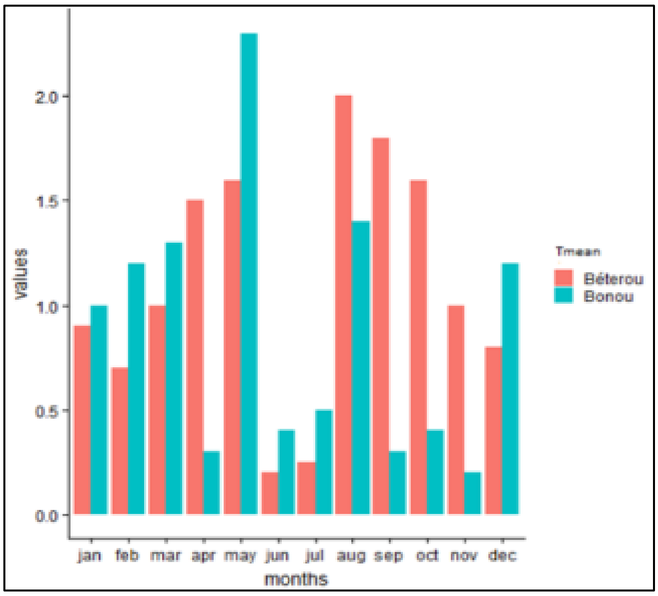
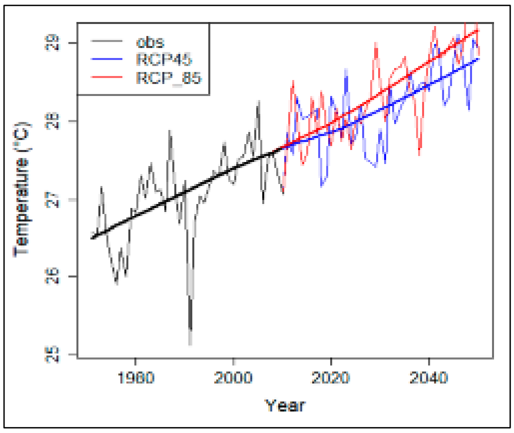


Figure 3240: Projected changes average temperature (°C) for each calendar month from the reference period (1961-2010) to (2021-2080).



84. These same tends were found by Lawin et al. (2019). The authors concluded that there will be a significant general increasing of the average temperature, 0.04 ◦C and 0.05 ◦C for RCP 4.5 and RCP 8.5, respectively, in the future (2020-2050) compared to the baseline (1971-2005).

Figure 41: Variation of the annual temperature from observations (1971-2005) to projections (2020-2050) based on the Representative Concentration Pathways RCP 4.5 and 8.5, using MPI-ESM-LR/REMO2009, ICHEC-EC-EARTH/ RACMO22T, CCCma-CanESM2_CCCma/ CanRCM4 and NCC



Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44).*
Period: *Past (1971-2005) and future (2020-2050)*
Source graph: *Lawin et al., 2019*

85. **A more recent study (2013) indicates a general upward trend in daily temperatures, of 1 to 3°C for the 2035- 2064 period, and 1 to 5°C for the 2070-2099 period, with higher temperatures affecting the Upper Ouémé area[72].**

3.5 Future trends in precipitation

86. A comparison of average monthly precipitation between the 1985-2014 and 2018-2050 periods based on the RCP4.5 scenario in the Upper and Middle Ouémé Basin indicates decreases in rainfall covering periods of two to three months over the start of the raining periods (main rainfall season; and short rainfall season for the part of Middle Ouémé with a bimodal regime). An analysis of daily values indicates that these observed declines would result both from a decrease in the amounts of rainfall in the months in which the rains start (especially for the short rainy season), but also from a delay in their appearance. In contrast to the start of the rains, the mid-season and the end of the rainy season show a significant increase in the amount of rainfall (Table 2).

[72] Gilles RC Essou and Francois Brissette, 2013, ''Climate Change Impacts on the Ouémé River, Benin, West Africa''

Table 2: Variability of average rainfall patterns in Benin between the 1985-2014 and 2018-2050 periods (future projection obtained from the RCP4.5 scenario); (significance of the results at thresholds of 5% according to the Student's Test).

	Dec	Jan	Fev	Mar	Avr	Mai	Jun	Jui	Aou	Sep	Oct	Nov
Copargo	-	-	-	-	-	-	-	-	-	+	+	-
Djougou	-	-	-	-	-	-	-	-	-	+	+	-
Glazouè	-	-	-	-	-	-	-	+	+	+	+	+
Zagnanado	-	-	-	-	-	-	-	-	+	+	+	+
Zogbodomey	-	-	-	-	-	-	-	-	+	+	+	-

87. A rainfall deficit is also observed during the month of the start of the short rainy season. Observations made in the transition zone between the northern climatic region and the southern climatic region of Benin since the beginning of the 2000s, indicate the gradual disappearance of the short rainfall/cropping season because of the deficits rain in March-April, which would affect the Middle Ouémé Basin.

88. In the general case, the variation in annual rainfall increases from 0.5% in 2005 to 5.73% in 2100. These data show the sensitivity of these areas to increasing water scarcity due to reduced rainfall.

Table 3: Average annual rainfall anomaly projected from 2000 to 2100

Région Centre Ouest (Copargo, Djougou)									
Year	**1971-2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2050**	**2075**	**2100**
Variations (%)		0,5	0,52	0,59	0,68	0,93	2,2	3,12	5,75
Rainfall in mm	1100	1106	1106	1106	1107	1110	1124	1134	1163

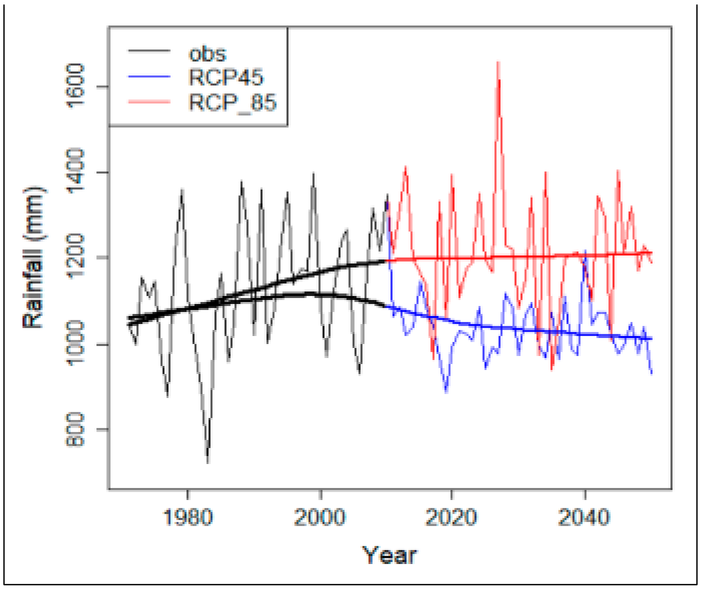
89. In the South, five-year variations in rainfall should not exceed 0.2%, implying a practically invariable annual rainfall by 2100. On a monthly scale, the greatest variations will be observed in the South East, with a decrease of up to 21% in April by 2100. Until 2050, rainfall differences between March and April are expected to increase, forcing farmers to adapt their practices by shifting cultivation to April or May. In addition to the increase in monthly or seasonal precipitation, climate change also leads to a shortening of the rainy seasons and therefore an increase in daily rainfall during this period followed by longer periods of drought. Precipitation disruptions are the cause of the observed climate risks with the greatest impact in the middle valley, which are flooding, long droughts, dry spells, late rains and heavy rains.

Table 4: Average annual rainfall anomalies projected from 2000 to 2100

South-east region (Zagnanado, Zogbodomey)									
Year	**1971-2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2050**	**2075**	**2100**
Variation (%)		- 0,31	-0,68	-1,02	-1,36	-1,35	0,35	2,87	3,57
Rainfall (mm)	1236	1232	1228	1223	1219	1219	1240	1271	1280

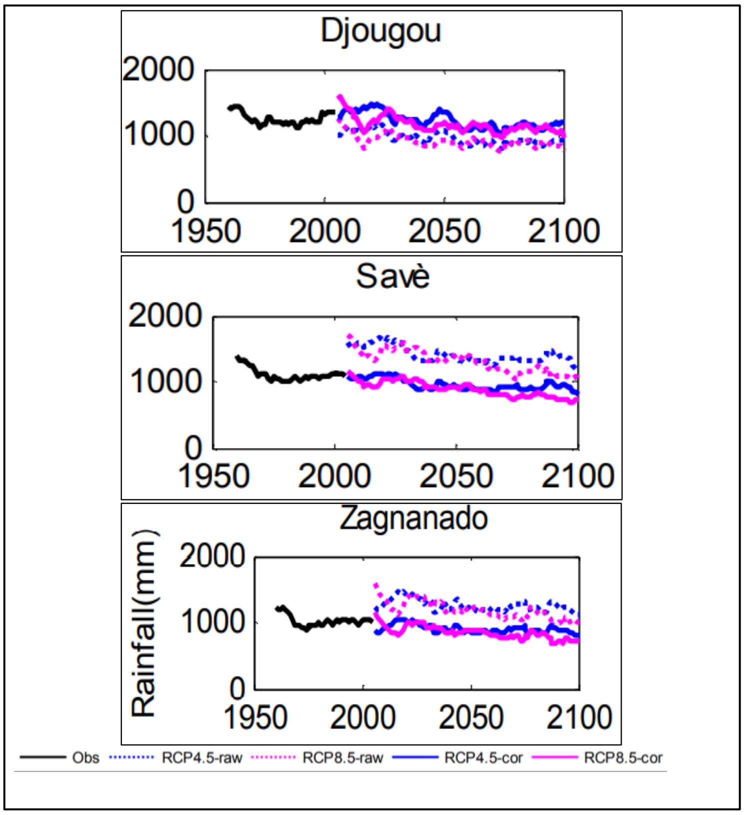
90. Another analysis of the future climate (2020-2050) by Lawin et al., 2019 in the Oueme basin confirmed that in general, under the RCP 4.5 projection scenario, rainfall is projected to decrease by 1.33 mm, whereas no clear trend was found for RCP 8.5 scenario. (fig. 42). Accordingly, analysis of the future (2015-2050) climate events by M'po et al. (2017), also showed a significant declining in the number of rainfall events in most stations of the basin) following RCP8.5 scenario. M'po et al., (2016) also found decreasing trends of rainfall for most stations on the Oueme basin (Djougou and Glazoue-Save for upper Oueme and Zagnanado for middle Oueme) (Fig 43,)), using the CCLM model. Moreover extreme rainfall is expected to increase in the southern stations on the basin for RCP 4.5.

Figure 42: Variation of the average annual rainfall from observations (1971-2005) to projections (2020-2050) based on the Representative Concentration Pathways RCP 4.5 and 8.5, using MPI-ESM-LR/REMO2009, ICHEC-EC-EARTH/ RACMO22T, CCCma-CanESM2_CCCma/ CanRCM4



Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44).*
Period: *Past (1971-2005) and future (2020-2050)*
Source graph: *Lawin et al., 2019*

Figure 3343: Annual precipitation trend for the period 2006-2100 as predicted by the CCLM model in the Oueme basin (M'Po et al., 2016)



91. Overall climate change impacts in the Upper and Middle Ouémé are very similar. Projections in both areas indicate a general upward trend in daily temperatures, of 1 to 3°C for the 2035-2064 period, and 1 to 5°C for the 2070-2099 period[73]. Higher temperatures and more frequent heat stresses [74], which will especially be felt in Upper Ouémé, will result in higher evapotranspiration, and disrupt the water balance of the basin, leading to a reduction of water flow in the Ouémé River, from upstream to downstream areas.

92. With regards to precipitations, there are uncertainties with regards to changes in annual amount of precipitation. However, several studies indicate that the single rainfall season, which takes place between March/April to November in the Upper and Middle Ouémé, will become shorter, and the dry season longer. Indeed, although at the annual and seasonal scale, climate models have not provided significant predictions, an analysis of average monthly precipitations, based on the RCP4.5 scenario, show a decrease in rainfall during the two-three months corresponding to the start of the main rainy season. In addition to this, in the Middle Ouémé[75] models indicate a decrease of precipitation in the months corresponding to the start of the short rainy season. Another study from Essou and Brisette (2013)[76] indicates a decrease

[73] Gilles RC Essou and Francois Brissette, 2013, ''Climate Change Impacts on the Ouémé River, Benin, West Africa''

[74] Gnangle C. P., et al. (2011). Tendances climatiques passes, modelisation, precipitations, et adaptations locales au Benin. Climatologie, vol. 8.

[75] To note that the Upper Ouémé area is characterized by a single rainy season, from March to November with a peak in July/ August; while Middle Ouémé has two rainy seaons, which peak in June and September.

[76] Gilles RC Essou and Francois Brissette, 2013, ''Climate Change Impacts on the Ouémé River, Benin, West Africa''

in daily precipitation for the 2035-2064 and 2070-2099 periods, but an increase in monthly precipitation: the study suggests that the number of rainy days, thereby the length of the rainy seasons, will decrease in the future, but not the amount of rain falling over the whole season. The Middle Ouémé short rainy season will be more affected with a 25% to 50% drop in daily precipitations during the beginning of the short season, leading to its gradual disappearance. Conversely, models predict more frequent heavy rainfall episodes during the middle and end of the rainy seasons in the Upper and Middle Ouémé Basin[77].

93. In other words, climate change will lead to an increased frequency of extreme rainfall events and an increased occurrence and intensity of floods during the middle and end of the rainy seasons, affecting in particular the Middle and Lower Ouémé Basin because of overflows of the Ouémé River. The late onset of the main rainy seasons will force a shift of the beginning of agricultural activities to April or May instead of March; while the short agricultural season in Middle Ouémé could completely disappear. It is important to note that these shifts in the main and short rainy seasons in Benin have already been observed, including in the Ouémé Basin[78]**.**

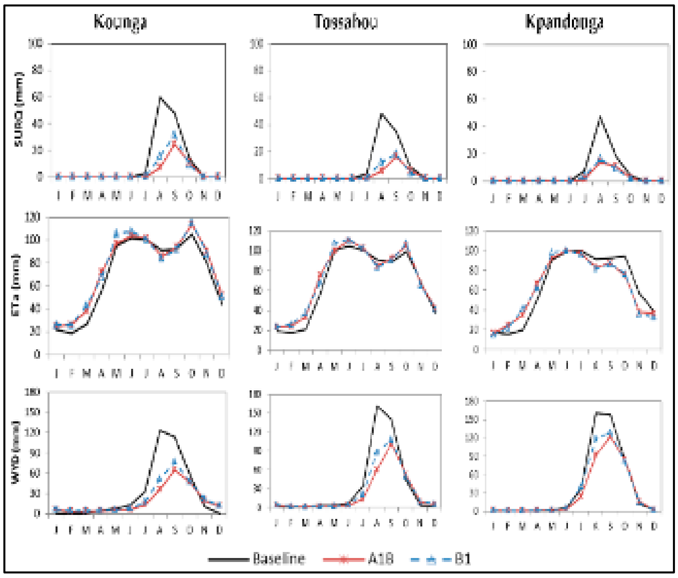
[77] Gnangle C. P., et al. (2011). Tendances climatiques passes, modelisation, precipitations, et adaptations locales au Benin. Climatologie, vol. 8.

[78] Baudoin M-A., Cuni Sanchez A. and Fandohan B. (2014). Small scale farmers' vulnerability to climatic changes in southern Benin: The importance of farmers' perceptions of existing institutions. Mitigation and Adaptation Strategies for Global Change, 8(19): 1195-1207. DOI : 10.1007/s11027-013-9468-9

Evapotranspiration

94. Analysis of the climate change effects (2030-2049) on these trends using the REMO model with the older SRES scenarios (B1 and A1B, comparable to the new RCP 4.5 and RCP 6.0, respectively (Danvi et al., 2018), showed that the surface runoff will increase by 54-65% (7-12 mm), as well as water yield, while evapotranspiration is likely moderately increase (fig. 44). Cocker et al. (2018) in the lower valley, observed a high rainfall variability, with serious consequences on the inflow rate and availability of water in the basin. For example, for a 100% rainfall water received within the lower Oueme basin, about 31-78% is lost as evapotranspiration, 20-68% is used for ground water recharge and only 0.2-1% flows (fig. 45). For Sintondji et al. (2013), runoff, actual evapotranspiration and the total groundwater recharge represent 7.8 %, 73 % and 18.8 %, respectively of the total annual rainfall at Save outlet of the Oueme catchment (near Glazoue). The potential evapo-transpiration (PET) will significantly increase by 4.51 mm and 4.92 mm according to the RCP 4.5 and RCP 8.5, respectively (fig. 46) (Lawin et al., 2019).

Figure 3444: Hydrological water balance components in some sub-watersheds around Djougou (Upper Oueme). SURQ, surface runoff; ETa, actual Evapotranspiration; WYD, total water yield.



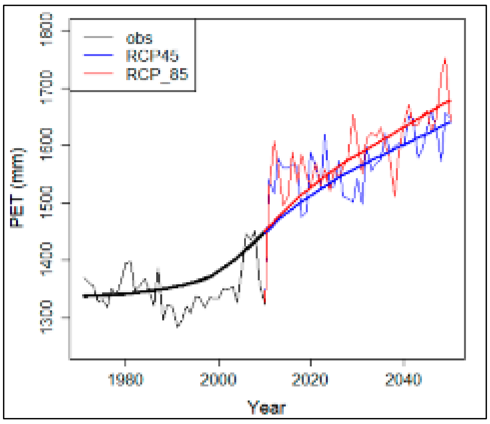
NB: SRES scenarios B1 and A1B are comparable to the new RCP scenarios as RCP 4.5 and RCP 6.0, respectively (Danvi et al.,2018). The water balance analysis was run using the SWAT model.

Source of data: *Simulated climate data using the regional climate model REMO, forced with data from ECHAM5 (GCM).*

Period: *past (1985-2003), future (2030-2049)*

Source graph : *Danvi et al., 2018*

Figure 3545: Variation of the annual potential evapotranspiration (PET) from observations (1971-2005) to projections (2020-2050) based on the Representative Concentration Pathways RCP 4.5 and 8.5



Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44)*
Period: *Past (1971-2005) and future (2020-2050)*
Source graph : *Lawin et al., 2019*

4 Impacts of climate change in the Upper and Middle Oueme

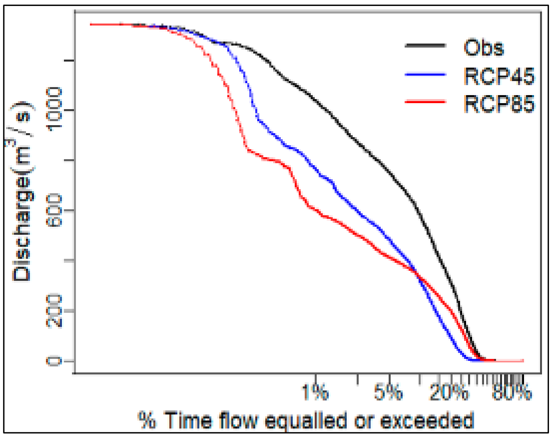
95. Under this section, climate change impacts in the project sites is assessed based on existing resources and productive ecosystems, and well as livelihoods that could be adversely affected.

4.1 Water resources

Surface water

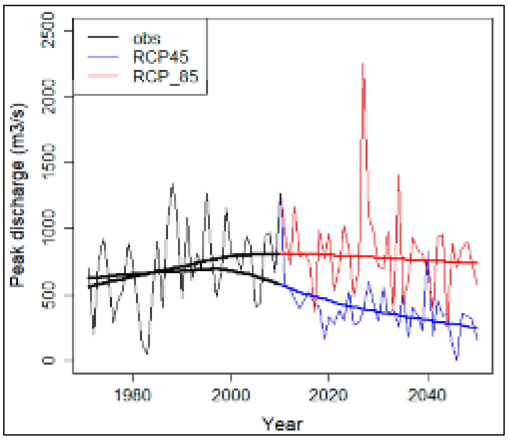
96. Oueme discharge flow water will decrease in the future (2020-2050) with probability of exceedance less than 10% compared to compared to the observed data (1971-2005) (fig. 46), with the peak discharge significantly decreasing by 6.58 m3/s under RCP 4.5. But RCP 8.5 reveals a non significant increase by 1.59 m3/s (fig. 47).

Figure 46: Variation of the observed flow duration compared to the future trends, from observations (1971-2005) to projections (2020-2050) based on the Representative Concentration Pathways RCP 4.5 and 8.5.



Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44)*
Period: *Past (1971-2005) and future (2020-2050)*
Source graph : *Lawin et al., 2019*

Figure47: Variation of the peak flow from observations (1971-2005) to projections (2020-2050) based on the Representative Concentration Pathways RCP 4.5 and 8.5.



Source of data: *Bias-corrected of 4 downscaled GCMs data. All the 4 belong to the CORDEX Africa (AFR-44)*
Period: *Past (1971-2005) and future (2020-2050)*
Source graph: *Lawin et al., 2019*

97. Climate change will affect water availability, as underlined in a study conducted by Biao in 2017[79]. More frequent extreme events, such as extended droughts and shifts in the rainy season, with a late onset and concentration of rainfalls over the middle-end of the season, **will decrease water availability at -20% to - 39% by 2080**. He also underlines that a more frequent risk of flooding will contribute to the loss of biodiversity. With regards to the hydrological system, the Middle Ouémé will likely face **reduced flow of temporary or seasonal rivers under the combined effect of the shorter rainy seasons, increased temperatures and silting.** In addition, the increase in the duration and frequency of droughts, combined with higher temperatures in the whole Ouémé basin, will have a negative impact on the availability

[79] Biao, 2017 Assessing the Impacts of Climate Change on River Discharge Dynamics in Ouémé River Basin (Benin, West Africa)

of water resources, as a result of reduced volumes of water. Water accumulated in aquifers and natural or built reservoirs, and will cause an increase in evapotranspiration. Likewise, a study from Gilles RC Essou and Francois Brissette (2013)[80] has indicated an increase of mean daily temperatures in the Ouémé Basin, accompanied by a reduction in mean monthly flows of the river both in the dry and in the rainy seasons. **The same study indicates that this reduction could probably lead to a slowing down of economic activity and a reduction in water availability in the Ouémé catchment.** The study also indicated that, compared to the reference period, extreme flows with a return period smaller than 10-year will diminish, and that for longer return periods, extreme flows are expected to be on the rise. Farmers perceived and reported type of rains, frequency and duration that lead to the recurrent flooding observed: subsequent high rains seems to be the cause of flood in the upper Ouéme (Copargo, Djougou) while end of (2nd) season rain lead to floods in the southern part of the middle Ouéme (Zogbodomey, Zagnanado) because the soil is wet and can no more infiltrate rains[81].

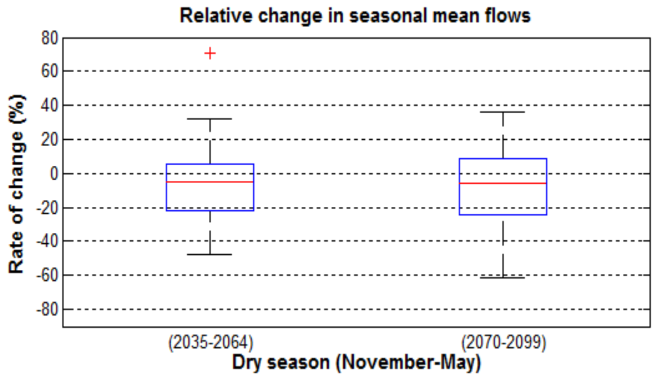
Farmers perception of rains, frequency and duration that lead to recurrent flooding in the Ouéme basin[81]

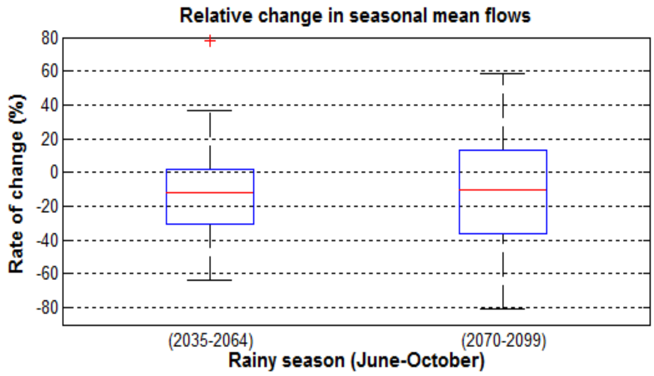
Evidences	Farmers	Localities	Sub-basin
"We have more and more floods in the second rainy season. The soils are already very wet and the rains are becoming more and more frequent. Sometimes we have rains every day in August-September. Heavy floods follow and spoils our crops."	A.T., Maize, mango farmer (male)	ZOGBODOMEY	Middle Ouémé
"In 2012, we had two successive heavy rains in two days in the middle of February. Which flooded our vegetable crops and spoiled the harvest."	O. I. market gardening farmer (male)	Dewa , Serou , DJOUGOU	Upper Ouémé

[80] Gilles RC Essou and Francois Brissette, 2013, ''Climate Change Impacts on the Ouémé River, Benin, West Africa''

[81] Akponikpè PBI (2022) Climate change and Environmental Impact study in the Oueme-basin (Benin): Update of literature and Analysis of the perceptions of climate change and farmers adaptive strategies. FAO Consultancy report, Fev-March 2022.

Figure 3648: Relative variation of monthly flows over the two future periods (right) and Relative variation of mean seasonal flows over the two future periods (left)





98. Concerning the hydrographic network, in the middle basin of the Ouémé, it is likely that **temporary or seasonal rivers will have a reduced flow due to the combined effect of reduced rainfall and silting**[82]. Moreover, increased length and frequency of dry seasons, and higher temperature and evapotranspiration especially in the Upper Oueme will have a negative impact on the availability of water resources. This is because of a reduction in the volumes of water accumulated in aquifers, natural or constructed reservoirs. Furthermore, increase in temperatures will lead to an increase in water consumption for irrigation and will reduce the capacity for drinking water supply and other uses.

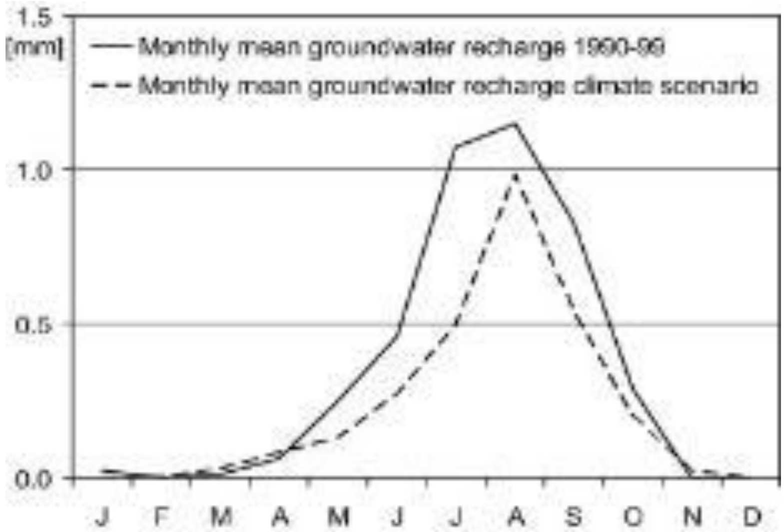
99. The quality of water resources will also be affected by climate change. Decreased run-off may lead to increased concentrations of contaminants in water due to reduced dilution capacity. In addition, high floods due to increased heavy rains may exacerbate erosion phenomena with river transport of high quantities of sediments, which will degrade the quality of surface water. The increase in temperature, together with the increase in phosphate concentration in natural or constructed reservoirs, could favour the invasion of water hyacinth. This, in turn, will degrade the quality of the water by modifying its colour, odour and taste, due to the reduction in the level of dissolved oxygen. In some cases, this phenomenon could make the water toxic for humans, flora and fauna.

82 Rapport Final, Profil du Bassin de l'Ouémé et caractérisation des sites pilotes (analyse des données) FAO, Direction du génie rurale 2009

Groundwater

100. Barthel et al. (2009). found a variation of 0.2 to 1.2 mm/month as recharge capacity of groundwater, with the maximum recharge usually observed in July-August. Under climate change scenario, the authors concluded that these trends decrease for the same period of study, with a maximum of 1.0 mm/month (fig. 49).

Figure 49: Groundwater recharge capacity from 1990 to 1999 in the Okpara sub-basin, under normal and climate change condition



Source of data: *Observed climate data (Meteo-Benin) and underground water data collected from Direction Generale de l'Eau*
Period: *Past (1990-1999) and future (9% reduction of rainfall and increase of temperature)*
Source graph : *Barthel et al., 2009*

Water resources of Inland valleys and

101. As any fragile ecosystem, inland valleys of the Oueme basin are also sensitive to climate change and variabilities. For example, study conducted by Danvi et al. (2018) showed that a large portion of the cultivated lands of inland valleys within the studied watersheds in the Commune of Djougou are more sensitive to climate change, resulting in about 50% (145 mm) decreasing of the water yield. However, soil and water conservation practices such as bunded fields can decrease the projected surface runoff up to 5% at Kpandouga, one of the watersheds located in the commune of Djougou (Danvi et al., 2018). Earlier, Worou et al. (2012) have also demonstrated that the use of bunded plots improves soil water content, the ponded water table, as well as rice grain yield.

4.2 Soil and ecosystems

102. Ecosystems in Benin are impacted by climate change in several ways. These impacts can be direct, such as increased tree mortality because of droughts, or indirect, for example the increased wood harvesting by farmers to compensate for reduced agricultural yields. Noteworthy, climate change impacts in the Upper Ouémé Basin have negative effects in the Middle Ouémé Basin, and lower areas of the basin. While both Upper and Middle Ouémé are experiencing a hotter and more arid climate, with late and heavy rains, long periods of heat,

and prolonged periods of drought[83], more irregular rainfalls with an increase in climate events such as torrential rains and higher temperatures, already observed in the upper catchment, lead to strong erosion of the riverbanks, and more frequent floods in the lower areas.

103. A rise in the projected temperature at horizons 2050-2100, and the **subsequent increase in** evapotranspiration**,** may put ecosystems at risk. For example, increased temperatures intensify the effects of droughts on forests. “Hotter droughts” because of climate change will likely increase tree mortality globally through impacts on tree physiology and ecology[84]. For example, trees lose more water through evapotranspiration under higher temperatures which intensifies the effects of drought. Forests in Benin will be exposed to these impacts since temperatures are predicted to increase across the country. In addition to fundamental physiological and ecological effects, the impacts of hotter droughts and other climate change factors will also depend on the attributes of trees in a particular region. Many tree species in Benin are able to tolerate both dry and humid conditions and may thus be resilient to climate change[85].

104. According to farmers, rainfall extremes (droughts, dry spells and flooding) have a highly negative impacts on crops yields over the Oueme basin[86]. In all the five communes, more than 60% of the respondents agreed that droughts and dry spells have a severe negative impacts on crops, especially in Copargo and Djougou, followed respectively by Zogbodomey, Zagnanado and Glazoue.

105. The negative impacts of floods on crops are especially noted in Zogbodomey (by over 60% of interrogated farmers), followed by Zagnanado (45%); and with much less extend in Djougou, Copargo and Glazoue (< 20%) (Figure 23). The typical example of the effects of flooding on agricultural activities was observed at Kpokissa (Zogbodomey), where farmers have to deal with the seasonal (per year) overflow of the Oueme and Zou river. To do so, farmers use storehouse for keeping safe their production during flooding.

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83 INE (2018), "Analyse de la vulnérabilité et de l'adaptation au changement climatique des communautés et agroécosystèmes aux variations actuelles du climat et aux phénomènes météorologiques extrêmes", Rapport provisoire, 61p.

84 Allen, C.D., Breshears, D.D. and McDowell, N.G., 2015. On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene. *Ecosphere*, *6*(8), pp.1-55.

85 Government of Benin (2008) National Adaptation Programme of Action (NAPA).

86 Akponikpè PBI (2022) Climate change and Environmental Impact study in the Oueme-basin (Benin): Update of literature and Analysis of the perceptions of climate change and farmers adaptive strategies. FAO Consultancy report, Fev-March 2022.

Figure50: Farmers perception of the impacts of drought/drought spells on crops yields

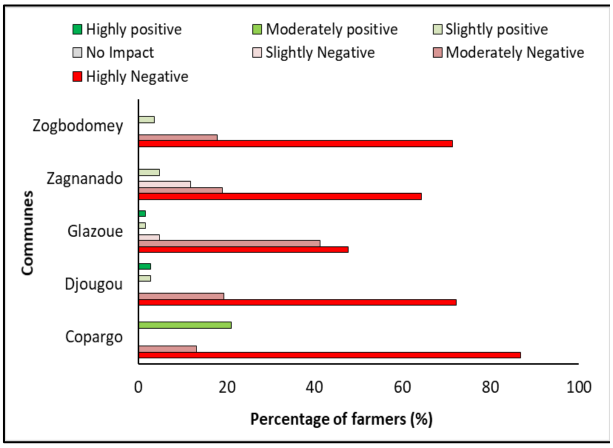

Figure51: Farmers perception of the impacts of flooding on crops yields

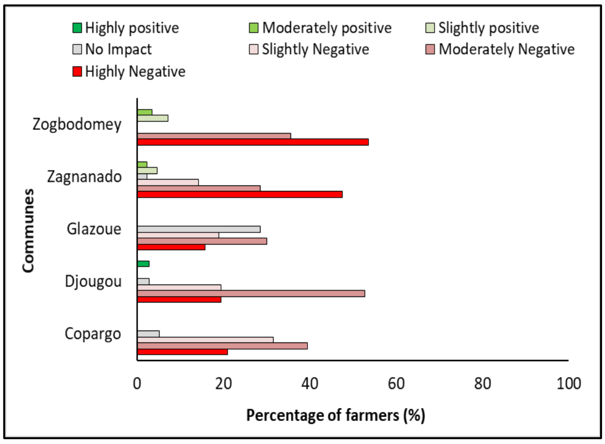

Figure52: Effect of drought on green vegetable(Gboman) at Zonmon (Zagnanado)

Figure53: Constructed storehouse for keeping agricultural production during flodding at Kpokissa (Zogbodomey)

Farmers' perceptions regarding impacts of climate change on ecosytems services and livelihood [87]

Evidences	Farmers	Localities	Sub-basins
"The second season becomes impossible to cultivate for more than ten years because of the recurring floods."	F.A., Maize farmer (women)	Bame, ZAGNANADO	Middle Oueme
"Late excessive rains from September are the main cause of soil erosion, flooding, crop loss, lack of food and loss of human life"	B.A., Maize, soya bean farmer (male)	Aklamkpa, GLAZOUE	
"We have climate change issues. We get low yields. The first season lacks water and the second often experiences excess water."	D. D., Maize farmer (male)	Akouègba, Sokponta, Glazoué	
"Many flowers of our trees such as cashew trees and mango trees abort and fall, including immature fruits, due to high temperatures, very low humidity, the great freshness of the harmattan and strong winds."	T. D., Maize and vegetables farmer (woman)	Akouègba, Sokponta, Glazoué	
"On Shea, the flowers and small fruits dry up and fall from March"	Y. D., Shea, maize farmer (male)	Timba, Djougou	Upper Oueme
"The rains become very late, with pockets of drought. What is even more serious is that the rains cease early in September whereas they fell until October in the past. The crops that suffer the most with important yield loss are annual crops such as corn, peanuts, yams. Trees like shea, cashew, mango resist better."	A. R., Corn, cashew, market gardening farmer (woman)	Foumbéa, Kolokonde, Djougou	

106. Forests and vegetation will also be affected by the predicted changes in rainfall. The recruitment of tree seedlings may be reduced by the predicted shortening of the rainfall season. The frequency and intensity of wildfires in Benin are expected to increase as a result of climate change. Elevated temperatures, a longer dry season and more intense droughts will create conditions that favour wildfires, including in the Oueme Basin. The risk of forest fire depends on a number of factors, including temperature, soil moisture and the presence of potential fuels such as trees, shrubs, grasses, the latter of which are predominant because of dominant savannah area in the middle and upper Ouéme. All of these factors have close direct or indirect links with climate variability and change. Climate changes in the Oueme basin create hotter and drier conditions (increased temperature and frequent drought and dry spells). Increasing drought and rising temperatures could increase the risk of wildfires and their spread.

107. Modeled projections of future climate identify a likely increase in the frequency of fire weather occurrence the targeted communes, including an increase in temperature and greater variance in rainfall. In areas already affected by wildfire hazard, the fire season is likely to increase in duration, and include a greater number of days with weather that could support fire spread because of longer periods without rain during fire seasons. Climate projections indicate that there could also be an increase in the severity of fire[88].

108. In addition, increased rainfall during the rainfall season will increase the amount of biomass that can burn during the dry season. For example, increased grass cover in woody savannas

[87] Akponikpè PBI (2022) Climate change and Environmental Impact study in the Oueme-basin (Benin): Update of literature and Analysis of the perceptions of climate change and farmers adaptive strategies. FAO Consultancy report, Fev-March 2022.

[88] https://thinkhazard.org/en/report/29-benin/WF

and open forests increase the risk and impact of wildfires[89]. These climate change factors will exacerbate forest degradation resulting from wildfires caused by human activities. Gallery forests are particularly vulnerable to wildfires, since they are often narrow, with high light penetration that supports substantial grass cover[90]. Similarly, forest degradation by factors such as wood harvesting, fabrication of charcoal, hunting for food security reasons in the basin can be compounded by fire, since the opening of the canopy increases grass cover and thus fire risk.

Table 5: Threats and Risks of Climate Change on Agro-Ecosystem Services and the Potential Degree of Use of these Services

Ecosystem service	Threats and risks related to climate change	Degree of the climate change impact
Food production	Disturbed seasonal cycle, poor rainfall distribution, increased flood frequency, increased temperatures, low nutrient mineralization	Very high The fall in yields could reach 30%
Primary production / Materials	It is difficult to separate climate change threats from anthropogenic threats.	Slightly affected. Decline in the availability of seeds, nuts, berries, hunting, and plants used in pharmaceutical medicine
Water supply	Disturbance of hydrological cycles, disruption of ecological functions increases of runoff rates inducing dissolution of minerals and decrease of water quality	Very high Several rivers could become seasonal (notably Ouémé in Camargo and Djougou). Drop in quality at Zogbodomey and Zagnanado
Energy production	All threats related to lower crop yields, and increased competitive use related to residue use for soil fertilization	Slightly affected Energy production in this study is seen as a potential. It is not yet implemented in the study area.
Forests	Much more related to anthropogenic pressures, notably deforestation, the conversion of forest ecosystems into agro-ecosystems. These trends are being exarcerbaed because of climate change, causing a vicious cycle.	Moderately affected
Erosion control	Increased wind and runoff: loss of low vegetation cover, including grasses	Very high Increasingly intense erosion in Copargo, Djougou and Glazouè.
Nutrient regulation	Increased runoff, reduced natural mineralization of plants, poor cultural practices	Very high

[89] Archibald, S. and Hempson, G.P., 2016. Competing consumers: contrasting the patterns and impacts of fire and mammalian herbivory in Africa. *Phil. Trans. R. Soc. B*, *371*(1703), p.20150309.

[90] Bufford, J.L. and Gaoue, O.G., 2015. Defoliation by pastoralists affects savanna tree seedling dynamics by limiting the facilitative role of canopy cover. *Ecological Applications*, *25*(5), pp.1319-1329.

Ecosystem service	Threats and risks related to climate change	Degree of the climate change impact
Carbon storage	Limited carbon input due to low rainfall and high rates of evapotranspiration. Anthropogenic causes include intensive farming with intensive tillage systems combined with the use of long bare fallows and the disposal of crop residues for animal feed.	Very high

Table 6: Synthesis of the description of the project's intervention communes

	High valley			**Middle valley**	
	Donga		**Collines**	**Zou**	
	Copargo	**Djougou**	**Glazoué**	**Zogbodomey**	**Zagnanado**

	Ecosystem conditions				
Agro-ecological zone	Zone 4 Ouest-Atacara	Zone 4 Ouest-Atacara	Zone 5 Cotonnière Centre	Zone 6 Des Terres des Barres	Zone 7 de dépression
Climate	Continental	Continental	Tropical	Subéquatorial	Subéquatorial
Soil types	Ferruginous soils Ferrallitic soils Hydro-morphic soils	Ferruginous soils Ferrallitic soils Hydro-morphic soils	Ferruginous soils Hydro-morphic soils Vertisol soils Rocky soils	Ferruginous soils Ferrallitic soils Hydro-morphic soils Vertisol soils	leached tropical ferruginous soils ferralitic soils hydro-morphic soils
Biomass	semi-deciduous forests, wooded savannas and riparian forests	semi-deciduous forests, wooded savannas and riparian forests	Natural light forests, wooded, wooded and shrubby savannas, rocky savannas.	wooded savannah, shrubby savannah, wooded savannah swamps	semi-deciduous swampy and non-swampy forests

4.3 Agriculture

109. **In the absence of climate-resilient production techniques and technologies for agriculture, the productivity in the Ouémé Basin will be negatively affected by climate change**. Agro-ecological areas in Upper Ouémé are particularly threatened by the expansion of desert areas, as climate change accelerates desertification and desert borders are gradually expanding towards the lower latitudes, while the agricultural production capacity in the highly agro-cultural southern zone is endangered by the depletion of useful nutrients in the soil because of increased frequency and intensity of torrential rains in the South. At the same time, climate

change impacts on water resources could result in a 40-60% reduction in the availability of water resources, further influencing food production in Benin[91].

110. The rise in temperatures will lead to a disturbance of crops by shortening vegetative cycles, while early flowering can significantly destabilize ecosystems and reduce yields. Higher evapotranspiration and intermediate dry spells will also lead to shorter growing seasons. More excessive rainfall events will result in more frequent destructive floods, while water staggering on fields cause crops to rot. More frequent floods and overflows of the Ouémé River have already been observed in recent years and have caused food shortages and health risks for the populations as well as destruction of natural ecosystems, infrastructure, and farmlands. The flooding phenomenon occurring in the Middle Ouémé has been intensifying over the years because of increasing frequency and intensity of heavy rains including in the upstream basin.

111. The projected impacts of climate change in the Upper and Middle Basin are likely to reduce overall food crop yields from 3 to 18 percent in 2050, with some crop like maize decreasing by more than 25%[92]. Given the importance the agriculture sector plays in the country's economy, according to Burke, Hsiang, and Miguel (2015), such impacts will cause Benin losses of more than 50% of the GDP per capita by 2100 if no adapting measure is undertaken. Below Table 7 is an overview of possible yield declines of major crops in the Upper and Middle Ouémé Basin.

Table 7: Climate change impacts on main crops and vegetable by 2050, based on 1995-2009 average[93]

	Acreage (ha)	Climate Change Impact on Production		Acreage (ha)	Climate Change Impact on Production
Food Crops	**105,100**	**-3%**	**Vegetables**	**4,545**	
Cassava	**15,688**	**-17%**	**Chilli**	**1,498**	**-30%**
Copargo	1,801	-17%	Copargo	60	-30%
Djougou	1,910	-17%	Djougou	173	-30%
Glazoue	6,426	-17%	Glazoue	957	-30%
Zagnanado	2,725	-17%	Zagnanado	109	-30%
Zogbodomey	2,826	-17%	Zogbodomey	199	-30%
Cowpea	**13,292**	**-18%**	**Green vegetables**	**272**	

[91] Climate Service Centre (2013)

[92] Lawin A. E. , Akponikpè P.B.I., Jalloh A., Nelson G.N., and Thomas T.S. (2013) Benin (Chap3) in Jalloh A., Nelson G.N., and Thomas T.S., Zougmoré R., and Roy-Macauley H. (Eds) West African Agriculture and Climate change: A Comprehensive Analysis, IFPRI, Washington USA, 408p https://www.ifpri.org/publication/west-african-agriculture-and-climate-change-comprehensive-analysis

[93] The models used are based on a dynamic statistical approach (Hounnou et al., 2019) and REMO A1B model (Awoye et al. 2017). Note that the area data in the table is from the DSA agricultural statistics database of Benin

Copargo	721	-18%	Copargo	27	-30%
Djougou	2,146	-18%	Djougou	245	-30%
Glazoue	5,765	-18%	Glazoue		
Zagnanado	1,945	-18%	Zagnanado		
Zogbodomey	2,715	-18%	Zogbodomey		
Maize	**38,271**	**-30%**	**Okra**	**1,441**	
Copargo	2,165	-30%	Copargo	178	-30%
Djougou	6,222	-30%	Djougou	188	-30%
Glazoue	18,756	-30%	Glazoue	624	-30%
Zagnanado	4,668	-30%	Zagnanado	146	-30%
Zogbodomey	6,460	-30%	Zogbodomey	305	-30%
Yam	**31,488**	**-3%**	**Tomato**	**1,334**	
Copargo	5,499	-3%	Copargo	42	-30%
Djougou	6,265	-3%	Djougou	294	-30%
Glazoue	19,360	-3%	Glazoue	683	-30%
Zagnanado	59	-3%	Zagnanado	121	-30%
Zogbodomey	305	-3%	Zogbodomey	194	-30%

112. With regards to agroforestry trees, ***Cashew* nuts** is Benin's most important cash crop, after cotton[94]. At present, cashew trees in Benin can produce nuts in the dry season and are especially productive when the rains are regular, and temperatures are moderate during the rainfall season. With climate change, increased rainfall variability and droughts will likely reduce cashew productivity[95]. In the Middle Ouémé Basin, cashew production is positively correlated with the number of rainy days[96], which suggests that the predicted shorter rainfall seasons will also have a negative impact on cashews. In the transition zone, rain during

94 Jalloh, Abdulai; Nelson, Gerald C.; Thomas, Timothy S.; Zougmoré, Robert and Roy-Macauley, Harold. 2013. West African agriculture and climate change: A comprehensive analysis. IFPRI Research Monograph. Washington, D.C. International Food Policy Research Institute http://dx.doi.org/10.2499/9780896292048

95 Balogoun, I., Ahoton, E.L., Saïdou, A., Bello, O.D. and Ezin, V., 2016. Effect of climatic factors on cashew (Anacardium occidentale L.) productivity in Benin (West Africa). *Journal of Earth Science and Climatic Change*, *7*, p.329.

96 Balogoun, I., Ahoton, E.L., Saïdou, A., Bello, O.D. and Ezin, V., 2016. Effect of climatic factors on cashew (Anacardium occidentale L.) productivity in Benin (West Africa). *Journal of Earth Science and Climatic Change*, *7*, p.329.

January and December, violent winds and drought periods have also been found to affect cashew productivity negatively by causing flowers to dry and drop.

113.***Shea*** trees can grow in hot and dry climates. In West Africa, shea trees[97] occur in areas with mean annual temperatures of 21–29 °C and with annual rainfall of 450–1,800 mm, with 1 to 7 months of at least 100 mm[98]. In the Sudanian climate zone, the optimum shea nut yield was found with rainfall of ~1,000 mm per year. In the Sudano-Guinean climate zone, shea trees may become more productive if the climate becomes drier. However, the recruitment of seedlings is predicted to be significantly decreased with increasing aridity in the Sudanian zone – which includes the Upper Ouémé – and will thus affect the natural regeneration of shea trees[99]. As a result, it will become increasingly important for people to plant shea trees to maintain the production of shea nuts.

4.3.1 Baseline production system for key value chain crops

The production systems of the four selected crops are presented below.

a) Corn

114.In the communes of Zogbodomey, Zagnanado, and Glazoué, maize is produced during the long and short rainy seasons. In the communes of Djougou and Copargo, on the other hand, corn is grown only once a year. In all cases, **soil preparation is done with rudimentary tools such as the hoe, the daba, etc**. However, some producers use animal traction and others motorized traction, particularly in the communes of Djougou, Copargo, and Glazoué. Sowing is done manually and seeders are used in rare cases.

115.Maize is an important part of the crop rotation systems used by producers. It is produced with low external input technologies. The most common maize-based rotations are maize-soybean, cotton-maize-cotton, and maize-niebe. According to Kamara et al (2008), rotations involving legumes not only improve soil fertility but also control *striga*, a plant that is very harmful to cereals in northern Benin.

116.In Glazoué, Djougou and Copargo, maize production benefits from cotton. As a result, the amount of fertilizer applied to maize in this area is relatively limited. As Baco (2019) also points out, cotton fertilizer is also diverted to maize.

117.Annual crops are often associated with maize during growth and development phases (pure association). Crops associated with maize include groundnuts, cowpeas, cassava, etc. The most predominant crop association is maize + sorghum. **This cropping combination is for**

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97 Shea trees in West Africa belong to the subspecies *Vitellaria paradoxa paradoxa*.

98 Naughton, C.C., Lovett, P.N. and Mihelcic, J.R., 2015. Land suitability modeling of shea (*Vitellaria paradoxa*) distribution across sub-Saharan Africa. Applied Geography, 58, pp.217-227.

99 Glèlè Kakaï, R., Akpona, T., Assogbadjo, A.E., Gaoué, O.G., Chakeredza, S., Gnanglè, P.C., Mensah, G.A. and Sinsin, B., 2011. Ecological adaptation of the shea butter tree (*Vitellaria paradoxa* CF Gaertn.) along climatic gradient in Bénin, West Africa. *African Journal of Ecology*, *49*(4), pp.440-449.

intensification and improved labor productivity, (and to some extent allows farmers to protect themselves from crop failure caused by climate change) and to have a sufficient grain reserve to feed the family (Baco et al., 2010). Another common practice is intercropping. For example, maize is planted in rows 2-4 m apart in groundnut fields.

118. The technical itinerary used for maize production varies very little from one commune to another. Soil preparation is the first activity, followed by plowing and planting. Fertilizer application, herbicide treatment and weeding take place at different stages of maize vegetative development. However, phytosanitary treatments on maize are relatively limited. For plot maintenance, mechanical control and weeding are increasingly abandoned in favor of chemical control (herbicide). According to Baco (2019), this change can be explained on the one hand by the reduction of family labor in agricultural activities due to the sending of children to school and, on the other hand, by the marketing of herbicides by input distribution companies. The latter are no longer limited to marketing cotton fertilizer and insecticides, but are also involved in marketing inputs for other crops (maize, rice) (Baco et al., 2010).

119. Sources of supply vary according to the input sought. Thus, seeds are either taken from previous stocks, purchased on the market, or obtained by donation.

120. The area planted to corn by producers varies significantly from one region to another. The average area per producer is 5 ha in Djougou and Copargo, 2 ha in Glazoué and 1.7 ha in Zagnanado and Zogbodomey. The large area recorded in Djougou and Copargo is explained by the availability of cultivable land, unlike in the other communes.

121. **Farmers also combine several varieties on the same field. This strategy has three objectives: (i) minimizing the risks associated with drought or flooding; (ii) having maize available quickly to shorten the hunger gap; and (iii) finding maize for storage. On the same field, the farmer can also plant the same maize variety at different dates to minimize the risks associated with drought. With these practices, farmers often obtain low yields, averaging around 700 kg/ha.**

b) Cashew nuts

122. The communes of Glazoué, Djougou and Copargo are located in areas that are very favorable to cashew cultivation, while Zogbodomey and Zagnanado are in an area that is favorable to this crop. The production of this crop is part of an agroforestry system where cashew trees share a good part of their vegetative development in association with other annual crops such as cotton, yams, maize, cassava, peanuts, and sorghum (Tandjiékpon, 2010). The duration of this association depends on the spacing of cashew plantations. The most light-demanding crops, such as cotton, yams and maize, are more likely to be associated with cashew trees at the beginning of their vegetation period. The association with these annual crops allows the producer to reduce the management costs (maintenance, protection, etc.) of the cashew plantations while the latter is not yet producing fruit. According to Crinot et al. (2015), the cashew-cotton-maize-ignam-sorghum system is the most profitable and competitive cashew crop system, with a financial return of 395,370 CFA/ha.

123. The **work in the plantations is more manual for the majority of producers, with traditional farming tools (hoe, daba, machete, etc**.). However, the use of animal traction and rarely of

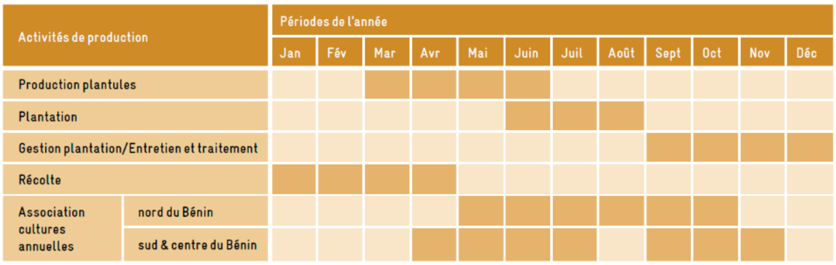
heavy machinery for soil preparation is noted among producers with large farms. In all cases, however, family labor remains an important contributor to farm costs.

124. In addition, inheritance is the dominant mode of acquisition of cashew plantations in the project area. Few women receive plots of land from their husbands or parents as a gift. It is also observed among migrants who receive plots of land from friends or the king of the village without compensation.

125. The average size of cashew farms per farmer is between 1.0 ha and 1.5 ha (Tandjiékpon, 2010). However, there are farms larger than 5 ha. These belong to landowners, economic operators, civil servants, etc.

126. **Furthermore, the cashew agroforestry system contributes to the resolution of environmental and socioeconomic problems of producers. Indeed, the presence of cashew plantations on farms contributes to the reduction of atmospheric carbon and promotes a healthy environment conducive to human development** (Balogoun et al., 2013). Figure 54 shows the cropping calendar of cashew in association with annual crops.

Figure84: Crop calendar for cashew in association with annual crops



c) *Mango*

127. **In** the Project area, as Bokonon-Ganta and de Groote (2002) indicate, mango production generally involves very few special cultural practices. **Apart from seedlings, inputs such as fertilizers and pesticides are sometimes used, and virtually none of the plantations practice irrigation.** In the 2019-2020 crop year, only 2% of producers used chemical fertilizer, and this only in Zogbodomey (see Sodjinou, 2020). It should be noted that the provision of fertilizer each year allows good maintenance of mango fruiting and also improves their yields.

128. **Almost** all the producers either inherited their plantation or created the plantation themselves. There are also plantations belonging to religious denominations or to the State. In the project area, several varieties of mangoes are produced, but the most dominant are the traditional varieties, the improved varieties Eldon, Kent and Gouverneur. According to Sodjinou (2020), traditional varieties are preferred for juice production. This is because processors believe that not only do these varieties contain more juice than the grafted varieties but they are also relatively cheaper.

129. **Given** the time lag between planting and first fruiting (5 years on average for grafted seedlings), the cultivation of other annual species in association with mango seedlings is done

at the farm level (Sodjinou, 2020). In addition to the income they could provide, the crop association contributes to the maintenance of the plot, a better balance against pathogens and possibly the enrichment of the soil in nitrogen with the cultivation of legumes (Tossou Lokossou et *al.*, 2019). Crops associated with mango plants are often maize, groundnut, sorghum, soybean.

130.**Mango trees suffer from various types of diseases and pests**. According to Sinzogan et *al* (2009), one of the main problems in mango production is pest damage to the fruit. This damage can reach 20% to 45% of the plantation production. Bacteria, fungi, and viruses cause diseases manifested by stunting, defoliation, flower and flower bud drop, leaf discoloration, blight, canker, and fumaginia (ATDA5, 2019b).

131.**Fruit** flies are the pests that cause most economic damage, since these insects affect the mango both in terms of quality (deterioration by fly larvae that penetrate the mango pulp) and quantity (loss of earnings, loss of up to 80% of the fruit at the end of June) (Cosinus Conseil, 2020). The flies encountered in Benin, in order of importance, are: *Bactrocera dorsalis, Ceratitis capitata, Ceratitis cosyra* etc. (ATDA5, 2019b).

132.**Various** harvesting methods are used by producers, the first of which (used by 75% of producers) consists of climbing the tree and picking the fruit at physiological maturity. This is due to the fact that most mango trees have not been pruned. In fact, pruning mango trees avoids this practice, since in modern orchards mango trees are maintained at a maximum height of 4 m. The second method is "gaulage", which consists of picking mature mangoes with a pole. Some producers drop the mangoes before picking them. This last harvesting technique is observed in producers with traditional mangoes, or in those lacking customers, etc. This is one of the causes of the poor quality of the mangoes put on the market.

133.**Overall (Table 9), the mango and cashew production systems are virtually identical. Associated cropping practices (maize, soybean, groundnut, cowpea), more specifically agroforestry, are noted. More and more today we note maintenance practices such as pruning, weeding of orchards and the use of grafted plants**.

d) Shea

134.**Unlike the mango and cashew trees, the shea or butter tree (*Vitellaria paradoxa*) is a tree that grows wild in tree/shrub savannahs, shea agroforestry parks and fallow lands**. It plays a fundamental role in maintaining the balance of the ecosystem. The shea tree particularly improves the yields of certain crops such as yams and chili peppers because it has the power to loosen the soil, which favors the growth of several plants around the tree.

135.According to Sodjinou and Kouton-Bognon (2019), the activity of collecting shea nuts is seasonal and takes place between May and August. During this period, collectors scour the fields and forests to collect fallen nuts. The trees closest to the villages are the first to be visited; it is necessary to travel great distances to reach other trees (Amoussou, 2017). The collection of shea nuts is done using various equipment (baskets, basins, calabashes, fertilizer bags, etc.) that are used at the same time to evacuate the product. The level of collection of shea nuts remains relatively low, compared to the existing potential, as it would not exceed 50% (Sodjinou and Kouton-Bognon, 2019). This is due to the rudimentary working conditions of the women who collect the kernels (no gloves, no boots, no means of transport and no means of collection), which does not allow for significant volumes. Also, the period of collection of the nuts coincides with the work of the fields where the women are very solicited. This overload of work makes it impossible for women to be fully available during this period to collect the nuts (Abdoulaye, 2000). Thus, a large proportion of the nuts rot in the fields and forests because they are not collected in time.

136. About 49% of the nuts collected are directly processed and 47% of this production is directly sold. For Faladé (2018), in a good year (good rainfall, less violent winds, no atrocious bush fires, etc.), national nut production is high and allows for 85,000 tons of almonds to be produced annually, or 242,860 tons of nuts processed into almonds per year. In a bad year, this production of nuts can drop by about 30%, i.e. 170,000 tons of nuts. The loss rate of nuts, after collection is about 4%. These losses are due, among other things, to problems of humidity, rotting, germination and poor drying practices.

137. In terms of production, different techniques of cultivation of the shea tree have been experimented, notably reproduction, grafting and Assisted Natural Regeneration (ANR). In reproduction, the germination period remains more or less long and the growth in height and diameter of young shea seedlings becomes very slow and it takes 15 years for a tree from a seedling to bear its first fruit (Gnanglè, 2017). In the grafting technique, an encouraging success rate was obtained (about 45%) and a reduction in the time to fruiting of shea trees to 5 years. The principle of ANR is to identify, materialize and protect young wildings (or young seedlings or natural regeneration) in parks or natural formations.

138. Finally, vegetable production (Table 8) is increasingly based on the conventional system, with heavy use of improved seeds combined with the use of chemical inputs (fertilizers, pesticides and herbicides). SLM practices are also increasingly used. It should be noted that some market gardeners are increasingly using organic products for crop maintenance.

Table 9: Some production practices used in the project communes

Crops	**Zagnanado**	**Zogbodomey**	**Glazoué**	**Djougou**	**Copargo**
Corn	- Sowing in rows with 80 cm spacing - Flat ploughing - Use of fertilizers - Demarriage - Use of herbicides - Use of TDM measures (crop association, crop rotation)	- Ridge and flat ploughing - Adoption of improved seeds - Crop residue management - Use of chemicals	- Adoption of seed of improved varieties - Flat ploughing - Use of chemical fertilizers - Use of total herbicides - Use of selective herbicides - Sarclo-butting	- Adoption of improved short-cycle varieties - Adoption of improved drought-resistant varieties - Crop association/rotation - Use of chemical fertilizers - No-till on a flat plough	- Adoption of improved short-cycle varieties - Adoption of improved drought-resistant varieties - Crop association/rotation - Use of chemical fertilizers - Direct seeding on flat plough or ridge

				- Use of chemical pesticides	- Use of chemical pesticides
Mangoes	- Tree pruning - Maintenance through treatments, weeding	- Adoption of improved varieties (Kent and Amelie) - Weeding, pruning of orchards	- Agroforestry - Market-oriented production - Pruning - Adoption of grafted plants	- Association of culture - Agroforestry - Mulching - Adoption of improved varieties (Kent and Amelie)	- Association of culture - Agroforestry - Mulching
Cashew nuts	- Production with respect to spacing, Pruning, Parasites, Grafted plants - Agroforestry	- Adoption of grafted plants - Pruning, Thinning, Foliage - Agroforestry	- Agroforestry - Market-oriented production - Pruning - Adoption of grafted plants	- Grafting of cashew trees - Adoption of grafted plants - Pruning, Thinning, Foliage	- Grafting of cashew trees - Adoption of grafted plants - Pruning, Thinning, Foliage
Shea nut	- Tree maintenance	- -	- Agroforestry - Market-oriented production	- Orchard maintenance - Creation of a shea butter park	- Orchard maintenance - Creation of a shea butter park
Vegetable crops	- Improved seeds - Crop rotation - Irrigation on board - Compost making, Use of chemical fertilizers and pesticides	- Targeted watering - Improved seed - Mulching - Organic materials - Chemical fertilizers - Drainage	- Nursery - Adoption of improved variety seed - Mulching - Irrigation - Production on board - Use of chemicals - Targeted watering	- Mulching, - Use of chemical fertilizers - Use of short cycle varieties - Use of climate change resistant varieties	- Mulching, - Use of chemical fertilizers - Use of short cycle varieties - Use of climate change resistant varieties

4.3.2 Current crop productivity

139. Maize productivity is relatively higher in the communes of Djougou (1,363 kg/ha) and Copargo (1,272 kg/ha) than in the other four communes (858 to 926 kg/ha). This trend is related to cotton production. In fact, in cotton production areas, maize benefits from the after-effects of inputs used on cotton. As a result, maize productivity is relatively higher there than in the other communes.

140. Regarding cashew, Glazoué Copargo and Djougou are located in zone 1 considered to be the good zone (very favorable zone) where cashew cultivation does not seem to pose any particular problem due to favorable climatic and geomorphological conditions (Tandjiékpon et al., 2008). Zogbodomey and Zagnanado are located in Zone 2, considered to be fairly favorable (favorable zone) for cashew, where climatic conditions do not allow the tree to express its productive potential. The productivity of cashew plantations is very low, in the order of 300 kg/ha to 500 kg/ha, whereas the current potential can reach 1,000 kg/ha-1500 kg/ha with currently available planting material (Tandjiékpon et al. 2005). This is becasue of the aging of certain plantations, low maintenance of the plantations, violent winds which cause the flowers to fall, the severity of the harmattan (lasts longer than expected, windier than usual, etc.), and other climatic hazards.

141.Productivity appears to be higher in the commune of Zogbodomey than in the other communes (see Table 9). However, mangoes suffer more attacks in Zogbodomey than in the other communes, so much of the production is lost in the field. Mango productivity is relatively low compared to the expected potential yield. The probable causes of this low productivity are, among others, poor cultivation practices (poor maintenance of plantations, lack of manure, etc.), the non-use of inputs, and fruit fly infestations causing significant quantitative and qualitative losses of mangoes. We also note a varietal mix in 90% of the producers. One of the solutions to the problems encountered by mango producers would be the design and extension of a proven technical itinerary, accompanied by a training plan for producers on good production and management practices for mango plantations.

142.As far as shea is concerned, there is a lack of reliable statistics on the stand and actual production of shea trees in Benin. At the national level, available statistics indicate a relatively large natural stand (estimated at about 6,550,000 shea trees) that is productive and favorable to the development of the shea industry. The proportion of productive trees is higher in parks than in natural stands. The climatic zone of predilection of the species in Benin is the Sudanian (in particular Djougou and Copargo). It is also found in the Sudan-Guinean (especially Glazoué, and the department of Zou), but in very low densities. The production of a shea tree does not exceed 20 kg of fruit per season, or 6 kg of dry shea kernels, allowing for 2 kg of shea butter (Said, 2018).

143.In addition, during the focus group interviews, producers were asked to estimate the production per hectare of their farm during the current season and the same as 10 years ago. The results obtained and presented in Table 10 show that, in general, the yields of all target crops have decreased except for vegetable production (tomato and pepper). Similarly, the productivity of mango in Copargo, maize in Zogbodomey, and cashew nuts in Glazoué and Zogbodomey increased compared to 10 years ago, according to the assessment of producers interviewed.

Table 10: Productivity (kg/ha) of selected crops

Crops	**Zagnanado**	**Zogbodomey**	**Glazoué**	**Djougou**	**Copargo**	**Benin(1)**
Corn (2020-2021)*	858	893	926	1 363	1 406	1 272
Cashew (2018-2019)*	411		326	326	521	394
Mangoes (2018)**	ND	12486,20	7768,00	10987,00	10987,00	4 507,5
Shea	ND	ND	ND	ND	ND	17 473
Tomato (2020-2021)*	2 705	2 783	3 222	5 084	7 290	6 622
Pepper (2020-2021)*	483	500	550	1 284	2 450	3 590

(1) National values for shea and mango are from FAOSTAT (2021), those for other crops are from MAEP (2022)

Source: *MAEP (2022); **ATDA5 (2019);

Table11: Farmers' estimates of average productivity (kg/ha) of crops now and 10 years ago

		Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	Current production	1000	900	2500	1500	800
	Production 10 years ago	1200	1500	3000	1000	1200
Mangoes	Current production	5000	3500	10000	4000	-
	Production 10 years ago	3000	4500	15000	6000	-

Cashew nuts	Current production	400	400	450	200	500
	Production 10 years ago	600	600	200	100	800
Shea nut	Current production	500	600	2000	0	150
	Production 10 years ago	700	1000	4000	0	350
Tomato	Current production	8000	15000	8000	5500	10000
	Production 10 years ago	8000	8000	4000	3500	8000
Chilli	Current production	3000	10000	4000	2500	8000
	Production 10 years ago	5000	7000	1500	1500	5000

= Decrease = Increase = No change/not produced

Source: Field data, 2022

4.3.3 Impacts of climate change on the four targeted value chains

144. Overall, the projected impacts of climate change in the Upper and Middle Basin are likely to reduce overall food crop yields from 3 to 18 percent in 2050, with some crop like maize decreasing by more than 25%[100].

Physical impacts of climate change on crops cause loss and damage

During interviews with farmers carrid out in 2021-2022, particularly in focus groups, farmers were asked to rate the influence of CCs (as increasing in intensity and frequency over time) on each of the crops grown in the project communes on a scale of 0 (no impact) to 10 (very high impact). The results obtained and presented in Table 12 indicate that CCs have a high impact on maize cultivation in all communes. The situation is the same for mango in Djougou and Zogbodomey and cashew in Glazoué. The impact of CC on shea nut collection is very high in Djougou and Copargo, according to producers. The same is true for market gardening in Glazoué and Zogbodomey.

145. These results are broadly consistent with those of Lawin et al. (2018) for which market gardening and food crop production are most affected by climate risks in the project area.

146. With regards to corn, there is poor emergence after germination, wilting of the plants, yellowing of the leaves and development of parasitic attacks from inside the plants. On vegetable crops, low emergence after germination for carrot and cabbage, low emergence after transplanting, wilting of plants and yellowing of leaves are noted. On perennial crops, fall of flowers, the decrease in yield of trees, the weak development of nuts and fruits, the low sugar content of mango are noted.

147. The effects of climate change on harvesting can be summarized as a change in the quality of the products as rainfall volume becomes more abundant over time. It is also noted that crops

[100] Lawin A. E. , Akponikpè P.B.I., Jalloh A., Nelson G.N., and Thomas T.S. (2013) Benin (Chap3) in Jalloh A., Nelson G.N., and Thomas T.S., Zougmoré R., and Roy-Macauley H. (Eds) West African Agriculture and Climate change: A Comprehensive Analysis, IFPRI, Washington USA, 408p https://www.ifpri.org/publication/west-african-agriculture-and-climate-change-comprehensive-analysis

are subject to rotting of the seeds planted and to parasitic pressures. As a result, there is an overall decline in crop productivity, due to climate change, worsened by sub-optimal use of inputs.(World Bank, 2018).

Table 12 Producers' assessment of the increasing impacts of CC on crops

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	7	7	8	7	7
Mango	6	7	5	7	5
Cashew nuts	6	6	8	3	4
Shea / collecting shea nuts	8	8	3	-	4
Vegetable crops	6	6	8	7	6
Rice	7	7	4	3	4
Soybeans	7	4	5	5	3
Cowpea	4	8	5	5	3
Peanut	6	8	6	5	3
Cassava	6	6	3	5	5
Sweet potato	4	4	4	3	3
Cotton	5	5	5	8	5
Yam	6	4	5	-	5
Oil palm	-	-	-	4	3

Considering a scale of 10, with 0=No impact and 10=Very high impact

0-3	Low	4-6	Medium	7-10	High

Source: Field data, 2022

Table 13. Impact of climate change on crops/production

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	Low germination rate Seedling wilt Dwarf development of corn plants Poor ear development	Low germination rate Seedling wilt Dwarf development of corn plants Poor ear development	Worm development Dwarf development of corn plants	Low emergence after germination Plant wilt Yellowing of the leaves Development of parasitic attacks from inside the plants	Low emergence after germination Plant wilt Yellowing of the leaves Development of parasitic attacks from inside the plants
Mangoes	Poor fruit development	Poor fruit development	Fruit acidity Poor fruit development	Low fruit size	Low fruit size
Cashew nuts	Low nut development Early fall of the nuts Acidity of almonds following heavy rains	Low nut development Early fall of flowers and nuts Acidity of almonds following heavy rains	Low nut development Acidity of almonds following heavy rains	-	Development of parasites causing low nut size
Shea nut	Low nut development	Low nut development	Poor fruit development	-	-
Vegetable crops	Plant wilt Weak development of vegetables Poor fruit development	-Plant wilt -Weak development of vegetables Poor fruit development	Development of worms especially in cabbage Weak development of vegetables (carrot, leafy vegetables) Attack on chilli and tomato leaves	Low emergence after germination for carrot and cabbage Low emergence after transplanting Plant wilt Yellowing of the leaves	Low emergence after germination for carrot and cabbage Low emergence after transplanting Plant wilt Yellowing of the leaves

Source: Field data, 2022

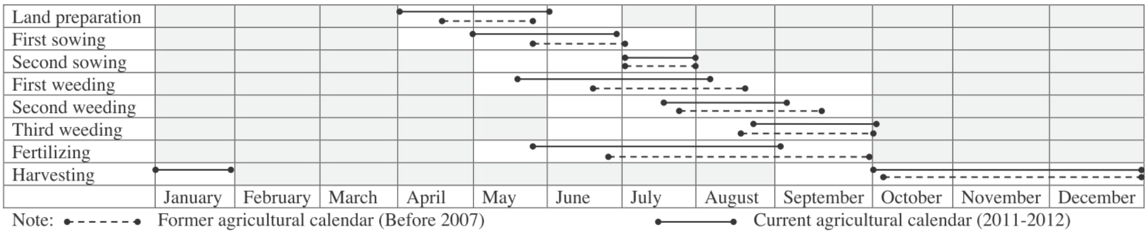
Table 14 . Impacts of climate change on the harvest of different crops

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	Foot drop in case of persistent rain	Foot drop in case of persistent rain	Grain turgidity when harvested in the rain Mould growth	No control of rain for harvesting and storage operations, especially in the first season	No control of rain for harvesting and storage operations, especially in the first season
Mangoes	Worm development	Worm development Fruit fall due to strong wind	No major impact on the mango crop	No major impact on the mango crop	No major impact on the mango crop
Cashew nuts	Blackening of the seeds	Blackening of the seeds	No major impact on the cashew crop	No major impact on the cashew crop	No major impact on the cashew crop
Shea nut	Blackening of the seeds	Blackening of the seeds	Blackening of the seeds	-	No major impact on the shea crop
Vegetable crops	Development of parasites	Development of parasites -Early rotting of the products after maturity -Invasion of early attack under high heat when the product is already ready	Harvesting in the presence of rain allows for even fresher and more preservable products	Destruction of crops by flooding	Change in the taste of certain products such as watermelon in case of excess water Poor vegetable development due to the long harmattan period

Source: Field data, 2022

148. A shift in the agricultural calendars is also noted mostly for annual crops like maize.[101]

Fig 55 Agricultural calendar in the village of Takonta (10.03° N; 1.34° E), near the commune of Copargo (upper Ouéme).



149. Historical trends of the impact of CC on ACV are not available, however future changes average yields are provided in Table 7, based on the future trends of yields as affected by CC under various scenarios (please see fig 57 below).

[101] Yegbemey, R. N., Kabir, H., Awoye, O. H., Yabi, J. A., & Paraïso, A. A. (2014). Managing the agricultural calendar as coping mechanism to climate variability: A case study of maize farming in northern Benin, West Africa. Climate Risk Management, 3, 13-23.

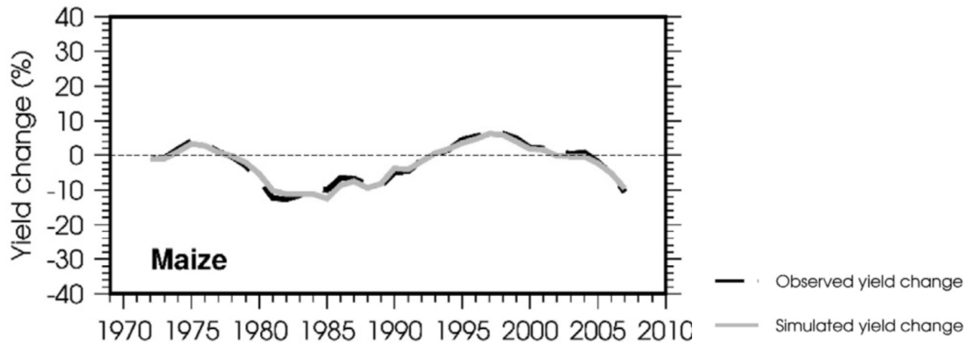


Fig 56 De-trended and normalized time series of annual yield (year to year variation) for maize crops from historical observations and fro statistical crop model (cross-validated linear model combined with Bayesian statistics).[102]

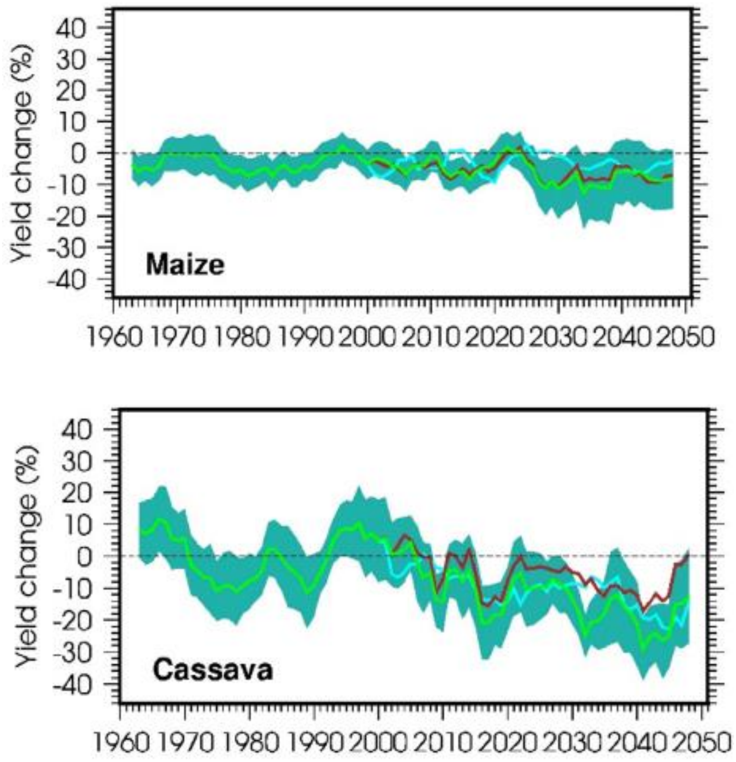


Fig 57 Projection of future crop yield changes under three climate change scenarios. The yield changes are displayed relative to the average yield for the specific crop over the time period 1995–2009. The brown, cyan and green lines show the projected yield change in percentage, assuming the SRES A1B scenario, SRES B1 + LCC scenario andSRES A1B + LCC scenario, respectively. The ABMA method is used to average the crop yield projections from individual models. The green area displays the uncertainty range(95% confidence interval) for the projected yield under SRES A1B + LCC scenario (Awoye et al., 2017)[102]

150. The effects of climate change on storage and preservation can be seen in the increasingly heavy rainfall that prevents the proper drying of products and favors the proliferation of attacks. The high heat in a poorly ventilated warehouse also contributes to the development

[102] Awoye, O. H. R., et al. "Dynamical-statistical projections of the climate change impact on agricultural production in Benin by means of a cross-validated linear model combined with Bayesian statistics." Agricultural and Forest Meteorology 234 (2017): 80-94.

of attacks. The cashew and shea nuts are subject to blackening during periods of high heat in a less ventilated location.

Table 15 . Impacts of climate change on storage and preservation of different crops

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	Development of the attacks in low temperature at the time of storage and conservation	-Development of the attacks in low temperature at the time of storage and conservation	Development of the attacks in low temperature at the time of storage and conservation	Grain rot when not properly dried due to recurrent rains	Development of the attacks in period of strong heat
Mangoes	No storage and preservation	No storage and preservation	No storage and preservation	No storage and preservation	No storage and preservation
Cashew nuts	Blackening of nuts in case of rain during drying	Blackening of nuts in case of rain during drying	Blackening of nuts in case of rain during drying	Blackening of nuts when not properly dried	During the drying period, the seeds lose their weight in the presence of rain
Shea nut	Blackening of nuts in case of rain during drying	Blackening of nuts in case of rain during drying	Blackening of nuts in case of rain during drying	-	Blackening of nuts in case of rain during drying
Vegetable crops	No storage and preservation	No storage and preservation	No storage and preservation	No storage and preservation	No storage and preservation

Source: Field data, 2022

151.The effects of climate change can be observed in processing through early fermentation, early ripening in high heat. Cashew seeds break early in the transformation process when the seeds are not well dried.

Table 16 . Impacts of climate change on the transformation of different crops

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	Early fermentation	Early fermentation	Early fermentation Poor quality	Poor quality of the products resulting from the processing when the grains are not of good quality	Poor quality of the products resulting from the processing when the grains are not of good quality and well dried
Mangoes	Early fermentation	Early fermentation	Early fermentation	Difficulties in preserving fruit	Difficulty in preserving fruit due to rising temperatures
Cashew nuts	The nuts are not well dried and still have water Difficult to preserve when the almonds are not well dried Breaks almonds when the seeds are not of normal size	The nuts are not well dried and still have water, which causes the kernels to break Difficult to store Breaks almonds when the seeds are not of normal size	The nuts are not well dried and still have water, which causes the kernels to break Difficult to store Breaks almonds when the seeds are not of normal size	The nuts are not well dried and still have water, which causes the kernels to break Difficult to store Breaks almonds when the seeds are not of normal size	The nuts are not well dried and still have water, which causes the kernels to break Difficult to store Breaks almonds when the seeds are not of normal size
Shea nut	The nuts are not well dried and still have water	The nuts are not well dried and still have water	The nuts are not well dried and still have water	-	The nuts are not well dried and still have water
Vegetable crops	Deterioration of the quality of the CVA dried chilli pepper when the rains are recurrent	Reduction of raw materials due to sorting for quality	Reduction of raw materials due to sorting for quality	Low quality of products in terms of color, weight, content and taste	Low quality of products in terms of color, weight, content and taste

Source: Field data, 2022

152. As for marketing, there are generally poor sales due to difficult access to production areas because of increasingly occurring floods, especially for mango and market garden crops, or the difficulty of transporting products to market.

Table 17 Impacts of climate change on the marketing and movement of products

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Corn	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain High corn prices due to lower production	Transportation of products is difficult during heavy rain High corn prices due to lower production
Mangoes	Lack of sales when it is difficult for customers to come to the field	Lack of sales when it is difficult for customers to come to the field	Lack of sales when it is difficult for customers to come to the field	Lack of sales when it is difficult for customers to come to the field	Lack of sales when it is difficult for customers to come to the field
Cashew nuts	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain
Shea nut	The transport of products is difficult during periods of heavy rainfall, given that nut collection is increasingly done in areas that are difficult to access (generally forests) with rudimentary means of transport (on foot, by bicycle)	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain	Transportation of products is difficult during heavy rain
Vegetable crops	Difficulty for consumers and traders to come to the field for shopping, mainly because of the poor quality of access roads	Difficult access to markets Lack of sales	Difficult access to markets, mainly due to poor access roads Lack of sales when buyers have difficulty accessing production sites	Difficult access to markets Lack of sales	Difficult access to markets Lack of sales

Source: Field data, 2022

Table 18 Impacts of climate hazards on maize value chains

Climatic hazards	**Impacts on the different links of the CVA**				
	Collection	Preservation/storage	Processing/ packaging	Transport	Sale
Heat	Acceleration of product degradation	Acceleration of product degradation	Effects on the quality of derived products	Destruction of products due to inadequate packaging, Reduction of the shelf life of products	Effects on product quality, deteriorated products
Delayed and shortened rains	Damage due to the fall of newly formed fruits	Reduction of product shelf life	Deterioration of the quality of the products (quality not always adequate for the transformation)		
Droughts	Increased wildfires with their corollaries on corn				

Strong wind		Destruction of storage facilities (granary)			
Flooding	Rapid destruction / deterioration of products in the field, difficulty in harvesting at the right time, contamination of corn by mold and aflatoxin	Destruction of storage infrastructures, development of mould and aflatoxin, deterioration of products, inefficiency of drying methods	Raw materials sometimes inadequate for processing	Difficulty of access to production areas and difficulties in evacuating products	Destruction of infrastructures, difficulty of transport, loss of products
Diseases		Mould development and pest attack	Poor quality raw material, poor quality finished products		Low and unprofitable selling price

Source: Synthesis made from field results (February 2021) of the literature review (Vodounou and Doubogan, 2016; Gastineau et al., 2015; Sodjinou and Kouton-Bognon, 2019; Aho et al., 2018 : Akponikpe et al., 2019)

Table 19 Impacts of climate hazards on the mango, shea and cashew value chains

Climatic hazards	**Impacts on the different links of the CVA**				
	Collection	Preservation/storage	Processing/ packaging	Transport	Sale
Heat	Acceleration of the degradation of the fruits even before they are ripe Early fall of the fruits	Acceleration of fruit degradation, Reduction of almond shelf life	Deterioration of product quality	Destruction of products due to inadequate packaging, Unfavourable physical conditions for transporting fruit, Reduction in the shelf life of fruit	Effects on product quality, spoilage (impact on access to safe and healthy food)
Delayed and shortened rains	Reduction in the amount of fruit to be harvested, Damage due to the fall of newly formed fruit	Reduction of product shelf life	Deterioration of the quality of the products (quality not always adequate for the transformation)		Effects on product quality, deteriorated products
Droughts	Increased wildfires with their corollaries on ripe or growing fruits				
Strong wind	Destruction of flowers and newly formed fruits, Deterioration of fruit quality	Destruction of storage facilities	Deterioration of fruit quality	Deterioration of fruit quality, unfavorable conditions for driving	Deterioration of fruit quality, Unattractive selling price
Flooding	Increased acidity of shea kernels, rapid destruction / deterioration	Deterioration of products, inefficiency of drying methods	Increase in the acidity level of shea kernels, Inadequate raw	Degradation of access roads / impassability of some access	Destruction of infrastructures, difficulty of transport, loss of products

	of fruits, difficulty in harvesting at the right date, contamination of fruits		materials for processing	roads to the market	
Diseases	Damage to mangoes by pests or diseases (fruit flies, termites, anthracnose and physiological accidents) and emergence of Bacteria Black Spot (BBS) which can lead to big losses in mango orchards	Fruit deterioration	Poor quality raw material, poor quality finished products	Deterioration of product quality	Poor quality fruit, Low level of satisfaction with the quality demanded by the consumer

Source: Synthesis made from field results (February 2021) of the literature review (Vodounou and Doubogan, 2016; Gastineau et al., 2015; Sodjinou and Kouton-Bognon, 2019; Aho et al., 2018 : Akponikpe et al., 2019)

Impacts of CCs on the processing of agricultural products

153. The impacts of climate change on these products are more or less indirect and minimal in all cases except for shea (and mango to some extent) (Table 20). Indeed, increasingly strong winds cause shea nuts to fall prematurely, and thus raw materials unsuitable for processing. The increasing irregularity of the rains appears to be the major factor that can affect the quality of raw materials that can be used for processing. According to the interviewees, the high temperatures getting more and more intense impinge on the processing process where fermentation is noted. Unpredictable rainfall impairs the quality of drying. It should also be noted that, indirectly, the drop in production contributes to the scarcity or even the high cost of raw materials.

154. In order to adapt to the effects of climate change, processors are stockpiling during periods of raw material abundance.

Table 20. Stakeholders' perception of the impact of CCs on the processing of agricultural products

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Shea Butter Almond	8	7	5	-	-
Corn derivatives	4	2	2	4	3
Cassava derivatives	4	2	5	4	4
Mango derivatives	6	5	1	3	0
Soybean derivative	5	5	4	4	5
Néré mustard	8	3	2	4	2
Yam Cossette	6	4	4	0	3
Palm oil	-	-	-	5	5

*CC=Climate Change; (1) Share out of 10 of the population practicing processing; (2) Considering a scale of 10, with 0=No impact and 10=Very high impact
Source: Field data, 2022

Trade and other sources of income

155. The trade sector is also impacted by the effects of climate change, although more indirectly. The manifestations of the effects of climate change can be summarized as the degradation of the routes for the transport of marketable products. We also note the high cost or even the scarcity of products due to the decrease in production caused by the irregularity of rainfall. There is also a decline in the quality of products due to the increasing droughts, or rains that fall during the harvest period, or rains that have interfered with the proper drying of marketable products such as corn, cashew nuts and shea nuts.

156. With regards to other sources of income, the effects of climate change are related to an increase in electricity consumption due to the persistent high heat, difficulties in mobility and access to markets in certain periods when the rains are absent.

Table 21 Stakeholders' perception of the impact of CC on trade and other activities

Cultures/activities	**Copargo**	**Djougou**	**Glazoué**	**Zogbodomey**	**Zagnanado**
Corn	4	3	2	5	2
Mangoes	4	5	4	4	4
Cashew nuts	3	3	4	5	4
Shea nut	2	1	3	0	4
Vegetable products	4	4	4	6	5
Livestock	4	5	1	4	2
Processing products	5	4	3	3	2
Handicraft	2	2	2	2	0
Small business	2	2	2	2	0
Provision of services	-	1	3	1	0
Plant production	5	6	7	7	8

*CC=Climate Change;(1) Share of population trading out of 10;(2) Considering a scale of 10, with 0=No impact and 10=Very high impact
Source: Field data, 2022

Effects of CCs on forestry

157. The collection of shea nuts, medicinal products, fishing and fish farming are more exposed to the effects of climate change (Table 22). In general, and in almost all of the 5 communities, the effects of climate change can be seen in the disappearance of certain species of high medicinal value due to changes in their microclimate, the decrease in productivity of shea trees due to irregular rainfall, and the early drying of watercourses that impinge on aquaculture production.

158. As coping strategies in forestry, we note the securing and restoration of forests. Farmers in the communes of Copargo, Djougou and Zogbodomey, use improved fireplaces to reduce the use of wood for energy as little as possible. Vegetable gardens are increasingly a coping strategy adopted by some, especially for the reproduction of species with high medicinal value. In terms of aquaculture, actors are raising fish in above-ground tanks and sometimes gravity drainage to ponds.

159. Restoration, securing through sacredness and law enforcement are proving to be effective means of ensuring the sustainability of forests, according to the producers interviewed. The adoption of improved stoves and the installation of vegetable gardens near the household are effective means of adaptation for the residents.

160. The various adaptation strategies in the logging, fishing and fish farming sectors that did not work well are listed in Table 23. The failure of these strategies lies in the fact that they create other social problems such as conflicts (repression by water and forestry), lack of technical competence or the high cost of their implementation.

Table 22 Stakeholders' perception of the impact of CCs on logging

	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
Collection of shea nuts	8	8	3	0	4
Firewood	5	2	1	0	1
Lumber	4	6	1	0	1
Charcoal production	3	8	2	3	2
Hunting	5	5	3	2	6
Medicinal products (leaves, roots, bark, etc.)	8	5	5	5	7
Non-timber forest products	8	-	1	5	7
Fishing	3	2	6	5	8
Fish farm	5	8	8	6	8

*CC=Climate Change;(1) Share of population engaged in logging, fishing and fish farming;(2) Considering a scale of 10, with 0=No impact and 10=Very high impact
Source: Field data, 2022

Table 23. Forest adaptation or preservation strategies that did not work well according to producers

Municipalities	Coping strategies that did not work well
Copargo	Repression of Water and Forests on the cutting of shea butter (social tension)
Djougou	Creation of a shea tree park (Permanent pressure from local residents for wood) Fish production in off-ground tanks (high cost of acquisition)
Glazoué	Adoption of pharmaceutical products (High cost of products)
Zogbodomey	Fish production in off-ground tanks (high cost of acquisition) Adoption of pharmaceutical products (High cost of products) Reconversion to market gardening in the lowlands in favourable periods (lack of technical skills)
Zagnanado	Establishment of private plantation (cost of implementation and monitoring)

Source: Field data, 2022

Economic impacts of CC on value chains

161. In a context where climate change is affecting practically all crops, producers need to adapt to it, which requires other production methods/techniques. In this sense, **production costs have practically doubled in comparison to ten years ago. It should be noted that this increase cannot solely be linked to climate change: it is also due to inflation and overal increase of living costs in Benin – including increase cost of field labour**. To limit the effects of climate change, producers need to buy seeds of new varieties which price in kg oscillates around 500 CFA contrary to 10 years ago when the kg was bought at 200 or even 300 kg. The same is true for bags of fertilizer (NPK and urea), the price of which has increased by more than 25% from 12,500 to 17,000 today. The strong presence of parasitic attacks is a problem that does not escape any crop, especially caterpillars on maize and white flies on perennial crops and market garden crops. The producer must therefore plan the phytosanitary treatment for his field.

162. Regarding the cost of sale, more and more today, we note the increase in transport costs which could be explained by the increase in the price of fuel having increased by more than

10%. Faced with this, the producer or trader will raise the price of the product to balance his operating account.

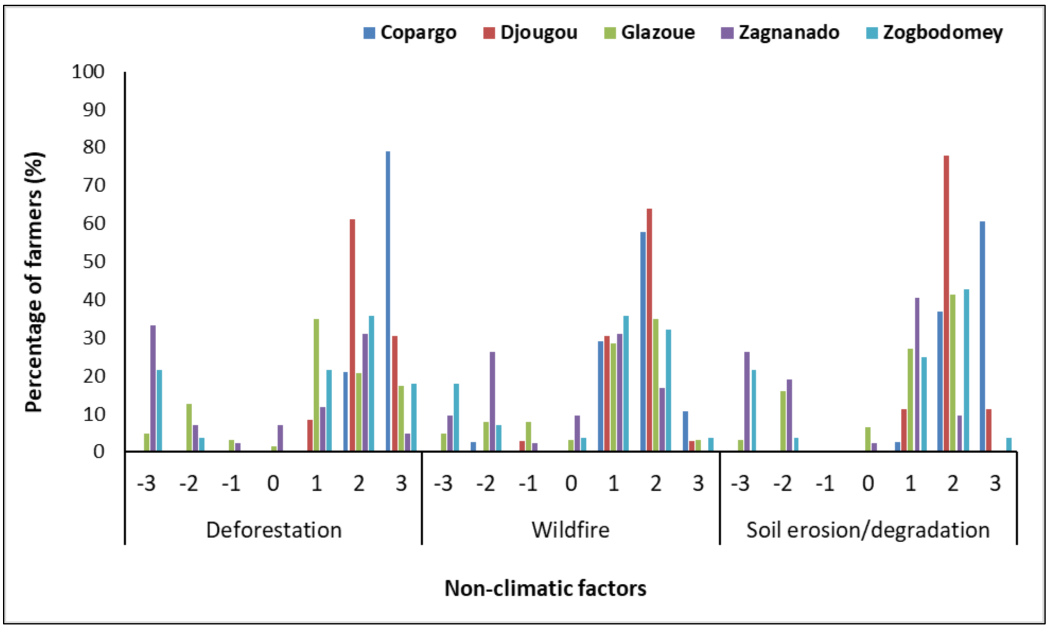
4.3.4 Unsustainable practices

163. The impacts of climate change on ecosystems combined with the population growth and overextraction of the natural resources will lead to serious impact of forest resources in the Ouémé Basin.

164. Non-climatic factors such as agricultural land expansion through slash and burn, inappropriate and unsustainable forest exploitation mainly through fuel wood usage and charcoal fabrication, hunting, interacting with climate stress, are likely to amplify the decline of the forest. These non climatic factors are, nontheless, being exacerbated by climate change: as yields decline because of changing climate patterns, communities increasingly turn to over extraction of wood for charcoal production, illegal logging, and clearing of forest lands and natural habitats for agriculture. This further accentuates the ongoing depletion of the natural resources and land degradation, which is in turn exacerbated by lack of appropriate agriculture practices.

165. In general and according to farmers, the non-climatic causes of vulnerability (deforestation, wildfire, soil erosion and degradation, as a result of intense agricultural activities and/or natural phenomenon), have significantly increased over the Oueme basin during the past few years, compared to the historical observations in the five communes. Examples of these phenomenon as observed during the field visits are shown in Figure 58. Farmers confirmed the impacts of human activities and non-climatic factors as further exacerbating climate change effects[103].

Figure58 : Farmers perceptions on changes of non-climatic factors



Decreased (-3 High, -2 moderate, -1 slight), 0 (no change), Increased (+1 slight, +2 moderate, +3 High)

[103] Akponikpè PBI (2022) Climate change and Environmental Impact study in the Oueme-basin (Benin): Update of literature and Analysis of the perceptions of climate change and farmers adaptive strategies. FAO Consultancy report, Fev-March 2022.

Table 24: Farmers testimonies regarding impacts of human activites and non-climatic factors

Evidences	Farmers	Localities	Sub-basin
"There are demographic problems, the destruction of forests, the manufacture of coal impact on the clouds and the rains become rare"	I.O., maize farmer (male)	Magoumi , GLAZOUE	Middle Ouémé
"Caring for cashew trees is very difficult. Fires that have become too frequent can destroy everything"	G.S, Cashew and maize farmer (male)	Gotho , Wèdèmè (GLAZOUE)	
"In our parents' time there were great species of trees that helped bring the rains, now they have been destroyed which has reduced the clouds and rainfall."	Z.S, orn, millet, cashew (male)	Kakindoni , Kpellebina , DJOUGOU	Upper Ouémé
"The regular passage of transhumant cattle promotes the degradation of our soils by contributing to the hardening of the soil. This lowers fertility and increases drought in the event of a lack of rain."	T.A, Corn, mango farmer (male)	Dewa , Serou , DJOUGOU	

Figure59: Field observations of Non-climatic factors

Deforestation at Kpakpaza (Glazoue)

Burned area at Kpakpaza (Glazoue)

Degraded land at Dalkpanhoun (Copargo)

Preparation of charcoal at Agbladoxo (Zagnanado)

166. In general, the practice of slash and burn agriculture is more and more common in the target municipalities. Farmers argue that this practice promotes soil fertility through biomass, the lack of labor to clear land and time saving or to avoid the passage of oxen causing soil compaction. According to Igue et al (2013)[104], the practice of slash and burn cultivation is the main human related factor of soil degradation in Benin. Cultivated land (slash and burn) is being depleted at an accelerated rate and crop yields are continuously declining; which dangerously compromises the productivity and sustainability of the entire agricultural system. The process of soil fertility loss is accelerated by climatic conditions, in particular heavy tropical downpours in southern and central Benin. In addition, shifting cultivation on slash and burn destroys the flora, organic matter as well as the fauna and microfauna of the soil. The slash and burn practices used by farmers also increase the pressure on available forest resources and this leads to scarcity and the impoverishment of land in natural resources[105].

167. The practice of commercial charcoal fabrication has become a common practice for nearly two decades, according to producers in the study areas. In all cases, this activity complements agriculture, which productivity is decreasing. In general, producers consider this activity as the one that makes it possible to get through the dry season. For others, because the land is no longer fertile, commercial charcoal making is another way to survive.

168. The woods exploited for the preparation of charcoal include African mahogany (Caïlcédrat), teak, cashew, Afzelia, néré and sometimes fruit trees such as mango and cashew.

Communes	**Reasons for clearing land**	**Reasons to use slash-and-burn techniques**
Copargo	- Increase in the need for land for agriculture (especially cotton and cashew) -Search for fertile land due to the impoverishment of land already exploited -Population explosion and migration	- Fertilization of the plot through the burned biomass -Saving time and minimizing costs related to manual clearing
Djougou	Search for fertile land for the establishment of crops Search for timber and charcoal as alternative sources of income Population explosion	-Strengthen soil fertility through biomass -Fast cleaning method and without great cost - Need for hunting
Glazoué	Increase in the need for exploitable land Yam cultivation requirement Impoverishment of land already exploited	Lack of manpower Avoiding the passage of oxen game hunting
Zogbodomey	Demographic explosion causing increased land needs	Facilitates soil preparation cultural issue Lack of means to do the plowing
Zagnanado	Migration of DANMENOU producers from Djidja to the commune of Zagnanado in search of land	Need to hunt cultural issue

[104] Igue A.M., Saidou A., Adjanohoun A., Ezui G., Attiogbe P., Kpagbin G., Gotoechan-Hodonou H., Youl S., Pare T., Balogoun I., Ouedraogo J., Dossa E., Mando A. et Sogbedji J. M. (2013). Evaluation de la fertilité des sols au sud et centre du Bénin. Bulletin de la Recherche Agronomique du Bénin (BRAB) Numéro spécial Fertilité du maïs. Pp. 12-23.

[105] Projet Forets Classées Benin (PFCB, 2019). Cadre de Gestion Environnementale et Sociale (CGES). Direction Générale des Eaux, Forets et Chasse ; Ministère du Cadre de Vie et du Développement Durable. Rapport final. Cotonou, 165p.

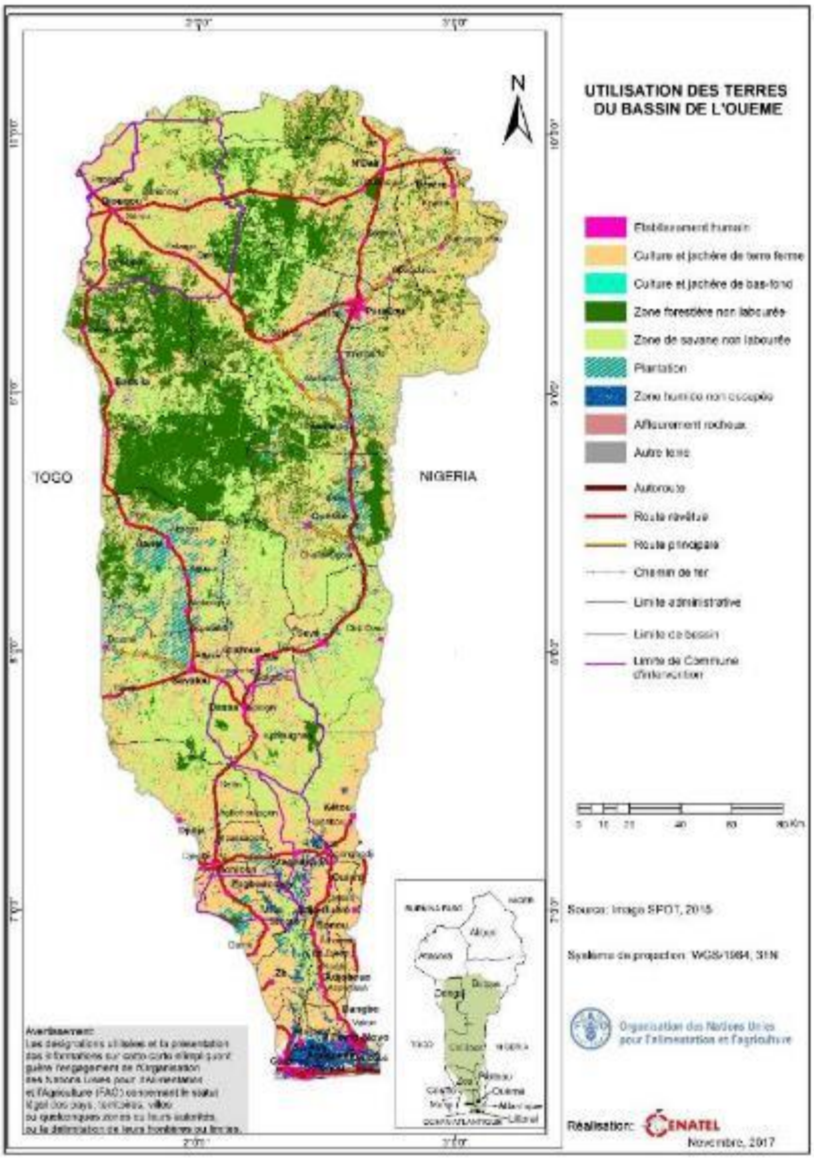
Figure60: Unsustainable agricultural practices in the Ouémé Basin

There are several agricultural practices that are commonly used by smallholder farmers in the Upper and Middle as agricultural productivity declines because of climate change impact. These they contribute to soil degradation, trapping smallholder farmers in a vicious cycle. The main ones being:

-**Cultivation on larger surfaces through land clearing**, without sufficient restitution of nutrients, without organic restitution on over-used lands or new lands extensively occupied and where the fertility decline of cultivated soils is a primary concern of farmers.

- **Cultivation along riverbanks**, where soil is more fertile and water abundant, which implies clearing of riverbanks, thereby leading to erosion, silting and increased flood risks

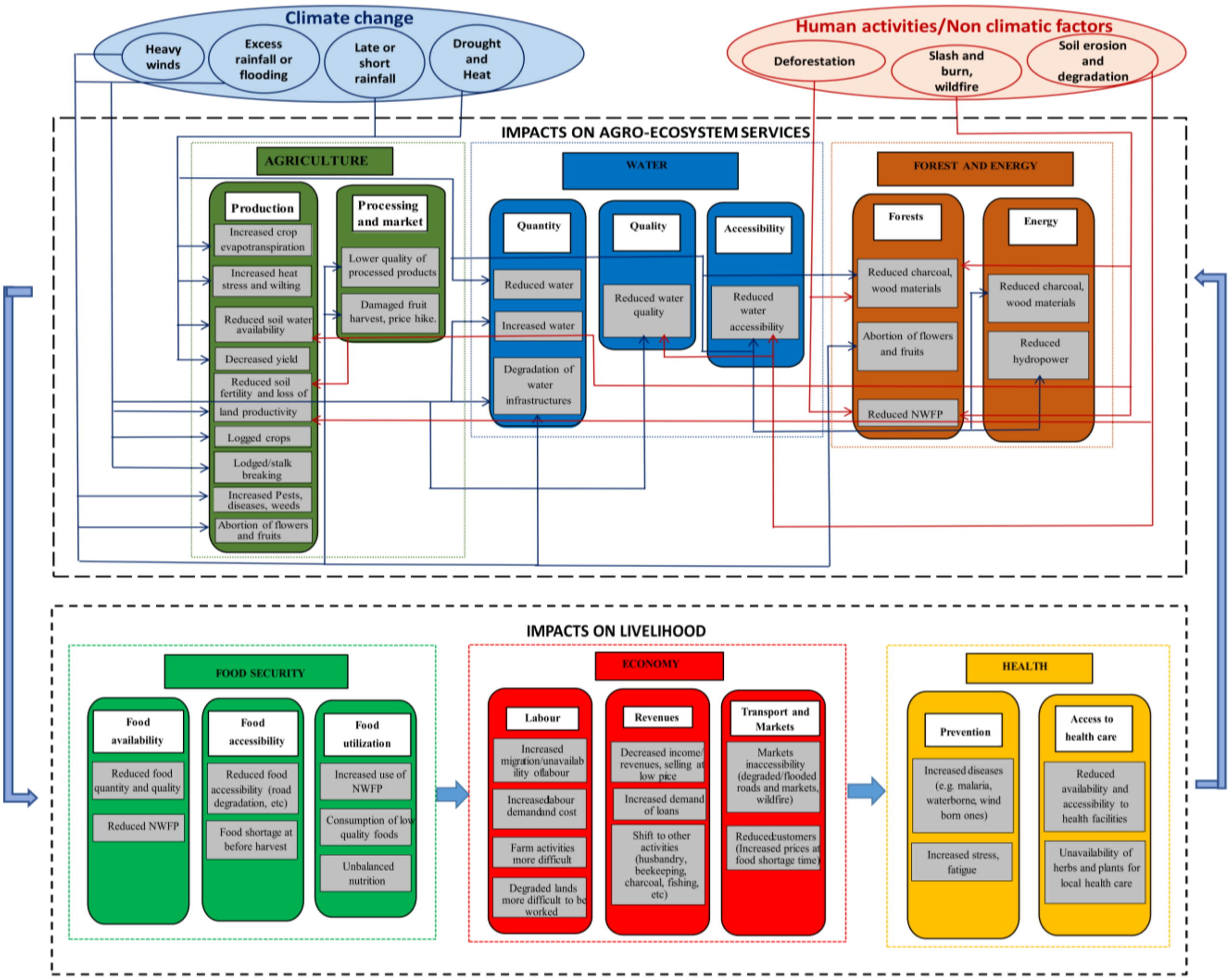
-**Agricultural encroachment on forest areas** or fragile ecosystems and fallow land, as a result of land clearing for yam and cotton, in the North and North Center of the Basin, where the largest land reserves are located.



Source : Cenatel, 2017

169.Climate change impacts combined with unsustainable agricultural and land exploitation practices contribute to the depletion of ecosystem services that are key to support agricultural productivity in the Oueme Basin (Benin). A decline in agricultural productivity (driven by climate change impacts along with unsustainable activities) lead farmers into a vicious cycle of further over-exploitation of their natural resources as they search for fertile lands (through wood extraction) or compensate agricultural losses by other activities (like the preparation and sale of charcoal). This further impacts livelihoods in Benin, as depicted in Figure 61.

Figure61: Linkages of climate change, human activities and non-climate factors on ecosystem services and livelihood in the Ouémé river basin in Bénin[86]



4.4 Exposure of communities

170. The project will be implemented in five municipalities of the Upper and Middle Ouémé Basin, namely Copargo, Djougou for the Upper Valley; Glazoué in the transition area; and Zogbodomey and Zagnanando for the Middle Valley. This is a densely populated area of Benin: according to the results of the fourth general population and housing census (RGPH), which were cross-checked with field data, the population of the Ouémé basin, 6 million people, has a growth rate at 3.5%. Within this area, the Upper and Middle valley of the Ouémé mostly comprise young people and constitute the majority of the country's workforce[106]. In 2002, it was estimated that 25% of households were headed by women (compared to the national average of female-headed households was 22.7%). The average household size is 4.6 people compared to the national average of 5.6. Table 12 shows basic statistics of the five municipalities located in the Upper and Middle Ouémé basin: their surface, total population and the population located in the basin areas of each municipality. Women represent approx. 50% of population.

Table25 Municipalities, acreage and population of the OCRI project target municipalities

Communes	*Surface area (km^2)*	*Total population*	*Proportion of the basin's inhabitants*	*Number of people living in the basin*
Copargo (Source Ouémé)	876	70,938	41%	29,085
Djougou	3,966	267,812	96%	257,099
Glazoué	1,750	124,431	100%	124,431
Sub-total Upper valley	**6,592**	**463,181**	**89,0 %**	**410,615**
Zagnanado	540	55,061	100%	55,061
Zogbodomey	139	92,935	88%	81,783
Sub-total Middle valley	**679**	**147,996**	**92,5**	**136,844**
Total	**7,271**	**611,177**	**89,6%**	**547 459**

171. The municipalities are characterised by a high concentration of population and agricultural land, as well as abundant water resources, currently over- and mis-exploited. While 70% of Benin's population is engaged in the agricultural sector, about 61% of this population in the Ouémé Basin rely on agriculture as main (and only) economic activity, which is essentially subsistence farming with small farms and is based on rain-fed agriculture.

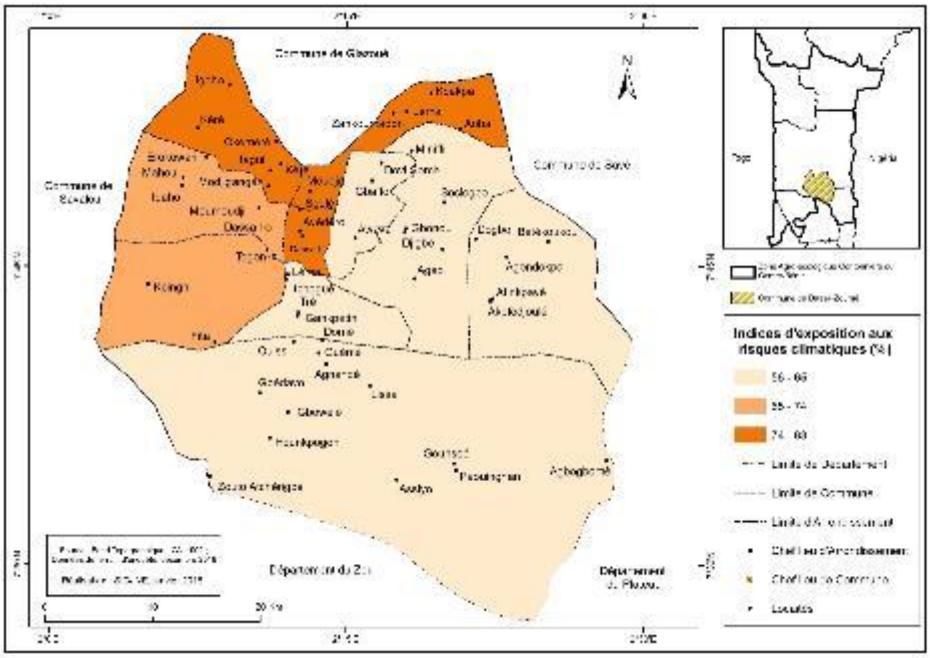
172. Findings from the climatic data analysis combined with population interview and consultations indicate that the Upper Ouémé Basin, where Copargo and Djougou are located, is particularly exposed to the late and violent rains, long period of dry spells and intense droughts, excessive heat, and violent winds. As a result, food crop is negatively affected, silting is observed in the Ouémé River leading to floods downstream, and existing hydraulic networks are being damaged. In the transition area (Glazoue), intense droughts, late rains and excessive heat are the most prominent climate-related hazards. This also affects food and cash crop production (including shea and cashew), while causing damages to existing infrastructures.

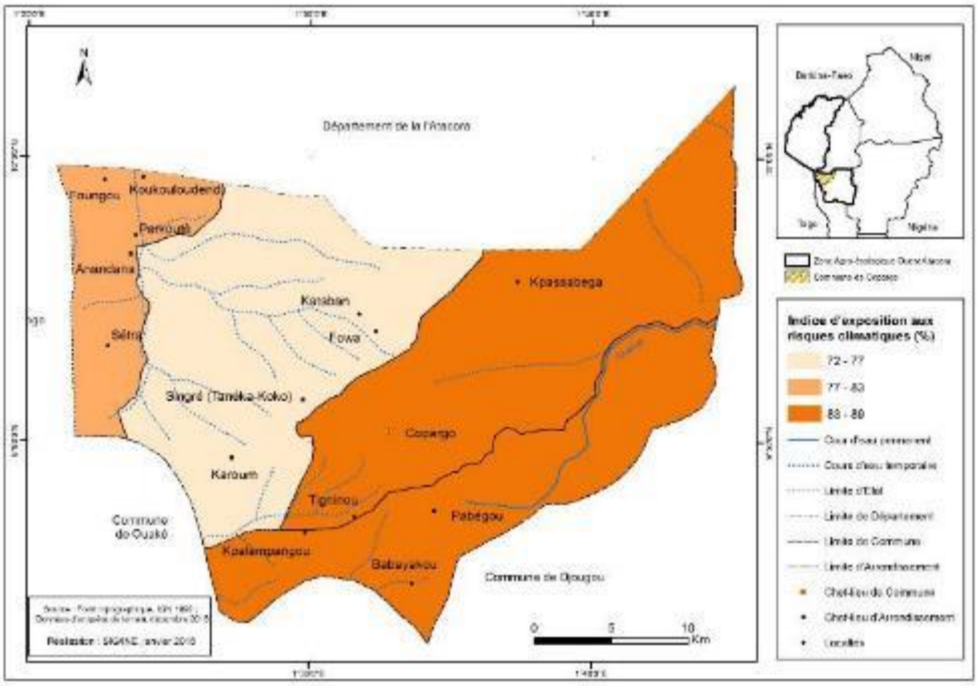
[106] RGPH, 2002

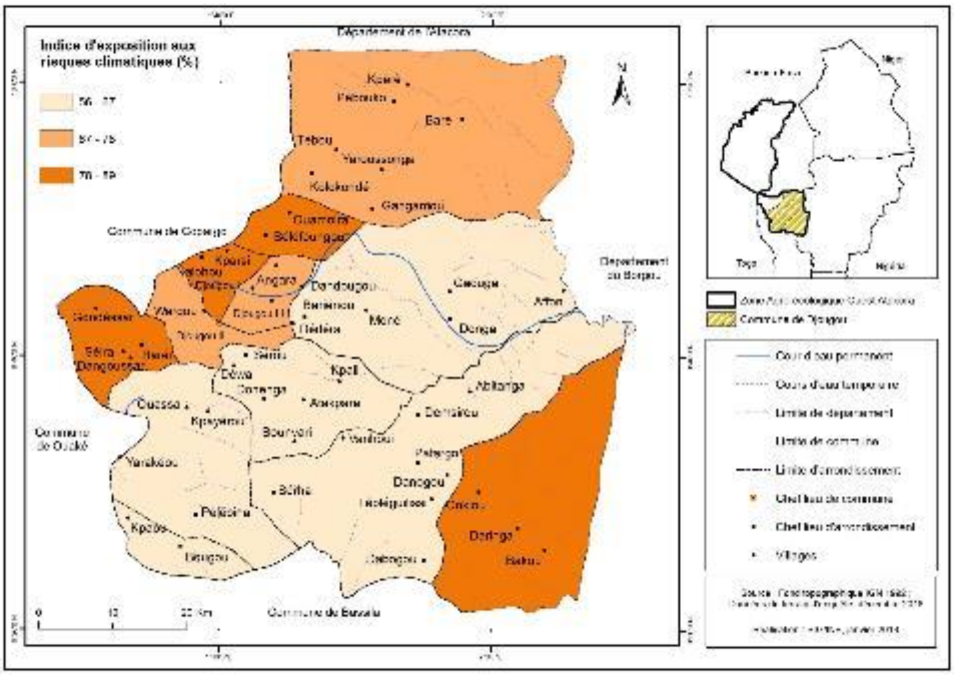
Finally, in the Middle Ouémé (Zagnanado and Zogbodomey), floods, long droughts and heavy rains are noted as key climate change impacts, with negative effects on food crops, land and water resources. See Figure 62 for climate change exposure in the five target municipalities.

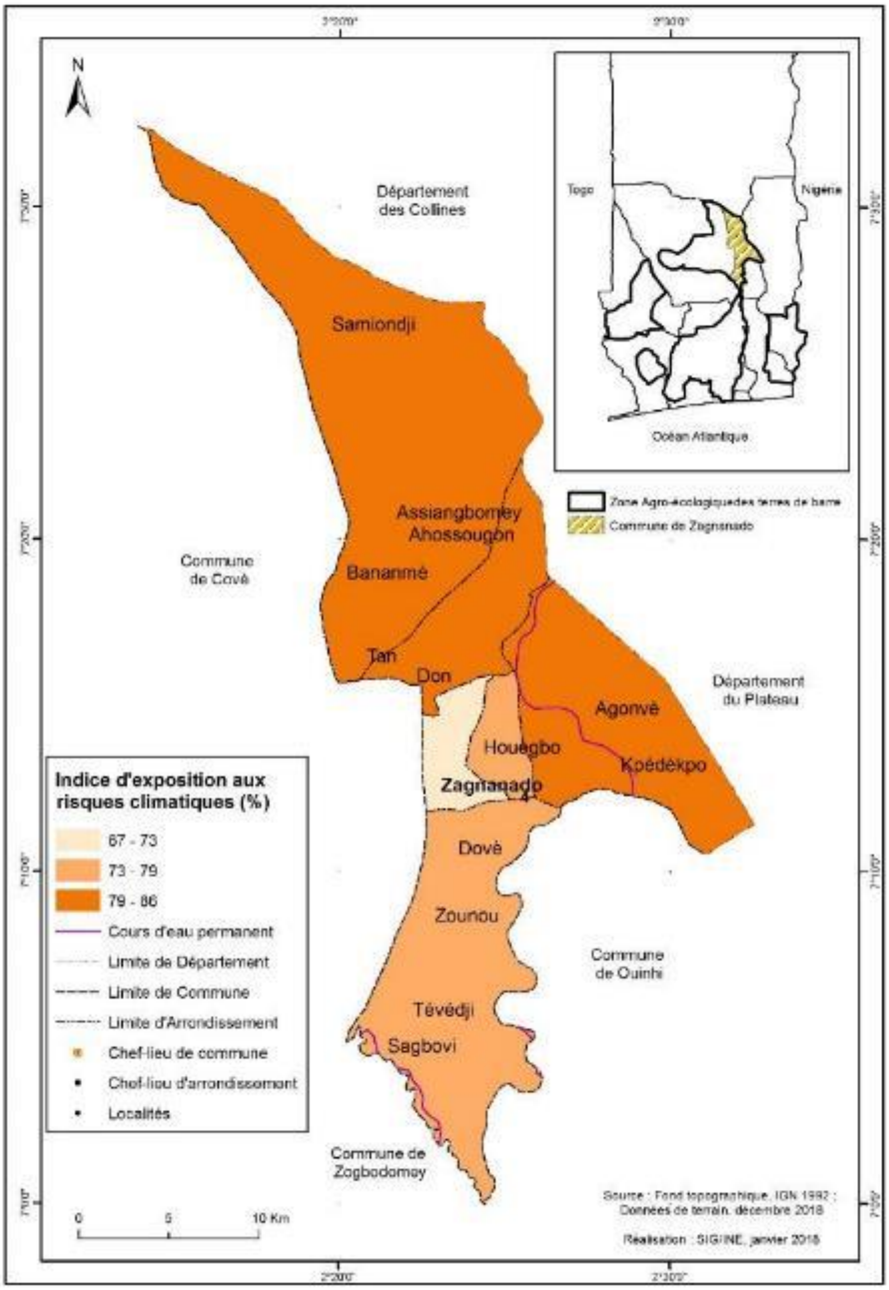
173.As part of the formulation of OCRI, FAO commissioned the National Institute of Water (INE) to assess the exposure of each targeted community, as per images below.

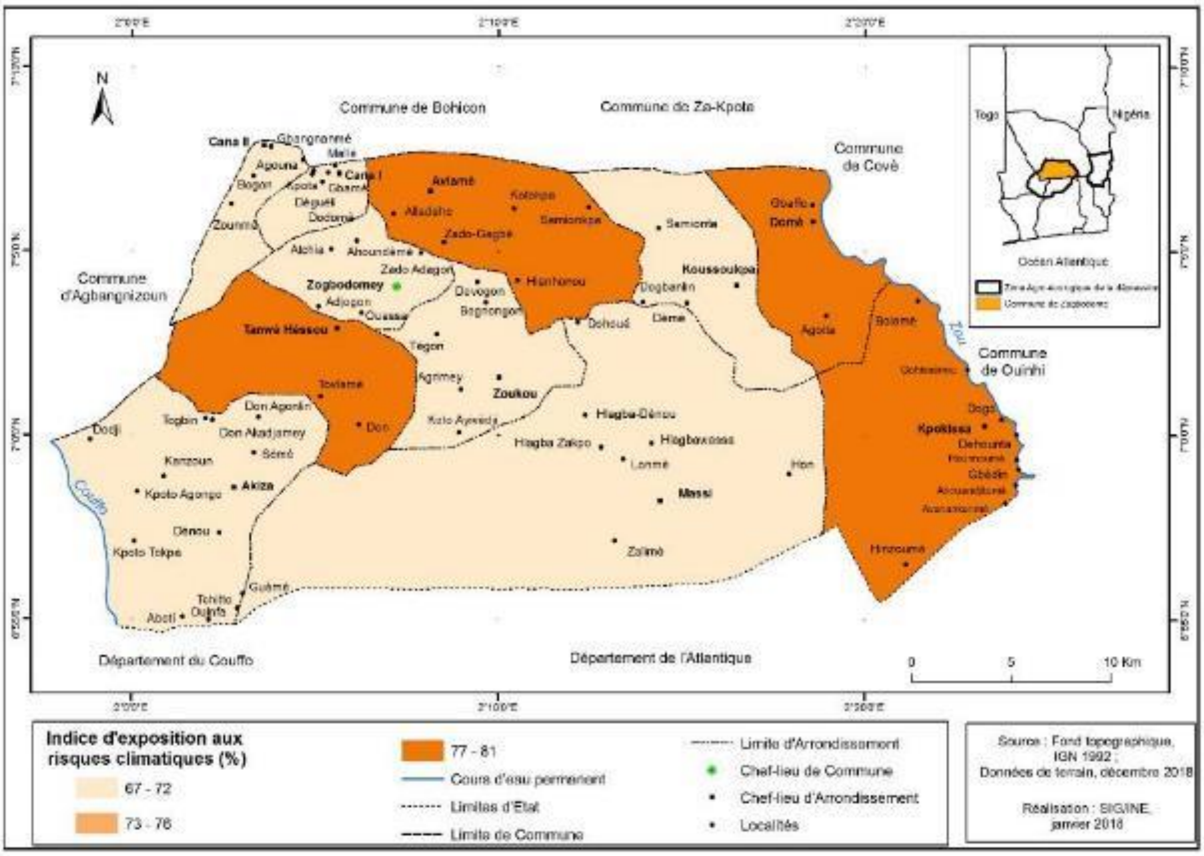
Figure62: Exposure map of the intervention municipalities




Département de l'Atacora
Kpassabega
Copargo
Tignirou
Pabégou
Kpalampangou
Babayakou
Commune de Djougou
Commune de Ouaké
Foungou
Koukouloudendi
Pamouté
Anandana
Séra
Karabian
Fowa
Singré (Tanéka-Koko)
Karoum
Indice d'exposition aux risques climatiques (%)
72 - 77
77 - 83
83 - 89
Cours d'eau permanent
Cours d'eau temporaire
Limite d'Etat
Limite de Département
Limite de Commune
Limite d'Arrondissement
Chef-lieu de Commune
Chef-lieu d'Arrondissement
Localités
Réalisation : SIGANE, janvier 2016


Département de l'Atacora
Indice d'exposition aux risques climatiques (%)
Commune de Copargo
Département du Borgou
Commune de Ouaké
Commune de Bassila
Kolokondé
Gangamou
Ouamou
Bélléfoungou
Dandougou
Barienou
Moné
Donga
Kpali
Abitanga
Sérou
Onklou
Dendougou
Barei
Kpayérou
Bouryori
Danogou
Pélébina
Patargo
Dabogou
Séra
Baréi
Dangoussar
Onessa
Djougou
Kpebo
Bakou
Daringa
Cours d'eau permanent
Cours d'eau temporaire
Limite de département
Limite de commune
Limite d'arrondissement
Chef lieu de commune
Chef lieu d'arrondissement
Villages


Département des Collines
Samiondji
Assiangbomey
Ahossougon
Bananmè
Commune de Covè
Tan
Don
Agonvè
Département du Plateau
Houegbo
Koédékpo
Zagnanado
Dovè
Zounou
Commune de Ouinhi
Tévèdji
Sagbovi
Commune de Zogbodomey
Indice d'exposition aux risques climatiques (%)
67 - 73
73 - 79
79 - 86
Cours d'eau permanent
Limite de Département
Limite de Commune
Limite d'Arrondissement
Chef-lieu de commune
Chef-lieu d'arrondissement
Localités
Togo
Nigéria
Océan Atlantique
Zone Agro-écologiquedes terres de barre
Commune de Zagnanado
Source : Fond topographique, IGN 1992 ; Données de terrain, décembre 2018
Réalisation : SIG/INE, janvier 2018
0
5
10 Km
N


Commune de Bohicon
Commune de Za-Kpota
Commune de Covè
Commune d'Agbangnizoun
Commune de Ouinhi
Département du Couffo
Département de l'Atlantique
Zogbodomey
Tanwé Hèssou
Zoukou
Massi
Akiza
Kpokissa
Koussoukpa
Domè
Avlamè
Cana II
Cana I
Indice d'exposition aux risques climatiques (%)
67 - 72
73 - 76
77 - 81
Cours d'eau permanent
Limites d'Etat
Limite de Commune
Limite d'Arrondissement
Chef-lieu de Commune
Chef-lieu d'Arrondissement
Localités
Source : Fond topographique, IGN 1992 ; Données de terrain, décembre 2018
Réalisation : SIG/INE, janvier 2018

5 Vulnerability of the target municipalities

174. This section assesses the degree to which the targeted project beneficiaries are susceptible to the adverse effects of climate change and weather extremes based on current farming practices, economic opportunities in the agricultural sector, and gender differentiations. The resulting vulnerability is exacerbated by socio-economic conditions in the Upper and Middle Ouémé Basin: poverty is affecting 53.3% of the population in Borgou (Middle Oueme), 43.3% in Donga (Middle Oueme), 39.8% in Zou, and 25.6% in Collines (in 2019 – compared to the national average at 38.5%)[107]. It should be noted that poverty is more prevalent in rural areas than in urban areas. Finally, food insecurity is especially prevalent in Middle Oueme (Borgou and Donga), affecting 10 to 20% households – and over 20% in Glazoue[108].

5.1 Farming practices

175. As mentioned in the previous chapters climate change challenges existing agricultural practices and calendars, through shifting seasonal patterns, increased temperatures, and more frequent extremes events, among others. The challenge is all the more important that agricultural practices are often basic or unsustainable and constrained by the limited financial resources, technical support or equipment available to the communities in the project area.

176. The vast majority of the population in Upper and Middle Ouémé relies on agriculture as their only economic activity. Food production and cash agriculture will increasingly be affected by hydrological and climatic risks. The vulnerability of smallholder farmers is further exacerbated by climate change impacts leading to difficulties of river transport resulting from long dry periods, the destruction of assets and socio-economic infrastructures including roads and markets. This impairs, for example, the transport of products and the income of stakeholders. In a nutshell, climate change is one of the main factors preventing the populations of the Upper and Middle Ouémé Basin from escaping from poverty and food insecurity[109].

[107] INSAE, Juillet 2020: Note sur la pauvrete en 2019.
[108] See WFP, Analyse Globale de la Vulnerabilite et de la Securite Alimentaire (AGVSA), Republique du Benin, 2017
[109] http://unfccc.int/resource/docs/napa/ben01f.pdf

Table26: The impact of Climate Change on the Upper and Middle Ouémé climate and the crop growing conditions.

		Upper Ouémé Watershed			*Middle Ouémé Watershed*	
	Ouémé overall	**Copargo**	**Djougou**	**Glazoué**	**Zogbodomey**	**Zagnanando**
Zone **Baseline Climate**		West-Acatora Continental	West-Acatora Continental	Central Cotton Tropical	Terres de Subequatorial	Depression Subequatorial
Rainfall period (up to 2000)	Mixed impact	mid-April to mid October	mid-April to mid October	two rainy seasons	mid-April to mid October	mid-April to mid October
Rainfall volume (2000 - 2020,	Mixed impact	800 to 1300	800 to 1300	1190	1400	1400
Rainfall volume (2000 => 2050)	Mixed impact	+ 20%	+ 20%	+ 10%	- 3%	- 3%
Rainfall variability (2000 => 2020)	Mixed impact	+ 0.68%	+ 0.68%		-1.26%	-1.26%
Rainfall variability (2000 => 2050)	More erratic	+ 2.2%	+ 2.2%		+0.35%	+0.35%
Rainfall distribution - climate change impact	More rain in less rain days; more torrential rains	More torrential rains	More torrential rains	One rainy season left. With high risk	No clear change projected	No clear change projected
Average change in temperature (2000 - 2020; °C)	+ 0.55	+ 0.60	+ 0.60		+ 0.48	+ 0.48
Projected change in temperature (2000-2050; °C)	+ 1.60	+ 1.78	+ 1.78	+1.0 to +3.0	+ 1.47	1.47
Climate change - impact on growing seasons	Evapotranspiration up	Growing season more erratic	Growing season more erratic	Growing season reduced from	Growing season more erratic	Growing season more erratic
Climate change - Impact on water availability (2000 - 2050)	-39%	-40% to -60%	-40% to -60%	-40% to -60%	-40% to -60%	-40% to -60%
Climate change - Impact on soil erosion & water quality	negative	Ongoing erosion	Ongoing erosion	River water polluted	River water polluted	River water polluted

177. Vulnerability in the agricultural sector is underpinned by existing practices. Like the rest of Benin, traditional family type of agriculture is the main economic activity, applied on small farms (often < 2 ha), oriented towards food crops and often including small livestock (poultry, small ruminants or pigs). It is mainly rain-fed, semi-itinerant agriculture on burnt land, characterised by low productivity and low yields. Farmers use basic agricultural equipment, such as hoe, and the use of harnessed cultivation on some farms. The production system is a shifting cultivation system involving large areas of uncultivated fallow land and high crop rotation. In addition to crops and vegetable, mango, cashew trees and / or of shea tree (Vitellaria paradoxa) of the agroecosystems constitute important sources of income for the producers. These trees are planted on the fields, in orchards or found in the wild (shea). Finally, to complement agriculture, some farmers have developed other activities such as livestock, fishing, beekeeping, and trade.

178. Access to irrigation is limited or non-existent, and the few functioning irrigation systems are either scattered or inoperable, because of a lack of technical capacity for maintenance. It is estimated that 14% or 360,000 hectares of arable land in the Ouémé basin can be irrigated. Despite this potential, only 1% of annually cultivated land is irrigated (SDAGE, 2013). Irrigation in the target area remains traditional and little modernised. The most widely used method is gravity-fed irrigation, while the majority of farms depend on rainwater and have no modern means of drainage and water supply. For example, the department of Zou has three types of irrigation: large-scale irrigation, urban and peri-urban irrigation and irrigation of inland valleys[110]. The total irrigated area was 163 ha with 96 ha of large-scale irrigation, 28 ha of

[110] Peter Speth et al. en 2010

urban and peri-urban irrigation and 36 ha of inland valley irrigation[111] (see Water work Annex 17).

179. As a result of low productivity, crops that are produced by rural communities in the Ouémé Basin are essentially used for direct consumption. If there is a surplus, it is sold wholesale to traders or on local markets, shortly after harvesting (due to limited storage capacity), at a very low price. Community members are often not aware of the market prices of these products, nor are they able to negotiate increased prices because the products are often not processed or packaged. They also have limited access to storage facilities, which would enable them to sell products when the market price rises, as well as protect them against pests or climate-related hazards. Poverty, as indicated above, is a key feature of the project area; it is also an important driver of climate change vulnerability, which increases the propensity of individuals or households to be harmed by climate stresses and extremes. In return, climate change exacerbates poverty, particularly in less developed countries, forming poverty traps and annihilating poverty alleviation efforts[112]. Several agro-products, grown in the Upper and Middle Ouémé Basin, are highly demanded on local, regional and international markets – namely maize, cashew, shea and mango – , and, therefore, could uplift farmers out of poverty and make them less vulnerable to the impacts of climate change. Yet, at the moment, the development of these value chains is hindered by several factors, affecting the demand and production side.

5.2 Women's vulnerability to climate change

180. Female-headed households in the Upper and Middle Ouémé Basin have specific responsibilities, rights and socio-economic constrains, which make them particularly vulnerable to poverty, climate change and food insecurity. For example, women have the responsibility to collect water and wood for the household, of which availability is reduced because of climate change impacts on natural resources. Therefore, the extra time they spend looking of these resources cannot be invested in other, income-generating activities.

181. In Benin, the structure of the population working in the field of cash crops – which increases income access – is largely dominated by men (70%). As head of household, the man is also in charge of the field and holds ownership title or lease and ensures the organization and the management of the plot. There are different modalities to access land in Benin, but they all present challenges for women. Women would gain access to land by purchase (though they are often without income), inheritance, alliance and gift; men by patrilineal inheritance and purchase. 73% of available areas occupied by man belong to them while only 54% of the land used by women actually belongs to them. In fact, 53% of women own at least one plot of land versus 78% of men. In the Upper and Middle Ouémé Basin, women rely mainly on the willingness of men to provide land for their personal activities. As land tenure security is a key

[111] https://books.google.fr/books?id=8ZYwIic9JxAC&pg=PA299&lpg=PA299&dq=Donga+irrigation+B%C3%A9nin&source=bl&ots=FuMkgUvMt1&sig=6rtnkHJwu_UP7rwMzu_Vl4H2ZuI&hl=fr&sa=X&ved=0ahUKEwih29z_69nYAhUMKlAKHUbmBeYQ6AEIQDAE#v=onepage&q=Donga%20irrigation%20B%C3%A9nin&f=false

[112] Leichenko R. M. & Silva J. A. (2014). Climate change and poverty: Vulnerability, impacts and alleviation strategies. Wiley Interdisciplinary Reviews Climate Change 5(4). DOI: 10.1002/wcc.287

factor in the decision-making process, for example on investing in soil protection and soil fertility improvement measures, or planting trees, women who often do not own land, have less capacity to adopt sustainable, climate-resilient agricultural practices. Land ownership is also important in order to invest in planting tree crops[113], in investing in soil restoration through using agro forestry and cover crops.

182. When they access land, women often receive the least fertile field. The few women who are owner of land or farmers are heirs, widows or urban women who invest in agriculture. In terms of agricultural activities, post-harvest processing is carried out by women. This includes the transformation of palm nuts into palm oil and soy into cheese; paddy rice in cargo rice; cassava in gari; peanut in patties and peanut oil and red oil in soap. Most women in this sub-sector are often organized into women's groups, but receive few supports to boost their business. Indeed, women have less access to extension services, inputs and information, the yields they obtain in their plots are often lower than yields obtained by men. Women are also present in value chains which are not a priority for the government (cowpeas, peanuts, soja, and vegetables). While men opt for migration when drought or floods destroy household livelihoods, women are more limited because of their domestic responsibilities, traditional roles and gender-based division of labour. When men migrate, women have to cope with the post-disaster situation and take care of the household, generating enough income for food and the needs of the family. In climate-change-related disaster contexts an increase in gender-based violence has been documented. Increased conflicts concerning access to pastures, water and land will increase tensions and could lead to higher incidence of Gender Based Violence (GBV). Climate-change effects on crop yields and climate-change disasters will lead to higher household indebtedness, which may in turn contribute to more household-level tensions and an increase in GBV.

183. Finally, the training of women in resilient agricultural practices is often hindered because of a low level of literacy of women 21,9% (men is 66%; INSAE, 2012); this indicates a large gap and a disadvantage of women in communication and technical trainings. Traditions and the many household tasks that women have to carry out also limit their availability and women’s mobility which influences their opportunities to participate in meetings and trainings. Local leaders (men and women) and participants might be asked to transfer the technical information provided during trainings to their wives but this transfer of information, if at all done, causes a loss of efficiency and often results in errors. Men prefer that women are trained and receive extension services by female extension workers; however the national extension services are male dominated. Please refer to the gender assessment for additional information on women vulnerability in Upper and Middle Ouémé Basin (Annex 8).

[113] In Copargo and Djougou, women who are given land by their husband are not allowed to plant trees or to make major investments on the land

6 Institutions, regulatory frameworks and projects

6.1 Key institutions in climate change, water management and agriculture

184. The Government of Benin (GoB) recognizes climate change as one of the main economic and social challenge for the country and has developed several strategies and plans that identifies the country's main climate change risks, impacts, adaptation and mitigation needs per sector, priority adaptation and mitigation activities and areas of intervention.

185. Comite National sur les Changements Climatiques – CNCC: With regards to its institutions, the adoption in 1992 and implementation of the UNFCCC in Benin has translated into the establishment of a National Committee on Climate Change (Comite National sur les Changements Climatiques – CNCC). The CNCC includes representatives of all sectoral ministries, of the private sector and civil society. Its main goal is to monitor and ensure the implementation of the UNFCCC and the related agreements and protocols. Besides the CNCC, the following institutions in Benin oversee the implementation of climate and environmental policies, and ensure sustainable management of the environment:

- the National Committee on Sustainable Development (Commission Nationale du Developpement Durable CNDD);
- the General Directorate for Environment (Direction Generale de l'Environnement);
- the General Directorate for Energy (DG Energie);
- the General Directorate for Energy and Water (DG Eau)
- the General Directorate for Forestry and Natural Resources (DG Foret);
- the Beninese Agency for the Environment (Agence Beninoise pour l'Environnement – ABE);
- the National Directorate of Meteorology (Direction Nationale de la Météorologie); and
- several environmental organisations and research institutes such as the National Institute of Agricultural Research (Institut National des Recherches Agricoles du Bénin – INRAB).

186. Ministere de Cadre de Vie et Developpement Durable – MCVDD: The issue of climate change management requires a global approach of response specially led by the Ministry of Livelihood and Sustainable Development (*Ministere de Cadre de Vie et Developpement Durable* - MCVDD). The main department involved in the fight against climate change within this Ministry are the Directorate General of Environment and Climate (DGEC), where the GCF NDA is located. The mission of the DGEC is to develop and ensure the implementation and monitoring and evaluation of the State's policies and strategies for managing the effects of climate change and promoting the green economy. Other two key departments part of the MCVDD are the Beninese Agency for Environment and Climate (ABEC) andthe National Fund for the Environment and Climate (FNEC).

187. The National Environment and Climate Fund – FNEC - has been, since 2003, a financial instrument placed under the supervision of the MCVDD. Its creation responds to a need to support and finance initiatives related to environmental protection and climate change. FNEC has been accredited with the Adaptation Fund since 2011; and with the GCF as Direct Access Entity since 2019. FNEC's financial sources currently consist of: (i) own resources (environmental 'green tax' and environmental fines: the FNEC receives 50% of the tax and

fines collected at national level), (ii) resources from the national budget (grants, distributed credits and credits from the National Environmental Management Program) and (iii) international resources via projects from the Adaptation Fund (AF) and, in the future, of the GCF. Through the green taxes and fees, FNEC yields an average CFA 1 billion every year (USD1.7 million). FNEC uses its resources to cover its running costs and implement various projects in the field of environmental management and climate change adaptation or mitigation. At the moment, these projects focus on waste management, recycling and sanitation, reforestation and support to small-scale agriculture (https://fnec-benin.org). For this, FNEC opens call for project proposal to a large array of proponents including NGOs, local associations, cooperatives and private sector organisation. The projects must be aligned with FNEC's strategy and list of project theme; these are only funding through grants.

188. Ministere de l'Agriculture, Eau, et Peche – MAEP: Climate change issues are managed by the MCVDD in partnership with other sectoral ministries, local governments (municipalities), the private sector and civil society organizations with the support of Technical and Financial Partners. One of the key partners is the Ministry of Agriculture, Livestock and Fisheries (*Ministere de l'Agriculture, Eau, et Peche* - MAEP). MAEP intervenes through the Directorate of Rural Engineering (DGR) and the Lowlands Unit under its supervision, the Directorate of Livestock, the Directorate of Fisheries, the Directorate of Forestry and Natural Resources (DFRN). The MAEP, with these local delegations - at the village level - is the institution responsible for agricultural and pastoral hydraulics, water and soil conservation, aquaculture, forest management and reforestation.

189. Fonds National de Développement Agricole FNDA – FNDA - is a public entity, under the guardianship of the MAEP. It facilitates access to loans from banks and MFIs (microfinance institutions) for producers through loan guarantees, interest rate subsidies in certain cases, and technical support (capacity building) for the preparation of financial plans to submit for credit acquisition. The latter is provided through FNDA's partnership with the Territorial Agricultural Development Agencies (ADTA), based at the communal level. Eligible agricultural activities for loans, with guarantee from FNDA, must be linked to the priority value chains promoted by ATDA namely pineapple, cashew, market gardening (horticulture), corn, rice, cassava, soya, shea, cotton, aquaculture, oil palm, fruit trees, meat and milk, eggs for consumption. Loans are provided for the acquisition of equipment and means of production, processing, storage, conservation, and transport / distribution; the acquisition of specific agricultural inputs; strengthening working capital; the provision of marketing and / or export credits. The beneficiaries are Small and Medium Enterprises (SMEs) in agriculture and Small and Medium Industries (SMIs) in agriculture; registered producer or processor cooperatives; Economic Interest Groups; smallholder farmers organized in registered cooperatives; or individual farmers.

190. FNDA offers three types of services to farmers and cooperatives (Table 14): i) subsidies (for individuals and agri-businesses); ii) non-financial services (agricultural research and vulgarisation, support for certification and market access, and capacity building); and iii) financial services (support to access agricultural credits, interest-rate subsidy, support to finance infrastructure). A key target of FNDA is to support farmers and agricultural entrepreneurs to start, consolidate, extend and / or professionalize activities. It also facilitates access to loans under conditions adapted to the specific needs and constraints of the

agricultural sector, through the establishment of facilitation, refinancing, guarantee, interest subsidy or any other financial instrument deemed appropriate[114]. To beneficiate from FNDA's support, an applicant must: i) have a bankable financial plan; ii) receive approval from the communal ATDA that the proposed project is aligned with the priorities for agricultural development (e.g. relevant value chains); iii) submit its application to a relevant bank or MFI.

191. In practice, to support the loan application process, FNDA collaborates with the ATDAs: ATDAs will identify relevant projects for farmers or cooperatives and the loan application (financial plan) will be reviewed by FNDA. Following this assessment, the application might need to be improved. Once it is ready, it can be submitted to a MFI, which has agreements with FNDA that will play the role of guarantor of the loan. Table 14 indicates the MFIs active in the Oueme Basin of Benin, with which FNDA has agreements. These MFIs are also members of the ALAFIA consortium[115].

Table27: FNDA's counter

Subsidies for agricultural investments	Counter 1.1 : Agricultural Investment Fund of public interest oriented towards agricultural entrepreneurship
	Counter 1.2 : Private Agricultural Investment
Non-financial services	Counter 2.1 : Applied Agricultural Research and Extension Fund
	Counter 2.2 : Capacity Building Fund
	Counter 2.3 : Certification and Marketing Support Fund
Financial services	Counter 3.1 : Interbank Guarantee Fund for refinancing between Financial Institutions
	Counter 3.2 : Guarantee Fund for the access of agricultural promoters / entrepreneurs to credit
	Counter 3.3 : Interest Rate Facilitation and Bonus Fund

Source : Development Plan FNDA, 2018

Table 288: FNDA's partner MFIs in the target communes

Names
Caisse locale de crédit agricole mutuel (CLCAM)
Promotion de l'Epargne-crédit à Base Communautaire-BETHESDA (PEBCo – BETHESDA)
Association de Lutte pour la promotion des Initiatives de Développement (ALIDE)
Caisses Villageoises d'Épargne et de Crédit Autogérées (CAVECA)
Réseau National des Caisses villageoises d'Épargne et de Crédit Autogérées (RENACA)
Coopérative des Membres Unis Bethel Actions (COMUBA)
Association de services financiers (ASF)
Programme d'Épargne Crédit à Base Communautaire (PEBCcO)
SIAN SON

[114] Based on Plan développement FNDA, 2018
[115] ALAFIA (https://alafianetwork.org/) is a professional association of decentralized financial services/ institutions – including micro-finance institutions (MFI); it does not regulate these institutions as each member operates according to their own rules.

Names
Association pour le Promotion de l'Appui au Développement des Micro-Entreprise (PADME)

192. With regards to OCRI, FNDA will cover a guarantee of 50% of OCRI farmers' loan value, which FNDA will repay to the MFI in case farmers are unable to; FNDA also ensures loan interest rate at 12% (while 'regular interest rate is at 18-24%). Please refer to Annex 19, Section 3 for details regarding FNDA support to OCRI farmers. The support FNDA has committed to provide to OCRI farmers will increase MFIs' confidency to provide loans to OCRI farmers, as indicated in Annex 19.

193. Institution National de Recherche Agricole du Benin – INRAB: The National Institute of Agricultural Research of Benin (INRAB) is in charge of the production of basic seeds, especially for corn, soybeans and rice, as well as training of seed producers. For maize in particular, INRAB, through the National Center of Specialization on Maize (CNS-Maïs)[116], intervenes in the production of improved climate-resilient seeds and in the development of processing technologies.

194. The Ouémé Basin Agency – OBA: The agency was created by Decree No. 2015-675 of December 31, 2015. Its mission is to coordinate, plan and promote water development through sustainable management and rational water resources use of the Ouémé Basin. It is responsible for: managing financial, material, and human resources; managing inventories and fixed assets; developing and monitor budget execution; preparing the financial statements; tracking disbursements and replenishments of accounts; managing supplies and contracts; processing salaries and other employee benefits. While the OBA is under the supervision of the Ministry in charge of water, a committee of the Ouémé Basin (COB) has been established in 2015 through DECRET No 2015-675. It brings together stakeholders throughout the basin. The COB includes 48 municipalities and 51 stakeholder representatives. Its main mission is to conduct with operational tools the integrated management of water resources in the Ouémé basin. This body is also responsible for carrying all the initiatives and investments that will be made in the Ouémé basin. It is supported by the government and several other technical and financial partners. However, COB has not been active since its creation, as no human and financial resources have been provided by the gouvernement.

195. Finally, Local Management Committees for Integrated Water Management (LMC/IWRM) and Water Users Associations (WUAs) are often set up at the local level to regulate water access between all users; however with limited operationality in the ground. Fees are charged to water users (especially farmers). But some users are not directly concerned (fishermen, herders), which creates frustrations for farmers who feel that they have more rights over water than other users because of the fees they pay. Water fees are often difficult to collect and vary according to the mode in which they are collected (either in cash or in kind). In cash, the amount varies from 500 FCFA / ha / year to 2,000 FCFA / ha / year. Formal fees do not very often apply to small, irrigated areas apart from participation in collective works.

[116] This is done with the funding of the Agricultural Productivity Program in West Africa (WAAPP) through the Framework Program of Support for Agricultural Diversification (ProCAD)

6.2 Policies and strategies pertaining to climate change, water and agriculture

Emission profile

196. Benin has published its Intended National Determined Contribution (INDCs) under the Paris Agreement in June 2017, which highlights the country's emission profile and intentions in terms of decarbonising its economy and investing in climate change resilience. The INDC indicates that Benin's total GHG emissions amounts to approximately 14.1 Mega ton CO2 Equivalent (Mt CO2 eq), that is approximately 1.5 ton CO2 eq per capita in 2012, without Land Use, Land-Use Change, Lands and Forestery (LULUCF). These emissions come from the sectors of energy (47.4 %), **agriculture (45.9%),** waste (5.0 %) and industrial processes (1.6 %). Considering LULUCF, the balance of GHG emissions (14.9 Mt CO2 eq) and absorptions (50.3 Mt CO2) shows globally that Benin remains a GHG sink with a net absorptive capacity of 35.4 Mt CO2 in 2012, this means that its GHG emissions are largely offset by the absorption of CO2 on the level of its forest cover. Even tough Benin remains a sink, its capacity of carbon sequestration is declining falling from (52.0) Mt CO2 eq in 1995 down to (41.3) Mt CO2 eq in 2005, that is a decrease of 20.6 %, and to (35.4) Mt CO2 eq in 2012, that is a decrease of 32.0 %.
197. In terms of projection of greenhouse gas emissions, in the BAU case, the tendency of overall emissions (without LULUCF) reveals an increase rate of 172.8% over the period 2012-2030 rising from 14.1 Mt CO2 eq to 38.5 Mt CO2 eq.The total of aggregate cumulative GHG emissions without any intervention over the period 2021-2030 is close to 306.1 Mt CO2 eq (without LULUCF).They would come up to 27.4% from the agriculture sector. Benin is committed to reduce its GHG emissions. Overall, excluding the forestry sector, Benin plans to reduce cumulative greenhouse gas emissions by 49.49 Mt CO2e, a reduction of 16.17% compared to the status quo scenario on the period 2021 to 2030. This could be achieved through: i) implementing improved farming techniques; ii) implementing soil fertility-maintaining techniques on a cultivated area; and iii) promoting sustainable irrigation schemes.

198. Furthermore, the implementation of the measures envisaged in LULUCF would contribute to increase its cumulative sequestration capacity of 32 Mt CO2 eq over the period 2021- 2030 including 76.6% of conditional contribution, by limiting deforestation (23.9 Mt CO2 eq) and creating planted forests (8.1 Mt CO2 eq). Lowering the annual rate of deforestation would make it possible to reduce the cumulative emissions due to the sector of forestry by 110 Mt CO2 eq over 2021-2030 period including 80% of conditional contribution and 20% of unconditional contribution. This could be achieved through: i) Protecting and preserving existing natural and planted forests to reduce deforestation rate; and ii) implementing reforestation.

199. To achieve its emission reduction targets or potential, Benin will need support in terms of technology transfer, capacity building, National resources (public funds and private investments) will also need to be supplemented by the external financial support (bilateral or multilateral). The estimated overall cost for the implementation of the mitigation-related measures is of USD 6,042.33 million.

Climate change and other key policies

200.The NAPA was adopted in 2008 and includes five priority projects:

- Agriculture and Food Security: this project aims to establish early warning systems on climate risks to enhance food security in four agroecological areas vulnerable to climate change, namely: i) far North; ii) West-Atacora; iii) central cotton zone; and iv) fisheries zone[117].
- Energy: this project aims to promote the use of sustainable energy and energy-efficient stoves to reduce land degradation, improve access to energy and promote adaptation in areas vulnerable to climate change impacts, particularly where land is degraded.
- Water: this project aims to improve access to water – especially during the dry season – in vulnerable municipalities of central and north Benin.
- Health: this project aims to protect children and women from malaria risks in the areas most vulnerable to climate change impacts.
- Coastal development: this project aims to protect the coastline from sea level rise by combating coastal erosion through rehabilitation of coastal ecosystems.

201.Of these projects, the first one – Agriculture and Food Security – has been implemented, and the second one – Energy – is currently being implemented.

202.Benin has ratified Agenda 21 in 2016 and committed itself to be part of the Paris Agreement. To comply with these commitments, Benin has published its **Intended National Determined Contribution (NDCs)** under the Paris Agreement in June 2017, which highlights the country's intentions in terms of decarbonising its economy and investing in climate change resilience. Benin's INDCs put forward action plans for both climate change mitigation and adaptation to align with the country's medium-term development agenda. Through the INDCs, Benin commits to implement adaptation action in three priority economic sectors: agriculture, water resources and forestry. Within these sectors, Benin aims to reduce the vulnerability of communities and ecosystems to climate change using appropriate measures. Overall, excluding the forestry sector, Benin plans to reduce cumulative greenhouse gas emissions by 49.49 Mt CO2e, a reduction of 16.17% compared to the status quo scenario on the period 2021 to 2030.

203.The INDC plans to achieve its adaptation goal through several measures in the period 2020 to 2030, including: (i) the diversification and promotion of high value-added agricultural value chains, as well as the modernization of resilient agricultural infrastructure in the context of climate change, (ii) the promotion of appropriate resilient and climate-resilient agricultural production systems for sustainable agriculture, food and nutrition security in the agricultural sector; (iii) the strengthening of knowledge of the climate system and the tools for generating climate and hydrological information and predicting climate hazards in; (iv) the reduction of the vulnerability of communities to the degradation of forest ecosystems, (v) and the promotion of agroforestry in the forest sector.

204.The national law on CC passed in August 2018 aims to fight against climate change as well as its negative effects and consequences and to increase the resilience of living communities. It allows among other things to take effective measures of response, adaption and mitigation by setting specific targets for sustainable economic and social development, energy security and efficiency, in accordance with the specific provisions of national and international legal climatic changes. The environmental objectives set by the prescription include:

- The protection of human beings and settlements, animals and plants against the global threats of: greenhouse gases, the alteration of the ozone layer, the loss of biological diversity, the management of pastoral spaces and associated conflicts, deforestation, desertification and drought;
- The fight against pollution of the sea, the soil, marine and continental surface and underground waters;
- The environmentally sound management of non-renewable resources and all types of waste;
- Disaster risk reduction.

205. The State, as the guarantor of the right of people to a healthy environment, ensures, in all initiatives related to climate change, the respect of the following principles:

- Preserve the climate system against climate change and its negative effects and consequences in all fragile and vulnerable economic and social sectors;
- Take precautionary measures to anticipate, prevent or mitigate the causes of climate change and limit its negative effects and consequences:
- Take all necessary measures to adapt to the new climatic context;
- Work for sustainable development by integrating measures to address climate change into national development programs and projects;
- Make accountable, directly or indirectly, the author or the authors of any act or activity likely to cause disturbances of the climate with negative effects and consequences.

206. **The Strategic Plan for the Development of the Agricultural Sector** (PSDSA) was adopted in 2017 and defines the sector's strategic policy objectives for 2025. Implemented by MAEP, the plan's objectives include the promotion of climate-resilient agriculture and the development of value chains for maize, cashew, shea, and other crops. The Strategic Plan contains the National Plan for Agricultural Investments and Food and Nutritional Security for the period 2017–2021 [Plan National d'Investissements Agricoles et de Sécurité Alimentaire et Nutritionnelle (PNIASAN)]. The objectives of the latter are to:
i) increase the production and productivity of agricultural value chains;
ii) improve markets, trade and value chains;
iii) increase resilience of livelihoods and systems; and
(iv) strengthen the governance of natural resources.

207. The PNIASAN has seven strategic areas of action: a) strengthening planning capacity; b) strengthening policies and institutions; c) strengthening leadership, coordination and partnerships; d) improving agricultural skills, knowledge and education; e) strengthening data and statistics; f) institutionalising mutual accountability; and g) increasing public and private funding. The PNIASAN aims to increase the yields of crops such as maize, cashew and cassava.

208. FNDA and ADTA provide support to farmers and cooperatives aiming at the operationalisation of the PSDSA and PNIASAN.

209.**The National Climate-Smart Agriculture (CSA) Development Strategy** in Benin and its Five-Year Action Plan (2018 - 2022), validated at the end of a national workshop held on 29 November 2017 in Cotonou, was developed with support from the project GCP/RAF/496/NOR (see below). The Strategy and its Action Plan will enable concrete and sustainable actions to reverse the trend of declining productivity in the agricultural sector, due to the throes of climate change, including delay and irregularity in the start of rainy seasons, the appearance of increasingly long bouts of drought, the frequency and extent of flooding. The CSA strategy has been included into Benin's PSDSA and PNIASAN, by devoting the third strategic axis to the issue of climate change and resilience. The strategy outlines an approach that involves transforming and reorienting agricultural systems to increase agricultural productivity and incomes sustainably and equitably, strengthen adaptation and resilience to climate variability and climate change. The strategy recognises seven agricultural development poles (*Poles de Developpement Agricoles* - PDAs). The Upper and Middle Valley of the Ouémé is the subject of particular attention, crossing several agro-ecological zones, namely zones 4 (West-Atacora), 5 (central cotton), 6 (Terres de barres), and 7 (de dépression).

210.By adopting the National Water Policy document on 31 July 2009, the Government has instructed the Ministry of Energy and Water to develop a **National Action Plan for Integrated Water Resources Management (PANGIRE)** in Benin, the main document to benchmark for its implementation. Since the implementation of PANGIRE, several actions have been initiated through projects with different financing and procedures. Several public and private actors have invested themselves to offer their interventions the IWRM address. It is the result of a long participatory process marked by political commitments at various levels, reform of the legal and regulatory framework, diagnostic analyses of different aspects of the water sector, as well as improvements in knowledge and monitoring instruments for water and its environment. It therefore presents itself as a reference document for the implementation of the Water Management Act. The PANGIRE covers a period of 15 years (2011-2025) divided into three five-year phases. A periodic evaluation and updating of the PANGIRE is planned.

211.The evaluation of the first phase (2011 – 2016) reveals positive points but also notable shortcomings in terms of management, coordination, programming, financial management. In conclusion, the PANGIRE was not operationalized. Lessons were integrated into the second phase, encompassing five (5) objectives, 146 actions grouped under 47 expected results which and serve as a structuring framework for this phase of PANGIRE. These actions help to make PANGIRE an essential plan in climate change-related actions. PANGIRE contributes to monitoring the impacts of climate change on water resources; It is involved in the implementation of mitigation measures through its water management and development plans; It aims to implement measures to protect and conserve water and soils; it establishes an institutional framework comprising central and decentralised bodies for water management. The total estimated cost of PANGIRE Phase 2 (2016-2020) is $27.4 billion. The implementation framework of the PANGIRE is based on a PANGIRE Steering Committee and coordination directly provided by the recently created Directorate General of Water Resources.

212.**A Schema Directeur d'Amenagement et de Gestion des Eaux du Bassin de l'Oueme (SDAGE)** – hereby called the Oueme Master Plan (SDAGE) – was adopted by the General Directorate of Water in 2013. The Plan promotes integrated water management in the Oueme Basin. It constitutes a decision-making and planning tool for stakeholders in land, water and ecosystem management, until 2025. The strategic approach of the SDAGE is to:

- Ensure the reduction and control of pollution in water bodies;
- Support institutional development and capacity building of DG Water;
- Enhance knowledge and monitoring on water resources and uses;
- Mobilise and valorise water resources to support economic activities; and
- Ensure fair and sustainable access to drinking water in the Oueme Basin.

213. To achieve its objectives, the SDAGE promotes various interventions, including the development of water infrastructures, institutional capacity building, improved water management, as well as support for the development of economic activities in the Oueme Basin, while at the same time raising awareness of the necessity to sustainably manage and use water resources. The Plan considers, to some extent, climate change into its integrated water management approach; however, its implementation has been delayed by a lack of financial resources and technical capacity.

214. Finally, Benin has been in a process of decentralization since adopting Law 97-029 of 15 January 1999 on the organization of municipalities in the Republic of Benin. Through this law, municipalities have specific roles and sectors of their intervention in conjunction with the government. The Ouémé basin covers 48 municipalities amongst the total of 77 located in 12 departments of the country. To play their respective roles and improve the living conditions of the population, the law requires each municipality to develop a local planning tool; in other words, a local development plan whose development follows a well-defined methodology. Indeed, a local development plan (LDP) is a framework outlining all the coherent and concerted development programs and projects to be carried out in accordance with the national and regional orientations and which specifies the goal, the objectives, the strategies, and the results to be achieved in a given time and the necessary means. Most municipalities have recently updated (2nd generation) their LDPs. However, the issue of climate change management is currently under-considered, either in terms of planning or implementation, of the LDPs.

6.3 Gaps and weaknesses in the institutional and regulatory frameworks

215. The policies and plans mentioned above all foresee a higher integration of climate change issues in the overall development strategy for the country. Nevertheless, a stocktaking study done by Climate Analytics (2018) on the integration of climate change in national and sectorial strategies and policies in Benin underlines to which extent scientific data and information relevant to climate change are considered. The study highlighted that even if the issue of climate change remains a concern for the development of the country, the aspects of climate change are not always reflected in the policy documents – through a concrete implementation plan, activities, budget, implementation arrangement or M&E plan – thereby not supporting concrete implementation of climate change adaptation on the ground[118].

[118] https://climateanalytics.org/publications/2018/integration-of-climate-change-in-national-strategies-and-policies-in-benin/

216. Key gaps and weaknesses identified in Benin's institutional and regulatory framework to the effective implementation of climate change adaptation are :

- A limited integration of climate change concerns into regulations, and the weak application of existing regulations are key problems to ensure sustainable, climate-resilient management of the natural resources. For example, the SDAGE was introduced on August 31, 2011. Despite the overriding will of the government, its implementation remains a major challenge. In addition, this decree does not include aspects related to climate change and adaptation, or mitigation priorities. Likewise, the weak enforcement of existing regulations on land use has contributed to the degradation of forest resources in the targeted localities.
- Insufficient integration of climate risks and mitigation or adaptation measures into local development planning. Climate risks and adaptation needs are not considered in sub-national financing and development strategies.
- The Beninese state also faces low levels of agricultural extension and lack of livelihood diversification due to low technical capacity. The limited number of experienced extension agents and providers (NGOs) hinders the large-scale deployment of resilient technical innovations.
- A limited mastery of technical skills related to the field of water, as well as the absence of hydrological infrastructures resistant to climatic variability in the territory impairs climate-resilient water management throughout the country.
- Information on adaptation alternatives in key climate-sensitive sectors like agriculture and water are not well compiled and shared to allow enhanced resilience. Adaptation cases such as successful agricultural technical improvement initiatives or micro-irrigation are not generally disseminated as a tool for raising awareness through the promotion of the benefits of climate resilience.

6.4 Past and ongoing projects

217. Despite a lack of centralisation and dissemination of adaptation good practices, several projects have been or are being implemented in Benin, with a view to reduce climate change vulnerability, increase agricultural production and improve water management. These past and ongoing initiatives – described below – constitute a rich database to draw lessons learned and best practices that inform the design of future climate-resilient project. Additionally, stakeholder consultations with representatives from municipal and district-level government departments, as well as communities from the target districts in central and north Benin, have provided insights on the local appropriateness of international best practices (for a summary of consultations during project development, see Annex 7 – Stakeholder Engagement Plan). By upscaling the successes of past and on-going initiatives, future initiatives can ensure sustainability and effectively enhance the climate resilience of rural communities in Benin. Please refer to section 8.1.3 for a description of OCRI's synergies with these projects.

Enhanced climate resilience of rural communities in central and north Benin through the implementation of ecosystem-based adaptation (EbA) in forest and agricultural landscapes (UNEP-SAP; GCF SAP005; 2019-2024)

218. This 1.1 million US$ project, implemented by UN Environment, has the objective to halt the negative cycle of climate change, agricultural yield depletion and natural resource degradation in central and northern Benin, and to build resilience of local communities. To achieve this, the project combines Ecosystem-based Adaptation (EbA) with climate-smart

agriculture interventions in selected sites located along rivers. More precisely, the project will reduce the vulnerability of small-scale farmers in these sites through three components focusing on restoration of degraded riparian forests, enhancement of agricultural productivity and improvement of technical and institutional capacity of governments and communities. Agricultural productivity is being improved through judicious management of soils and planting of climate-resilient crops and trees; while ecosystems' goods and services, including water availability, soil conservation and cooling, fibre, medicines, fruits, fuelwood and timber, are being restored through reforestation. The project interventions are taking place in several municipalities of central and north Benin, including the Betecoucou and OSN forests, located in the Upper Ouémé watershed.

Transforming Financial Systems for Climate (AFD; GCF FP095; 2018-2026)

219. This 36 million US$ AFD programme aims to provide loans and technical assistance in 17 developing countries across Africa and Latin America and the Caribbean, among which Benin, to create self-sustaining markets in energy efficiency, renewable energy, and climate resilience. The private sector in these selected regions still perceives sustainable energy and climate resilience as expensive and complex, as the environmental advantages of more resilient investments and practices is not well understood. Efforts to demonstrate the benefits of financing these areas are required to reach a critical mass and upscale the commercial viability of climate projects. The main objectives of this programme are to scale up climate finance in the targeted countries, to redirect financial flows towards sustainable energy and climate resilient development and reinforce the capacity of local partners in climate-related sectors. This will be achieved by providing loans through local partner financial institutions to borrowers in sustainable energy, energy efficiency, housing, agriculture, forestry and water and waste management, and by providing technical support to loan beneficiaries. Hence, this project will provide relevant lessons learned and best practices on pathways to ensure that agribusinesses, like farmers' cooperatives, can be financed on a longer term and self-sustaining basis, including in Benin.

Programme for Integrated Development and Adaptation to Climate Change in the Niger Basin (PIDACC/NB; GCF FP092; 2018-2025)

220. This 7 million US$ AfDB programme aims to 'Improve the resilience of populations and ecosystems in the Niger Basin by managing natural resources sustainably." The Niger Basin of the Sahel is one of Africa's most vulnerable regions to climate change. Over the past six decades, the total annual rainfall has reduced by 20 to 40 percent. Recurrent droughts have resulted in the increasing fragility of ecosystems and reduced social resilience; the latter disproportionately affects women, children, and disabled people in the basin. This programme will address these issues by implementing a series of integrated and comprehensive actions that reduce the silting of the Niger River, improve natural resources management and enhance the population's ability to adapt to climate change. The programme also includes mitigation activities, through forestry and land use improvements. Benin is one of the recipient countries of this programme, which intervenes in the departments of Alibori, Atacora and Borgou (Upper Ouémé watershed). Within these Departments, the programme will build capacity for integrated water management and set up climate resilient hydro-agricultural infrastructure. Moreover, ten community-based climate adaptation action plans will be prepared in the selected target Departments of Benin[119]. Hence, this initiative will

[119] https://www.greenclimate.fund/projects/sap005?inheritRedirect=true&redirect=%2Fwhat-we-do%2Fprojects-programmes

provide lessons learned and best practices on integrated water management and community-based adaptation, relevant to similar initiatives.

World Bank Agricultural productivity and diversification project (APDP) – 2011 -2021

221. Implemented from 2011 to 2017 and extended until 2021, the project objective is to restore and improve the productivity and cash value for selected agricultural value chains in the APDP recipient 's territory. Some of the financed activities include: (i) adoption of improved technologies for the development of food crops and export-oriented crops (aquaculture, maize, rice, cashew and pineapple); (ii) the restoration of the means of production of flood affected households by purchasing and distributed maize, rice seeds, fertilizers to crop farmers and fingerlings to fish farmers; (iii) the rehabilitation and development of small scale irrigation infrastructures to improve productivity and reduce output variability; (iv) dissemination of the planting materials through support to nurseries, and (v) promotion of best farms management practices through farmer's field schools[120]. The project resulted in increasing rural incomes, induced by the adoption of new technologies that led to an increase in crop yields, and the processing of products in the targeted value chains. A total 9,000 ha of irrigation lands has been developed, half of which is located in the Ouémé (2,500 ha) and Glazoué (2,000 ha) production basins using GFRP. Additional small-scale irrigation infrastructure activities are being implemented on 4,500 ha in the Malanville (2,500 ha) and Tanguiéta (1,500 ha) and Glazoué (500 ha) production basins.

222. Through the development of small-scale irrigation schemes, and water retention infrstructure to reduce the impacts of more frequent, extended droughts – as experienced in the Upper Ouémé – and floods – as experienced in the Middle Ouémé – and support agriculture under climate change conditions, project APDP resulted in increased income generation from agricultural crop sales for project beneficiaries. Because of its success, the project has received additional financing in order to consolidate and scale up successful activities until 2021; and to strengthen the project focus on income generating activities and improving nutritional status of poor households. Support to relevant value chains will be promoted, as well as improved access to finance for agricultural cooperatives.

Programme intégré d'adaptation pour la lutte contre les effets néfastes du changement climatique sur la production agricole et la sécurité alimentaire au Bénin (PANA-Agriculture) [Integrated Programme for the Adaptation to the Adverse Effects of Climate Change on Agriculture and Food Safety in Benin] (GEF, UNDP, 2010–2014)

223. This US$11.31 million project, also called PANA-Agriculture (Programme d'Action National d'Adaptation-Agriculture), was financed by the Global Environment Facility (GEF) for US$3.41 million, UNDP for US$0.5 million, the GoB for US$4.96 million and beneficiary municipalities for US$2.43 million. PANA-Agriculture aimed at enhancing the capacity of rural communities to adapt to climate change in the four most vulnerable agro-ecological zones of Benin, namely: i) far North; ii) West-Atacora; iii) central cotton zone; and iv) fisheries zone. The project contributed to: i) the integration of climate change adaptation into sectoral plans and strategies; ii) the enhancement of the knowledge base required to foster local adaptation initiatives; and iii) the sharing of experiences at the local, national, and international scales.

[120] http://documents.worldbank.org/curated/en/690591468200934160/pdf/571770PAD0P1151e0only1910BOX358303B.pdf

224. More specifically, PANA-Agriculture aimed at developing the climate resilience of local communities through the dissemination of innovative farming practices and awareness-raising campaigns. The long-term objectives were to reduce the climate vulnerability of rural populations, especially through the enhancement of food security in the face of a changing climate. Demonstration sites were selected to serve as examples for the future upscaling of efficient, climate resilient solutions. The nine demonstration sites were Bopa, Ouinhi, Adjohoun, Sô-Ava, Aplahoué, Savalou, Ouaké, Matéri and Malanville. The project benefitted 2,210 people directly and 12,155 people indirectly. Valuable lessons learned to implement successful climate-smart agriculture interventions can be drawn from this project, to inform the selection and implementation of similar initiatives across Benin.

Projet d'appui à la gestion des forêts communales (PAGEFCOM) [Support project for the management of communal forests], (Phase 1: 2007–2014, ~US$66.9 million 121 *; Phase 2: ~US$12.9 million, 2017-2022)*[122,123]

225. The PAGEFCOM is the main national programme on land-use management in the central and coastal departments of Benin. The first phase of the PAGEFCOM was implemented from 2007 to 2014, with the objective to combat desertification and secure rural livelihoods by supporting the reforestation of degraded land. Target departments were Collines, Atlantique and Zou. The entity in charge of implementation was the Direction des Forêts et des Ressources Naturelles (Directorate of Forests and National Resources), under the Ministère de l'Agriculture, de l'Elevage et de la Pêche (Ministry of Agriculture, Livestock and Fisheries, MAEP). Funding was provided by the GoB for ~UC35 million, and by the African Development Fund (ADF) for ~UC8.7 million.

226. Phase 2 of the PAGEFCOM is being implemented since 2017, with a view to build on the achievements of Phase 1 by continuing to enhance land use practices in the central and coastal regions of Benin. This phase targets the departments of Borgou and Donga in addition to the departments of Collines, Atlantique and Zou, which were also included in Phase 1. Adaptation to climate change is one of the main components in the project's logical framework. Activities under this component include: i) strengthening early warning systems; ii) improving water availability; iii) protecting coastal areas affected by sea-level rise; and iv) building the capacity of local authorities to plan adaptation interventions.

227. A key lesson learned from PAGEFCOM is that investment activities introduced by the project need to be accompanied by proper training of the beneficiaries to ensure they have the necessary experience and organization to sustainably manage them effectively. A participatory approach is, therefore, key to successful preservation and enhancement of natural forest resources. In PAGEFCOM, this approach has led to the success of reforestation activities. It however requires sensitizing communities about climate change and adaptation options, including using sustainable land and water management.

[121] The African Development Bank group uses Units of Aid (UA) as its official accounting unit, with the conversion rate 1 UA = 1 Special Drawing Right. For the sake of clarity, all budgets originally labelled in UA have been converted in US dollars.

[122] African Development Fund (2005) Projet d'appui à la gestion des forêts communales : rapport d'évaluation.

[123] African Development Bank (2017) Projet d'appui a la gestion des forets communales – Phase 2 : Rapport d'evaluation.

THE IFAD MARKET DEVELOPMENT SUPPORT PROJECT (PADMAR) 2018 – 2025 (overlapping with OCRI in Zogbodomey and Zagnanado), IFAD, 2018-2025

228. The overall objective of PADMAR, a USD 49.2 million project, is to contribute to the sustainable improvement of food production and security, to poverty reduction, and to increase the income of vegetable farms sustainably, while improving their resilience to the effects of climate change**.** PADMAR is circumscribed in the southern regions of Benin and intervenes in 7 departments out of 12 in the country, namely the Atlantic, Couffo, Littoral, Mono, Ouémé, Plateau and Zou. Lessons learned and best practices for improving the productivity and income of vegetable farms will be relevant to similar initiatives across Benin.

Adaptation de l'agriculture au changement climatique (PACC) [Adapting agriculture to climate change], (GIZ, 2014–2019, ~US$3,29 million)[124]*.*

229. The PACC aimed to combat the adverse effects of climate change in northern Benin by promoting sustainable land-use practices and watershed management. The project has been implemented in three communes bordering the Pendjari National Park and the "W" National Park. These communes are particularly vulnerable to the impacts of climate change. The PACC focused on the following areas of action: i) the application of standardised procedures to prioritise adaptation measures in degraded watersheds; ii) investments in climate-proof irrigation infrastructure; and iii) capacity-building of stakeholders involved in land-use and watershed management. Furthermore, the implementation of the protection and usage regulations in the management plans contributed to reduce the pressure on the natural resources of the neighbouring national parks. The PACC was implemented by the Germany-based GFA Consulting Group in coordination with the Beninese MAEP, and is funded by the GIZ. Valuable lessons learned to restore watersheds and improve water and land use management can be drawn from this project to inform future initiatives.

Renforcement des capacites dans les secteurs de l'energie, de l'agriculture, de la sylviculture et d'autres secteurs d'utilisation des terres pour une transparence accrue de la mise en oeuvre et le suivi de la CND (CBIT – FAO, 2021-2024, ~US$1,779,863 million)

230. The CBIT aims to set up strong basis to enable Benin to implement a rigorous, transparent monitoring and evaluation (M&E) process of the implementation of its INDC. Hence, the project has three key targets: i) stronger, more efficient and transparent institutions; ii) improved capacity for GHG emission inventory; and iii) a robust M&E tool to monitor progress linked to implementation of the INDC (mitigation and adaptation). Reflection INDC's priorities, the focus of the project is on the Agriculture, Land Use and Forestry (ALUF) sector; capacity building interventions will target staff members of MCVDD and MAEP. Besides improved monitoring of GHG emission, CBIT will also enhance the capacity of the GoB to monitor and evaluate progress in the field of climate change adaptation. To achieve this, nationally relevant indicators will be developed, and a national adaptation M&E tool designed; trained staff members from MCVDD and MAEP will then be able to monitor the country's progress in achieving its climate change adaptation targets as defined in the INDC.

Projet d'appui a la mise en oeuvre du PADAAM (UE, 2020-2023, US$1,971,797)

231. Project PADAAM aims to provide support to develop the agricultural sector and improve market access in Benin, in order to improve food security and income for smallholders. The project includes three key components: i) Build partnerships and create added-value; and ii) Improve agricultural productivity – specifically for rice, maze and yam. The project is

[124] Website of the GIZ: https://www.giz.de/en/worldwide/31841.html. Retrieved on 3 April 2017.

implemented in Benin's agricultural hotspots – which include the Oueme Basin. More precisely, PADAAM will create added-value to agricultural products, and facilitate economic partnerships between smallholders and their cooperatives, on the one side, and market and private sector, on the other side. This will contribute to enhance rural income and food security in the rural areas of Benin. This objective will be achieved through, among other, improved access to financial tools and services, training on marketing and business techniques, training on rural and agricultural finance, on finance mechanism to support value chains, and on micro-finance. This project will thus strengthen key agricultural value chains in the Oueme Basin.Profile of OCRI's key value chains.

7 Barriers for adoption and adaptation needs

7.1 Adaptation barriers

232. There are currently six main barriers that jeopardize the sustainable adoption of adaptation solutions in the Ouémé Basin. These barriers will be addressed in the project strategy, as indicated in Chapter 8.

<u>Technical barriers</u>

<u>Barrier 1</u>: The communities of Upper and Middle Ouémé Basin have limited tools and capacity to implement climate-resilient agricultural and water management practices that improve productivity in the agricultural landscapes while, at the same time reducing the negative effects of climate change, including erosion, floods, and flash floods, especially in downstream areas.

233. The communities of Upper and Middle Ouémé Basin have limited technical and material capacity and awareness on how to implement, climate-resilient agricultural and water management practices that improve productivity in the agricultural landscapes while, at the same time reducing the negative effects of climate change, including erosion, floods and flash floods, especially in downstream areasFirst, there is a lack of hydro-agricultural technologies implemented to cope with the impacts of climate change (see water works study). As a result, farming communities face a chronic deficit of mobilization of water resources, which impairs the promotion of promising economic activities such as irrigated agriculture and off-season horticulture. Effective irrigation systems are almost non-existent and there is no control of water, for example through water retention infrastructures or micro-dams; when such structures exist, they are obsolete because of the absence of capacity, at the local level, for sustainable water management and maintenance of waterworks (see Waterworks Feasibility: Annex 17 for an assessment of existing irrigations schemes and water infrastructure in the target areas).

234. With regards to agricultural practices in the Ouémé Basin, they are characterized by the use of basic tools and low mechanization. Extensive, rainfed agriculture dominates, which is very sensitive to climate variability and extremes like droughts and late onset of rainfalls. The use of climate-resilient production technologies is very limited on project sites, with a low adoption rate of improved seeds and a low use of on-farm rainwater harvesting techniques. This is because, on the project sites, there are no integrated water management and climate-resilient agriculture – including agroforestry – projects therefore farmers, who have not received adequate training and are not aware of the climate benefits of CRA, present low levels of adaptation capacity.

<u>Private sector barriers</u>

<u>Barrier 2</u>: The communities have limited/ no access to micro-credit or other financial support (from the government or the private sector) to invest in climate-resilient practices, improve their productivity, access market, and boost their profits.

235. There are financial institutions and schemes to provide micro-finance and loans in Benin. For example, the country's credit actors are structured around a consortium of 43 micro-credit

institutions called "ALAFIA"[125]. Yet, not all of these institutions provide finance for agriculture. In fact, the agricultural sector remains under-financed. Smallholder farmers also face many difficulties accessing credits for agricultural investments, particularly for the more vulnerable groups of society, such as women and youth. The financing schemes tend to focus on Alternative Income Generating Activities, such as sale of transformation products, honey, etc, while the risk of investing in agricultural production is still perceived as high. As a result, micro-finance institutions have high requirements with regards to collateral, high interest rates and short payback periods, on top of their administrative fee – which smallholders cannot meet. Furthermore, finance institutions are more reluctant to lend to individual farmers than to organised groups. Finally, a credit application is often a complex process, that requires the preparation of detailed finance plans, which many farmers and cooperatives do not have the capacity to prepare.

236. An investigation conducted by MAEP[126] on the reason why many smallholder farmers in Upper and Middle Ouémé do not contract credits indicates, as five main reasons: i) smallholders are scared and uncomfortable to be in debt; ii) high interest rates of credits; iii) lack of stable income, or income too low; iv) lack of knowledge of how to get a credit/ prepare a financial plan and application package; and v) they have not thought about it (not aware of credit potential).

Barrier 3: there is currently little coordination between producers and buyers and among producers which jeopradize access to market and profitability of the interventions.

237. With regards to access to market, on the demand (buyer) side, there is a lack of communication between producers and buyers of agro-products, to discuss market needs and demands that could be met by the producers. The productivity of some products like mangoes can vary a lot in quantity and quality (because of climate change, limited water management capacity, and non-adapted agricultural techniques), which impairs buyers from planning ahead their buy. On the producer side, farmers are often not aware of the various potential buyers operating in their area, therefore relying on the same buyers without being able to negotiate prices. This is also because of a lack of organisation among smallholders, mostly working individually rather than in cooperatives. Finally, on the technical side, farmers are facing difficulties accessing quality seeds and tree seedlings; they lack the equipment for crop processing (e.g. 97% of cashews are sold raw), collection and transport (mangoes are most often directly collected by the buyers on the field), packaging, marketing skills to prepare and label agro-products.

Institutional coordination barriers

Barrier 4: Land management in the Ouémé Basin is not implemented in an integrated climate-resilient way that complement the restoration and preservation of critical ecosystems (especially along the Ouémé River) with sustainable productivity for agriculture and agro-forestry, with a view to improve livelihoods and resilience on the entire Ouémé Basin; there is no coordinated efforts among relevant stakeholders in environmental management, agriculture and water to support such an approach.

238. Climate change and ICRM is not yet integrated into local development plans (LDPs) and regional strategies in the Ouémé Basin; neither is it in the Ouémé Master Plan, which however

[125] http://newsite.alafianetwork.org/

[126] MAEP, 2019

promotes integrated water management. Yet the SDAGE is underfinanced and few interventions are currently implemented. Mainstreaming adaptation into development plans would inform and guide public interventions and investments towards climate-resilient development.

239. Another weakness is the lack of coordination mechanism or platform to facilitate the coordination of public and private stakeholders in water management, agriculture, and agri-markets. For example, a platform including the Ministry of the Livelihood and Sustainable Development (MCVDD), the Ministry of Agriculture, Livestock and Fisheries (APRM), the National Fund for the Environment and Climate (FNEC), FNDA, the Ouémé Authority, farmers' cooperatives and finance organisations would support coordinated efforts towards ICRM in the Ouémé Basin, that generate benefits for all parties. On the contrary, a siloed approach to development prevails in the target areas of the Ouémé Basin, where projects and development initiatives tend to focus on a single sector like agriculture or water access, without integrating climate change concerns or basin-specific considerations – as interventions implemented upstream have impacts on downstream communities and landscapes. As a result of these limitations, agricultural landscapes in the Ouémé Basin are not resilient to climate change and the communities are increasingly vulnerable to water scarcity, droughts, shifts in seasonality and floods.

Barrier 5: The government of Benin and its local extension services do not have the knowledge and technical capacity to implement an integrated basin-level management approach, and therefore cannot provide the necessary technical support to the local population. The institutional, regulatory and governance capacity to plan and implement this approach in a coordinated, complementary, or synergetic way is missing. In addition, there is an overlap of competences between the main structures involved in the fight against climate change.

240. As underlined in Chapter 6, there is a limited mainstreaming of climate change concerns, especially into local and regional development plans. While, at the national level in Benin, there is an ongoing process to integrate climate change adaptation into relevant policies and strategies, at the local level, there is limited integration of integration of climate change into local development plans prepared by the municipalities. This is because of limited technical and financial capacity among local-level government staff (described above) and limited availability of climate change-related information, including on the benefits of adaptation (further described below). Consequently, municipalities and communities do not receive support for the design and implementation of locally appropriate climate change adaptation interventions.

Public and private sector awareness

Barrier 6: The government of Benin and the private sector are not aware of the socio-economic benefits to implement an integrated sustainable climate-resilient approach for the management of basin. In other words, there is no incentive for the private sector and agri-businesses to invest in climate-resilient value chains as their benefits are not demonstrated yet.

241. Benin's economy is mainly based on agriculture, trade, and transport to and from neighbouring countries. Despites improvements on the economic front, the average economic growth rate is 4.2% over the period 2006-2015[127]. This growth rate is insufficient to combat

[127] *www.banquemondiale.org/fr/country/benin/overview*

poverty in a sustainable manner. Moreover, the population does not have the financial capacity to overcome poverty, provide sufficient food for the household, and invest in climate-resilient technologies, infrastructure, or equipment. This is particularly the case in the project intervention areas, where the economic and socially vulnerable targeted populations is further threatened by climate change impacts.

242. The public sector, within its very limited capacity, is the main actor responsible for promoting agriculture, irrigation, and drainage in Benin, while investments from the private sector in the field of irrigation, for example, are almost non-existent as there are few incentives at present. Indeed, there is yet no clear demonstration of the socio-economic and environmental benefits to implement ICRM in basin areas in Benin. While climate change is partly integrated into agricultural research (for instance at the National University of Agronomy in Porto Novo), programmes are focused on improving agricultural productivity under existing climatic conditions rather than focusing on future changing climatic conditions. Finally, there is no platform where information about climate change impacts in Benin and best adaptation practices are stored and shared with policy- and decision-makers. As a result, there is a lack of user-friendly information to inform policies, plans, and appropriate CRA interventions in the agriculture; and demonstrating the socio-economic benefits of this approach. Such demonstration could incentivise public and private investments in project interventions. The potential of the project to increase agricultural productivity would also secure future investments from farmers and cooperatives that would maintain the project beyond its lifespan (see Annex 4).

7.2 Adaptive capacity

243. Adaptive capacity represents the degree to which an ecosystem or a community is able to cope with or adjust to the adverse effects of climate change and weather extremes. As demonstrated previously, smallholder farmers in the Upper and Middle Ouémé are extremely vulnerable to climate change. They also have very limited capacity for adaptation, because of poverty level in the area and limited access to finance, as detailed in Annex 19 Section 2. A lack of strong institutions, regulatory frameworks, development plans and strategies that promote and implement adaptation in the Upper and Middle Ouémé – see Chapter 6 – is another cause for low adaptive capacity in the area. Finally, there is a limited knowledge among smallholders, of relevant, climate-resilient, practices that can reduce the vulnerability of agricultural landscapes and communities in a watershed context like the Ouémé Basin. Some stories were reported by famers on how they currently cope with climate change sometimes with unreliable outcomes (table 16)[128].

244. Field visits on the project sites have indicated limited capacity to adapt agricultural and production systems to current and future climate change impacts. While some adaptation strategies were noted in the target communes, and several adaptation projects have been conducted in Benin , some in rural areas with positive results such as NAPA-1, the target municipalities have been neglected until now and have not yet been the subject of large-scale

[128] Akponikpè PBI (2022) Climate change and Environmental Impact study in the Oueme-basin (Benin): Update of literature and Analysis of the perceptions of climate change and farmers adaptive strategies. FAO Consultancy report, Fev-March 2022

adaptation interventions. For example, no agroforestry projects based on improved adaptation systems, pastoral systems and large-scale ecosystems restoration and resilient management of basin areas could be identified during the field missions or through interviews with governmental stakeholders and review of the literature. No agricultural land has yet been made resilient due to the lack of change in agricultural practices that have remained rudimentary. Agricultural practices remain essentially traditional and often not adapted to new climate-related threats and shifts.

245. During the field missions, some of the interviewed farmers shared their experience in implementing adaptation strategies for both annual and perennial crops.

- The use of improved short-cycle varieties, especially for corn. Indeed, farmers are changing varieties (in search of earliness as an adaptation factor to lower rainfall), and even cultivated species, in favor of hardier crops. Producers often see earlier varieties as a good response to delayed rains. Some producers seek out maize varieties from tens or hundreds of kilometers away in traditionally drier areas (for example, in neighboring countries such as Burkina Faso and sometimes beyond). However, these varieties are frequently less productive and/or more demanding in soil quality (Bosco and Doubogan, 2016). According to PANA (2015), the DMR maize variety has been adopted by producers. Another short-cycle variety was also reportedly introduced. This is CINE 2000, which is a 60-day variety;
- Zaï: creation of small holes in the field for water management used for various crops;
- Mulching: spreading straw over the row spacing in the field for water and weed management. This also includes using dead plant debris to cover the soil to reduce evapotranspiration losses and conserve soil moisture;
- The use of improving plants (Mucunan, angolan weight);
- The use of means of production (labor, inputs) is reasoned to take into account the risks: this translates in some cases into extensification, elsewhere into the concentration of means on "safer" areas (from the point of view of available water in particular);
- ISFM, Integrated Soil Fertility Management: a combination of several techniques for soil fertility (compost, mineral fertilizer as needed, etc.);
- Integrated water resource management: use of water-saving techniques (drip and sprinkler irrigation);
- Crop associations: maize-perennial crops (mangoes, cashew nuts, etc.), especially during the first few years following the planting of these perennial crops.

246. According to PANA (2015), the agricultural populations of the commune of Glazoué and surrounding areas also implore the deities to cope with the scarcity of rainfall. To do this, sacrifices are made and prayer sessions are organized for the vodun "Woulouwoulou".

247. Overall, in maize production, producers found the adoption of short-cycle and climate-resilient varieties and to some extent crop diversification and the use of chemical inputs to strengthen the crop effective.

248. In perennial crops and regardless of the commune, the measures used are summarized as grafting of trees, adoption of grafted cashew and mango plants, thinning, pruning, chemical and biological control of pest attacks. It should be noted that the diversity of economic activities such as the association of livestock with agriculture is increasingly practiced by producers. Producers find the adoption of early grafted plants such as Kent and Amelie varieties effective. According to the producers, maintenance operations allow them to fight against certain effects of climate change.

249. Market gardening is based on the use of new seed varieties, the use of fertilizers and chemical treatments, targeted watering (water saving), mulching, the installation of dams to control water levels and mainly off-season cultivation to avoid the effects of climate change.

250. The adaptation strategies adopted for the four crops targeted in this study are summarized in Table 16. **Overall, these climate adaptation innovations are not adopted by many producers because of a lack of technical capacity and knowledge of the practices, and limited access to relevant input like adapted seeds and water for irrigation.**

Table 29: Innovations/resiliency measures in response to climate change impacts

Crops	**Copargo**	**Djougou**	**Glazoué**	**Zogbodomey**	**Zagnanado**
Corn	- Use of improved short-cycle varieties, - Use of varieties that are resilient to climate change, - Crop diversification - Use of improving plants (*Mucuna*, Angolan weight) - Change of sowing date,			- Drainage - Adoption of high-yielding and climate-resilient seeds - Lowland Corn Production - Pesticides for targeted treatment - Use of improving plants (*Mucuna*, Angolan weight) - Change of seeding date	
Mangoes	- Adoption of grafted plants (Kent and Amelie) - Use of chemicals for treatment - Thinning (reducing plant density); - Windbreak Installation; - Use of firewalls; - Practice of permanent crop association/Labour between tree intervals; - Mistletoe removal			- Artificial watering / Irrigation under half-moon - Mulching around the plants - Adoption of grafted plants (Kent and Amelie)	- Artificial watering / Irrigation under half-moon - Mulching around the plants
Cashew nuts	- Adoption of grafted plants (Kent and Amelie) - Use of chemicals for treatment - Thinning (reducing plant density); - Windbreak Installation; - Use of firewalls; - Practice of permanent crop association/Labour between tree intervals; - Mistletoe removal, - Grafted use (consider that cashew plantations made with grafted seedlings from the nursery have better vegetative development than those made with direct seeding for several reasons)				
Shea	- Increased frequency of orchard maintenance	- Creation of shea parks - Orchard maintenance	- Creation of shea parks - Orchard maintenance		- Creation of shea parks - Orchard maintenance

	- Chemical and biological control - Weeding - Protection of young shea plants, - Use of fertilizer, early varieties of crops associated with shea, - Pruning (reducing old branches and roots of shea trees for new life) - Substitution of shea by cashew - Mistletoe removal.	- Chemical and biological control - Use of fertilizer, early varieties of crops associated with shea, - Pruning (reducing old branches and roots of shea trees for new life) - substitution of shea by cashew - Mistletoe removal.	- Chemical and biological control - Use of fertilizer, early varieties of crops associated with shea, - Pruning (reducing old branches and roots of shea trees for new life) - substitution of shea by cashew - Mistletoe removal.		- Chemical and biological control - Use of fertilizer, early varieties of crops associated with shea, - Pruning (reducing old branches and roots of shea trees for new life) - substitution of shea by cashew - Mistletoe removal
Vegetable crops	- Short cycle seeds - Targeted watering - Mulching, stone cordon - Crop rotation - Use of pesticides and chemical fertilizers - Gravity irrigation	- Short cycle seeds - Targeted watering - Mulching - Use of pesticides and chemical fertilizers - Targeted Irrigation/Targeted Hand Irrigation - Off-season production	- Short cycle seeds - Targeted watering - Mulching - Use of pesticides and chemical fertilizers - Targeted Irrigation / Targeted Hand Irrigation - Off-season production	- Gravity drainage - Targeted irrigation - Adoption of seeds of improved varieties resistant to climatic hazards - Installation of the dikes	- Raised boards - Construction of dikes for water level control - Gravity drainage - Targeted irrigation - Adoption of improved seeds

Source: Synthesis based on field results (February 2021 and February-March, 2022) from the literature review (Vodounou and Doubogan, 2016; Gastineau et al., 2015; Sodjinou and Kouton-Bognon, 2019; Aho et al., 2018 : Akponikpe et al., 2019)

Table 30: Successful adaptation measures in practice and effectiveness in agricultural production

Municipalities	Successful coping strategies	Coping strategies that did not work well
Copargo	- Adoption of improved seed varieties resistant to drought conditions - Crop residue management - Increased frequency of maintenance - Sarclobuttage - Mulching applicable to market gardening - Increased cleaning frequency - Association of livestock with agriculture	- Early planting (high risk of no rain) - Stony cordon (difficult to apply on large areas)
Djougou	- Adoption of short-cycle seed varieties - Adoption of grafted cashew plants - Adoption of grafted mango plants - Association of crops - Crop residue management	- Adoption of aqueous extracts of neem (Extraction process constrained by unavailability of adequate equipment) - Increase in maintenance frequency (Increase in production cost)

	- Association of livestock with agriculture	
Glazoué	- Association of mucuna with cashew trees for yam production - Crop residue management - Adoption of mulching - Adoption of improved seed	-
Zogbodomey	- Improved seed varieties - Adoption of chemical fertilizers - Adoption of some local resistant varieties - Crop rotation - Use of organic materials - Drainage in case of flooding - Manual watering - Association of livestock with agriculture	- Early sowing (Risk of not having rain) - Reseeding - Adoption of organic fertilizers (Inefficiency, cost)
Zagnanado	- Drainage of water - Crop diversification - Increased daily watering frequency - Early planting after floodwaters recede in the lowlands - Use of chemical fertilizers	- Change of site (Insufficient favorable area) - Construction of dykes (high cost of construction) - Off-season production (no permanent water source)

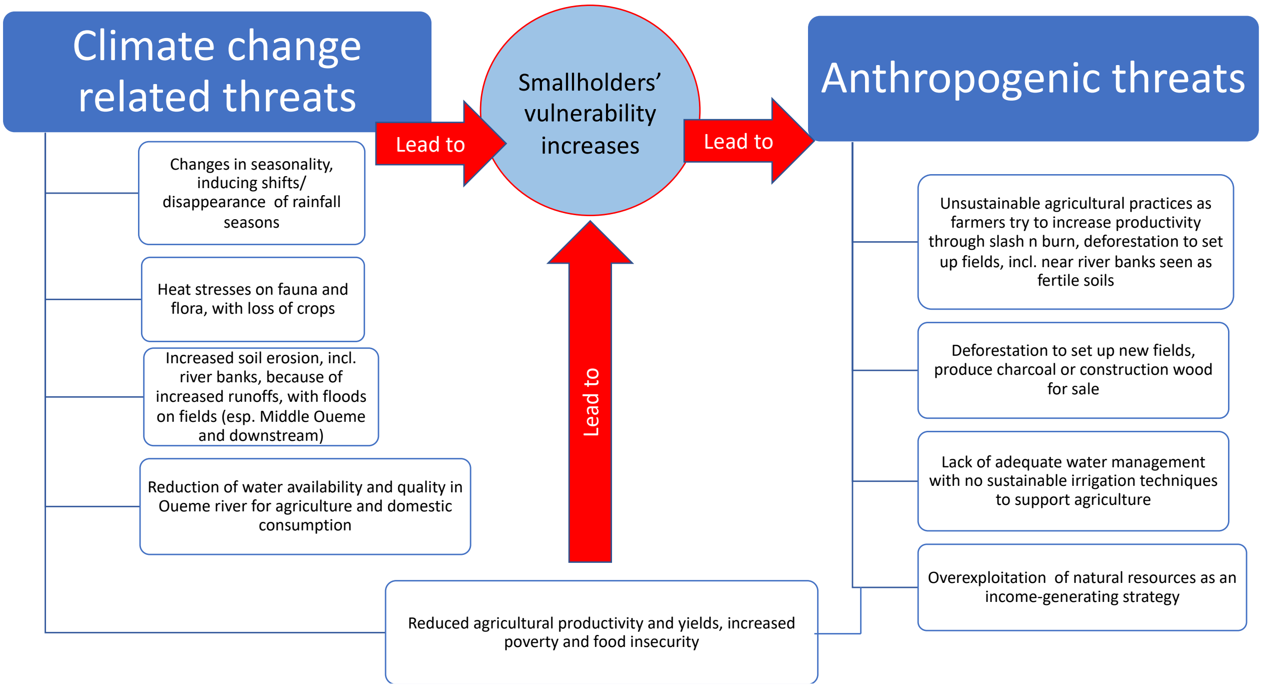
251.`Another major problem in the project's intervention zones is the limited capacity for water management in agricultural systems. The few irrigation, drainage or water retention structures and infrastructures are rudimentary, inefficient or not functional anymore. Although some initiatives have been implemented in the past to develop lowlands, irrigated perimeters, micro-irrigation systems, construction and protection of water retention structures for agro-pastoral purposes, these were not maintained due to a lack of monitoring and technical capacity to maintain, operate and rehabilitate them. No effective, climate-resilient, and integrated water resource management practices have yet been promoted in the area.

252.Low yields, food insecurity and high poverty in the target municipalities of the Upper and Middle Ouémé Basin, as well as a lack of adaptive capacity, and economic and financial opportunities (such as access to credit and investments) to support small-scale, and climate-resilient agriculture, drive the local communities towards unsustainable practices, which underpin the vicious cycle represented in Figure 63 : as yields decline because of changing climate patterns, communities turn to over extraction of wood for charcoal production, illegal logging, and clearing of new lands for agriculture. This further accentuates the depletion of the natural resources, already initiated by climate change. A decline in ecosystem goods and services, which underpin livelihoods in the Upper and Middle Ouémé areas, leads to increased vulnerability to floods and flash floods especially in Middle Ouémé, water scarcity especially in Upper Ouémé, and reduced agricultural productivity in the whole Basin. This situation further drives the populations towards unsustainable practices, locking them into a vicious cycle.

Table 31:Farmers' currently applied adaptation strategies and effectiveness against climate change in the Ouéme basin

Evidences	Farmers	Localities	Sub-basin
"Two years ago (2020), the spells of drought were intense and long; we had to contribute 40,000 francs and call on a diviner, we also provided for his transportation. He started his prayers and there were a lot of clouds but a strong wind followed but no rains; we had lost our money and our crops."	F.A., Corn, beans, rice farmer (woman)	Zounnon, Dovi, ZAGNANADO	Middle Ouémé
"Those who buy certified seeds with a three-month short cycle manage to harvest enough for their household needs despite the difficulties and climatic disturbances."	D.D., maize farmer (male)	Akouègba, Sokponta, GLAZOUÉ	
"The crops that suffer the most from repeated spells of drought are annual crops such as maize, groundnuts, yams. Trees resist better. Fruit trees such as shea, mango and cashew are adpating much better, so I've planted some in recent years to cope better."	A.R., Corn, cashew, market gardening farmer (Woman)	Foumbéa , Kolokonde , DJOUGOU	Upper Ouémé

Figure63: Vicious cycle



7.3 Needs and best options for the Upper and Middle Ouémé

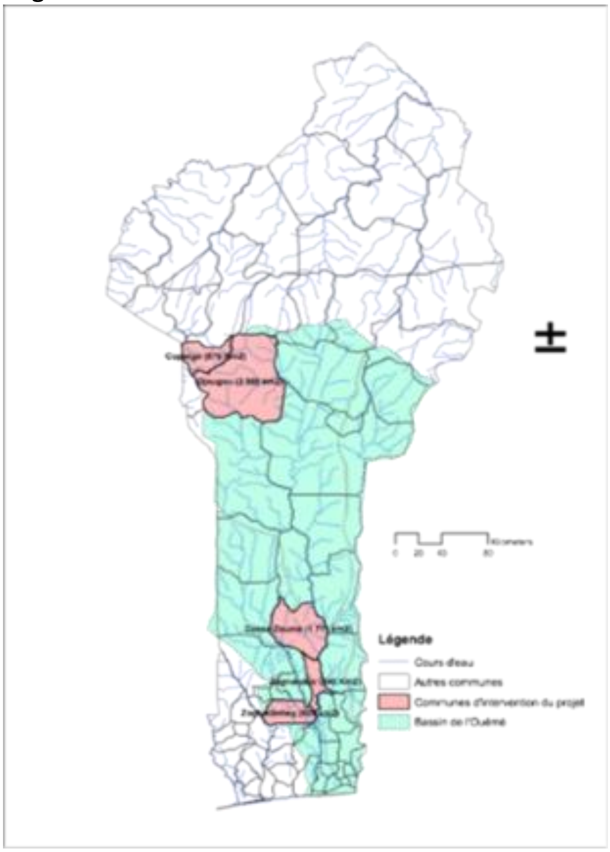
253.Climate change is threatening the well-being and livelihoods of vulnerable communities in Benin, in particular poor small-scale farmer communities living in the Ouémé Basin. The regional climate change scenario (please see sections 2 and 3) indicates a gradual disappearance of the short rainy season in Upper-Middle and Middle Ouémé, an increase in droughts especially in the Upper Ouémé, and increasing temperatures, rainfall intensities and late onset of the main rainfall season in the whole Basin area. In the Middle Basin and transition zones (Zagnanado and Zogbodomey), there is a growing risk of flooding especially because of overflow in the Ouémé River, which threatens agriculture and livelihoods. Conversely, in the northern zone (Glazoue, Copargo and Djougou), water stress is increasing, with direct negative impacts on widespread rainfed agriculture, while the presence of hills and valleys also makes these municipalities vulnerable to floods. As a result of climate change impacts, agricultural yields will decrease, exacerbating food insecurity among the growing population. As agricultural yields decline and farmers have limited knowledge, technical and financial capacity and support to adapt to a changing climate, they increasingly turn to unsustainable practices: overextraction of natural resources like wood and vegetation, and clearing of land along the Ouémé riverbanks result in aggravated soil erosion, silting of the river, and floods, especially affecting the lower parts of the Ouémé Basin, thereby increasing the climate change vulnerability of rural communities.

254. To reduce climate change-related threats in the whole Ouémé Basin, enhance food crop production, reduce the vulnerability of small-scale farmers, and build their resilience and adaptive capacity to climate change, it is critical to improve the availability and management of water resources, ecosystems' goods and services, and agricultural landscapes. **Achieving this effectively in the target region requires shifting to an innovative, integrated and climate-resilient approach to basin management in the Ouémé area (or, as we call it, 'Integrated Climate-Resilient Management' – ICRM), that sustainably increases the resilience of smallholder farmers, and boosts agro-ecosystems productivity. A shift of behaviours towards sustainable land and water management especially along riverbanks, will also contribute to buffer upstream to downstream populations against climate change impacts**.

255. The specific interventions underpinning the whole OCRI project are based on scientific evidence, best practices, experiences, and lessons learned from ongoing and previous projects. Additionally, extensive stakeholder consultations with representatives from municipal and district-level government departments, as well as communities from the target districts in Upper and Middle Ouémé region of Benin, have provided insights on the local appropriateness of international and national best practices. Replicating or upscaling the successes of past and on-going initiatives, is a pathway to ensure the sustainability and effectiveness of project interventions, to enhance the climate resilience of rural communities in Benin.

Figure64: The watershed approach and the project intervention municipalities

Upper Valley: Copargo, Djougou ; Upper-Middle Valley: Glazoue; Middle Valley: Zogbodomey, Zagnanando



The OCRI project aims at sustainably increasing the resilience of smallholder farmers and their agro-ecosystems through an integrated climate-resilient management (ICRM) approach at basin level.

This proposed integrated approach considers the interactions between climate change impacts on water, crops and population, from upstream to downstream areas. It aims to combine interventions that restore ecosystems along riverbanks to reinforce their functions, while tackling the climate and non-climate causes of ecosystem degradation. As a result, ecosystem functions are restored and enhanced, thereby protecting the population against climate change impacts, while at the same time ensuring the production of goods and services that underpin agricultural production. These soft adaptation interventions are combined with small water infrastructure to ensure water capture, flow and recharge, as well as its sustainable management to enable agricultural activities. Finally, introducing new climate-resilient agricultural techniques, which also contribute to ecosystem restoration and protection, allows to sustain crop production while resorting the ecological functions that deliver critical services to humans in a changing climate.

The watershed approach strengthens the basin's ability to maintain its functions (stabilizing soils through vegetation, storing water or regulating the flow and providing socio-environmental services) in light of climate change impacts according to the characteristics of the agro-ecological zones. The up taking of climate resilient agricultural practices and protection of the ecosystems and water sources upstream indirectly benefit a larger part of the population located in the lower basin areas.

256.In addition to supporting an integrated climate-resilient management approach in basin area, the considered measures on ecosystems, water and agriculture, as well as capacity building and support to value chains (as a pathway to ensure the long-term implementation of ICRM in the Ouémé Basin – see below), were selected based on the flowing criteria:

- Address the main climate change impacts identified in the project area and detailed in Chapter 3, i.e. increase intensity and duration of drought/water scarcity, floods and contribute to sustainably increase resilience of smallholder farmers to climate change impacts.
- Best practices for climate-resilient agriculture (CRA) Benin as identified in FAO guidebook "Pratiques et Technologies pour une Agriculture Intelligente face au Climat (AIC) au Benin"[129].
- Technologies alignment with Benin's national priorities and policies for water, agriculture, and climate change adaptation.
- Complementarity of project interventions with existing initiatives in the target area.
- Building on lessons learnt or scaling up best practices from past or on-going successful projects.
- Inclusion of environmental and social safeguards, gender-inclusive approach.

257. It is important to note that all crops and agroforestry products, promoted by the project, have been selected because: i) they are currently grown on the project sites and are part of the local diet; ii) they are locally-relevant and resilient varieties or production techniques to address the climate stressors identified are available; iii) they can be produced by smallholders (providing some training and technical support); iv) there is a market demand - especially for those crops which value chains will be strengthened; and v) they do not pose threats to the local environment (and are aligned with risk category B). Therefore, the project will target the following: maize, cassava, cowpea, chillies, okra, green vegetable, tomatoes, yam, shea, mango and cashew – the latter being part of agroforestry systems.

The proposed specific practices for waterworks and CRA will be decided through the FFS using a participatory process with the beneficiary farmers. The CRA practices will be tailored to each project site, based on the local environmental and climate conditions, as well as the needs and capacity (technical and material) of the targeted communities to implement them; it will also be informed by the the success of existing adaptive strategies that have already been implemented in the target communes, as described in Section 8.2; Table 32 also underlines known adaptation strategies that are suited to each target commune,based on climatic hazards and climate change impact on crops. During the field visits farmers higligthed adaptation measures that worked well and those that didn't work. Although in general farmers tend to use similar adaptation measures in Upper and Middle Oueme, some of them show that are context-specific based on different climate hazards. For instance, among vegetal crops Zagnanado included adaptation measures such as raised boards and construction of dikes for water control, as it is more affected by flodding; while Diougou, among other adaptation measures included short cycle seeds and targeted watering/irrigation, which are CRA practices more adapted to dry spell, drought and heat. CRA practices indicated in the Table 32 will be further fine tuned at the inception phase of the FFS sessions, through a community vulnerability assessment, which is the first FFS activity to update the adaptation measures based on the specific current farmer needs.
In addition, an integrated and holistic resilience assessment using the SHARP tool will be conducted aiming to identify the main areas of vulnerability in the selected municipalities. The

[129] Tiemoko, y. et al. 2017. Pratiques et Technologies pour une Agriculture Intelligente face au Climat (AIC) au Benin. FAO, Cotonou

results will support the targeting and decision-making on which of and where the proposed strategies are most needed and identify who need them the most. The results will also support the refinement of the M&E strategy and set a project baseline for key M&E indicators with primary up-to-date data. SHAPR tool has been widely used by FAO in climate change projects.

Table 32: Climate hazards, impacts on crops and effective adaptation measures

Crops	Upper Oueme		Middle-Oueme	South-middle Oueme	
	Copargo	Djougou	Glazoué	Zogbodomey	Zagnanado
	Climatic hazards -Irregular rainfall -Shift in the agricultural calendar - Heavy wind - Early drying of rivers	**Climatic hazards** - Drought - Late arrival of rain - Early drying of rivers	**Climatic hazards** -Rain delay -Drought -Early arrival and end of rain -Heat -Heavy wind -Excessive rainfall causing flooding of the lowlands	**Climatic hazards** -Late/short rainfall -Imbalanced distribution of rainfall -Heavy wind -Flooding -Early drainage of lowlands	**Climatic hazards** -Drought -Late arrival of rain -Irregular rainfall - Long harmattan duration -Early drainage of lowlands -Flooding
Maize	**CC impact on crops** -Low germination rate -Seedling wilt -Dwarf development of plants -Poor cob development	**CC impact on crops** -Low germination rate -Seedling wilt - Dwarf development of plants -Poor cob development	**CC impact on crops** -Worm development - Dwarf development of corn plants	**CC impact on crops** -Low emergence after germination -Plant wilt -Yellowing of leaves -Development of parasitic attacks from inside the plants	**CC impact on crops** -Low emergence after germination -Plant wilt -Yellowing of the leaves -Development of parasitic attacks from inside the plants
	Adaptation measures -Crop rotation and association -Adoption of short cycle and resistant varieties - Zai - No tillage	**Adaptation measures** -Crop rotation and association - Adoption of short cycle and resistant varieties - Zai - No tillage	**Adaptation measures** - Crop rotation and association - Adoption of short cycle and resistant varieties - Zai - No tillage	**Adaptation measures** -Drainage -Adoption of high-yielding and CC-resistant seeds -Lowland maize production - No tillage	**Adaptation measures** -Drainage -Crop diversification -Adoption of high-yielding and CC-resistant seeds -Lowland maize production - No tillage
Mango	**CC impact on crops** Low fruit development (+ fruit acidity / Glazoue)				
	Adaptation measures - Pruning - Mechanical control - Adoption of grafted plants -Windbreak installation - Zai	**Adaptation measures** -Pruning -Mechanical control -Adoption of grafted plants (Kent and Amelie) -Windbreak installation - Zai	**Adaptation measures** - Pruning - Mechanical control - Adoption of grafted plants (Kent and Amelie) -Windbreak installation - Zai	**Adaptation measures** -Artificial watering / Irrigation under half-moon -Mulching around the plants to conserve moisture - Zai	**Adaptation measures** -Artificial watering / Irrigation under half-moon -Mulching around the plants to conserve moisture -Agroforestry: association with crops - Zai

Cashew nut	**CC impact on** crops---Low nut development -Early blooming of flowers	**CC impact on crops** -Low nut development	**CC impact on crops** - Low nut development	**Impact CC on crop** Development of pests causing low nut size	**CC impact on crops** Development of parasites causing low nut size
	Adaptation measures -Pruning, Thinning, Foliage -Adoption of grafted plants -Use of chemicals for treatment - Windbreak installation - Zai				
Shea nut	**CC impact on crops** Low nut development (except in Zogbodomey and Zagnanado)				
	Adaptation measures - Orchard maintenance - biological control -Weeding - Zai	**Adaptation measures** - Orchard maintenance - Creation of shea parks - biological control - Zai	**Adaptation measures** - Orchard maintenance - Creation of shea parks -biological control -Zai	**Adaptation measures** - Orchard maintenance - Creation of shea parks - biological control - Zai	**Adaptation measures** - Orchard maintenance - Creation of shea parks - biological control - Zai
Vegetable crops	**Impact on crops** - Plant wilt -Weak growth of vegetables -Poor fruit development	**Impact on crops** -Plant wilt -Weak growth of vegetables -Poor fruit development	**Impact on crops** -Development of worms especially in cabbage -Weak growth of vegetables (carrots, leafy vegetables) -Attack on chilli and tomato leaves	**Impact on crops** -Plant wilt -Low emergence after germination for carrot and cabbage -Low emergence after transplanting -Yellowing of the leaves	**Impact on crops** -Plant wilt -Low emergence after germination for carrot and cabbage -Low emergence after transplanting -Yellowing of the leaves
	Adaptation measures -Short cycle seeds -Targeted watering -Mulching -Crop rotation -Targeted irrigation -Off-season production - No tillage	**Adaptation measures** - Short cycle seeds - Targeted watering - Mulching - Crop rotation - Targeted Irrigation/Targeted Hand Irrigation - Off-season production - No tillage	**Adaptation measures** - Short cycle seeds - Targeted watering - Mulching - Crop rotation - Targeted Irrigation/Targeted hand Irrigation - Off-season production - No tillage	**Adaptation measures** - Adoption of seed of improved varieties resistant to the effects of CC - Gravity drainage - Targeted irrigation -Installation of dikes - No tillage	**Adaptation measures** -Adoption of seed of improved varieties resistant to the effects of CC -Raised boards -Construction of dikes for water control -Gravity drainage -Targeted irrigation - No tillage

Climate change impacts on value chains: processing, conservation, and sales Error! Bookmark not defined.:

	Climate Threats	*Climate change impacts and Adaptation strategies*		
Crops	**1-Drought, heat** **2-Late/shorter rainy season** **3-Excessive rainfall/flooding** **4-Heavy wind**	**Climate change impacts (**Threats #)	**Adaptation measures (promoted under OCRI Component 2)**	**Measures expected impact**

Upper and Middle Oueme (All communes)	Maize (staple crops)	1, 2, 3, 4	Grains humid at harvest and deteriorate/spoil fast (1,3), Lower quality of processed products (1,2,3), Heavy rain hampers access to fields and markets compromised (3), Price hikes (3)	Drying stocking practices organized processing, & sale	Stable quality capture of higher prices make up for reduced production
Upper and Middle Oueme (All commu	Vegetab les	1,3	*Poor quality fruit products (1, 2 & 3) heat affects products conservation (1)* *Price hikes (3)*	Organized packaging, & sale	Stable quality capture of higher prices make up for reduced production
Upper and Middle Oueme (Glazoue-Djougou-Copargo)	Cashew (nuts)	1, 2, 3, 4	Damaged fruit harvest (1,2,3,4) small, broken nuts (1,2,3,4) humid nuts fast deteriorate (3), heat affects fruits conservation (1) Price hikes (3) *Low quality fruits (1,2,3,4)*	Ventilated storage, organized packaging, & sale Marketing and finance capacity building	Stable quality capture of higher prices make up for reduced production
Upper Oueme (Djougou-Copargo)	Mango	1, 2, 3, 4	*Heat affects fruits conservation, rapid deterioration of fruits (1)* *Reduced shelf life (1,2)* *Price hikes (3)* *Shea nut acidity (3)* *Harvest delayed (3)* *Low quality fruits (1,2,3,4)*	*Ventilated storage organized processing, & sale* Marketing and finance capacity building	*Stable quality capture of higher prices make up for reduced production*
Upper Oueme (Djougou-Copargo)	Shea	1, 2, 3, 4	*Nuts humid at harvest* *Low quality fruits (1,2,3,4)*	Drying organized processing, & sale Marketing and finance capacity building	*Stable quality capture of higher prices make up for reduced production*

7.3.1 Waterworks and enabling CRA to restore ecosystems and boost agriculture under climate change

258. Climate change impacts in the Ouémé Basin of Benin are affecting water availability, with negative effects on agriculture, essentially rainfed. Increased rainfall variability, shifts in the seasonality with the late onset of the main rainy season and a possible disappearance of the short rainy season in Middle Ouémé, increasing temperature, more frequent droughts, intense rainfall events and floods result in significant agricultural yield declines. Moreover, these impacts negatively affect vegetation cover, soil nutriment and moisture, and land stability in particular along the riverbanks.

259. As part of the ICRM approach, waterworks and CRA interventions aim at addressing especially the following climate change impacts in the target areas:

- **An increase in soil erosion**. Many parts of the Ouémé Basin of Benin are subject to soil erosion, since land degradation has occurred widely as a result of heavy rainfall events, increasing temperature and droughts, as well as unsustainable land management practices and wood extraction – also exacerbated by climate change impacts on agriculture. Areas that have erosion-prone soils such as in the Upper Ouémé are particularly vulnerable to soil erosion. During intense rainfall events, raindrops strike the bare soil surface and disperse clay particles. The dispersed clay seals the soil surface, which increases run-off and consequently erosion. Agricultural fields situated on long slopes are particularly affected[130]. Soil erosion also causes the loss of soil

[130] FAO. Keeping the land alive - Soil erosion: its causes and cures. Available at: http://www.fao.org/docrep/t0389e/t0389e02.htm

nutrients and organic matter[131] via sediment removal. Consequently, crop yields decrease and the need for costly inorganic fertilisers increases[132,133]. Finally, erosion along the banks of the Ouémé River leads to floods in the lower parts of the Basin.

- **An increase in the frequency and intensity of floods – particularly in the Middle Ouémé area**. Changes in rainfall patterns with more extreme rainfall events upstream lead to soil erosion, run-off, river silting and eventually increase flood risks in the Middle and Lower Ouémé. Floods and heavy rainfalls in the Middle Ouémé lead to erosion and major crop losses and damages agricultural infrastructure. Flooding also causes waterlogging in fields, which reduces crop yields by decreasing the oxygen available for roots[134,135]. Economic activities, livelihoods and well-being are at risk.
- **A shortened growing period due to the shorter or unreliable rainfall season and higher temperatures both in Upper and Middle Ouémé areas**. When the growing period is shorter, with a late start, flowering is delayed, resulting in the decline of the yields of certain crops. Increased heat also impairs the growing of some crops and NTFPs. Additionally, the late onset of the rainfall season may result in field operations, such as seedbed preparation, planting and harvesting, being performed at the wrong times, which leads to crop failure or reduced yields[136]. Finally, higher rainfall variability punctuates the rainfall seasons with drought pockets, which can also lead to crop failure as agriculture is essentially rainfed in the Ouémé Basin.

260. According the field studies, there are 95,000 ha of lowland[137] and riverbanks area in the Upper and Middle Ouémé which can be subjected to improved management and surface water mobilization through micro-dams, water retention of variable size, and water management (soft and hard) infrastructures to enable climate-resilient agriculture, agroforestry, and counter-season horticulture, in the context of climate change, while at the same time improving water filtration in soils and vegetation cover to buffer communities against floods, heat and water scarcity. This estimation (95,000 ha) takes into account soil erosion problems and risks in the area. Within this target 95,000 ha, the project will set up the following:

- 30 new surface water collection structures are built: 8 in Copargo, 11 in Djougou; 8 in Glazoue; 2 in Zangnanado; 1 in Zogbodome

- 23 surface water collection structures are rehabilitated: 5 in Copargo, 7 in Djougou; 10 in Glazoue; 1 in Zangnanado

- 680ha of irrigated plots are established: 200 ha in Copargo, 170 ha in Djougou; 160 ha in Glazoue; 25 ha in Zangnanado; 125 ha in Zogbodome

- 58 water sources are protecter: 2 in Copargo; 14 in Zangnanado; 42 in Zogbodome

- 44 artesian boreholes are built

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[131] FAO. Keeping the land alive - Soil erosion: its causes and cures. Available at: http://www.fao.org/docrep/t0389e/t0389e02.htm

[132] Laube W, Schraven B & Awo M. 2011. Smallholder adaptation to climate change: dynamics and limits in Northern Ghana. *Climatic Change.* 111: 753–774.

[133] Even at present, very few smallholder farmers in central and north Benin can afford to apply the recommended amounts of inorganic fertilisers.

[134] Bakker, D. Waterlogging Fact Sheet. Available at: http://soilquality.org.au/factsheets/waterlogging

[135] Other gases detrimental to root growth, such as carbon dioxide and ethylene, also accumulate around roots when soil is waterlogged. Furthermore, waterlogged soils release increased amounts of nitrous oxide (N_2O), a particularly damaging greenhouse gas.

[136] Iizumi T & Ramankutty N. 2015. How do weather and climate influence cropping area and intensity? *Global food security*. 4: 46–50.

[137] Lowlands are defined as "inland valleys, flat or concave with temporary or perennial flow axes, which are flooded for periods of at least several days of the year, and in which soils with hydromorphic characteristics and a relatively small catchment area are found" (APRM / Direction Génie Rural, 2010).

This is based on the results from the various field missions conducted during the project development phase, including area available within each commune, need for water access or water protection infrastructure, and degraded riverine forests to be restored.

- A total of 9,000 ha of degraded land are reforested including: 1,500ha in Copargo; 1,750ha in Djougou; 300ha (OCRI) and 680ha (IFAD) in Glazoue; 600ha (OCRI) and 1,360 (IFAD) in Zagnanado; and 850ha (OCRI) and 1,960ha (IFAD) in Zogbodome

261. The overall expected impacts of the project will be reduced degradation and improved land and water management of 95,000 ha of land in the Upper and Middle Oueme through OCRI including 530 ha through IFAD. Within this area, waterworks and CRA interventions will be implemented with the objective to:

i) expanding water access and improving water availability to enable irrigated agriculture (including counter-season) in a context where droughts are more intense and seasonality is shifting (from current 4,080 ha of existing irrigated agricultural plots to an additional 2000 ha from OCRI including 1320 with MAEP/IFAD; and

ii) expanding the area covered with agroforestry (tree-crop mixed systems) from 8 trees/ha (currently) to 24 trees/ha (equivalent to 1,863 ha to 9,000 ha of land covered with agroforestry, including 4,000 ha with MAEP/IFAD) to improve water retention in soil, moisture and fertility, as well as provide shade.

262. Table 20 describes the type of water and land management interventions needed per project site to reduce climate change vulnerability. These interventions aim at improving water supplies especially in support of agriculture; and conserving, in a sustainable way, existing water resources. They are based on waterworks studies (Annex 17), which have identified the following needs:

1. to build 30 new surface water collection structures (dams, micro-dams, weirs, over-embanked ponds, etc.),
2. to rehabilitate 23 old surface water collection structures (small earth dams, water reservoirs, weirs, overflow weirs, etc.), (iii) to rehabilitate the existing water storage facilities (water reservoirs, weirs, etc.)
3. to develop 680 ha of small irrigated perimeters including 105 ha downstream of the water collection structure to be built and/or rehabilitated and 220 ha downstream of the artesian boreholes in Zangnanado and Zogbodomè; and
4. to develop for the sustainable protection of 58 water sources and 44 artesian boreholes.

The dimensions of the project in terms of areas to be developed took into account the potential of the delimited area, the presence of similar projects in the area (PADMAR, PADAAM, PRIMA, PAIAVO, PSAAB, PDPIM, PADAC, etc.) and certain particularities related to natural resources (protected forests, plantations, proximity to major centres, lakes and lagoons, etc.), the constraints of targeting groups related to the structuring of professional organizations, and the constraints of available financial resources. On this basis, the physical objectives in terms of construction/rehabilitation and development relate to the actions for which the table below shows the preliminary breakdown by intervention commune (Table 33).

Table 33: Waterworks to be built by OCRI project

Type of infrastructures / *Municipality*	Construction of micro-dams/weirs (unit)	Rehabilitation of micro-dams/weirs (unit)	Development of small irrigated perimeters (ha)	Development for the protection of springs and watercourses (unit)	**Total site improvement through sustainable water and soil conservation practices (ha)**
Copargo	*8*	*5*	200	*2*	***20 115***
Djougou	*11*	*7*	170	*0*	***38 762***
Glazoué	*8*	*10*	160	*0*	***6 993***
Zangnanado	*2*	*1*	25	*14*	***11 509***
Zogbodomè	*1*	*-*	125	*42*	***17 622***
Total	30	23	680	58	**95 000**

263. These interventions are fully aligned with, and support the implementation of Benin's SDAGE and climate change strategies, including the INDC, and the Climate-Smart Agriculture axis of the PDSA.

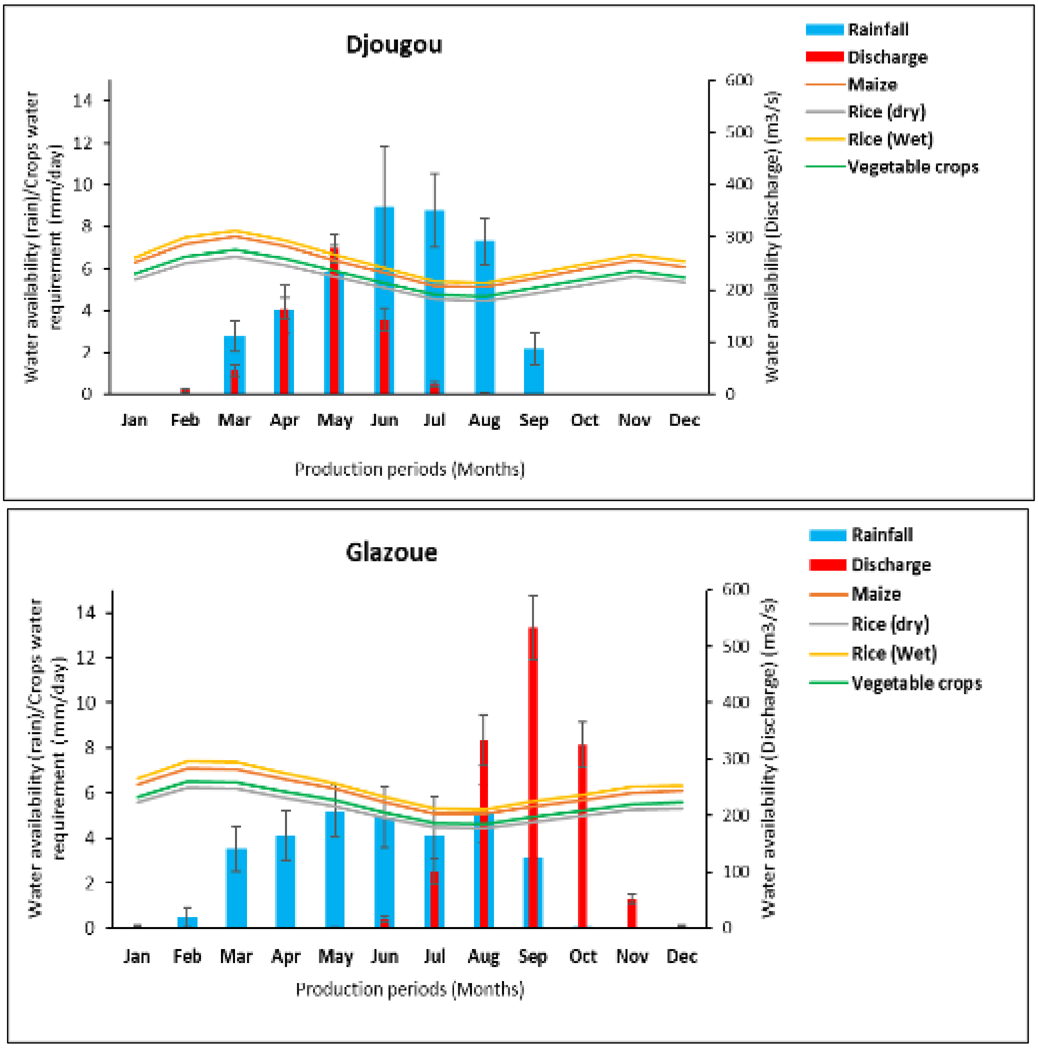
264. In addition to GCF's planned improvements, IFAD will ensure 1,320 ha of additional land is irrigated for agriculture in Glazoue and Djougou; and that 4,000 ha of land are replanted in Glazoué, Zagnando and Zogbodomey.

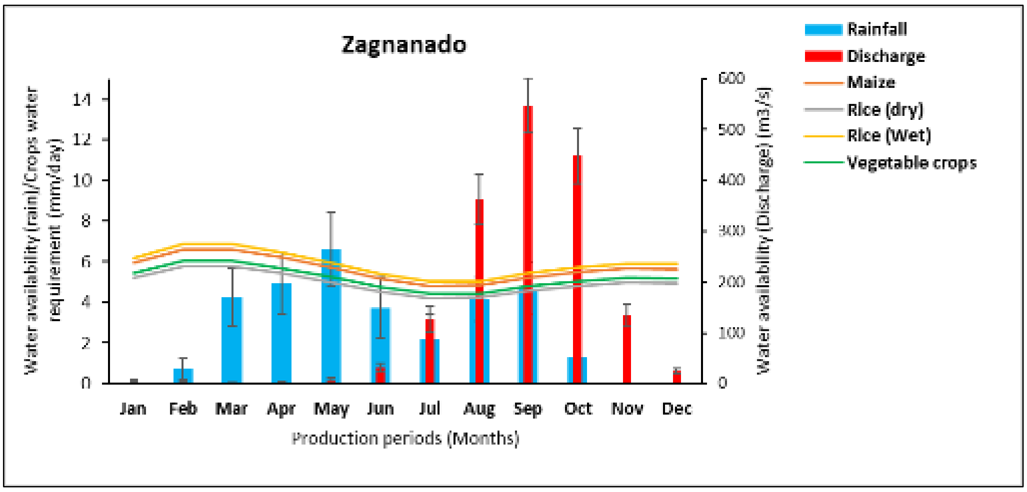
265. The water and land management interventions were carefully selected, considering the watershed context of Upper and Middle Oueme. Although the impacts of climate change have many similarities in Upper and Middle Oueme Basin, there are specific impacts related to respectively, the predominance of strong erosion and degradation of the uppermost sub-catchment, and more frequent flooding in the middle valley. Hence, protecting the uppermost sub-basin through the promotion of soil and water conservation practices will contribute to increased water infiltration over a large area of the basin upstream with an expected substantial effect on the reduction of downstream flows and floods in the lower valley. Then, more infrastructures to store water (micro-dams, weirs etc) (90%) or rehabilitation (96%), and in-field water harvesting/infiltration management (69%) will be implemented in the upper Oueme. Development of irrigation perimeters will also be more targeted to the upper Oueme to valorise the mobilized water and combat the drier climate effect. Protection of artesian boreholes will more developed (97%) in the middle Oueme to better make use of the water resource and control flooding. In-land valley management will be developed equally (50%) in both the upper and the middle Oueme.

266. To further guide project's interventions, crops water requirements were analysed, and compared to the availability of water in the basin (rainfall and discharge water) made. Three intervention communes (municipalities) were used for the analysis: (i) Djougou (Upper Oueme), (ii) Glazoue (upper oueme) and (iii) Zagnanado (middle oueme). The main crops cultivated in the basin (maize, rice and vegetable crops) were used for the analysis. **Fig.** 65

shows the critical water stress periods per crops in different regions of the basin. For the three regions, Jan, Feb, Apr, Oct, Nov and Dec are the most critical periods for rice (wet) and vegetable crops production, where the crops experienced the highest water stress. Subsequently, production of these crops during those periods needs efficient irrigated systems, where sufficient water source is needed. These periods usually correspond to the dry season (off season) of the different regions in the basin. The discharge water can therefore be stored during its available time and be used later during dry season for crops irrigation. The water discharge is high from August to October in the South upper (Glazoue) and middle Oueme (Zagnando) rather than being high at the onset of the season like in the case of Djougou (Upper O.), mainly because most of the water running-off from the northern parts of the country flow towards the South.

Figure 65: Crops water requirements against water availability at Djougou (Upper-Oueme). Baseline, Historical data from 1960 to 2014; Crop water requirement computed with CROPWAT 8.0, discharge data from GRDC 1960-2014)





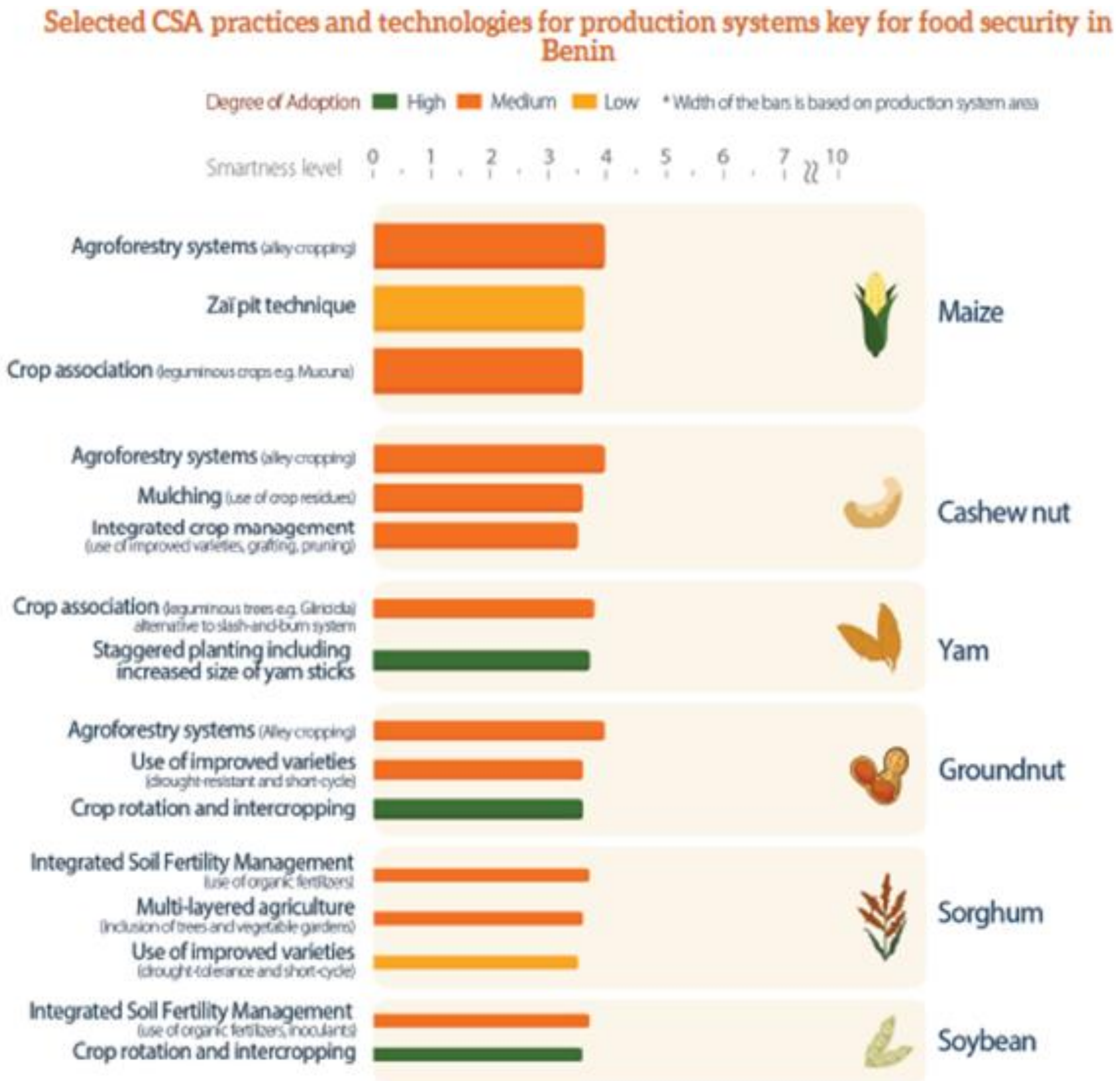
267.The development of small-scale irrigation schemes, and water retention or collection infrstructure is identified as a best practice to reduce the impacts of more frequent, extended droughts – as experienced in the Upper Ouémé – and floods – as experienced in the Middle Ouémé – and support agriculture under climate change conditions, including counter-season horticulture. For example, such practices has proven successful through the *World Bank Agricultural productivity and diversification project (APDP),* which resulted in increased income generation from agricultural crop sales for project beneficiaries. In areas submitted to frequent intense floods, like Middle Ouémé, and frequent crop, livestock and grazing areas losses, it is urgent to control the water resource through the implementation of irrigation system to redistribute water through appropriate regulation and drainage systems. Similarly, irrigation systems would allow the strengthening of resilience of agriculture and vegetable production zone, which is producing cereals (rice), cassava, legumes and other crops twice during the year.

268.CRA options includes some agroforestry technologies which combines the most common crops such as maize, cashew, yam, shea with climate resilient management practices including alley cropping, Zai pit, crop association, mulching, crop rotation, use of improved varieties and propagation material (eg grafted plants), cover crops (eg mucuna). These options were identified and assessed for their degree of acceptance by small scale farmers in Benin[138].

269.The figure 66 summarises the assessment of the CRA practiced in Benin and the level of adoption by farmers.

138 FAO, ICRISAT, CIAT. 2018. Climate-Smart Agriculture in Benin. CSA Country profiles for Africa series. International Center for Tropical Agriculture (CIAT); International Crop Research Institute for the Semi-Arid Tropics; Food and Agriculture Organization of the United Nations (FAO). Rome. Italy. 22 p.

Figure66: Good CRA practices adopted by small scale farmers in Benin (source: FAO et al 2018)



270.These technology options and guidelines will be further adapted to the field reality and needs (using holistic tool SHARP, as indicated previously), to ensure the selection and implementation of the most relevant adaptation options.

271.The project will target the following crops, which are identified as locally-relevant, part of the community's diet, already cultivated in each project area, environmental-friendly and climate-resilient (at least through the application of relevant production techniques or use of improved seeds), and, particularly for those which value chain will be strengthened, with substantive market potential (see Annex 19): these crops are maize, okracassava, green vegetable (women-oriented culture), cashew, mango and shea. All these crops will be negatively impacted by climate change impacts, as detailed in Section 3. The latter tree cultures can be combined with currently-grown crops in the project sites, through climate-resilient agroforestry systems.

272. Agroforestry and the diversification of crop varieties will be implemented to ensure a broader source of crop resilience to the uncertain occurrence and effects of extreme weather events[139]. The development of agroforestry systems will be considered through the design of dynamic vegetation models that integrate both net primary production and forest yield approaches. This would allow on the one hand to calibrate and adjust the biogeochemical processes (regulation of greenhouse gases) and biophysical processes (regulation of water and energy) to be implemented for sustainable management of agricultural ecosystems, forests, and on the other hand to simulate forest biomass, primary and food production, the water and nutrient cycle, the effects of fires, insect infestations and extreme events, the evolution of biodiversity as well as climate feedbacks. Water-holding capacity of soil will improve, and soit erosion reduce.

Table34: Agroforestry models to promote over the 95,000ha restored by OCRI

Baseline cover	After-project cover
Cropped dryland: • Maize 56% • Tubers (Manioc) 21% • Cowpea 18% • Vegetables 5% • Fertilisation: 25 kg NPK (fertiliser); 50 kg NPK (manure) / ha*y • Farmer type: subsistence	**Agroforestry:** • Baseline crops + inputs + • Mango 5% • Cashew 5% • Shea 5% • Fodder tree 5% • Farmer type: semi-commercial

273. Sustainable land management techniques, such as the use of compost, intercropping, crop rotation systems or the use of covering crops and legumes also improve agricultural productivity, in a context where temperatures are rising, aridity is more prominent, and soil nutriments are reduced. Cover cropping and agroforestry on the fields contribute to enhance water filtration and retention in the soil. This results in reduced surface runoff and enhances soil moisture, which in turn improve productivity. Other techniques, like stone lines, countor and muclhing, contribute to improve water retention especially in drought- and flood-prone areas. Sustainable management of degraded agricultural landscape and basin areas is also key to reduce climate change vulnerability and improve agricultural productivity[140]. In Benin, these techniques have been promoted successfully in various projects, such as *Programme d'Appui au Secteur du Développement Rural (PASDeR)*[141]*.* In addition, several projects have supported or are supporting the sustainable management of natural resources – such as soil and water – to increase agricultural productivity in Benin[142], namely PGTRN, ProCGRN, *Projet PAGDT-C* (*Projet Intercommunal d'Appui à la Gestion Durable des Terres et d'adaptation aux*

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[139] Ratnadass A, Fernandes P, Avelino J & Habib R. 2012. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review. *Agronomy for Sustainable Development.* 32: 273–303.

[140] GIZ, 2017. Adaptation de l'agriculture au changement climatique (PACC). Available at: https://www.giz.de/en/worldwide/31841.html

[141] IASS Working Paper, 2016. Expériences en Gestion Durable des Terres au Bénin: quelles leçons tirer pour les orientations futures? Available at: http://gsf.iass-potsdam.de/wp-content/uploads/2015/02/Benin_workshop-report_IASS_sept-2016_klein.pdf

[142] Amoussou E., Vodounon H.T., Hougni A., Vissin E.W., Houndenou C., Mahe G. and Boko M. 2016. Changements environnementaux et vulnérabilité des écosystèmes dans le basin-versant béninois du fleuve Niger. International Journal of Biological and Chemical Sciences, 5(10)

changements climatiques dans le Département des Collines), the GIZ's *Adaptation de l'Agriculture au Changement Climatique*[143], and the GCF/ UN Environment SAP project.

274. Finally, the project will invest significant resources in building the technical capacity of local stakeholders to maintain, operate and rehabilitate the waterworks, a necessity that stems out from field observations; indeed past projects promoting water management through infrastructures and irrigation systems have failed in the long-term because of a lack of maintenance and operational capacity of this equipment.

7.3.2 Training through Farmers Field Schools, VSLA and Caisse de Resilience

FFS and FBS approach

275. The project will adopt a training approach using Farmers Field School (FFS) and Training of Trainers approach (ToT). The FFS approach is designed to enhance understanding of complex agro-ecosystems. Communities are encouraged to change practices and take a lead role in improving the production system. FFS are based on observing, analysing, and understanding local agro-ecosystems, "the field is the book" and all activities are discovery-based. Activities aim at finding out solutions to the local needs, based on a thorough understanding of biological synergies and ecosystem functions. Thanks to the flexibility of the approach, its capacity to be adapted to different contexts, its innovation, and its foundation on the principles "learning by doing, discovering learning", the FFS can be considered a very suitable methodologies to face with the climate change.

276. Key principles of the approach are[144]:

- *Learning by doing*. Adults learn better by experience than by passive listening during a lecture or demonstration. Discovery-based learning is an essential part of the learning process, as it helps participants to develop a sense of ownership and make them realize they are able to reproduce activities and results in their own field or herd.
- *Learning activities centred on producers*. Producers, not the facilitator, decide what is important to them and which topics should be addressed in the FFS, in alignment with the project objectives. This approach guarantees that the selected content is relevant and focused on the real needs of the participants.
- *Producers become technical experts* in their own production systems.
- *Comparative experimentations in the field*. The approach builds on local knowledge systems while adapting and validating scientific concepts developed elsewhere to the specific site.
- *Improve decision-making*. Farmer capacity to make critical and informed decisions is improved in order to increase the profitability and sustainability of farmers' production.
- *FFS enhances participants' skills for critical analysis and problem-solving*.
- *Exchanges are critical*. The approach encourages exchanges between producers, extension agents and researchers, so that they can work together to test, evaluate and adapt a variety of options while respecting the local context.
- *Collective action*. The approach promotes collective action, fostering group cohesion and community decision-making to improve agriculture and livelihoods.

[143] GIZ, 2017. Adaptation de l'agriculture au changement climatique (PACC). Available at: https://www.giz.de/en/worldwide/31841.html

[144] Guidance on field schools can be found here: http://www.fao.org/3/i5296e/i5296e.pdf

277. The FFS approach has since addressed a wide range of topics in many countries and regions, adapting its key features of ecological literacy, field-based learning and group collaboration to different ecosystems. **Climate change** is currently one of the key topics integrated into the FFS learning process, as the approach ensures a continuous process for updating the information base needed to cope with climate vagaries. Below are the key elements of FFS focused on climate change, also described in 'Climate Change Adaptation Guide for FFS'[145] which will guide project interventions:

1. Integrating climate change adaptation and mitigation into a FFS begins when FFS Master Trainers and Facilitators introduce the FFS programme to the community and the subsequent ground working activities that take place. During the preparatory stage, the Baseline Climate Change Community Vulnerability Assessment is carried out for each site, through a Community Resource Mapping exercise together with other members of the community. The assessment includes consideration on the community exposure and sensitivity to weather stresses. The results of the discussions during the mapping exercise include the refinenemnt of strategies and options that farmers/community may have been implementing and could be included in the community-based adaptation plan.
2. Baseline assessment exercises are used to identify site specific adaptation strategies and options to be further assessed in Field Studies and Special Topics (key activities of the FFS learning process) and to be integrated in the curriculum. Regardless of the field studies that are chosen, it is important to include the collection of weather information as part of the FFS activities.
3. Being able to record and compare what happens with the weather, and how the different treatments in the field studies respond to specific weather stresses, is essential to assessing whether the different practices offer farmers adaptive solutions for the specific sit, or not.
4. Information gained from FFS activities, including results of field studies, are shared with the community in a more systematic approach. FFS participants are encouraged to prepare a plan on how they can help to spread the benefits of the new technologies and practices that prove useful in their field studies. Finally, the community develops its adaptation plan based on its own experience and taking lessons learned from FFS farmers.

278. Some examples of special topics on climate change adaptation and mitigation to be integrated into the FFS curriculum are: Testing seed germination; Mulching and mulches; Moisture stress during the growing season; Responding to an increasingly uncertain start to the growing season with seed priming and dry seed; Adaptive Varieties – temperature and moisture stress tolerant and early maturing varieties; Impacts of extreme weather threats; Traditional knowledge on predictors of climate events; Using forecast weather data; Spreading the word and adapting together; Benefits from trees outside forests; income and carbon sequestration; Improving nitrogen fertilizer management and production; Reducing emissions from enteric fermentation; Sequestering carbon in agricultural and forestry systems.

279. While the FFS training on CRA and waterworks will target 25,250 individual farmers (including 16,250 through OCRI and 9,000 through MAEP/IFAD) in the project areas, training on business methods, marketing, and finance will target existing and new cooperatives. Indeed, one of the key weaknesses to strengthening value chains and profits from high-value agro-products is the lack of structuration and organisations among the rural communities; along with limited skills and knowledge of finance, business and marketing techniques. To address these gaps, the project will organise the smallholders participating to the FFS into agro-cooperatives,

[145] Published by WMO, IIR, Adaptation Fund, ICPAC and FAO in 2021.

based on their interest and capacity to produce 1 or 2 key value chain products. Section 8.1.2 indicates which products will be specifically targeted.

280. Several projects in Benin have supported or are supporting farmers' cooperatives in order to strengthen agricultural production, processing and sales, and reduce farmers' vulnerability to climate change. For example, the GCF/UN Environment's SAP project supports farmers organised in cooperatives through trainings on climate-resilient agriculture and market, and equipment to improve agricultural productivity, processing, and sales. The AFD's project *Transforming Financial Systems for Climate* also aims to sensitise private sector companies about climate change, and to improve loan access to support activities pertaining to climate change resilience. Projects across Benin have proven that supporting cooperatives contributes to reduce pressures on the natural resources, including water, land, and forest resources. To achieve this, it is vital to ensure that cooperatives are well-established and trained by the end of a project, so that they are able to manage their small businesses independently and efficiently[146] once the project ends. It is important to ensure that any newly established structures receive the necessary support to be fully independent by the end of the project. No dependency link should be created between a cooperative and the project. Continuation of the support provided to cooperatives or committees, for instance by government officers, can also enhance the long-term sustainability of project interventions.

281. With regards to the FBS approach, based on the experience of FAO and other organizations, a positive impact has been found worldwide in terms of improving economic conditions and income generation, by carrying out actions based on the Farmer Field School (FFS) and Farmer Business School (FBS) approaches.

282. The FFS/FBS demonstrated its potential to enhance human, social, natural and financial capital of rural communities. Financial capital was enhanced through increased income and profits, savings and loans schemes, with a potential to reduce poverty.

283. A multi-country study in East Africa showed that participation in the FFS was associated with increased productivity and, on average, a 61% increase in household income[147]. A study in Kenya suggested that the FFS on tea increased family income and the number of income sources[148]. Increased income was also reported in studies from Ecuador[149], Ethiopia[150], Nepal[151], and the Philippines[152].

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[146] République du Bénin, 2011. Revue de l'Assistance du Groupe de la Banque Africaine de Développement (BAD) au secteur forestier Béninois.

[147] Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R., & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. World Development, 40(2), 402–413.

[148] Waarts, Y., Ge, L., Ton, G., & Jansen, D. M. (2012). Sustainable tea production in Kenya; impact assessment of Rainforest Alliance and farmer field school training. LEI report 2012-043. The Hague: LEI, part of Wageningen UR.

[149] Cavatassi, R., González-Flores, M., Winters, P., Andrade-Piedra, J., Espinosa, P., & Thiele, G. (2011). Linking smallholders to the new agricultural economy: The case of the plataformas de
concertación in Ecuador. Journal of Development Studies, 47(10), 1545–1573.

[150] Todo, Y., & Takahashi, R. (2013). Impact of farmer field schools on agricultural income and skills: Evidence from an aid-funded project in rural Ethiopia. Journal of International Development, 25(3), 362–381.

[151] Regmi, P. P., Bahadur, G., & Bhattarari, H. P. (2014). Impact assessment of National Integrated Pest Management (NIPM) programin Nepal. Final report. Lalitpur: Nepal Development Research Institute.

[152] Sanglestsawai, S., Rejesus, R. M., & Yorobe Jr., J.M. (2015). Economic impacts of integrated pest management (IPM) farmer field schools (FFS): Evidence from onion farmers in the Philippines. Agricultural Economics, 46(2), 149–162.

284. Another study investigated on the perceived impact of Farmer Business School (FBS) approach on smallholder cocoa farmers in Ondo and Osun States, Nigeria. The results of the study indicated that the majority (87.5%) of the respondents confirmed that they benefited in marketing skills to a large extent after participated in FBS. Many FBS cocoa farmers experienced increment in their income after getting involved in FBS approach in the year 2011 to 2013. There was a significant difference between respondents' income before the year 2010 and income after intervention of FBS in year 2011 ($t = -2.613$, $p = 0.028$), year 2012 ($t = -3.012$, $p = 0.016$) and year 2013 ($t = -3.012$, $p = 0.022$), respectively[153].

285. Referring specifically to Benin, the Section 1 of the Market Study carried out in March 2022 (Sodjinou, 2022) for OCRI project shows that for different products, 18%-54% of households is engaged in processing and trade. The study also shows the strengths and weaknesses of different value chains, which imply that FBS also in the Bénin context have the potential to address frictions in the value chains and increase households' income." The OCRI project will carry out an impact study to compare economic/financial impact with the mentioned studies reported in the literature, which highlighted changes in cost, income or profit as a consequence of participation in the FFS/FBS.

Caisse de Resilience

To address existing gaps regarding access to rural finance, the project will promote also the "Caisse de Resilience" approach. This has been sucessfully implemented by FAO in 15 Countries, namely:

- West Africa: Togo, Liberia, Mali, Burkina Faso, Niger, Nigéria, Sénégal, Cabo Verde, Guinee Bissau, Gambia
- East Africa: Uganda, Burundi,
- Central African Republic, Democratic Republic of Congo, Tchad, (Comores)
- Southern Africa: Malawi
- Central America: Guatemala and Honduras

286. The Caisse de Resilience approach is an integrated community-centred and participatory approach that combines technical, financial and social dimensions in a mutually reinforcing way. It empowers households and communities to build more resilient and sustainable agri-food systems and in doing so it fosters an integrated social and economic development dynamics based on a more profitable and sustainable management of natural resources and regeneration of agroecosystems. It is constructed around small groups of 20 to 30 persons living in the same area and sharing similar concerns. Rural people routinely establish such groups for various purposes (field and construction works, informal savings groups, etc.). Considering their central social and economic role, women's participation is prioritized.

287. With the Caisse de Resilience (CdR), each group is supported along the 3 pillars of the approach in a coordinated manner:

[153] Adetarami, O., Alfred, S. D. Y., Fasina, O. O., Soetan, O. J. and Johnson, S.B. (2020). PERCEIVED IMPACT OF FARMER BUSINESS SCHOOL (FBS) APPROACH ON SMALLHOLDER COCOA FARMERS IN ONDO AND OSUN STATES, NIGERIA. International Journal of Agriculture and Rural Development, 23(2): 5143-5153.

288.**Technical pillar:** Activities under this pillar consist in the deployment of the Farmer Field School (FFS). It involves an active learning approach that strengthens the group dynamics, participants' self-confidence and their analytical and operational capacities. Building on their individual and collective expertise, group members further strengthen their knowledge, skills and capacity allowing them to better understand their agro-ecosystem and how they can adapt and changes their practices to make the most of it and improve their living conditions. The group selects work themes such as: i) introduction of agro-ecological practices to increase production and build more resilient farming systems in the face of climate change and threats such as animal and plant diseases and pests. ii) Diversification of production to minimize risks, diversify diets, preserve biodiversity and agroecosystems services; iii) improving performance of value chains through post-harvest losses reduction, local value-addition creation, and market access improvement. Many groups also engaged into learning and implementing seed multiplication and tree nursery management.

289.**Financial component:** The group develops practical knowledge and skills to manage by itself (without any external cost) a “saving and loans fund” along the Village Saving and Loans Association (VSLA) methodology developed by CARE. Each group member is thereby enabled to save weekly small amounts of money and to access short term loans, 2 to 4 times per year, to invest in profitable activities", many of which consist in the retail trade of raw or transformed/cooked food products. About every 12 months, the fund capital (made of the total amounts of savings plus the interests earned on loans) is shared between members, proportionally to their savings. At this point, each member receives a substantial amount of moneys (5 to 10 times the amount of loans) that can be used for longer term and transformative investments. Some will be buying one or several animals that will provide manure for crops, milk for kids and/or additional income. Some will invest in growing vegetables following kitchen garden technical model, buying quality inputs and hiring workforce. Others will invest in opening a small shop that will contribute to improve connection between producers/sellers and consumers/buyers at local level and between the community and the external economic agents. To address the weakness of inputs supply chain, some have set-up collective inputs shops.

290.The Village Savings and Loan Association (VSLA) approach, adopted by farming communities in many countries of the world, facilitate the accompaniment of smallholder farmers in accessing microcredit. Through the integration of the VSLA into the farmer groups already organized in FFS groups, this approach has proved extremely effective. The VSLA model creates self-managed and self-capitalized savings groups that use members' savings to lend small amount of money to each other. VSLAs are composed of between 15 and 30 members, groups of farmers large enough to create a pool of useful capital, and small enough to keep meetings manageable. Groups voluntarily come together to save and periodically grant small loans from those savings. Around 90% of groups continue to operate longer than five years after receiving training. On average they double their capitalization and average loan sizes. Around 80 % of the members are female.

291.The VSLA methodology requires that the whole group meets every week or every other week (absence are discouraged with fines). These regular meetings empower groups, build trust and develop business and entrepreneurial skills, which are complementary and synergic to the ones developed under the technical component. Beyond the framework of the CdR approach, contacts between experienced CdR/VSLA groups and microfinance institutions are being facilited by CARE. Access to additional financial resource could be used by them to further invest in value chains development, at production, storage, processing or transport levels. In parallel and in addition to the main fund, a solidarity fund is put in place and used to assist a member facing a major difficulty (death, sickness, etc.). Although amounts are very small the existence of the fund and regular activities around it fosters a spirit of solidarity amongst the group and towards the rest of the community.

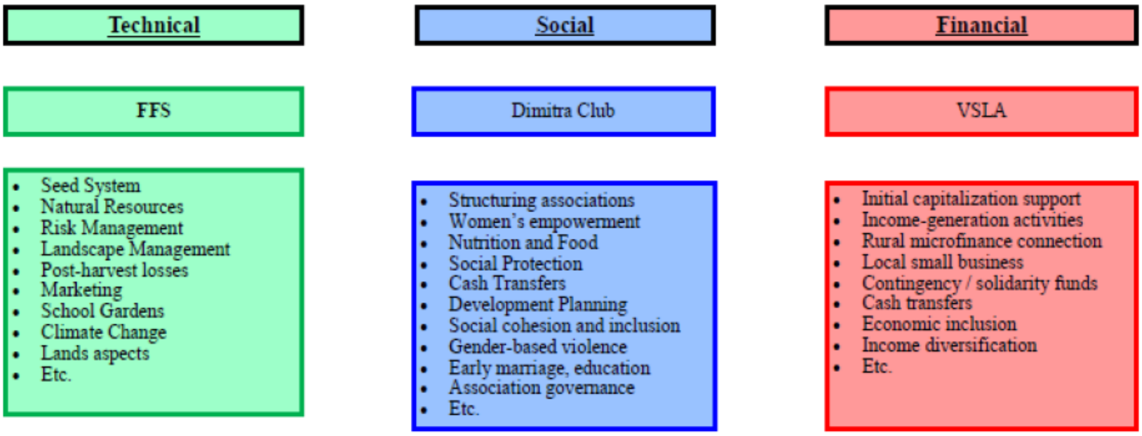
Composition of management committee and best practice of VSLA

- As for a FFS, the composition of the management committee will consist of the Chairperson, the Record Keeper, the Box Keeper and two Money Counters. In addition, the VSLA will have three (3) person selected from the General Assembly who will serve as the key holders for the group;
- The Management Committee members are elected for one cycle (approximately one year). Each member has one vote in electing the Management Committee and developing the constitution. VSLAs ensure that their members memorize the basic features of the constitution
- The cash box is locked with three padlocks.
- The three keys are held by three members, who are not part of the Management Committee.
- The main purpose of the cash-box is to ensure that no transactions occur outside the Association meeting, rather than to prevent theft by outsiders. Theft of boxes by outsiders is very rare.
- At the end of every cycle, all outstanding loans are recovered and the share fund is shared out. The funds (which includes lending profits) is divided by the total number of savings shares purchased by members during the cycle, to calculate a new per-share value. Each member then receives his or her share according to the number of shares purchased by that member.

292. **Social pillar:** Using a methodology inspired from the Dimitra Clubs, group members are trained and accompanied to discuss and address social or environmental issues that they consider as a priority for the community. The work benefits both the group and the whole community; members experience the advantage of increased solidarity and cohesion within the group and beyond. CdR groups tackle various key social issues such as: nutritional education and care of malnourished children, assistance to vulnerable individuals (social inclusion), women's status and rights and gender-based violence, schooling, access to land and water, literacy, hygiene and health, HIV prevention and conflict resolution. Through the social pillar, a share of the economic gains generated from technical and financial pillars is invested to strengthen social cohesion and to combat extreme poverty and food and nutrition insecurity. Women, who play a central role to improve child diets, are a priority target of the CdR approach. They are further empowered thanks to the social pillar activities. Please see Annex 8, Gender Assessment, for details on how Dimitra clubs will be used to foster gender equality through the OCRI project.

293. This model is intended to enhance peacebuilding and social cohesion through economic empowerment at community level. The "Caisse de Resilience" approach helps in the durability of the project. Therefore it is ensures the sustainability of the actions undertaken by the project.

SOME ACTIVITIES DEVELOPED THROUGH THE 3 PILLARS



7.3.3 Support to value chains and access to financial tools, including through capacity building and innovation

294. Increased agricultural productivity, through the promotion of CRA and agroforestry, will result in agricultural surplus and potentially higher income generation for local communities, thereby reducing vulnerability, and promoting climate change resilience[154]. Smallholder farmers can use surplus products to generate further income, and savings. These additional products reduce farmer vulnerability to market changes as well as their dependence on outside products, thus helping improve food security. In return, farmers are more likely to support sustainable land and water management practices as they benefit directly from them[155] and because they are not facing poverty and food insecurity. However, an enabling environment for the sustainable production and value-added sale of key agro-products is necessary to ensure the generation of income.

295. Among the main farm products in Upper and Middle Oueme, **maize, cashew, shea and mango** have been identified as key value chains to support. This is based on: i) their current presence on the project sites, already part of agricultural systems; ii) the existing demands on national and international markets; iii) environmental-friendly production (and aligned with risk category B); and iv) their resilience to climate change if produced in appropriate agro-systems. Finally, based on field consultations[156] led in Upper and Middle Oueme, these agro-products are also perceived by the population has having great potential for sale and profits.

296. A field investigation on the project sites, combined with literature review has identified production and market potential for the selected value chains; their strengths, weaknesses, opportunities and threats are summarised in Table 35.

[154] Rice RA. 2008. Agricultural intensification within agroforestry: the case of coffee and wood products. *Agriculture, Ecosystems and Environment.* 128: 212–218.

[155] IASS Working Paper, 2016. Expériences en Gestion Durable des Terres au Bénin: quelles leçons tirer pour les orientations futures? Available at: http://gsf.iass-potsdam.de/wp-content/uploads/2015/02/Benin_workshop-report_IASS_sept-2016_klein.pdf

[156] A field mission was conducted in January 2021 to analyse agro-markets and value chains in Upper and Middle Oueme.

Table 35: SWOT assessment of selected key value chains[157]

Strengths	**Weaknesses**	**Opportunities**	**Threats**
Cashew nuts			
- Favourable conditions especially in Upper Oueme and the transition area (Glazoue) - Prioritised for export by the Government of Benin. - Can be produced in orchards or within agricultural fields (agroforestry) to contribute to restoring soil fertility. - Combines well with locally-appreciated crops like maize, yam, cassava and sorghum. - Increasing global demand for cashew nuts. - There are regional cooperatives in Upper Oueme, which collect and sell cashews from municipal and village-based cooperatives - Improved plants are available (limited quantity)	- Limited organisation of farmers at local level - Limited price negotiation capacity - Limited productivity of cashew trees - Lack of processing equipment and technical capacity amongst most communities to add value to cashew nuts. - Lack of skills amongst local communities for developing businesses based on cashews. - Lack of storage facilities for nuts. - Lack of relationships with trading companies, currently raw cashews are sold to Indian traders).	- Capacity amongst local communities for establishing cashew nut cooperatives. - Opportunity to cultivate in forested areas along Oueme River (to reforest) or on private land (agroforestry; intercropping; private/community plantations). - Potential to increase yield - Potential to improve local value through processing and storage. - Potential for international export through national companies. - Inter-cropping with cashew trees, maize, yam and sorghum has high market value, up to CFA 395,370/ha[158].	- Recurring fires in orchards - Influx of foreign capital for trading in raw nuts to the detriment of local processors[159] - increased flower and fruit abortion due to reduced rain and increseas temperature (Bello et al., 2016)[160] - reduced productivity and quality of fruits (Ballogoun et al., 2016)[161]
Shea			

[157] Based on the market analysis developed for GCF SAP UNEP project in Benin; data have been updated based on field analysis
[158] Crinot et al. (2015)
[159] Analysis of the Benin Cashew Sector Value Chain. African Cashew Initiative, 2010. Available at: http://www.africancashewinitiative.org/files/files/downloads/aci_benin_gb_150.pdf
[160] Bello, O. D., P. B. I. Akponikpè, E. L. Ahoton, A. Saidou, A. V. Ezin, G. E. Kpadonou, I. Balogoun, and N. Aho. "Trend Analysis Of Climate Change And Its Impacts On Cashew Nut Production (Anacardiumoccidentalel.) In Benin." Octa Journal of Environmental Research 4, no. 3 (2016).
[161] Balogoun, I., L. E. Ahoton, A. Saïdou, D. O. Bello, V. Ezin, G. L. Amadji, B. C. Ahohuendo, S. Babatounde, D. C. Chougourou, and A. Ahanchede. "Effect of climatic factors on cashew (Anacardium occidentale L.) productivity in Benin (West Africa)." Journal of Earth Science & Climatic Change 7, no. 1 (2016).

Strengths	Weaknesses	Opportunities	Threats
- Prioritized for export by the Government of Benin. - Shea trees occur throughout the central and northern parts of the country, either within the forests or in cultivated fields. - Nuts can be processed as oil or butter; used in direct consumption or sold on local, regional and international markets. - Adapted to arid, less fertile soils - Natural regeneration - Tree lasts for 200 yrs - Local know-how for valorizing shea products among women	- Low price negotiating capacity among producers - Limited knowledge of production techniques (shea is often collected from wild trees) - Lack of processing equipment and technical capacity amongst most communities to add value to shea. - Lack of skills amongst local communities for developing businesses based on shea nuts. - Lack of storage facilities for nuts and processed products. - Lack of relationships with relevant traders (shea butter can be lost through spoilage if not sold on time).	- Resilient to climate change - Potential for strengthening capacity of local cooperatives. - Opportunity to produce shea nuts in forested areas or on agricultural land (intercropping). - Potential to improve add value locally through processing. - Potential for international export through national companies (to be identified by CCIB). - High potential for women's involvement in shea cooperatives as the processing of shea nuts into oil and butter is typically a women's task.	- Increasing aridity in the north of Benin as a result of climate change is predicted to decrease the recruitment of seedlings, which will affect the natural regeneration of shea tree populations [162]. Planting shea trees to maintain the production of shea nuts will thus become increasingly important. - Shea trees are often cut down as part of land clearing process for agriculture (because its use if agroforestry system is not well known) - Sensitive to bush fire
Mango			
- Market demand steadily increases especially for international market - It can be produced in orchards or in agroforestry system, associated with current crops like maize, sorghum or cassava. - Embedding mango plantations in the cultural habits of the population (as savings for retirement, and as a	- Farmers are not well-organised and sale is mostly done along the road where prices are subjected to buyers/ poor negotiating capacity - Production techniques are not well-controlled by the producers, therefore productivity is low, and the quality of the fruit is lacking - Poor accessibility to good quality plants	- Mango collection and sale is a women-oriented activity - Given the increasing demand for mangoes on local to international markets, profits could be improved if production and processing techniques are better controlled - Availability of cultivable land and existence of possibility of extension of plantations - Agro-climatic conditions favorable to mango production	- Mangoes are sensitive to pest attacks which tend to increase with climate change - Difficulties in accessing land and land tenure insecurity - Influence of climatic hazards - Destruction of plantations by oxen; - Destruction of plantations for other crops (cotton, cashew nut) or for

[162] Glèlè Kakaï, R., Akpona, T., Assogbadjo, A.E., Gaoué, O.G., Chakeredza, S., Gnanglè, P.C., Mensah, G.A. and Sinsin, B., 2011. Ecological adaptation of the shea butter tree (*Vitellaria paradoxa* CF Gaertn.) along climatic gradient in Bénin, West Africa. *African Journal of Ecology*, *49*(4), pp.440-449.

Strengths	Weaknesses	Opportunities	Threats
tool for securing land holdings) - Existence of well trained and supervised nurserymen - Suitability of the soil for mango production	- Lack of the practice of irrigation in the plantations - Insufficient or lack of advice and training on good practices in setting up and managing orchards, and on monitoring and maintaining mango orchards - Lack of skills at the level of actors (producers, supervisory staff) in harvesting techniques - Almost non-existence of phytosanitary products approved in Benin on mango, - Lack of control of pests or diseases (fruit flies, termites, anthracnose and physiological accidents) and emergence of Bacteria Black Spot (BBS) which can lead to large losses in orchards; - Low knowledge and low compliance with quality standards; - No mastery of the different pruning techniques for the rehabilitation of old orchards; - Lack of windbreaks around the mango plantations; - Poor knowledge of alternatives to chemical control for organic mango production;	- Socio-economic importance of mango as a source of income and food security - Existence of proven methods of controlling fruit flies - Current government policy favorable to the promotion of sectors - Enthusiasm of the State and certain TFPs to support the development of the mango sector - Existence of a National Development Strategy for Fruit Tree Cultivation in Benin	the manufacture of fuelwood; - Lack of adequate funding for the acquisition of packaging, storage and processing equipment.

Strengths	Weaknesses	Opportunities	Threats
	- Lack of adequate packaging, transport and marketing infrastructure and equipment (absence of packaging stations and quality control service); - High concentration of production over a short period of the year		
Maize			
- Most widely planted crop in Benin. - Many suitable soil - Production techniques well-known - Strong local, regional (Nigeria), and international demand for food crop and livestock. - Beneficiate from governmental support for production techniques and access to relevant seeds (from INRAB, DDAEP and ATDA/FNDA). - Staple food and used extensively as animal feed[163]. - Various improved varieties have been released in Benin [164] and these are	- Basic production techniques using hoe for soil preparation - Productivity is low at 700kg/ ha - Rural communities often lack proper facilities to store harvested maize and can therefore not wait until prices improve to sell maize. - Despite some local cooperatives, limited organisation of the value chains: individual producers sell directly to wholesalers, who are then selling on local and regional markets - No negotiating power for price among the producers - Lack of processing equipment	- Maize yield can be increased further in Benin despite climate change[166]. - Maize production is already part of rotation culture, which is climate-resilient - Short-cycle seed varieties are available in Benin (from INRAB) and in the neighbour countries, where farmers are already buying these seeds (Burkina-Faso). - Domestic, regional and international demands is increasing - Funding available from FNDA	- New pests such as the fall army worm[167]. - Access to markets limited because of degradation of roads from extreme rainfalls - Production affected by shift in rainfall patterns

[163] Elbehri, A., J. Kaminski, S. Koroma, M. Iafrate, and M. Benali (2013), West Africa food systems: An overview of trends and indicators of demand, supply, and competitiveness of staple food value chains, In: Rebuilding West Africa's Food Potential, A. Elbehri (ed.), FAO/IFAD.

[164] From 1970 to 2010, 36 maize varieties were released in Benin. Walker, T.S. and Alwang, J. eds., 2015. *Crop improvement, adoption and impact of improved varieties in food crops in sub-Saharan Africa*. CABI.

[166] Jalloh, Abdulai; Nelson, Gerald C.; Thomas, Timothy S.; Zougmoré, Robert and Roy-Macauley, Harold. 2013. West African agriculture and climate change: A comprehensive analysis. IFPRI Research Monograph. Washington, D.C. International Food Policy Research Institute http://dx.doi.org/10.2499/9780896292048

[167] FAO, 2017. Briefing Note on FAO Actions on Fall Armyworm in Africa. Available at: http://www.fao.org/3/a-bs183e.pdf

Strengths	Weaknesses	Opportunities	Threats
adopted readily by farmers[165].			

297. For a detailed analysis of the key VCs, please refer to Annex 19. Based on this, key support that should be provided to producers in these 4 value chains include:

- Support and training to organise and register farmers into local, municipal and regional cooperatives to organise the production and sale, and to develop business, finance/ access to credit, and marketing skills (*BAU – non-climate change intervention*)
- Technical training on increasing productivity and producing quality products – especially for mangoes, cashews and shea nuts (*BAU – non-climate change intervention*)
- Provide high-quality, climate-resilient seeds from national institutes (INRAB - *climate change-related*)
- Training on climate-resilient production techniques ensuring pest control, irrigation, protection against strong winds and extreme rainfalls, among others (*climate change-related*)
- Create bi-annual forums to connect producers/ cooperatives with wholesalers/ retailers to develop market opportunities and negotiate price and contracts (*BAU – non-climate change intervention*)
- Provide storage and processing equipment (*climate change link as pest attacks, heat and floods can damage products)*
- Provide transportation means to collect products from local farmers and transport them to the regional cooperative in charge of sales (*BAU – non-climate change intervention*)

5. For all these interventions, the project will work with the key organisations – cooperatives, wholesalers, processing units and exporters – which have been identified as active in the project target areas. Buyers, in particular, would be interested in developing trade agreeements with OCRI farmers as the quality of their products will be enhanced.

7.3.4 Women-oriented activities

298. As indicated in Section 5, women in the Ouémé Basin face multiple socio-cultural and technical barriers to adapt to climate change, which make them extremely vulnerable to their impacts. These barriers include high responsibility in the household with limited assistance from men[168], their low literacy levels, socio-cultural barriers on mobility and language barriers. Post-harvest activities carried out by women are affected by climate change either because of change in quality of the product, difficulties to access clean water, fuel wood, difficulties to dry and to store produce. These activities are underfunded in climate change adaptation and response initiatives and in community development plans.

299. Women are involved in forestry mainly in collection of Non-Timber Forest Products (NTFP) and, in the project intervention zone, in particular in the collection and processing of Shea nuts, and mango, and vegetables production, which are providing an income to women; a coping mechanism when other crops fail. Even if the forestry sector and forest management mechanisms are often male dominated, some women have started tree nurseries to benefit

[165] Mahoussi, F.E., Adegbola, P.Y., Zannou, A., Hounnou, E.F. and Biaou, G., 2017. Adoption assessment of improved maize seed by farmers in Benin Republic. *Journal of Agricultural and Crop Research*, *5*: 32-41.

[168] As documented in results of the time use survey conducted in 2015

from development initiatives. Female Headed Households in the project intervention zone are depending on NTFP to overcome shocks, source fuel wood and food to respond to loss of crops due to climate change.

300. To address the specific climate change vulnerability of women and their adaptation needs, the proposed project has designed several women-specific interventions. For example, the CRA interventions will promote the development of counter-season horticulture (local vegetables) through improving water access, irrigations schemes and targeted trainings (with the setup of 100 women FFS) : this will boost women's current vegetable production, an activity in which they are largely involved in the project area, improving production during the rainy season through access to water (as rainfall becomes less reliable), and enabling production during the dry season. In order to ensure women can benefit from specific training, the project will ensure that the proportion of female trainers and female technicians in the project team is at least 30% and that at least 50% of the training participants are women (overall rate not excluding that some activities could be 100% female or male). Furthermore, 100 FFS will be specifically dedicated to women. The use of farmer-to-farmer training videos for the extension on already confirmed best practices will also be applied to overcome time and mobility constraints of women.

301. In terms of the support provided to value chains and enhanced income stream, the project will target NTFPs in which women are already active, such as shea nuts; support will be provided to women organised in cooperatives for the collection, storage, processing and marketing of these products, as part of the value chain approach of the project. Finally, women-led cooperatives will receive specific support through competing for an annual climate change award specifically dedicated to women agribusinesses.

8 Project justification and strategy

8.1 Rational and description of OCRI

302. The proposed project will address current barriers to enhancing the resilience of the population in the Ouémé Basin and address the identified impacts of climate change. The OCRI project will break the vicious cycle in which vulnerable communities are locked, and catalyse a shift towards integrated climate resilient management (ICRM) in the Upper and Middle Ouémé Basin; this will enhance the climate resilience and improve livelihoods in the whole Ouémé Basin, with benefits in the upstream areas spreading to downstream areas. To initiate this transformative change, the OCRI project is comprised of three complementary Components, which will support the implementation, institutionalization, and long-term funding of ICRM in the Ouémé Basin, reduce climate change vulnerability from Upper to Lower Ouémé Basin, and facilitate the replication of ICRM beyond the project's sites.

- <u>COMPONENT 1. Low carbon climate Resilient Crop production enhanced and Ecosystem services restored in the Upper and Middle Ouéme</u>

303. Under climate change conditions, a steady increase in temperatures is observed in the Upper and Middle Ouémé, which leads to soil desiccation, degradation of vegetation cover, and reduced water availability, including in the Ouémé River (see Chapter 3). In addition, shifts in the main rainy season result in a late start of this key agricultural season, and heavy rains during the middle and end of the season. These rains lead to soil erosion and silting in the Ouémé River which, when happening in upstream areas, result in river overflows and floods in the middle and low areas of the Ouémé Basin. Finally, in the Middle Ouémé area, a gradual disappearance of the short rainy season – one of the two agricultural seasons in this area, is noted. These climate change related threats are increasing the vulnerability of the population to climate hazards like floods and droughts, reducing agricultural productivity and increasing risks of food insecurity in one of Benin's main agricultural hub.

304. Through Component 1, an ICRM approach will be implemented in the Ouémé Basin. This approach combines waterworks like micro-dams, dikes, stone lines and contour ploughing, with climate-resilient agriculture (CRA), also enabled by the waterworks as fields will be protected against floods and water available for irrigation and counter-season horticulture (especially for women). Agro-forestry using climate-resilient, high-value tree species (like shea and cashew) will also be implemented to restore land cover especially near the riverbanks. The waterworks and agroforestry will especially focus on degraded areas of the Upper Ouémé, to reduce flood risks in Middle and Lower Ouémé, enhance water availability, especially in Upper Ouémé, reduce soil erosion especially along the riverbanks, and improve soil fertility. Ecosystems services will be restored and enhanced. Combined to CRA techniques, this approach will enhance productivity in agricultural and agroforestry landscape, to counter-act the potential yield decline of 25% due to climate change. The continuation and replication of activities under Outcome 1 will be supported by developing and sharing training modules on CRA, waterworks and agroforestry through the OCRI platform (see Component 3); moreover, a FFS approach, the establishment of hundreds of farmer field schools, and seed groups to

multiply improved seeds will enable the continuation of trainings in the target municipalities beyond the project's lifespan.

305. Through compoment 1, carbon emission will be reduced, floods will be reduced, soil erosion limited, access to water improved, agricultural productivity enhanced, and climate change vulnerability reduced. Site specific assessments of resilience will be undertaken at the start of the project using the SHARP tool or similar holistic and integrated approaches. This will aim to increase the understanding of the prevailing livelihood conditions of smallholders according to the specific sites, as well as their resilience and adaptive capacity levels. The tool will serve to identify the main areas of vulnerability in the selected municipalities. The results will support the targeting and decision-making on which of and where the proposed waterworks and CRA are most needed and identify who need them the most. The results will also support the refinement of the M&E strategy and set a project baseline for key M&E indicators with primary up-to-date data.

- COMPONENT 2. Climate-resilient and gender-sensitive value chains, supporting farmers' livelihoods in the Upper and Middle Ouémé.

306. Under Component 1, farmers' productivity is expected to increase; moreover, farmers will produce high-value agriproducts like shea and cashew nuts. The additional crops, nuts, and fruits, produced on the climate-resilient farms, can lead to a significant increase of local income for the farmers, if prepared, processed and stocked adequately (considering climate change conditions like increased temperature, shifts in rainfalls, floods and pest risks). Furthermore, adequate marketing that value climate-resilient agri-product can contribute to enhance profits while selling these products. Increased profits mean that farmers will have additional resources to continue investing in CRA and maintenance of the ecosystems beyond the projects' lifespan. Such investments in OCRI activity can also be supported by public and private funds, if the socio-economic benefits are demonstrated and the resilient farms become attractive for investors. However, at the moment, cooperatives and agri-businesses in the beneficiary municipalities do not have the capacity to market their product in order to boost their sale; their access to credit is also limited, while the private sector is not investing in climate resilient agriculture.

307. By investing in training on marketing techniques and access to finance, the project will secure farmers' livelihoods and income streams, thereby reducing poverty, food insecurity and climate change vulnerability. Strong agri-businesses and climate-resilient farms, combined with the demonstration of the project's economic benefits, through rigorous M&E, will also boost private sector's willingness to invest in CRA and ICRM in the Ouémé Basin. Finally, a long-term, solid relationship will be insured between farmers, agri-businesses, sellers of agri-products and private investors during municipal forums. Farmers will also have the capacity to prepare robust financial plans to access micro-credit and boost their productivity and marketing under climate change conditions. Access to micro-credit will be facilitated by FNDA. Productivity is further boosted as Component 3 of this project will institutionalise ICRM in the Ouémé Basin, and unlock additional finance to support resilient land and water management.

- COMPONENT 3. An enabling institutional and financial environment established to promote and upscale climate-resilient management in Benin's Basins.

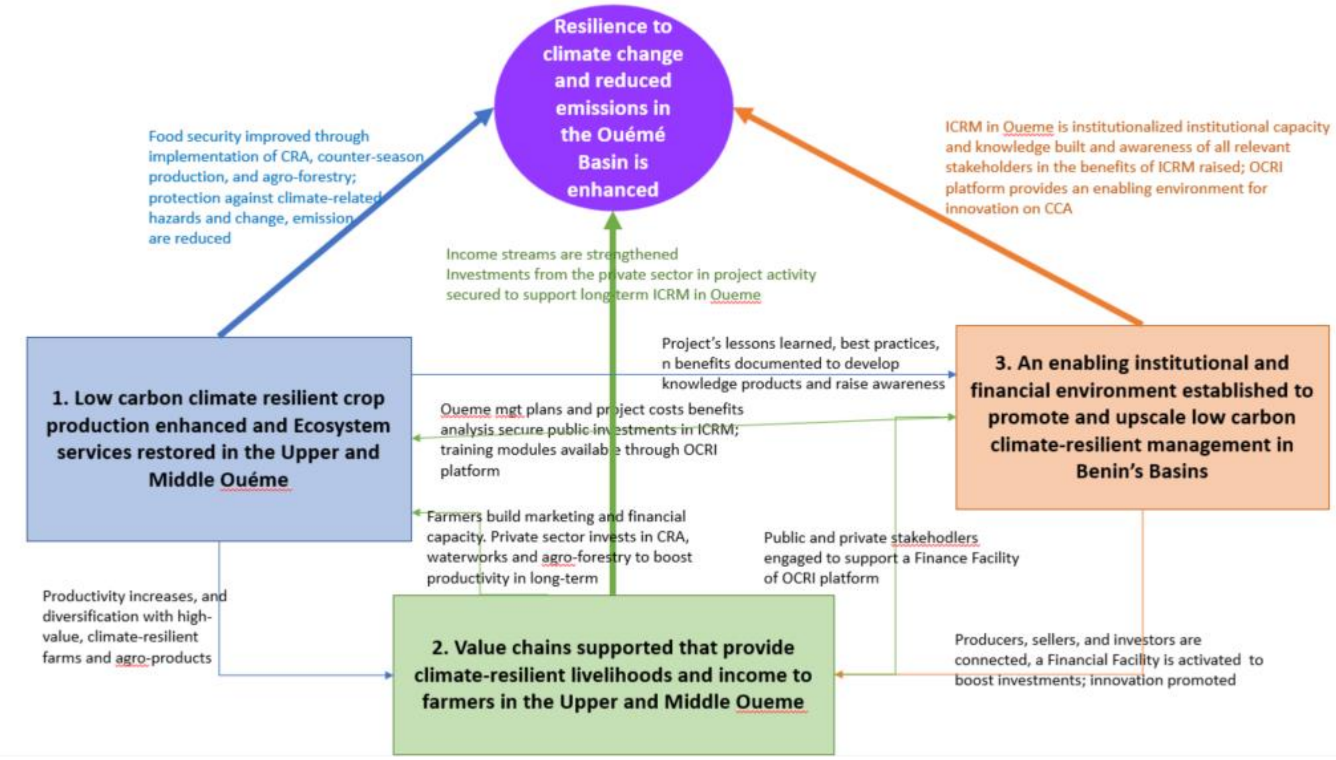
308. Climate change in Benin has detrimental effects on livelihoods, food security and sustainable development. The OCRI project will demonstrate the environmental, social, and economic benefits of an ICRM implemented in the Ouémé Basin. Not only will project interventions protect populations against climate change impacts like floods, flash floods and the scarcity of water resources, but it will also enhance food production on the Upper and Middle Ouémé. A mix of soft and hard technologies focusing on restoring and enhancing ecosystem's goods and services – to reduce climate change vulnerability and enhance crop productivity – will also contribute to generate new income streams for the vulnerable communities living in the Upper and Middle Ouémé. Through technical training, development of financial and marketing skills, and equipment to produce and sell high-quality, climate-resilient agri-products on the local and regional market, the project will ensure continuous re-investment from farmers, public and private stakeholders in OCRI interventions.

309. To further root the OCRI approach in the Ouémé Basin, a multi-stakeholder platform (the OCRI platform) will be set up to coordinate, under the leadership of MCVDD, on-the-ground tree plantations, small waterworks, land management and CRA in the Upper and Middle Oueme area. The platform will thus host the five OCRI's Local project implementation Units (which are branches of the PMU, one per commune) who will coordinate project implementation with relevant local institutions in each commune. The OCRI platform will also serve to connect all relevant partners, from national to local level, that have an interest to promote ICRM in the Oueme. This includes representatives of MAEP, OBA, FNEC, FNDA, ADTA, communes, relevant private sector institutions, NGOs, and CBOs. Through the platform, they will be informed about project implementation progress, potential challenges and solutions. They will also access all the knowledge products produced by the project.

310. The OCRI platform (governance mechanism) will blend the conditions to leverage responsible and sustainable investments from public and private stakeholders across the Ouémé Basin. This will be done by: i) associating the FNDA, ADTA, and MFIs (via ALAFIA) as members of the platform; they will receive regular update on OCRI project, brochure and information on the socio-economic benefits, and encouraged to allocate more finance (micro-credits) for climate-resilient agriculture in the Oueme; and ii) a partnership with the Direct Access Entity Fonds National pour L'Environnement (FNEC), as co-chair of the OCRI platform (MCVDD will chair). FNEC currently uses its resources to finance climate-resilient and environmental projects in Benin. Its financial strategy will be strengthened under Component 3 to leverage more funding specifically financing climate change-related projects. A roadmap to replenish FNEC's fund after the project will be developed to ensure the long-term availability of finance towards ICRM in the Oueme Basin. Finally, the OCRI platform will also serve to coordinate the revision and strengthening of the existing Ouémé Master Plan (Schema Directeur d'Amenagement et de Gestion des Eaux du Bassin de l'Oueme – SDAGE) and local development plans (plans de developpement locaux – PDL).

311. The following diagram illustrates the relationship and complementarity between OCRI's three Components.

Figure 67: OCRI's components



8.1.1 Theory of change

312. Through an innovative partnership with the Direct Access Entity FNEC, the FNDA, IFAD, MAEP and MCVDD, the establishment of a multi-stakeholder platform (for coordination of land restoration activities in the Oueme) and the development of a robust financial strategy (to provide funding for CRA and ecosystem restoration), the proposed project will address current barriers (see Section B.1 and table below) to enhance the resilience of the population in the Ouémé Basin, reduce emissions and ensure activities persists over time. The OCRI project will break the vicious cycle in which vulnerable communities are locked (see Section B.1) that is causing increasing emissions and catalyze a shift towards low emissions integrated climate resilient management (ICRM) in the Upper and Middle Ouémé Basin; this will enhance the climate resilience, reduce emission, and improve livelihoods in the whole Ouémé Basin, with benefits in the upstream areas spreading to downstream areas. To initiate this transformative change, the OCRI project is comprised of three complementary Components, which will support the implementation, institutionalization and long-term funding of ICRM in the Ouémé Basin, reduce climate change vulnerability from Upper to Lower Ouémé Basin, reduce emissions, and facilitate the replication of ICRM beyond the project's sites.

313. The project includes the following 3 Components, which Outputs and Activities are presented in the Theory of Change (Figure 67) and described in Section B.3.

- COMPONENT 1. Low carbon climate Resilient Crop production enhanced and Ecosystem services restored in the Upper and Middle Ouéme (with government cofinancing). An integrated climate-resilient management (ICRM) implemented over 95.000 ha of land in the Upper and Middle Ouémé Basin provides benefits not only on project sites but in downstream areas as well. Floods are reduced especially in Middle and Lower Ouémé, soil erosion is limited, agricultural productivity is enhanced, water access secured especially in Upper Ouémé, and climate change vulnerability reduced in the whole Basin. This component will support reducing emissions by 1,783,633 tCO2-eq over 20 years.

COMPONENT 2. Value chains supported that provide climate-resilient livelihoods and income to farmers in the Upper and Middle Ouémé (with government cofinancing). Combining the use and planting of diversified high-value adapted crops and trees and enhanced productivity under Component 1 to training in climate-resilient farm planning, marketing techniques, access to private sector and finance through the FNDA will secure farmers' livelihoods and diversify income streams despite climate change impacts. This income can be re-invested in CRA and waterworks for scaling up and expansion of the interventions. The demonstration of the significant environmental and economic benefits of project interventions will also unlock additional private investments to sustain CRA in the long-term, materialized under Component 3.

- COMPONENT 3. An enabling institutional and financial environment established to promote and upscale low carbon climate-resilient land and water management in Benin's Basins (with government cofinancing). The establishment of a multi-stakeholder coordination mechanism, to support on-the -ground tree planting and ecosystem restoration, CRA, supporting regulatory frameworks, and institutional capacity building will ensure the long-term implementation of ICRM in the Ouémé Basin. Moreover, FNEC's financial strategy will be revised and strengthened to specifically support climate-resilient projects in the long-term. During project's implementation, FNEC will provide fund to cooperatives and organisations willing to implement CRA and ecosystem restoration in the Oueme. Finally, a strong communication and knowledge management strategy to compile, disseminate OCRI results and knowledge products beyond the 5 target municipalities will also support the replication of this approach in other areas, and basins of Benin. The upscale of OCRI interventions is also promoted through various awareness raising events, as well as a rigorous M&E system to demonstrate the environmental, social and economic benefits of the project.

Causal pathway of proposed interventions

314. The proposed OCRI project will effect a paradigm shift that results in enhanced climate resilience, low carbon emission and improved livelihoods for smallholders in the Ouémé Basin. This will be achieved through institutionalizing the implementation of ICRM in the Upper and Middle Oueme Basin, capacity building and unlocking access to finance for local farmers and cooperatives, operating in key value chains (namely shea, cashew, mango and maize) to sustainably continue the low carbon ICRM activities. Achieving this goal will reduce the climate vulnerability of the communities and assure the reduction of emissions from upper to lower Oueme in the long-term: vegetation cover will be restored to reduce flood and erosion risks, water access will be improved, productivity will be enhanced despite climate change impacts, and income will increase (see Business model in Annex 3). The project fully integrates gender equality principles to make sure that women and men benefit equally from the proposed interventions.

315. OCRI project is comprised of 3 components which will support the main goal.

316. The first intervention (Component 1) aims at restoring degraded land and riverbanks along the Oueme, using infrastructure, tree plantations and CRA, as well as improved soil and water

management practices, with impacts over 95,000 ha. This component will not only promote climate change adaptation in the Oueme Basin, but also mitigation of CO2 emissions. Component 1 will restore soil and secure water access in the context of climate change, while increased ecosystem services will improve agricultural productivity and buffer communities against climate change impacts. Currently, interventions under this component are undermined by the limited knowledge, among local communities, of the goods and services provided by restored ecosystems, and their limited technical capacity to implement CRA. These barriers will be addressed by the proposed activities under Outputs 1.1 and 1.2.

317. Under Output 1.1, grey infrastructure will be built to capture run-off and rainfalls and enable irrigated agriculture; while degraded river banks and fields will be restored using tree planting to reduce soil erosion, provide shade, increase moisture and soil nutriment. Tree planting on field will favor value chain species, namely shea, cashew and mango. Note that all water and land management interventions were carefully selected, considering the watershed context of Upper and Middle Oueme. Although the impacts of climate change have many similarities in Upper and Middle Oueme Basin, there are specific impacts related to respectively, the predominance of strong erosion and degradation of the uppermost sub-catchment, and more frequent flooding in the middle valley. Hence, protecting the uppermost sub-basin through the promotion of soil and water conservation practices will contribute to increased water infiltration over a large area of the basin upstream with an expected substantial effect on the reduction of downstream flows and floods in the lower valley. Infrastructures to store water (micro-dams, weirs etc) (90%) or rehabilitation (96%), and in-field water harvesting/infiltration management (69%) will be especially implemented in the upper Oueme, which suffers from drier conditions because of climate change impacts. Development of irrigation perimeters will also be more targeted to the upper than middle Oueme to valorise the mobilized water and combat the drier climate effect. Protection of artesian boreholes will essentially be developed (97%) in the middle Oueme to better make use of the water resource and control flooding, which happen more and more often in this area. In-land valley management will be developed equally (50%) in both the upper and the middle Oueme.

318. Overall Output 1.1 will secure water access on field, rehabilitate degraded soil and protect plots against flood risks (Output 1.1). However, there is a risk that local communities cut down newly planted trees to use as fuel wood or timber. To reduce this risk, reforestation will essentially target individual plots (owned by farmers – promotion of agroforestry) as well as some very degraded riverbanks, which are located near the plots and can therefore be controlled by beneficiary farmers (against illegal logging, which can be reported to the local forest department). Reforestation will be implemented with local communities, through the FFS approach (Output 1.2), which will increase project ownership, while sensitization on the benefits of ICRM will be conducted through the FFS and more widely, under Output 3.3. The construction of water harvesting and retention infrastructure will induce a change of 1 ha from vegetated to non-vegetated land leading to an additional carbon emission of 115 tCO2-e over 20 years.

319. Output 1.1 will be complemented by, and support the implementation of CRA in Upper and Middle Oueme under output 1.2. This will be promoted using the FFS approach. CRA techniques have been selected based on best practices in Benin, to address existing and

foreseen climate change impacts as well having mitigation results. The training will encompass sustainable land and water techniques to ensure the rational use of natural resources. Sustainable management of degraded agricultural landscape and basin areas is also key to reduce climate change vulnerability, improve agricultural productivity [169] and reduce emissions. Such interventions contribute to CO2 reduction in a sustainable way as farmers are incentivised to manage their land sustainably (as it increases productivity), and contribute to Benin's mitigation efforts. In fact, as productivity increases thanks to the project intervention farmers will be less incentivised to carry out high emission practice and clear additional forest land to expand their agriculture production (see also the description of the vicious cycle in Figure 59). Currently, farmers in the project area practice full tillage, burn their crop residues and use low input. This production system results in low yield and high emission. Under this output, the beneficiaries with be trained to adopt the technic of non-tillage on 2 000 ha and the residue will no longer be burned. In addition, to significantly increase the yield, there will be an increase in input use. As a result, the improved agronomic practices will avoid the emission of 52 587 tCO2-e over the 20 years while the irrigation system will emit 623 tCO2-e over 30 years. In addition, currently, the project areas are highly degraded and fire is used on 20 percent of the land (16 800ha). With the project, 15 percent of the total land (12 600ha) will be planted with perennial crops (cashew) with improved residue management. The project will also increase tree covers on 85 percent of total parkland (71 400 ha) (agroforestry combined with fruit trees). The improvement of tree density will increase carbon sequestration potential on this land. No residue will be burnt under the project. In addition, 9 000 ha of forest that is highly degraded will be restore to become a low degraded area. Thus, the agroforestry system on 84 000 ha will contribute to sequester 1 469 260 tCO2-e over 20 years while the improved forest management on 9 000 ha will sequester 232 518 tCO2-e during the same period. Emission associated with irrigation are from dam construction, leading to 115 tCO2-e emitted over 20 years.

320. Field missions during the project development phase have indicated farmers' interest to receiving technical support for agricultural production, thereby ensuring buy-in of the proposed interventions, which will support the implementation of CRA, agro-forestry and sustainable resource management in the Oueme Basin (Output 1.2). However, as indicated in Annex 8 (GAP), there is a risk that women do not fully participate to, and benefit from, the project's interventions, especially with regards to technical agricultural support. To ensure women are not left aside from the project's expected benefits, Dimitra club approach will be promoted through Output 1.2. By stimulating social dialogue and social mobilization, the implementation of the Dimitra Clubs methodology will allow the targeted communities to engage in a process to transform discriminatory gender and social norms that are at the root of gender inequality. Equal participation in FFS will also be promoted, all trainers will be sensitized and trained on gender awareness, community engagement and the Dimitra Clubs approach, and schools dedicated to women set up, to benefit them with labor-saving tools among others (see Annex 8).

321. All together, Output 1.1 & 1.2 will enhance crop production in the Upper and Middle Oueme. Farmers will benefit from increased agricultural productivity and reduced exposure to climate-related risks while contributing to reducing emissions (Outcome 1), which will incentivize the long-term implementation of CRA and sustainable land management in the Oueme Basin; the

[169] GIZ, 2017. Adaptation de l'agriculture au changement climatique (PACC). Available at: https://www.giz.de/en/worldwide/31841.html

demonstration of OCRI's benefits (through sensitization under Component 2 & 3) will also facilitate project replication (including its adaptation and mitigation benefits) in other areas. In return, farmers will contribute to CO2 emission reduction beyond the project's lifespan. The training on CRA will particularly target key agro-products namely maize, mango, cashew and shea. The quality of these products will improve by using appropriate, and resilient production techniques. Component 2 will further support the development of robust value chains for these key products – that is Component 2 will add value to these agro-products by improving capacity for harvesting, processing, marketing and sale – so that they can be sold by local farmers and cooperatives to make profit. Shea, maize, cashew and mangoes were selected for this target support because: i) these crops, fruits and nuts are already produced in the target area; ii) the FS indicates their adaptation potential, providing the use of adapted techniques (CRA); iii) shea, cashew and mangoes in particular contribute to CO2 emission reduction, through reforestation; iv) they are among prioritized agricultural products by the GoB; v) there is a demand from domestic and international markets; and vi) there is currently few initiatives promoting these value chains. The total emission reduced from component 1 is 1,783,633 tCO2-eq over 20 years.

322. At the moment, the full development of maize, shea, cashew and mango value chains is impaired by a lack of technical and financial capacity (for production, harvest, processing, storage, and sale) as well as business skills amongst farmers and cooperatives in the Oueme Basin. While Component 1 will enable farmers to produce high-quality crops under climate change conditions, interventions under Component 2 will address the lack of capacity for marketing and sale, to boost profits. First, under Output 2.1, farmers will be organized into cooperatives around key value chains – namely shea, cashew and maize – using the FBS approach. This will enhance their capacity to work together (as cooperatives and unions) to negotiate sale prices, prepare high-quality agro-products which respond to market demands and expectations.

323. Second, access to finance will be unlocked in the Oueme Basin. Currently, a lack of access to finance impairs value chain development in Upper and Middle Oueme. In particular, access to loans and micro-credits for agriculture is limited in Benin (see Market study Section 2.3). Such access would enable farmers' investments in agricultural inputs and quality seeds, labor support for harvesting, storage, processing and packaging equipment, among others. To address this issue, training on financial management will be organized through FBS to ensure farmers and cooperatives can meet MFIs' requirements for accessing micro-credits. FNDA will ensure access to credit for OCRI farmers. Access to loans will finally be enhanced as VSLA will be established among the beneficiary communities. With a better access to loans, cooperatives can invest in CRA and relevant equipment to create added value to their agriproducts – beyond the project's lifespan. To further ensure a more efficient and profitable agriculture, the project will promote use of the innovative FarmTree App. This App offers cost-benefits simulation of combining crops and trees on the fields, taking into account climate change and agro-ecological conditions. It is therefore a key tool to help agri-business planning and will be used, through OCRI project, to identify best combination of trees, crops and vegetables that ensure high productivity, while responding to market demands.

324. Third, Output 2.2 will create a favorable environment for private sector investments in low carbon climate-resilient value chains. This will be done by demonstrating the socio-economic

(e.g. returns on investment) and environmental benefits of the project (see business model in Annex 3). Information products underlying the economic benefits of CRA and land restoration – as demonstrated through the FarmTree App – will be specially packaged for the private sector organizations, including MFIs, agri-businesses, private donors and investors. Finally, match-making municipal forums that connect sellers and local, national and international buyers/ exporters will be organized to facilitate sale of shea, mango, cashew and maize in the five target municipalities. There is no risk of limited buyers for these key value chains as the chains were selected based on field mission, Benin's agricultural priorities, current production in the target areas, and a list of potential buyers for each value chains was prepared (see Section B.1 of the FP).

325. Outputs 2.1 & 2.2 together allow for the development of robust, climate-resilient value chains and income streams in the Upper and Middle Oueme Basin. In particular, Output 2.2 will reduce the risk that private sector does not support resilient value chains, through targeted sensitization messages and products, which highlight the added-value (especially return on investment) from CRA. Furthermore, the promotion of gender equity and women empowerment within Component 2 is key as there is a significant risk that women cannot fully participate to, and benefit from the development of robust value chains – especially due to cultural reason in the Middle Oueme (see Annex 8). Women in the Oueme Basin are currently engaged in different links of these value chains – for example processing maize into flour or shea into butter, or sale home, along the roads and in local small markets. However, women are often poorly organized, have less decision-making power than men, and are more burden to access micro-loan and credits to buy efficient agricultural and processing equipment (please see Annex 8 for additional information). To increase women's participation in climate-resilient value chain, women and women-led agribusinesses and cooperatives will be purposely targeted by capacity development initiatives and as recipients of equipment and storage facilities.

326. Moreover, interventions to improve loan access will have a special focus on women's access to credit, who face issues due to their limited ownership of assets as collateral to access formal credit. Micro-credit opportunities will therefore prioritize women in the targeted area. In addition, in order to support their entrepreneurial potential, women farmers will be trained on financial management and business plan development. While the Dimitra Club sits under Component 1 to maximize the impact of FFS, its social dialogue and social mobilization effects are meant to be cross-cutting to all components. In particular, community discussion has proven effective in changing discriminatory social norms resulting in women's increased access to opportunities, voice and decision-making and better distribution of gender roles. Together and in dialogue with PSEA procedure and mechanisms, the Dimitra Club approach will also be used to discuss and address issues around gender-based violence, as indicated above.

327. The third intervention (Component 3) will ensure a long-term, enabling institutional and financial environment to support and sustain Outcomes 1 & 2 – including their adaptation and mitigation benefits – in the long-run. At the moment, there are limited technical and institutional capacities in Benin, and more particularly, the Oueme Basin to plan and implement gender-responsive low carbon ICRM in the Oueme Basin. Moreover, there is a lack

of coordination among national, regional and local government entities to implement ICRM in the Oueme Basin and to foster climate-resilient value chain development. Such support and coordination need engagement and collaborative work from various sectoral institutions represented at the national, regional and local level. To enable this and address both barriers, the OCRI platform will be establish with a view to coordinate project interventions and land management efforts in the Oueme Basin, in the long-term (beyond the project's lifespan). Establishing a robust, long-lasting platform will tackle the existing risk that authorities in the target municipalities of the Oueme Basin cannot implement ICRM beyond the project's lifespan, because they lack the capacity or resources. This risk is also reduced as the project will develop tools to guide ICRM implementation: more precisely, the SDAGE and LDPs will be revised, using a participatory approach, to mainstream ICRM as well as gender concerns. These plans are key to guide future public investment and development initiatives in the Oueme Basin (beyond OCRi project)

328. Capacity building of local authorities and extension service (making sure to train and involve women's extension workers) for adaptation planning will also be implemented to further create an enabling institutional and technical environment for adaptation in the Oueme Basin. Field missions have also confirmed the willingness and interest of local authorities in the Oueme Basin, including field agents and the OBA, to increase their capacity for implementing sustainable and resilient land and water management.

329. Beyond an adequate technical and institutional framework, the GoB also lacks financial resources to implement low carbon ICRM in the Oueme Basin. To address this gap and ensure long-term investments in ICRM and adaptation in Benin, the project will develop a strong partnership with FNEC, Benin's GCF accredited entity. FNEC is already supporting Benin's climate change related efforts through financing micro-projects or implementing larger projects funded by international funds; there are opportunities to leverage FNEC's resources to upscale ICRM in Benin.

330. The project will collaborate with FNEC to identify additional financial streams, that could increase the fund's resources for supporting adaptation in Benin. Moreover, FNEC's capacity to develop, implement, monitor and report on, climate change related projects will be increased and 3 micro-projects on ICRM in the Oueme Basin will be selected and financed by FNEC (using its own resources), as well as monitored with support from FAO. This will strategically contribute to build FNEC's capacity for the design and implementation of climate change initiatives, and to tap into existing resources from public or private fund (e.g. Adaptation Fund). It will strengthen the role of FNEC as Benin's accredited entity for the AF and GCF, and as a key player supporting adaptation efforts in the country (Output 3.2). To foster large-scale awareness and knowledge of ICRM in the Oueme Basin and its benefits, all knowledge and best practices generated through the project and captured under various activities (2.1.3, 3.1.3) will be used to develop sensitization campaigns.

331. This will contribute to address the existing lack of awareness of the benefits of ICRM in Benin; in particular, authorities for Benin's other basin areas – namely Volta, Niger and Couffo – will be invited for field visits on project sites to support project's replication and upscale. Finally, the OCRI symposium will be organized to showcase climate-resilient agricultural practices in the selected key value chains to local farmers, cooperatives, entrepreneurs, and private sector

stakeholders and incentivize upscale of successful project interventions across Benin. These activities will ensure large-scale awareness of OCRI, as well as a robust institutional and financial environment for upscaling ICRM – including its adaptation and mitigation benefits – across the country (Outcome 3), and supporting its continuity beyond the project.

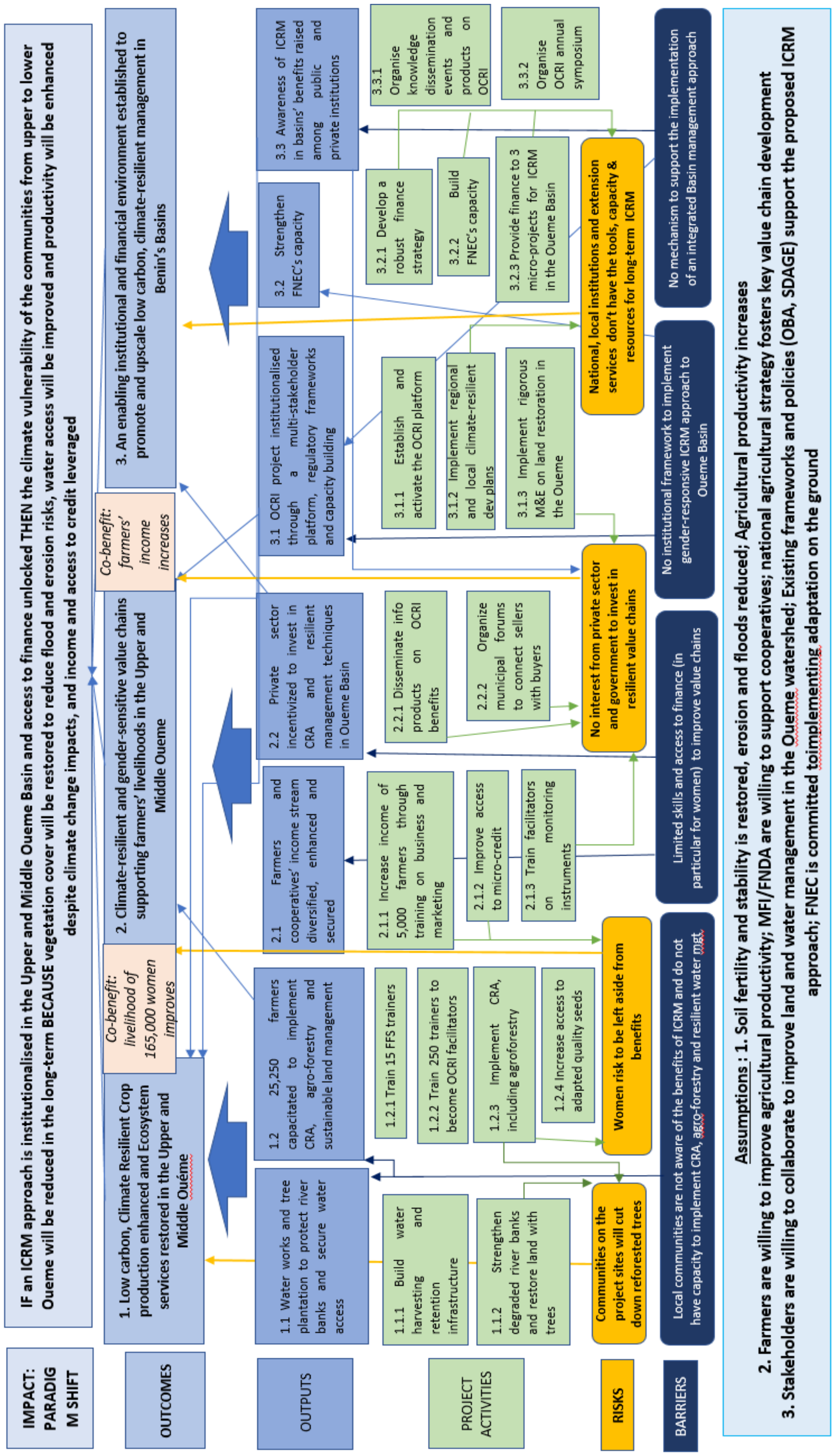


Figure 68 : OCRI's Theory of Change

The project will also address the barriers identified in Chapter 8 the following way:

Table 36: Barriers to be addressed by OCRI project

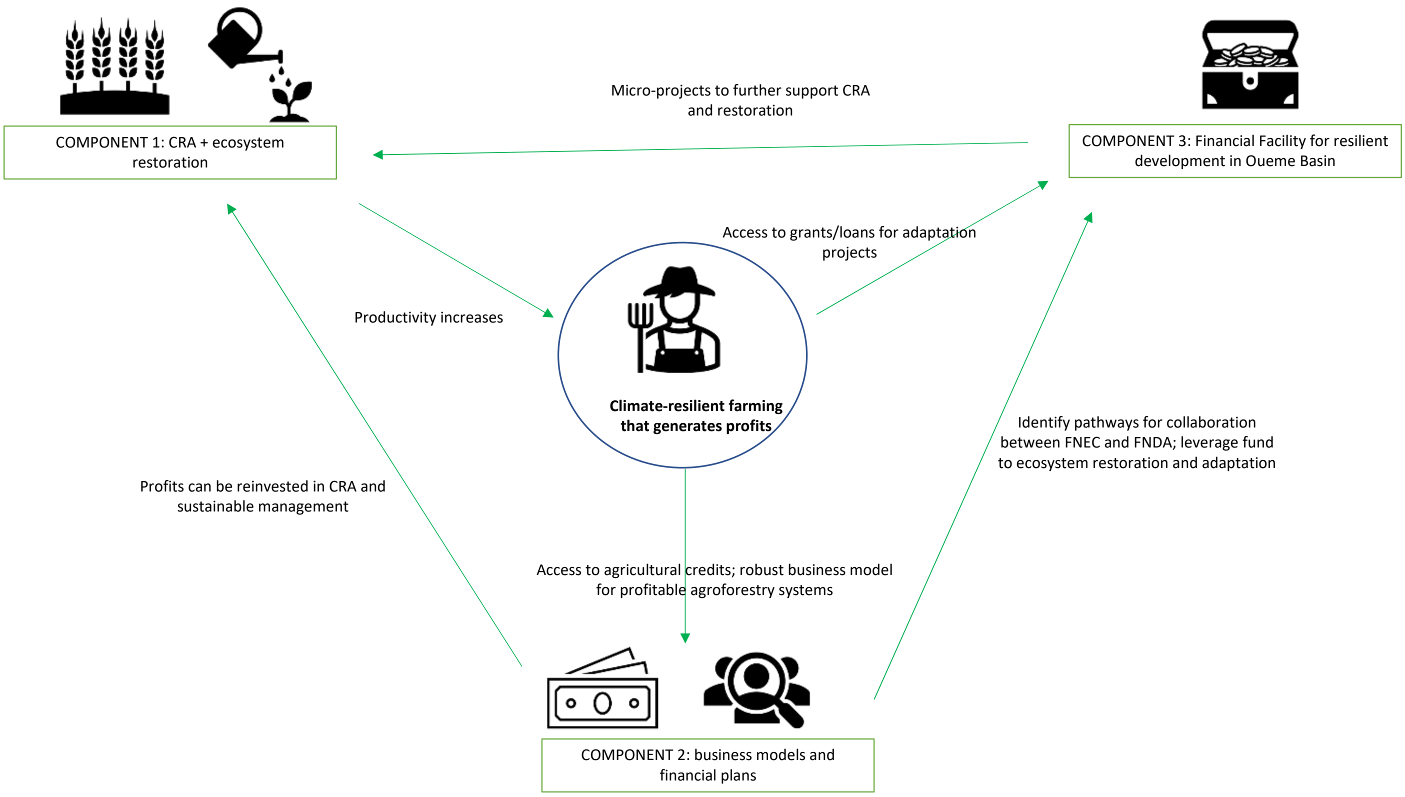
Barriers	**How to be addressed by project**
Technical capacities	
The communities of Upper and Middle Ouémé Basin have limited technical and material capacity and awareness on how to implement, climate-resilient agricultural and water management practices that improve productivity in the agricultural landscapes while, at the same time reducing the negative effects of climate change, including erosion, floods and flash floods, especially in downstream areas. The Baseline Study conducted in the project sites of Upper and Middle Ouémé indicates a lack of hydro-agricultural technologies implemented to cope with the impacts of climate change. As a result, farming communities face a chronic deficit of mobilization of water resources, which impairs the promotion of promising adaptive economic activities such as irrigated agriculture and off-season horticulture. Effective irrigation systems are almost non-existent and there is no control of water, for example through water retention infrastructures or micro-dams; when such structures exist, they are obsolete because of the absence of capacity, at the local level, for sustainable water management and maintenance of waterworks. (see Waterworks Feasibility: Annex 17 for an assessment of existing irrigations schemes and water infrastructure in the target areas). With regards to agricultural practices in the Ouémé Basin, they are characterized by the use of basic tools and low mechanization. Extensive, rainfed agriculture dominates, which is very sensitive to climate variability and extremes like droughts and late onset of rainfalls. The use of climate-resilient production technologies is very limited on project sites, with a low adoption rate of improved seeds and a low use of on-farm rainwater harvesting techniques. This is because, on the project sites, there are no integrated water management and climate-resilient agriculture – including agroforestry projects – projects therefore farmers, who have not received adequate training and are not aware of the climate benefits of CRA, present low levels of adaptation capacity.	Under Component 1 of the project, communities will be trained (through FFS) to implement CRA, agro-forestry and water management; waterworks will also protect their land and home against floods (especially in Middle Ouémé) and facilitate water access and retention in the desiccated soils (especially in Upper Ouémé). Likewise, a detailed resilience and adaptive capacity assessment will be carried out to improve targeting and identification of context-specific solutions to enhance communities' resilience. Moreover, under Component 3, awareness raising events, and radio broadcasts will contribute to disseminate knowledge of climate change and resilient practices; training modules will also be available on the OCRI platform.
Financial capacities	
The communities have restricted/ no access to micro-credit or other financial support (from the government or the private sector) to invest in climate-resilient practices, improve their productivity, access market, and boost their profits (see Section 4). Although there are financial institutions and schemes to provide micro-finance for smallholders, the agricultural sector remains under-financed. Smallholder farmers also face many difficulties accessing credits for agricultural investments, particularly for the more vulnerable groups of society, such as women and youth. The financing schemes tend to focus on Alternative Income Generating Activities, such as sale of transformation products, honey, etc, while the risk of investing in agricultural production is still perceived as high. As a result, micro-finance institutions have high requirements with regards	Under Component 2, in partnership with MAEP/IFAD, the project will facilitate access to finance via trainings for cooperatives. Farmers and cooperatives will learn how to plan their field (TreeFarm App), and to grow resilient, high-value products; they will also be trained on marketing techniques to boost their sale, and financial management to access credits and re-invest in their activities. The project will also develop agreements with MFIs to secure their support through the guarantee from the FNDA. Communication products on the economic benefits to invest in CRA and ecosystem restoration will be disseminated to private sector institutions to encourage investment in the project. A roadmap to increase FNEC's resources will be developed under Component 3, to further enhance access to fund in the long-term, as a replenishment strategy will be developed. Moreover, farmers and buyers will be linked through biannual municipal forums, and through the

to collateral, high interest rates and short payback periods, on top of their administrative fee – which smallholders cannot meet. Furthermore, finance institutions are more reluctant to lend to individual farmers than to organised groups. An investigation conducted by MAEP on the reason why many smallholder farmers in Upper and Middle Ouémé do not contract credits indicates, as five main reasons: i) smallholders are scared and uncomfortable to be in debt; ii) high interest rates of credits; iii) lack of stable income, or income too low; iv) lack of knowledge of how to get a credit; and v) they have not thought about it (not aware of credit potential).	OCRI platform, to facilitate sale of climate-resilient agriproducts responding to market demands.
Institutional coordination	
Land or water management in the Ouémé Basin is not implemented according to an integrated climate-resilient approach. Therefore degradation of the natural capital is observed. There is lack of capacity and resources invested in restoration and protection of critical ecosystems (especially along the Ouémé River) and in CRA, with a view to improve livelihoods and resilience on the whole Ouémé Basin; there is no coordinated efforts among relevant stakeholders in environmental management, agriculture and water to support such an approach. Climate change and ICRM is not yet integrated into local development plans (LDPs) and regional strategies in the Ouémé Basin; in addition, the Ouémé Master Plan (SDAGE), which promotes integrated water management, is underfinanced and few interventions are currently implemented. Mainstreaming adaptation into development plans would inform and guide public interventions and investments towards climate-resilient development. Another weakness is the lack of coordination mechanism or platform to facilitate the coordination of public and private stakeholders in climate resilient water management, agriculture, and agri-markets. For example, a platform including the Ministry of the Livelihood and Sustainable Development (MCVDD), the Ministry of Agriculture, Livestock and Fisheries (MAEP), the National Fund for the Environment and Climate (FNEC), FNDA, the Ouémé Authority, farmers' cooperatives and finance organisations would support coordinated efforts towards ICRM in the Ouémé Basin, that generate benefits for all parties. On the contrary, a siloed approach to development prevails in the target areas of the Ouémé Basin, where projects and development initiatives tend to focus on a single sector like agriculture or water access, without integrating climate change concerns or basin-specific considerations – as interventions implemented upstream have impacts on downstream communities and landscapes. As a result of these limitations, agricultural landscapes in the Ouémé Basin are not resilient to climate change and the communities are increasingly vulnerable to water scarcity, droughts, shifts in seasonality and floods.	Under component 3, the OCRI platform will be established to provide a space where national and local governmental agencies join their efforts to improve management in the Ouémé Basin. The ICRM will also be institutionalized through the Ouémé Master Plan (SDAGE), and implemented through the LDP of the 5 project municipalities. Developing/ integrating ICRM in the municipal plans will also ensure public funding are invested in climate-resilient interventions in the future. Local extension officers will be trained to implement ICRM. Under component 1 such strategies of protection and restoration, sustainable adapted production will be implemented and farmers will be trained to do so.

The government of Benin and its local extension services do not have the knowledge and technical capacity to implement an integrated basin-level management approach, and therefore cannot provide the necessary technical support to the local population. The institutional, regulatory and governance capacity to plan and implement this approach in a coordinated, complementary or synergetic way is missing. As underlined in Section 5 of the FS there is a limited mainstreaming of climate change concerns, especially into local and regional development plans. While, at the national level in Benin, there is an ongoing process to integrate climate change adaptation into relevant policies and strategies, at the local level, there is limited integration of integration of climate change into local development plans prepared by the municipalities. This is because of limited technical and financial capacity among local-level government staff (described above) and limited availability of climate change-related information, including on the benefits of adaptation (further described below). Consequently, municipalities and communities do not receive support for the design and implementation of locally appropriate climate change adaptation interventions.	Under Component 3, local extension, forest and water officers will be trained to implement ICRM in the basin, including the resilient plans developed in the 5 target municipalities, which they will contribute to develop. They will also be trained under the ToF programme under Component 1 to disseminate their knowledge on CRA, agro-forestry and waterworks to other local officers/ farmers, thereby multiplying the expected project beneficiaries after project completion.
Awareness	
The government of Benin and the private sector are not aware of the socio-economic benefits to implement an integrated sustainable climate-resilient approach for the management of basin. In other words, there is no incentive for the private sector and agri-businesses to invest in climate-resilient value chains as their benefits are not demonstrated yet. Benin's economy is mainly based on agriculture, trade, and transport to and from neighboring countries. Despites improvements on the economic front, the average economic growth rate is 4.2% over the period 2006-2015 . This growth rate is insufficient to combat poverty in a sustainable manner. Moreover, the population does not have the financial capacity to overcome poverty, provide sufficient food for the household, and invest in climate-resilient technologies, infrastructure, or equipment. This is particularly the case in the project intervention areas, where the economic and socially vulnerable targeted populations is further threatened by climate change impacts. The public sector, within its very limited capacity, is the main actor responsible for promoting agriculture, irrigation, and drainage in Benin, while investments from the private sector in the field of irrigation, for example, are almost non-existent as there are few incentives at present. Indeed, there is yet no clear demonstration of the socio-economic and environmental benefits to implement ICRM in basin areas in Benin. While climate change is partly integrated into agricultural research (for instance at the National University of Agronomy in Porto Novo), programmes are focused on improving agricultural productivity under existing climatic conditions rather than focusing on future changing climatic conditions. Finally, there is no platform where information about climate change impacts in Benin and best adaptation practices are stored and shared with policy- and decision-makers. As a result, there is a lack of user-friendly information to inform policies, plans, and appropriate CRA interventions in the agriculture; and demonstrating strengthening the socio-economic benefits of this approach. Such demonstration could incentivise public and private investments in project interventions. The potential of the project to maintain agricultural productivity despite	Under component 2 & 3, the economic and environmental benefits of project interventions will be carefully monitored (using an innovative App), compiled, packaged into targeted knowledge products, and shared, in particular towards governmental institutions and the private sector. This will incentivize future investments in resilient farming activities. In addition, all knowledge products and project's data, training modules, lessons learned and best practices for ICRM in watershed will be shared on OCRI's online portal. Field visits and awareness-raising events will also be organised for the communities surrounding the project's sites, in order to showcase the benefits of restored and protected ecosystems along the Oueme River. Finally, field visits and training sessions will be organised for other basin authorities in order to promote replication of OCRI approach across Benin's watersheds.

climate change, and to increase the acreage of production of high value crops and trees (see Economic Analysis, Annex 3) would also secure future investments from farmers and cooperatives that would maintain the project beyond its lifespan.	

Figure69: Farmers benefiting from OCRI interventions



8.1.2 Project's description

332.The proposed OCRI project aims at sustainably reducing climate change vulnerability and build climate-resilient livelihoods among the rural communities of Upper and Middle Ouémé through restoring the services and productivity of ecosystems and agricultural landscapes, strengthening climate-resilient value chains, and introducing innovative financial mechanism through the collaboration with FNEC and FNDA. The following Components, Outputs and Activities will be implemented over a period of 6 years.

Component 1: Low carbon climate Resilient Crop production enhanced and Ecosystem services restored in the Upper and Middle Ouéme

333.To enhance climate-resilience on the Ouémé Basin, an ICRM approach – including waterworks, agroforestry and CRA – will be implemented in selected municipalities of the Ouémé Basin to provide benefits not only on project sites but in downstream area as well. Floods will be reduced, soil erosion limited, access to water improved, agricultural productivity enhanced, and as such climate change vulnerability reduced. There are 95,000 ha of degraded lowland[170] and riverbanks area in the Upper and Middle Ouémé which can be better managed and restored through sustainable land and water management practices, waterworks and agroforestry on the riverbanks (Output 1.1) and CRA (Output 1.2). The target area was selected because it can be subjected to surface water mobilization through micro-dams, water retention of variable size, and water management (soft and hard) infrastructures to enable climate-resilient agriculture, agroforestry, and counter-season horticulture, in the context of climate change, while at the same time improving water filtration in soils and vegetation cover to buffer communities against floods, heat and water scarcity. This estimation (95,000 ha) takes into account soil erosion problems and risks in the area.

334.A vulnerability assessment was conducted on each project site during the FP development phase. Its results will be refined with a site specific assessment of resilience in the project sites to be undertaken at the start of the project using the SHARP tool or similar holistic and integrated approaches. This will aim to increase the understanding of the prevailing livelihood conditions of smallholders, as well as their resilience and adaptive capacity levels. The tool will serve to identify the main areas of vulnerability in the selected municipalities. The results will support the targeting and decision-making on which of and where the proposed waterworks and CRA are most needed and identify who need them the most. The results will also support the refinement of the M&E strategy and set a project baseline for key M&E indicators with primary up-to-date data.

CRA and agroforestry

335.These techniques will be implemented to increase productivity of maize, cassava, cowpea, chillies, okra, green vegetable, tomatoes, yam, shea, mango and cashew. Climate resilient management practices include alley cropping, Zai pit, crop association, mulching, crop rotation, use of improved (heat- and drought-tolerant) varieties and propagation material (eg

[170] Lowlands are defined as "inland valleys, flat or concave with temporary or perennial flow axes, which are flooded for periods of at least several days of the year, and in which soils with hydromorphic characteristics and a relatively small catchment area are found" (APRM / Direction Génie Rural, 2010).

grafted plants), cover crops (eg mucuna). These options were identified and assessed for their degree of acceptance by small scale farmers in Benin[171]. Moreover, agroforestry and the diversification of crop varieties will be implemented to ensure a broader source of crop resilience to the uncertain occurrence and effects of extreme weather events[172]. The development of agroforestry systems will be considered through the design of dynamic vegetation models that integrate both net primary production and forest yield approaches. This would allow on the one hand to calibrate and adjust the biogeochemical processes (regulation of greenhouse gases) and biophysical processes (regulation of water and energy) to be implemented for sustainable management of agricultural ecosystems, forests, and on the **other hand to simulate forest biomass, primary and food production, the water and nutrient cycle, the effects of fires, insect infestations and extreme events, the evolution of biodiversity as well as climate feedbacks. Water-holding capacity of soil will improve, and soit erosion reduce.**

336. This results in reduced surface runoff and enhances soil moisture, which in turn improve productivity maize, cassava, cowpea, chillies, okra, green vegetable, tomatoes, yam, shea, mango and cashew (see details of practices in Annex 19). 130 FFS will be implemented per target municipality (spread between selected villages), each lasting 4-to-5 months (following length of the growing season).

Agroforestry and CRA systems also directly contribute to reducing emissions through no tillage practices and discontinuation of biomass burning; better residue management practices; reduce deforestation caused by agriculture expansion caused by low productivity; and increase carbon sequestration through enhancing existing tropical moist deciduous forest area, improving vegetation coverage and soil quality by planting trees.

The activities under component 1 will support reduce emissions as follows: (a) improved CRA practices to enhance agricultural productivity, including the development of small irrigation system, corresponding to emission reduction by 52 587 tCO2eq over 20 years; (b) Strengthening degraded river banks and restoring perennial parkland land with additional trees and SLM/SFM practices, resulting in a direct reduction in emissions of approximately 1 469 260 tCO2 equivalent (tCO2eq) over 20 years (per year which corresponds to 73 463 tCO2eq per year.Additional reduction in emissions of approximately 29,383 tCO2eq over 20 years is expected from phasing out mineral fertilization); and (c) improving the management of degraded forest over an area of 9 000 ha, which is subject to severe anthropic pressure, contributing to a reduction emission by 232 518 tCO2 eq over 20 years.

Overall, Component 1 of the project is expected to create a carbon sequestration result of 1 783 633 tCO2eq over 20 years compared to baseline.

<u>OUTPUT 1.1 Waterworks and tree plantation to protect river banks and secure water access</u>

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[171] FAO, ICRISAT, CIAT. 2018. Climate-Smart Agriculture in Benin. CSA Country profiles for Africa series. International Center for Tropical Agriculture (CIAT); International Crop Research Institute for the Semi-Arid Tropics; Food and Agriculture Organization of the United Nations (FAO). Rome. Italy. 22 p.

[172] Ratnadass A, Fernandes P, Avelino J & Habib R. 2012. Plant species diversity for sustainable management of crop pests and diseases in agroecosystems: a review. *Agronomy for Sustainable Development.* 32: 273–303.

337. Under this Output, ecosystem goods and services in the Ouémé Basin will be restored and enhanced: floods and water scarcity risks will be reduced, and small scale irrigation facilitated, soil fertility and moisture will be improved, tree cover increased, hence enabling climate-resilient agriculture (CRA) and ecosystems restoration. The following activities have been identified as best solution to the adaptation problems in the Upper and Middle Oueme:

Activity 1.1.1 Build water harvesting and retention infrastructures (*target of 2000 ha irrigated land including 1,320 ha with cofinancing from MAEP*)

The project will subcontract relevant local companies to build hard and soft infrastructures such as micro-dams (length of 100 to 150m, to capture 30,000 m^3 to 80,000 m^3 of water, in line with FAO safeguards), dykes, wells and surface boreholes, as well as ‘soft’ contour ploughing, and stone lines that can easily be reproduced and maintained by the communities (see training under Activity 1.2.3). These infrastructures will enable CRA (see Output 1.2), in a context where water scarcity is increasing and seasonal shifts affect the agricultural calendar, especially with the late onset of the main rainy season, and the disappearance of the short rainy season in Middle Ouémé. Water retention will also enable counter-season horticulture, a women-oriented activity, as well as facilitate recharge of underground water. The waterworks and their localisation have been pre-identified in Annex 17 - Feasibility waterworks; this preliminary study will be refined, reviewed and adjusted, during the project inception phase (year 1), to confirm the specific location and type of the waterworks. Simple adaptation techniques, like contour and mulching, that also contribute to improve water retention especially in drought- and flood-prone areas, like Upper and Middle, as demonstrated in previous projects, will be promoted on all project sites (also to be determined during the project inception phase).

The sub-activities are as follows (Based on OCRI feasibility Study on waterworks):

1.1.1.1 Construction of surface water storage structures or harvesting structures (Small earth dams, water rising structures, etc.)
1.1.1.2 Rehabilitate 23 old surface water collection structures
1.1.1.3 Development of small irrigated perimeters with full water control
1.1.1.4 Development for the protection of water sources (river, head of streams, artesian boreholes, etc.)
1.1.1.5 Support for waterworks guidance
1.1.1.6 Set up 1,320 ha of irrigated land in Glazoue and Djougou

1.1.1.7 Secure government support to co.invest in waterworks

Figure70: Irrigation and inland-valley management sites (OCRI Waterworks report)

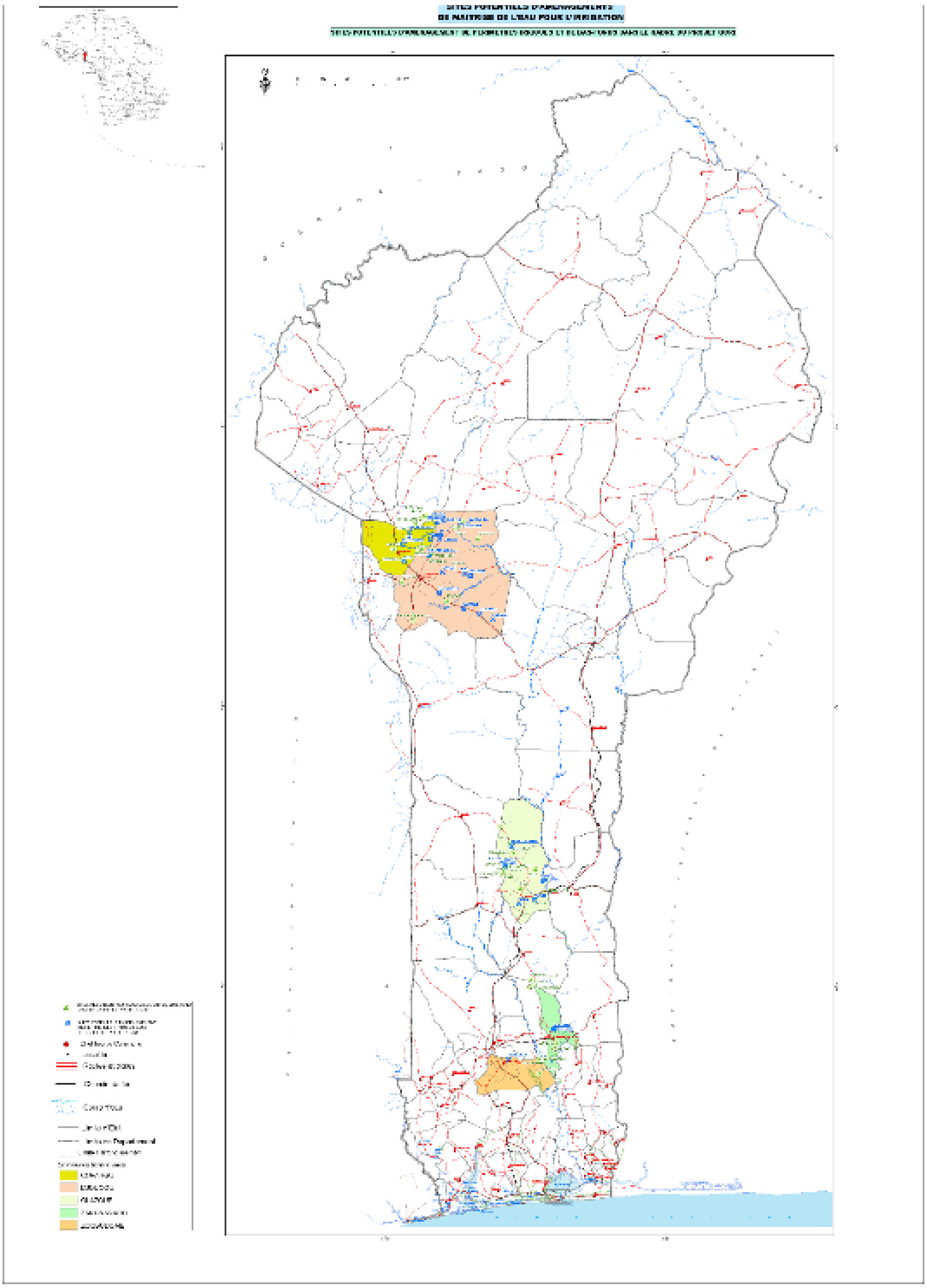
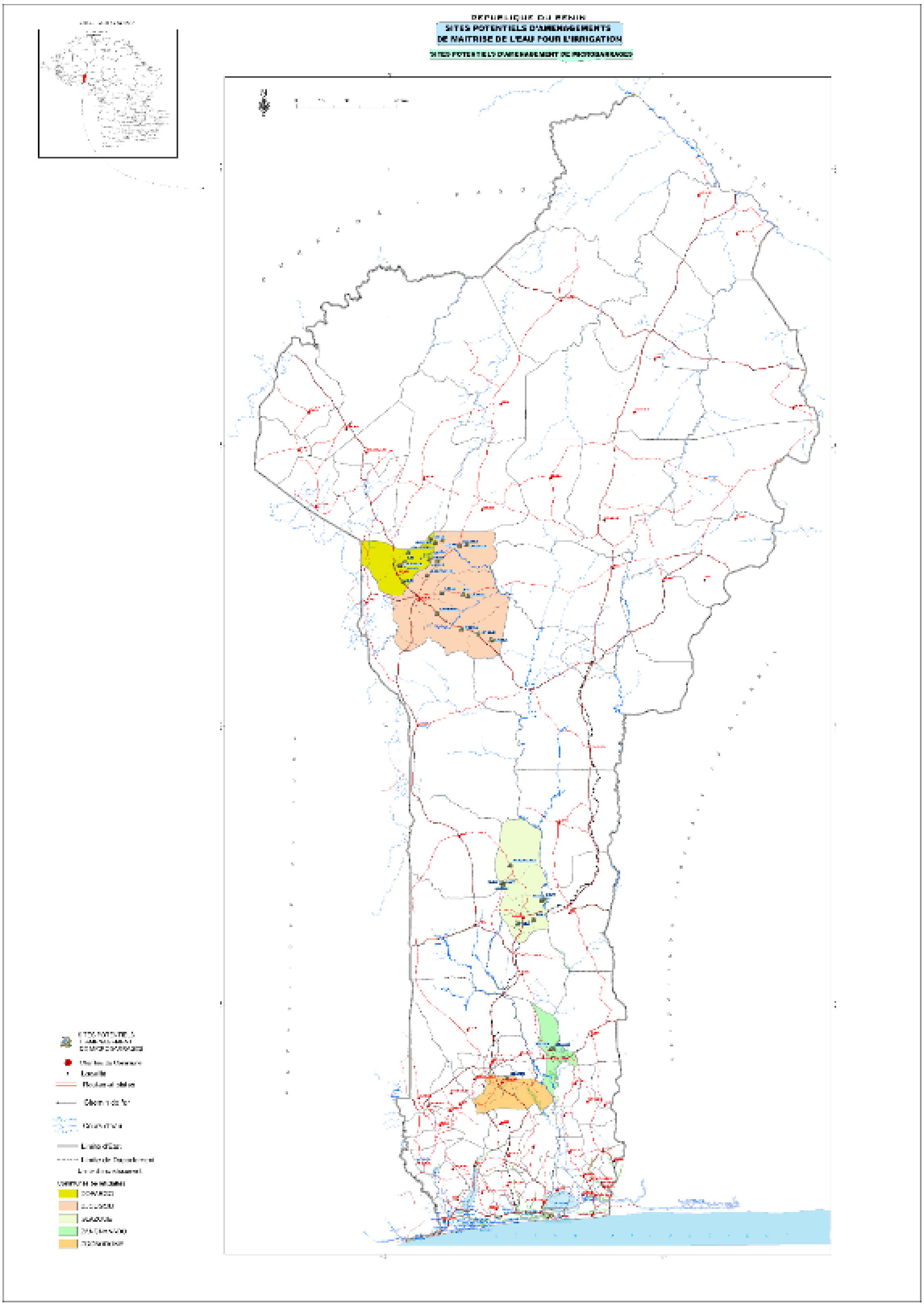


Figure71: Water reservoirs/Dykes sites (OCRI Waterworks report)



Activity 1.1.2 Strengthen degraded river banks and restore land with trees (*target of 9,000 ha with including 4,000 ha with cofinancing MAEP*)

Well functional riparian forest provides essential goods and ecosystem services of multiple benefits (shelter for pollinators, wild animals, medicinal plants, Non Wood Forest Products…) to local communities. This will reduce risks of erosion during heavy rainfall events, which become more frequent especially during the middle and end of the rainy seasons; and improve water recharge for boreholes. This activity will especially focus on Upper Ouémé and contribute to reduce flood risks in Middle and Lower areas; for example, FAO GEF-7 project is located in the Lower Oueme Basin and will therefore benefit from OCRI's interventions.

The exact locations of the sites will be selected during the inception phase. Selection of the sites for activity 1.1.2 will be guided by criteria such as (1) size of degraded sites should be more than 2ha, (ii) low aboveground biomass of less than 50 t/ha for minimum tree dbh of 10 cm for riparian forest, (iii) degraded agroforestry parkland with tree density less than 25 trees/ha for minimum dbh of 10 cm (iv) interest of local people on Non Timber Forest Products (NTFP), (v) engagement of the local people to participate in the restoration activities, (vi) at least 30% of the farmers willing to participate in the restoration of river banks degraded are women wo will also benefit from the related NTFP initiatives.

Trees will be planted on farmers' fields and along degraded river banks with the direct participation of the beneficiary farmers, during the FFS. As farmers will be directly engaged in tree plantation and sensitised about their benefits during the FFS, this will contribute to their maintenance and protection by the population. The project will also consider using tree species which are not cut down for their wood, like cashew and shea trees. Plantations on field and along the river banks will restore vegetation coverage, reduce flood risks due to heavy rainfalls falling on bare land, restore fertility, provide shade and keep moisture in a context where heat stresses and evapotranspiration increase.

The restoration of river banks using climate-resilient and high value tree species was identified as a best practice on the UNEP SAP and PADAAM projects; the OCRI project will replicate good practices from these projects to upscale reforestation along the Oueme River. Reforestation sites will be determined at project onset and related land and tree tenure practices assessed and enhanced. In line with Benin national forest resources (including riparian forest) management policies and regulations, river banks restoration and protection will be enhanced. This activity will specifically target degraded river banks. Moreover, trees will be planted on farmers' field to restore vegetation coverage and diversify income stream (Component 2).

Tree planting activities will be coordinated by the MCVDD and its local branches, through the OCRI platform (see component 3). Planting sites will be selected based on their level of degradation (where tree density is less than 25 trees/ha), interest for the restoration and of tree cover is acknowledge by the local communities and tree the related goods and services have proven socio-economic value for the local communities and the Ouéme basin ecosystems. To produce tree seedlings, the project will build one tree nursery of 10,000 tree/year capacity in each target commune; the existing nurseries attached to the local Forest Department services will also be mobilised to grow additional tree seedlings as needed.

Sub activities are as follows:

1.1.2.1 Conduct detailed biodiversity analysis in Upper and Middle Ouémé to identify site specific locally relevant and resilient tree species- conduct technical and hydrological studies to identify best site for the micro-dams
1.1.2.2 Set up 5 community tree nurseries and provide technical support to produce high-quality seedlings
1.1.2.3. Plant 5,000 ha of trees along degraded riverbanks and fields

1.1.2.4 Plant additional 4,000ha of trees in Glazoué, Zagnando and Zogbodomey
1.1.2.5 FAO provides technical support to produce high-quality tree seedlings to enhance rural community resilience to climate change.

The proposed project will use the FFS approach as key methodology for field activities, in conjunction with the Dimitra Clubs approach. The FFS approach ensures a continuous process for updating the information base needed to cope with climate impacts. It is considered the most appropriate approach to implement ground-based activities with farmers on climate change adaptation and mitigation as it is flexible, focused on learning by doing, it responds to farmer needs, it is context-specific, it helps farmers to organize collective action (i.e. for natural resource management), it focuses on farmers' decision-making and helps the community to develop adaptation plans. Due to its flexibility, innovation, adaptive capacity to different contexts, the FFS approach fits very well to cope with climate change. Based on identified local community priorities and farmer needs related to climate stresses and climate threats on production and natural resources, the approach aims at find out context-specific solutions. Starting from a community needs assessment, which is the basis of the FFS curriculum development, FFS farmer experiment different options in the field and adopt those which are more promising to face climate unpredictability and impact.

<u>OUTPUT 1.2 25,250 farmers capacitated to implement climate resilient agriculture, agro-forestry and sustainable land management over 95,000 ha</u>

Under climate change conditions, agricultural productivity in the Ouémé Basin is projected to decline by 25%. Under this Output, 25,250 selected facilitators and farmers will be trained through the FFS approach, and implement (on their own field) CRA and agroforestry, to restore soil fertility, retain moisture, provide shade; CRA will focus on maize, cassava, cowpea, chillies, okra, green vegetable, tomatoes, yam, shea, mango and cashew, which are the main cultures in the target area**;** irrigated agriculture and counter-season horticulture will be implemented, supported by the water schemes set up under output 1.1.

Agroforestry, using cashew, mango and shea trees, will not only stabilise soil, especially along the riverbanks, and improve water retention – thereby reducing risks of flood in the Middle and Lower Ouémé – but it will also support new income streams for the beneficiary communities. Indeed, high-value tree species grown using climate-resilient techniques (CRA and agroforestry) will be planted along the Ouémé River and on fields, as well as other indigenous species, to improve crop productivity and support sustained income – to be valued under Component 2 of the project.

Agroforestry will also support increase carbon sequestration and reducing emissions from additional tree planting and no tillage.

The methodological alliance between FFS and the Dimitra Clubs has been tested in DR Congo, Mali, Niger and Senegal, mainly in the framework of climate-smart and resilience projects. This alliance has led to promising results in terms of improved access to information and knowledge about climate-smart agricultural practices and innovations as well as enhancing the leadership and empowerment of rural women. The FFS enable Dimitra Clubs' members to access technical knowledge by adopting more sustainable agricultural practices and better seeds varieties, improve their management of natural resources and develop better marketing skills. This valuable knowledge and experience that arises within the FFS is discussed within Dimitra Clubs that facilitate the scaling-up and broader application of these practices at community-level, particularly among the most marginalized groups such as rural women and youth.

The combination between FFS and Dimitra Clubs enhances community participation, inclusion, gender equality and the adoption of more sustainable agricultural practices, thus making it more possible to effectively contribute to improve livelihoods and reduce rural poverty. The Dimitra Clubs improve rural women and men's capacities to organize, express their needs, exchange information, and influence decision-making processes. Thanks to this approach, rural women have improved their access to services, information and resources and enhanced their leadership, voice and participation in decision-making processes at different levels (households, organizations and communities). As the gender dimension is inherent within the Dimitra Clubs' approach, this methodological alliance enables rural women farmers to enhance their capacities and knowledge on improved agricultural techniques so that they can become better farmers and enhance their yields while also enhancing their leadership and organizational capacities, crucial to influence decision-making processes.

The Dimitra Clubs allow women to get together and discuss issues that are important to them. The results of these discussions are also showcased at village meetings with the presence of the whole community, including men and village chiefs. This mechanism enables women's voice to be heard and recognized at community level.

Integrating climate change adaptation and mitigation into a FFS curriculum begins when FFS Master Trainers and Facilitators introduce the FFS programme to the community and the subsequent ground working activities which take place. During the preparatory stage, the site specific Baseline Climate Change Community Vulnerability Assessment is carried out, through a Community Resource Mapping exercise with the community. The assessment includes site specific consideration on the community exposure and sensitivity to weather stresses, based on the analysis already carried out at formulation stage. Baseline assessment exercises are used to identify site specific adaptation strategies and options to be included in Field Studies (through comparison among plots) and Special Topics (specific topics to be deepen) and to be integrated in the curriculum. Regardless of the field studies that are chosen, it is important to include the collection of weather information as part of the FFS activities, including the use of thermometers and rain gauges, which are critical, simple and cheap, and tools to be used by farmer to monitor key variable of weather patterns. At the end of the FFS learning process, the community develops its adaptation plan based on its own experience and taking lessons learned from experimentations in the field.

Low carbon climate resilient management of the targeted crops and trees identified in the formulation phase in the intervention areas, will be adapted to the different sites and improved through the FFS trainings in order to increase communities' resilience and to develop specific value chains (see component 2).

Some examples of field studies and special topics on climate change adaptation and mitigation to be integrated into the FFS curriculum are: Seed germination; Mulching and mulches; Moisture stress during the growing season; Responding to an increasingly uncertain start to the growing season with seed priming and dry seed; Site specific Adaptive Varieties – temperature and moisture stress tolerant and early maturing varieties; Impacts of extreme weather threats; Traditional knowledge on predictors of climate events; income and carbon sequestration; Improving nitrogen fertilizer management and production; Reducing emissions from enteric fermentation; Sequestering carbon in agricultural and forestry systems.

Activity 1.2.1: Train 15 FFS Master Trainers and Facilitators (women and men).

Selection and training of 15 existing FFS Master Trainers (mix of agronomy, forest, land and water experts) (at least 30% women). Four training sessions (one week x session) are organized to refresh and update the Master Trainers on the FFS methodology and on the key technical issues needed by the project. These Master Trainers will conduct the trainings of facilitators (ToFs), which are described in the following activity.

Training of Master Trainers will include also basic finance and business matters – particularly related to farm management. As Master Trainers have an agronomic background profile, during the training of facilitators (see activity 1.2.2) they will be supported by external subject experts on financial/business matters, similarly this external support will be provided to facilitators during the implementation of FFS.

Master Trainers and selected Facilitators (see activity 1.2.2), will create a network/association to operate as technical business advisors to secure the future scale up and sustainability of the project. Specifically, the network/association will assure the support of the future activities linked with the financial facility (see component 3), which will provide financial support to maintain the network. The mechanism will be formalized through agreements during the project implementation to assure the sustainability of the support.

There is a very strong FFS network in Benin, from which the Master trainers will be selected on the basis of the following criteria:
a) have a diploma in agricultural engineering or water and forest inspector or any other equivalent diploma;
b) have a demonstrated knowledge of production techniques linked to the production systems of the project;
c) have participated in a comprehensive training course for FFS master trainers;
d) have conducted at least 1 training course for facilitators; e) have at least 5 years of experience on the FFS.

Master Trainers will be contracted (paid stipends) to carry out Training of Facilitators and FFS supervision and coaching, for a few months per year based on the project work plan.

Sub-activities are as follows:

1.2.1.1 Develop training courses
1.2.1.2 Select 15 Master trainers to train and capacity/ skills assessment
1.2.1.3. Implement 4 x 1-week training sessions

Activity 1.2.2 Train 250 facilitators (at least 40% women) – that is 50 per selected municipality – to become OCRI facilitators.

First, a training curriculum will be developed based on the key priorities of the Ouémé Basin. This activity will include a validation workshop, which involve technical experts and FFS Master Trainers. Secondly, according with the curriculum, the training material will be compiled and adjusted, covering the following thematic: FFS methodology, climate-resilient agriculture (CRA) for maize, cassava, cowpea, chillies, okra, green vegetable, tomatoes, yam; agro-forestry with shea, mango and cashew; sustainable land management (with focus on river banks); and construction and maintenance of small waterworks (as per operation and maintenance manual developed in Section 8). Key framework of FFS trainings will be the agroforestry approach which combines crops and trees producing a mutual benefit as the tree roots bring up water and nutrients from deep in the soil, their leaves add to the soil's organic matter, pruning from trees and shrubs can be used as mulch or to make compost. In addition, planting trees decrease land degradation and tree fruits are used for value chain purposes (see component 2) as well as providing mitigation co-benefits. CRA will focus on maize, cassava, cowpea, chillies, okra, green vegetable, tomatoes, yam, shea, mango and cashew. Different CRA technologies and agricultural practices will be locally adapted and adopted, such as construction of anti-erosion bunds along the contour lines; stabilization of anti-erosion bunds through the planting of agroforestry species including those that fix nitrogen ones; application of mulch using crop residues, practices of fertilizer micro-dosing; the zai techniques, cover crops; protection of water sources through the planting of adapted low water-consuming species.

FAO has already designed several training materials for FFS, including on Land and Water management and Climate Change, which will be easily adapted to the local context in Benin. The material will include 6 modules[173], with gender-sensitive chapters to ensure the full participation of women to agricultural activities (e.g. focusing on horticulture or processing of nuts and fruits); it will also comprise demonstration video. The training modules will be disseminated on the knowledge portal of OCRI platform (Activity 3.1.1) and regularly updated during the project lifespan, based on lessons learned from the project sites, new site specific technologies for CRA, and peer-to-peer review as the material will be disseminated through the OCRI platform and subject to expert examination. Finally, the modules on CRA will explain the various 'starter kits', with specific adaptation options and seed varieties, based on the needs and specificities of their farm (that will be distributed under Activity 1.2.3. Once the training modules are ready for use, 250 facilitators (50 per municipality) will be trained: the project will organize 10 Training of Facilitators (ToF), for a duration of 5 months each (sequential training - 1 week per month) to follow the entire production season. Each ToF will be attended by 25 facilitators. Based on the country capacity, more ToFs can be organized simultaneously in the various municipalities. Once trained, the facilitators will disseminate their new knowledge on field schools set up under Activity 1.2.3: each facilitator will implement 2-to-3 Farmer Field Schools (FFS) per year, lasting 4 to 5 months each. These facilitators will come from local extension services in forestry and agriculture, local rural irrigation and waterworks department of the Ministry of Agriculture, Livestock and Fisheries (MAEP), young educated community members and leads, technicians or members of agri-businesses. They will be chosen based on their willingness to become OCRI facilitators to continue the training beyond the project's lifespan.

The common selection criteria for facilitators are as follows: a) have agricultural training of some kind, formal or informal, or have some level of advanced skills, knowledge and experience in agriculture/forestry; b) be technically competent for the agroecosystem at hand; c) be available to facilitate the FFS process; d) be able to share experiences and connect well with other community members; e) have good people skills and an aptitude for informal and participatory ways of working; f) have at least some reading and writing skills; g) speak the local language; h) live in the local community; i) ave a dynamic and confident personality.

Sub-activities are as follows:

1.2.2.1 Develop training curriculum and modules on CRA; agro-forestry; sustainable land management (with focus on river banks); and construction and maintenance of small water works

1.2.2.2 Organise 10 training of facilitators sessions of a 5-month duration, to accommodate 25 facilitators per session (for a total of 250 facilitators trained)

Activity 1.2.3 Implement climate resilient agriculture, including agroforestry, to enhance agricultural productivity under climate change and reduce emissions.

Farmers in the target sites will be trained and receive agricultural input. Training will take place in 650 farmer field schools (FFS) set up by OCRI plus 250 FFS set up by IFAD, including 100 schools dedicated to women. The 250 facilitators trained under Activity 1.2.2 will disseminate the practices through the established FFS to a total of 16,250 farmers (25 farmers per FFS) – including at least 50% women – spread over the 5 target municipalities; an additionbal 9,000 farmers will be trained under the IFAD FFS.

Beneficiaries of the training activities will be selected based on the following criteria: owning a plot of less than 2 ha, their willingness to participate, their availability and their interest in developing climate-resilient farms; the sharing of same needs/priorities related to the production; and the strong

[173] CRA technologies have been identified by FAO-Benin, and compiled in the following manual, which will be used to guide the trainings: FAO (2017). Pratiques et technologies pour une Agriculture Intelligente face au Climate au Benin.

motivation to follow the entire training cycle. These selection criteria will be further refine at project onset by FAO**.** 20 FFS per municipality will be dedicated to women, as they are more vulnerable to climate change; training will focus on vegetable production and counter-season horticulture, production, processing and storage of nuts, fruits and crops like cassava.
Training sessions will be tracked through attendance registers. In addition, a tool called "logbook" is used in which the facilitators summarize each day of animation session. Finally, at the beginning and at the end of each training cycle a knowledge test is carried out through incoming and outgoing questionnaires involving all participants, allowing to estimate the improvement of general knowledge and technical skills acquired by each participant. Also, a final evaluation is carried out for each FFS at the end of the training cycle.

The 16,250 training beneficiaries trained under the OCRI FFS will also receive farmer's starter kits, including small tools like spade, water can, trowels, wheelbarrow, as well as climate-resilient seeds.

Selected based on demonstrated interest and capacity of the members, 150 FFS will receive an introduction to the key elements of the business. Although a special focus on business will be dedicated during the second cycle of FFS (see activity 2.1.1), key elements of finance, marketing and business management concepts will be introduced into the curricula of the first cycle of FFS, based on Farmer Business Schools modules. These modules include basic financial literacy, farm accounting, market plans and farm investment planning, with special focus on developing women's entrepreneurial capacity.. In parallel, linked to the FFS groups, the VSLA approach (Village Savings and Loan Associations) will be developed. The VSLA allows members to take out a loan and develop small income generating activities. It retrieves traditional ways of saving and manage small amount of money at group level and allows to consolidate and develop basic notions of business. When associated with Farmer Business Schools modules, it creates the initial conditions for improving farmers' capacities to develop small local development projects that they can later present to microcredit institutions (Component 2 and 3).

Key steps of setting up and operating VSLAs are: a) Preparatory phase (4-6 weeks): facilitators assess community needs, select beneficiary communities, provide background information to local leaders and select VSLA groups to be formed; b) intensive phase (14 weeks): VSLA groups receive training structured in six modules, during which members elect their leaders, draw up their internal rules and define procedures that will govern their activities. They learn how to manage the solidarity fund and share buying / savings and loan meetings; c) supervision phase (up to 36 weeks): it consists of a development phase and a maturity phase, each lasting approximately 18 weeks. The facilitator continues to assist the group by attending some meetings. At the end of the cycle, if the group chooses to enter a second cycle, an assessment is carried out to determine how well the organization should support it.

Introducing climate-resilient agriculture through Activity 1.2.3 would contribute to shifting cropping practices on a variety of crops. Emissions will be sequestered from area undergoing additional tree planting to enhance tree cover through agroforestry practices and implementation of perennial fallow agroforestry system Emissions will be avoided from no tillage practices and discontinuation of biomass burning. The carbon balance of this activity corresponds to a reduction of emission by 52 587 tCO2-eq over 20 years.

Sub-activities are as follows:

1.2.3.1 Set up 650 FFS and training beneficiaries in areas not covered by MEAP; or beyond the MAEP project period. Each FFS will include 20 training sessions and involve 25 farmers (at least 40% women)
1.2.3.2 Technical support, coaching and supervision to the implementation of 650 FFS
1.2.3.3 Provide training to additional farmers in Glazoué, Djougou, Zagnando and Zogbodomey (MAEP USD 1,269,200)

Activity 1.2.4: Increase access of adapted quality seeds and plant propagation material

For tree seeds and propagation material (eg shea) the project will rely on MCVDD who already has established a national tree seed collection and supply system. The project will strengthen the existing system by improving the technician's and farmers' knowledge on seed sources identification, mother trees selections, seed harvesting – cleaning – storage, control and certification of seed genetic and physiologic quality. Given the specificity of shea seeds which unowned to be recalcitrant, particular actions will be developed to ensure that the seedling producers receives viable seeds. Further to propagation through seeds, Farmers will be trained to apply Farmer Managed Natural Regeneration (FMNR) of shea. This will also include grafting operations on farm to shortened the production cycle and enable the production of desired fruit straits.

For Mango, Cashew and annual crop seeds and propagation material, the project will collaborate with *l'Institut National de Recherche Agricole du Benin (INRAB)* through the synergies that will be put in place by the OCRI with the IFAD projects. PROCAR confirmed that INRAB is supporting their projects with aspects related to seed supply: INRAB provides the base seeds, which can then be re-produced and multiplied for local nurserymen.

The project will set up or rehabilitate village nurseries for the production of quality seedlings; then, selected farmers will be organized into seed producer groups in order to multiply/ reproduce improved climate adapted seeds. This activity will benefit from the IFAD projects experience on seed and seedlings supply. This will enable communities to continue climate-resilient farming beyond the project's cycle.

Sub-activities will be as follows:

1.2.4.1 Rehabilitate/build and operationalise 1 nursery per target municipality
1.2.4.2 Organise and support 1 seed producer group per municipality
1.2.4.3 Train technicians and farmers to collect, handle and dispatch shea seeds and to produce seedlings.

Component 2: <u>Climate-resilient and gender-sensitive value chains, supporting farmers' livelihoods in the Upper and Middle Ouémé</u>

Following the trainings in FFS (under Output 1.2), 100 IFAD Farmer's Business Schools will provide training and 100 best-productive OCRI farmers field schools will be selected to participate in a second cycle of training in Farmer's Business Schools (FBS) in order to reinforce their business capacity, create or consolidate cooperatives and reinforce values chains. Each FBS will train 25 farmers, organised in cooperatives[174]. By investing in training on marketing techniques and access to finance – the latter will also be supported by FNDA through informing the training session for OCRI farmers to submit relevant, high-quality loan application to FNDA-affiliated MFIs – , the project will secure farmers' livelihoods and income streams, thereby reducing poverty, food insecurity and climate change vulnerability. Strong agri-businesses and climate-resilient farms, combined with the demonstration of the project's economic benefits, through rigorous M&E, will also boost private sector's willingness to invest in CRA and ICRM in the Ouémé Basin, by providing resources to the FNEC for climate-resilient projects, under Component 3. Finally, trade agreements between farmers, agri-businesses, and sellers of agri-products will be facilitated through organizing match-making municipal forums in the project sites.

<u>OUTPUT 2.1 Farmers and cooperatives' income stream diversified, enhanced, and secured in the face of climate change</u>

[174] The project will work with existing cooperatives, or will help organizing farmers into cooperatives for maize, shea, cashew or mango.

This component will be implemented in partnership with MAEP (IFAD).

As productivity improves under Component 1, and high-value products, including maize, shea, mango and cashew, become available for sale, farmers will be organised in cooperatives (or Farmer interest groups – FIGs), and capacitated through FBS to develop new income streams, and sell their processed, packaged products on the local and regional market, at best possible price. An innovative App (FarmTree App) will be used to ensure climate-resilient farm plans that are cost-effective, profitable, while responding to the impacts of climate change; the App will also serve to demonstrate the economic benefits of sustainable land management and CRA in order to incentivise private sector investments (under Output 2.2 and 3.2). As packaged, well-marketed products create an added-value, private income will increase, enabling re-investment in project activities. Support to smallholder farmers and cooperatives will be provided though capacity building and technical assistance for accessing micro-credits that can be invested in CRA techniques, and equipment to increase the sale value of agriproducts.

Activity 2.1.1 Increase income of 5,000 farmers through training on business and marketing techniques and equipment using FAO farm business schools (FBS) methodology (FBS. -100 plus 100 from MAEP).

This activity will train 5,000 farmers. The training will take place on 100 IFAD FBS and in the **100 most-productive OCRI FFS**. FBS will be conducted by FFS facilitators, with the support of Master Trainers and external experts on business and marketing management modules. FBS will be set up and farmers not yet organized in cooperative will be supported to set up cooperatives (approx. 100 cooperatives) around key value chains: mango, shea, cashew and maize. Cooperatives will be reinforced and consolidated to be able to be autonomous and well equipped to face the market challenges. The learning programmes will be designed to boost the productivity and profitability of these high-value products, by developing business and marketing skills among cooperatives, supply and demand, income/expenditure book and operating account. Processing, packaging and storing equipment for shea, cashew, mango and maize will be provided to the cooperatives in need. Training on processing, packaging, operational and financial feasibility, commercial negotiation, labeling and marketing of agri-products will also be provided to increase product value on local, regional and international markets. Specific attention will be given on improving women's capacity to add value to their products (e.g. shea butter by producing off-season or cassava flour). Processing and storing interventions will not only help farmers boosting their costs and sales, but also protect agri-products against climate change impacts, like floods, heat, and pests.

In addition to the establishment of cooperatives and the strengthening of the capacities of their members, the FIGs will be established to strengthen ties with the market and facilitate the marketing of products. Farmer Interest Groups (FIGs), independent group of farmers with a shared goal and interest, will be selected based on their demonstrated entrepreneurial capacity, and trained using the FAO/INRAE (Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement) Innovator Handbook which guides groups through the development of a business plan for their collective initiative. The handbook offers advice on consumer engagement, building markets, innovative finance, guarantees and certification, processing, packaging, logistics, formal registration of the group, advocacy and partnerships, input supply, and engagement with research. The idea behind this approach is that there is a diversity of market channels that can be pursued (from own-consumption, to local markets, to national markets and to export). These FIGs will be trained to identify transparent intermediaries who can link them to export markets (e.g., organic juice producer in the south of Benin selling organic and fairtrade certified origin juice to the French Monoprix supermarket) as well as how to begin to develop these activities themselves. For those cooperatives that are most advanced, the project will support the hiring of a business coach who can facilitate the cooperatives access to different markets and provide a marketing service to the farmers. This approach will effectively work like a business incubator as this incubator could also offer seed financing for the most promising ideas that emerge from each round of training.

FBS will be selected based on the following criteria: a) FFS groups which demonstrated most interest and capacity on business/marketing topics and VSLA related activities; b) FFS groups (or at least important number of members of the groups) which are already organized or connected with cooperatives or structured producer organizations; c) FFS groups which are producing the crop/tree included in the selected value chains and are willing and aware about the steps needed to sell products to the markets.

Sub-activities will be as follows:

2.1.1.1 Train 2,500 farmers organized in agribusinesses and cooperatives – including 33% women. Each FBS will include 20 training sessions and involve 25 farmers.
2.1.1.2 FBS coached and supervised: coaching, reporting, monitoring & evaluation process, by a group of local focal points (FBS experts); 1 month per FFS, funded by the FBS funder

2.1.1.3 Provide at least 15 small processing/ packaging/ storing units to cooperatives

2.1.1.4 Train and equip additional cooperatives for post-harvest, processing, storing and sale of agriproducts in Glazoue, Zogbodomey, Djougou and Zagnanado

Activity 2.1.2 Improve access to micro-credit and investments

The 2,500 farmers trained under Activity 2.1.1 will receive training on financial management for cooperatives, and developing business plans to boost their financial profits (through better financial management) and to address current barriers in accessing micro-credits (see Annex 19, Section 2.3). This activity will improve farmers' access to finance tools like micro-credits.

The main microfinance institutions in Upper and Middle Oueme – Association for the Promotion of Community-Based Saving-Credit (P.E.B. Co-BETSHEDA) and NGO SIA N'SON Microfinance, Savings, Credits Advice – ensured their availability to provide loans in upporting value chains for mango, cashew, shea and maiz. In addition they will provide direct support to the project through the following services: a) provide expertise on credit products adapted to project beneficiaires; b) facilitate the conditions for granting loans; c) make credit managers available for awareness raising, orientation and training of beneficiaires.

Access to Finance will be facilitated by the FNDA and by Agence Territoriale du Developpement Agricole (ATDA). ATDA works with FNDA at the municipal level, providing technical assistance to farmers for loan application and quality review of loan applications before their submission to MFIs; and FNDA works closely with several MFIs (members of ALAFIA) in Benin to ensure credit access to relevant farmers and cooperatives (by reducing the interest rates and/ or by providing a 50% guarantee for loan collection). The project has secured FNDA's engagement to provide training support and quality review of OCRI farmers' loan application; these loan applications will be prepared so that farmers can access MFIs affiliated with FNDA. This will give farmers an opportunity to benefit from lower interest rates and to have FNDA's 50% guarantee for the loan.. **OCRI farmers trained on CRA and financial management (Outputs 1.2 & 2.1) will be eligible to apply, as individual farmers or through registered cooperatives, for a loans or micro-credits.** The conditions will be to apply with a project that is eligible for ADTA and FNDA support: that means the project must be linked to the priority value chains promoted by ATDA namely pineapple, cashew, market gardening (horticulture), corn, rice, cassava, soya, shea, cotton, aquaculture, oil palm, fruit trees, meat and milk, eggs for consumption**.** Under this Output, an additional, climate-change related selection criteria will be added: the project must respond to climate change-related impacts. These projects will directly aim at increasing agricultural productivity and boost profits, under climate change conditions. Loans will be provided for the acquisition of equipment and means of production, processing, storage, conservation, and transport / distribution; the acquisition of specific agricultural inputs; strengthening working capital; the provision of marketing and / or export credits.

The financial training modules will be shared under the Finance Facility of OCRI platform, under Activity 3.1.2. A women-specific module will be developed to enable women's access to credit and buy equipment to support their activities in the processing of high-value nuts and crops.

FNDA, ADTA and MFIs

The collaboration with FNDA and ADTA with OCRI will take place under Output 2.1 of the project. Complementing Output 3.2 to subsidize micro-projects in the field of adaptation and restoration of ecosystems in the Ouémé basin, Component 2 aims to make the livelihoods of producers and cooperatives more resilient to CCs, in particular by improving their capacity to transform and sell agricultural products in key value chains. As such, improved access to micro-credit is important: it allows producers to buy equipment to implement resilient agriculture (eg irrigation system, small retention basin for off-season cultivation, processing and storage equipment to keep production sheltered from bad weather while improving their added value, etc.).

The OCRI project will improve access to microfinance through training for producers in FBSs, under Component 2. This training will be facilitated in FBS by FAO coach. ATDA through their communal units will review the credit application of the beneficiary farmers to ensure they are aligned with agricultural priorities in the region. The FNDA relies on ATDA to operationalize its support for the development of agricultural sectors through playing the role of warranty for applicants to access credit.

Under the OCRI project, trained farmers and cooperatives will beneficiate from the support of ADTA and FNDA to access micro-credits. Applicants, which can be eligible for such support (based on FNDA's list of eligible applicants, registered cooperatives and individual farmers are included), will need to ensure their projects fall within one of the eligible actions of FNDA. Moreover, it will be requested that their loan submission aims to respond to climate change impacts, e.g. farmers responds to climatic hazards and stresses, and / or contribute to the restoration of ecosystems.

Thus, within the framework of the OCRI project, FNDA will play an important role in improving access to financial mechanisms - micro-credits - by producers. This will make the livelihoods of producers and cooperatives more resilient to CCs, in particular by improving their capacity to transform and sell agricultural products with profit. This approach supports the farmers' business plans that will also be developed under Component 2 of the project (see below 3.). Please refer to Section 2.1.2 in Annex 19 for more information on FNDA.

Compared to the micro-projects funded through a FNEC's grant under Component 3, and that must contribute to ICRM in the Oueme Basin, the actions eligible for a micro-credit will more directly support local-level agricultural production – through buying equipment, processing or storage units, or water related infrastructure that contribute to increase productivity under climate change conditions.

Increased access to micro-credits will contribute to tackle the identified value chains' weaknesses. Indeed, the current situation of the actors (especially producers and processors) of the value chains is as follows:

- at the start of the season, producers lack the money to buy inputs (improved seeds, fertilizers, pesticides) and to pay for labor, especially for plowing and maintaining crops. In the absence of financial means, producers resort to poor quality seeds (often taken from the previous harvest), use a limited quantity of inputs in production or poorly maintain their farms. Under these conditions, the products obtained are of mediocre quality, little appreciated which does not participate in the development of value chains. In some cases, products like mango rot on farms for lack of takers.

- At the level of the transformation link, the same situation arises. In fact, funding remains limited for the acquisition of raw materials, the purchase of processing inputs, and access to improved technologies.

Farmers and cooperatives could acquire the necessary production input, processing equipment and other input through micro-credits or loans, once they have increased access to these financial tools. This will be supported by OCRI, thereby strengthening the value chains for target products. For example, producers could buy quality seeds and input, and pay labor during harvest period using a loan, which will be reimbursed under preferential rate (through FNDA commitment) once they sell their high-quality product.

The forms of credits that can contribute to the development of value chains are in particular credits for the maintenance of plantations (case of cashew nuts), credits intended for the acquisition of quality inputs (improved seeds, fertilizers, pesticides, seeds of maize varieties resilient to climate change), credits for plowing and maintenance of crops, credits for storage, credits for coaching (coach for the benefit of producer cooperatives).

At the level of the transformation link, the credits will not only be directed towards the acquisition of raw materials and inputs but also towards the improvement of the transformation process and support for the standardization of the quality of products (mango, shea in particular), capacity building of processing units, acquisition of modern processing equipment.

In addition, among the 150 farmer groups which set up VSLA (see activity 1.2.3), the OCRI project will carry out an evaluation in order to retain the most efficient. Assessment criteria will be based on operational (organizational aspects) and financial performances.

Operational performances - analysis of the functioning of VSLAs: a) application of disciplinary measures (fines); b) mastery of roles and responsibilities by the members of the VSLA office; c) regularity of holding weekly meetings; d) quality of recording of financial data in the VSLA register by the secretary general; e) stability of the office (number of members having left the office); f) cash management by the treasurer, g) management capacity; h) procedures for making decisions during meetings.

Financial performances: a) total amount purchases by all members during the cycle; b) total amount of assistance provided to members during the cycle; c) balance in the solidarity fund during the cycle; d) total amount of credits granted to members during the cycle; e) credit repayment rate.

Sub-activities are as follows:
2.1.2.1 Develop training material addressing current barriers to credit access
2.1.2.2 Organise 5 training sessions for each FBS to train 2,500 farmers
2.1.2.3 Establish Village Savings and Loans Associations to foster low-threshold small loan provision
2.1.2.4 Improve access to financial services for farmers in Glazoue and Djougou (MAEP USD 2,511,000)

Activity 2.1.3 Train facilitators (selected educated young) and national/local climate change experts (from relevant institutions eg MCVDD, MAEP) on the use of assessment and/or monitoring Instruments for Resilience (TreeFarm App are the identified tools).

The activity will train selected educated young facilitators and national/local climate change experts (from relevant institutions eg MCVDD, MAEP) on the use of assessment and/or monitoring Instruments for Resilience (TreeFarm App are the identified tools).

The FarmTree App enables climate-resilient agri-planning. It offers cost-benefits simulation of combining various crops and trees on the fields, based on climate change and agro-ecological conditions, and thereby enables a more efficient and profitable agriculture. The App will help farmers turn their field into a climate-resilient, high-profit landscape. The facilitators will train entrepreneurs and cooperatives on resilient farm planning methods (Activity 2.1.1); they will also use the App to provide on-the-field advises to individual farmers, who search ways to improve their profit. Moreover, through the App, the facilitators will collect evidence of the economic and environmental benefits of OCRI's interventions. These data will inform the development of information products geared towards the private sector, to incentivize investments in ICRM in the Oueme Basin (activity 2.2.1) and private sector contributions to climate-resilient projects (Output 3.2). 2 Facilitators per target municipality and 20 national and local experts from MCVDD and MAEP will be trained and equipped to use these assessment and M&E tools.

Facilitators will be selected based on:

a) their skills/knowledge demonstrated at the exit test (entry and exit tests will be used) at the end of the training sessions on the use of assessment/monitoring Instruments for Resilience (TreeFarm App).
b) representativeness criterionto allow the selection of representatives from different national institutions.

Sub-activities are as follows:2.1.3.1 Select 10 facilitators (2 per target municipality) and 20 experts from MCVDD and MAEP (national and municipal services) to be trained on the tools

2.1.3.2 Equip them and train them through 1x 5-day training session in Cotonou

<u>OUTPUT 2.2 Private sector incentivized to invest in climate resilient agriculture and resilient management techniques in Ouémé Basin</u>

This Output aims to boost private and public investments in OCRI activity – to secure long-term climate-resilient management in the Upper and Middle Ouémé, thereby reducing climate change vulnerability – by demonstrating the significant environmental and economic impacts of climate resilient agriculture, creating an exchange platform for farmers and sellers to discuss market opportunities and demands, and facilitate trade contracts. Private investments include those of banks, individuals and compagnies that are willing to provide financial resources to secure OCRI interventions because they understand their added-value.

Activity 2.2.1 Disseminate information products packaged for private sector to demonstrate the socio-economic benefits of combined waterworks, CRA and agroforestry.

A strategy for the dissemination of knowledge products will be developed under Output 3.1, as part of the OCRI platform. The strategy will identify best format and communication channels for various stakeholders, including private sector institutions like investors and credit organisations in the field of agriculture. The demonstration will be supported by the data collected through the FarmTree App (activity 2.1.3) and the project's M&E under Activity 3.1.1, which will conduct a rigorous monitoring of project's interventions and impacts. This will target private sector institutions such as investors and credit organisations, processing compagnies or buyers of agri-products, in the field of agriculture, Knowledge products will be packaged for specific target groups and shared to relevant stakeholders via email, brochures, OCRI platform, etc. The purpose of this activity is to demonstrate the profits of ICRM and CRA to MFIs and other private sector investors, who are currently reluctant to invest or provide credits for agriculture. Their reluctances will be tackled by demonstrating the project's benefits especially on value chains (mango, cashew, shea and maize) for which private sector has an investment interest; it will also convince MFI that loans supporting ICRM and CRA are profitable.

Sub-activities are as follows:
2.2.1.1 Develop information products packaged for private stakeholders and finance institutions
2.2.1.2 Disseminate financial products via the OCRI platform, flyers and booklets distributed, etc.

2.2.1.3 Organise field visit in each project municipality for private stakeholders (including MFI, wholesaler, export companies, etc.) to showcase the benefits of project activities

Activity 2.2.2 Organise municipal forums to connect female and male farmers and small businesses to local and regional buyers.

The municipal forum will be designed to include a match making function that helps all stakeholders in the forum find the best business match. During OCRI's formulation, buyers have expressed their interest in buying better quality products especially for mangoes, shea and cashew, which the OCRI project will provide. Additional relevant buyers will be further identified under Activity 3.1.1 and connected to farmers through the OCRI platform. The bi-annual municipal forums will be opportunities for producers to showcase their innovative climate-resilient production practices, and their resilient products, as well as to conclude trade agreements between farmers and buyers of agri-products, or receive new demands for alternative products from the buyers, based on market demands. Successful farmers from the UNEP SAP project in the municipalities of Djougou (same project site than OCRI) and Dassa-Zoume (close to Glazoue), will be invited to participate to the forum and showcase their agricultural methods and products. These farmers will be invited to OCRI-organized municipal forums to demonstrate their climate-resilient agricultural techniques. Selection criteria for SAP farmer field will be: implementation of at least 3 new climate-resilient agricultural practices; visible land improvement (e.g. reduced erosion); 1 sustainable irrigation scheme in place; +20% agricultural productivity; and +10% income.

Key interested buyers of (raw or processed) cashew, shea, mango and maize were identified in the target municipalities and are repsented in Annex 19. Letters of interest from these companies are provided with the project package.

The producers in the target municipalities would benefit from connection with these compagnies and traders, which will be supported through activity 2.2.2. Finally, in order to promote climate-resilient production techniques, successful farmers from the UNEP SAP project in the municipalities of Djougou and Dassa-Zoume, will be invited to participate to the forum and showcase their agricultural methods and products.

Sub-activities are as follows:
2.2.2.1 Further Identify relevant buyers in each municipal to invite to the forums
2.2.2.2 Liaise with the GoB and municipal authorities to provide support to the forums and to facilitate trade agreements between men and women farmers and buyers
2.2.2.3 Organize bi-annual forums (5 in total, from project Y3)
2.2.2.4 Ensure partnerships between farmers, processing companies and buyers in Glazoue, Zogbodomey and Zagnanado (MAEP USD 350,000).

Component 3: An enabling institutional and financial investment environment established to promote and upscale low carbon climate-resilient management in Benin's Basins

To further root the OCRI approach in the Ouémé Basin, and upscale it to other sites, Component 3 will support the establishment of a multi-stakeholder coordination mechanism and platform. The platform, managed by MCVDD and co-chaired by FNEC, will coordinate the tree plantation, climate resilient agriculture and waterworks activities implemented under Output 1.1 (with a view to restore degraded riverbanks) and Output 1.2. Moreover, MFIs, buyers of agri-products, FNDA and ADTA will be represented on the platform to support Output 2.2 of the project and increase the availability of credits and loans to farmers. Through the platform, FNDA, ADTA and MFIs (members of ALAFIA) will be consulted and informed about ICRM interventions in the Oueme Basin. They will receive regular updates on the project's progress and results. For example, they will receive regular updates in terms of changes in soil and agricultural productivity via the project, and the quantity of agri-products that are available for sale in each commune. This will serve to reduce current reluctances from MFIs to provide agricultural credits.

A robust communication strategy including newsletters and events will be designed for the platform, which will also provide an online portal where knowledge products such as training material developed under Component 1 & 2, and data demonstrating the benefits of project's interventions, will be uploaded. Information generated by the project – including data collected through the FarmTree App (activity 2.1.3) and the project's M&E under Activity 3.1.1 – will be specially packaged (by a communication specialist) for the private sector organizations, including MFIs and agri-businesses. These partners will be selected respectively based on their belonging to the ALAFIA for MFIs and Benin Chamber of Commerce for agri-businesses. A long-term strategy will be designed to ensure the platform's continuation beyond the project, especially to continue ICRM efforts in the Oueme Basin. Through the platform, regulatory frameworks will be developed, and capacity building implemented for local extension officers. This will root the OCRI approach within all development processes implemented in its target municipalities. To combine institutional strengthening with availability of finance, a roadmap to expand FNEC's resources, which are currently made up of green-taxes, fees and government fund, among others, will be developed. The roadmap will also detail how FNEC can use its resources to implement projects (who can apply and what projects are eligible) to ensure FNEC specifically supports climate change interventions. The goal is to unlock finance to implement ecosystem restoration and CRA in the Oueme Basin in the long-term. Therefore, FNEC will be linked to OCRI platform, as its key financial mechanism to implement climate-resilient initiatives.

FNEC

Component 3 of OCRI aims to create a favorable institutional and financial environment for the promotion and scaling up of climate-resilient soil and water management in the Ouémé basin. To achieve this, it is planned to act on three levels: 1) strengthening institutional capacities and local governance to promote adaptation to CC; ii) the strengthening of an innovative financing mechanism to promote public and private investment in adaptation to CC and ecosystem restoration; and iii) the development of resilient soil and water management plans. The involvement of FNEC in OCRI project in this component will materialize through the following:

1) FNEC will be directly involved in the co-financing and implementation of project activities (more particularly under Output 3.2 of OCRI), as financial facility to support projects related to CC and ecosystem restoration; and

2) FNEC will benefit from OCRI's activities in terms of capacity building, including to leverage fund (as a national entity accredited to the GCF) in the development and implementation of GCF projects.

Moreover, the project will explore pathways to launch the first collaboration between FNEC and FNDA, as the former would benefit from FNDA's experience in promoting agriculture in Benin, through financial mechanisms that are not yet available to FNEC, like loans.

FNEC as a co-execution partner under Component 3

FNEC will co-execute Output 3.2 with FAO and MCVDD, as a financial mechanism for innovative micro-projects on adaptation. Through resources from green taxes and fines (which will be expanded through the project), FNEC has committed an estimated 180,000 USD[175] to finance one local micro-projects per target commune during the course of the project, through grants. These projects will be submitted by one of the farmer or cooperatives trained under OCRI's Output 2.1. They will need to be aligned with FNEC's project selection criteria, as well as support the integrated climate-resilient management approach promoted by OCRI. Projects combining reforestation and agroforestry, ecosystem restoration, and sustainable management of Ouémé watersheds will be favoured. These projects will be financed via grants provided by FNEC to the selected project beneficiaries. The specific selection criteria (or checklist) for the project proponents and themes will be developed with FNEC during the first year of OCRI's implementation; the selection will ensure these projects contribute to Benin's priority for climate change adaptation.

To ensure additional financial resources for climate resilient land planning in Benin beyond the project's lifetime, a robust financial strategy for FNEC will be developed, including pathways to leverage more fund. This will include an analysis of the base of products for which the green tax is levied, with a view to expanding it. Pathways to improve the mobilization of public and private resources will also be identified; and the development of a climate change project ready for submission to the AF or GCF will also contribute to gear new funds for FNEC.

FNEC as beneficiary of capacity building

Under Output 3.2, FNEC's capacity for the preparation, management and monitoring of projects in the field of CC will be enhanced. Through OCRI's support, FNEC will aim to expand the number of climate change-related projects in its portfolio, which at the moment includes more waste management and recycling interventions. The training will cover aspects related to the selection process of candidate projects for FNEC's grants, management of the allocated fund, ensuring alignment of these projects with national CC priorities, and M&E of these projects - especially to identify the environmental and socio-economic benefits of supported projects, the results of which will be shared through OCRI's online communication platform. In addition, it is planned to support the FNEC in the development of a bankable climate change project proposal for resilient watershed management to be submitted to the GCF or AF with the FNEC as an accredited entity, and which will replenish the financial facility.

This capacity building will be provided by FAO during project implementation with a view that FNEC fully takes ownership by project's end. This support will at the same time strengthen the role of the FNEC as an accredited entity with the GCF.

Additional support to strengthen FNEC's capacity for preparation and active participation in international climate and environment bodies (COP; etc.) will also be provided.

In a nutshell, Output 3.2 will:

- develop micro-project selection criteria for FNEC, that ensures the prevalence of CC in the selected projects;
- select and finance 3 micro-projects on adaptation to CC and in relation to the OCRI project;
- develop FNEC's capacity for implementation and monitoring of CC projects;
- strengthen the long-term financing strategy of the FNEC to leverage public and private funds - including through the development of a project to be submitted to a fund, lobbying to receive private funds (link with component 2 of the OCRI, which aims to develop awareness products on the benefits of resilient agriculture and ecosystem restoration intended for the private sector), and the expansion of the FNEC's green tax base.
- enhance FNEC's capacity to design bankable CC projects in order to attract additional fund from the AF.

[175] estimation made following consultations with FNEC. A cofinancing letter will be received and shared with the GCF shortly indicating the final amount.

This Output 3.2 would ensure future resources to be invested in the adaptation and restoration of ecosystems.
Pathways for collaboration with FNDA will also be explored (see 3.) to provide additional financial resources and tools like loans in support of climate-resilient initiatives.

Finally, to ensure the continuation and upscale of the ICRM approach, awareness-raising events will be conducted; the project will also reach out to other Basin Authorities in Benin to showcase OCRI project's impacts.
Indeed, Benin includes several basins: Oueme, Mono, Niger, and Volta. The Volta and Niger basins are transboundary and therefore managed by several countries through an inter-African agency.
- The National Committee of Mono Basin is a recent entity established in May 2021
- The Niger Basin Authority is a multi-country institution, created in 1964. It is in charge of integrated development planning in the Niger Basin
- The Volta Basin Authority is a multi-country institution.

<u>OUTPUT 3.1 OCRI project institutionalised through a multi-stakeholder platform, regulatory frameworks and capacity building</u>

There is currently no coordination mechanism that allows concerted efforts to sustainably manage Benin's basins and to share knowledge and best practices for upscaling resilient land, water and agricultural management in watershed landscapes. The OCRI multi-stakeholder platform will thus be established to connect all relevant stakeholders engaged in land planning in the Ouémé Basin. This includes representatives from MCVDD FNDA and MAEP (committed to support OCRI through signed cofinance letters), especially their local extension services for agriculture, waterworks and forest management; the Oueme Basin Authority (OBA); and FNEC (for the on-granting facility – also committed to support OCRI through signed letter). These stakeholders play a key role in local development planning; they will therefore be capacitated – through training and the development of local adaptation plans – for climate-resilient management in the Oueme Basin. This will support the replication of OCRI's approach beyond the five target municipalities. To ensure the platform's continuation beyond OCRI, the project will support obtention of a legal status for the platform as a decentralised governmental structure. A sustainability (financial) strategy will also be developed under OCRI.

The platform design will include a communication strategy to ensure the dissemination of knowledge, including on gender aspects, to support long-term ICRM in the Ouémé Basin, and beyond; and a sustainability strategy to support its continuation. The platform will be managed by MCVDD, with FAO support, in terms of capacity building for project coordination and on-the -ground implementation. FNEC will also be consulted to design the platform and define its specific role for financing, designing and implementing climate change projects. Women and women's organizations engagement in the platform will also be proactively promoted.

Another key step to ensure long-term governmental support to implement ICRM in the Ouémé Basin is to formally institutionalise the approach through local regulations and ensure their implementation; and to build local capacity for implementing ICRM. These efforts will be conducted through the OCRI platform: members will be trained on climate change adaptation planning and participate to the revision of key development plans for mainstreaming ICRM. This is a pathway to ensure post-project's support through future public funding that target development initiatives in the Ouémé Basin. This, complemented with the strengthening of private finance investments in OCRI (see Output 3.2), will support the project's exit strategy, as well as its replication in neighbouring areas and beyond.

Activity 3.1.1 Establish and activate the OCRI platform ensuring adequate and meaningful participation of women and women's organizations at local and national level

The platform has three key functions: i) coordinate the tree plantation, CRA and waterworks interventions in the 5 target areas with the LIU; ii) support the revision of key regulatory frameworks; and iii) build capacity for climate-resilient management in the Oueme. Moreover, the platform will disseminate new knowledge on the benefits from ICRM in basins, thereby contributing to the project's awareness-raising interventions (under Output 3.3) and include a sustainability strategy for long-term implementation and financing of OCRI (see Output 3.2).

The platform will be managed by MCVDD as EE, and include municipal representatives of the five target communes, as well as extension services from forest department, agriculture and waterworks; and the OBA. Their main responsibilities will be to coordinate the tree plantation, waterworks as other hard and soft anti-erosion infrastructure, and land restoration interventions in the 5 project sites (during the project) and beyond these target areas afterwards (e.g. following the guidance of the revised Oueme Master Plan). For this, they will receive technical support from FAO and training on gender-responsive climate change adaptation, ICRM in basin context, and gender-responsive resilient local planning. The design of the role, responsibility, legal status and composition of the platform will be done with MCVDD. To ensure smooth implementation during and after the project, FAO will provide technical support. The technical support will also enable local forest agents to implement the revised PDL (activity 3.1.3) and the OBA to implement the strengthened SDAGE (activity 3.1.2).

A communication strategy for the platform will be developed to facilitate interactions between the platform members, disseminate project-related information, best practices for CRA, raise awareness of climate change, and the socio-economic benefits of ICRM applied to basin areas, and organise the Annual Symposium (3.2.2). Best communication channels and packaging will be identified through a consultative process with communities and stakeholders. It will guide activities under Output 3.3.

The platform will include a website (online portal) hosted by MCVDD, and newsletter will be sent on a regular basis to share relevant communication and knowledge information about the OCRI project to stakeholders in the public and private sector. Finally, a sustainability strategy will be developed to confirm the management of the platform at project's end. It is envisioned that MCVDD will fully take over, and that the government will cover the running/ operational cost of the platform. These costs could be covered through FNEC's financial resources, as the project will contribute to increase FNEC's fund under Output 3.2. A detailed financial plan for OCRI platform, along with role and responsibilities of key institutions including MCVDD, FNEC, FNDA and OBA, will be prepared under this activity.

Sub-activities are as follows:

3.1.1.1 further Identify relevant stakeholders to participate on the platform, including their roles and responsibilities

3.1.1.2 Design the platform operational strategy and multi-stakeholder coordination mechanism

3.1.1.3 Design the platform's financial and communication strategies – including an online portal to be hosted by MCVDD

3.1.1.4 Disseminate all training modules, knowledge products, and project's lessons learnt and best practices on the platform's online portal

3.1.1.5 Ensure government support to OCRI platform

Activity 3.1.2 Implement regional and local climate-resilient development plans in the Oueme Basin to ensure long-term investment in low carbon integrated climate-resilient management. .

The Ouémé Master Plan (SDAGE) will be the legal tool that institutionalises an ICRM approach in the whole Ouémé area. It will be revised to address the gaps identified in the FS , and implemented by OBA (which capacity are strengthened under 3.1.1). Particular attention will be made to provide an integrated approach that considers and reduces climate change impacts from upstream to downstream areas of the Basin. The strengthened SDAGE will serve as the umbrella under which project activities linked to tree plantation and restoration of the riverbanks (Output 1.1) will take place. The coordination of these interventions is supported under 3.1.1. Moreover, ICRM will be mainstreamed into the PDL of the 5 target municipalities. Climate-change management is currently under-considered in these plans. The existing LDP will be revised to mainstream the ICRM approach promoted under the Ouémé Master plan to guide future (post-project) local governmental investments in the Ouémé Basin, including reforestation and strengthening of the Oueme riverbanks. It will provide guidance for waterworks (and their maintenance) and other soft and hard adaptation technologies, including tree nurseries and tree plantations to protect river banks – needed to strengthen the Ouémé river banks at the municipality level, reduce flood risks and improve water access. The plans will be developed at project's end, based on project's results, lessons learned and best practices.

The implementation of the plans – including reforestation along the Oueme riverbanks by local forest services and communities – will be coordinated under the OCRI platform. To support this, members of the platform – OBA and extension officers – will be trained; the training will be extended to members of other basins' authorities (Volta, Mono and Niger) in order to support project upscale in other basins of Benin.
Sub-activities are as follows:
3.1.2.1 Organise participatory workshop to discuss options for strengthening the SDAGE
3.1.2.2 Revise the Operational Management Plan with all relevant stakeholders and validate through a workshop
3.1.2.3 Organise 1x5-day training sessions on ICRM targeting extension officers and OBA staff members
3.1.2.4 Revise local development plans (LDPs)

Activity 3.1.3 Implement rigorous M&E on land restoration in the Ouémé Basin.
Staff members of MCVDD and MAEP, as well as extension officers from the forest department in the target municipalities will receive technical support from FAO to conduct rigorous M&E of the impacts of tree plantation among the Oueme riverbanks. Moreover, they will be capacitated to implement the SHARP tool (or similar resilience assessment approaches) during target training sessions. A field survey will take place afterwards to assess changes in the resilience and adaptive capacity levels of smallholders in the selected municipalities, resulting from the project's interventions. Finally, extension officers will be capacitated to provide advises on climate-resilient agriculture and adaptation to farmers living in their commune. To ensure this, training will be provided and ToRs of the extension workers will be adjusted to include financial/business/climate change continued support to the communities.

Staff members of MCVDD and MAEP who will receive technical support to monitor the impact of tree planting and riverbank restoration will be selected based on (i) their effective involvement on forest and/or agriculture extension (ii) familiarity with at least two of the five targeted communes (iii) ability to communicated in the local language, (iv) participation of women will be highly encouraged.

Extension officers who will be capacitated to provided advises to farmers, will be selected based on (i) their field experience on climate resilient agriculture (ii) their duty station, which must be in one of five beneficiary communes (Copargo, Djougou, Glazoué, Zanghanado, Zgbodome), (iii) priority will be given to female extension officers.

Sub-activities are as follows:
3.1.3.1 Organize 1x 5-days training workshop to train 20 officers on M&E techniques

3.1.3.2 Train 10 extension officers to provide advises on climate-resilient agriculture

3.1.3.3 Conduct mid-term evaluation

3.1.3.4 Conduct end of project evaluation
3.1.35 Conduct impact assessment

OUTPUT 3.2 Strengthened FNEC's capacity to ensure continuous support to climate-resilient farming in the Oueme Basin

Under the OCRI platform, GCF fund will be used to strengthen FNEC's capacity to capture climate finance and to design, finance and implement climate change-related projects will be strengthened. Moreover, FNEC's fund (cofinance) will be used to finance climate-resilient micro-projects. These grants will be accessible to OCRI farmers and cooperatives through a call for micro-project proposal (based on current existing procedure within FNEC to call for micro-project proposals). FAO will work with FNEC to develop a project selection 'check-list', which ensure the selection of projects aligned with OCRI approach and gender-responsiveness; FAO will also strengthen FNEC's capacity to monitor the implementation of these micro-projects on the ground, produce detailed progress reports, and ensure financial transparency; training will also include gender-responsive budgeting. Finally, a replenishment strategy for FNEC (to increase its current resources, some of which will contribute to covering the operational costs of OCRI platform post-project) will also be developed to enable the continuation of climate-resilient agriculture and value chains beyond the project's lifetime.

Activity 3.2.1 Develop a robust financial strategy for FNEC
A complete financial strategy to boost FNEC's resources and sharpen its focus on supporting climate change-related projects, will be developed with the FNEC and MCVDD. This strategy will include:
- a list of criteria (or checklist) that projects submitted to the FNEC must aligned with; criteria will ensure the prevalence of CC concerns in selected projects.
- eligible proponents.
- financial roadmap, with a view to increase FNEC's available resources to implement climate change-related projects, including disbursement modalities (at the moment, FNEC only provides grants but the possibility to add loans will be explored).

The financial roadmap will include pathways to increase the current green-taxes base that provides funding to FNEC, to leverage investments from the private sector (which will already be incentivized under Output 2.2), and to develop 'bankable' projects that can attract resources from international climate funds, including the Adaptation Fund (AF) and GCF, for which FNEC is a national accredited entity. Access to these funds will also be enhanced under Activity 3.2.2. Other pathways to mobilise climate funds at national and international level to replenish the Facility and ensure the facility remains operational to support ecosystem restoration and CRA initiatives will be explored.

The project is committed to verifying the institutional possibility of collaboration between the two institutions FNEC and FNDA. Although each of them has its independence, a synergy between the two funds is envisaged to allow reciprocal advantages by sharing the experience and capacities of each other. This could be an avenue to explore to increase the resources available to the FNEC, particularly in terms of private sector involvement, expansion of access to credit in the environmental sector, opening up of the possibility of financing projects that use an integrated agricultural-environmental approach.

Sub-activities are as follows:

3.2.1 Review FNEC's existing financial strategy and identify gaps and opportunities to expand it

3.2.2 Organise consultations with FNEC and MCVDD to discuss best options for increasing FNEC's resources
3.2.3 Organise validation workshop with GoB to validate the financial strategy
3.2.4 Through consultation with FNEC, identify relevant criteria to facilitate the selection of relevant climate change adaptation projects to be financed through FNEC's resources

Activity 3.2.2 Strengthen FNEC's capacity to design, select, implement and monitor climate change-related projects ensuring financial access for both women and men
This capacity building will be supported by FAO.
GCF fund will be used to provide technical assistance and build FNEC's capacity to design bankable climate change projects, which can attract investments from private sector institutions (because of their demonstrated returns), or receive funding from national/ international funds and donors. At the end of the project, FNEC will have designed at least one fully-fledged Funding Proposal, with high potential to receive funding from international donors. GCF fund will support FNEC to develop such proposal (capacity building) and submit it to the most adequate fund by project's end. Finally, training on gender-responsive budgeting will be provided to FNEC's members to guarantee the use of fund will take into account women-specific needs and priorities

Sub-activities are as follows:
3.2.2.1 Conduct a detailed assessment of FNEC's capacity to design, implement and monitor climate change-related projects
3.2.2.2 Design training modules and train 5 members of FNEC (2x1-week training)
3.2.2.3 Provide regular support to FNEC to design a bankable climate change project to submit to the AF or GCF

Activity 3.2.3 Provide finance to 3 micro-projects (one per target commune) that contribute to climate change adaptation and ecosystem restoration in the Oueme Basin – to the benefits of small-scale farmers (FNEC cofinance).
This activity will be funded by FNEC. A call for proposal will be launched by FNEC (using its current procedures for *appel a projets*) and farmers' associations and cooperatives, trained in the FBS, will have the opportunity to submit proposals for micro-projects that focus on climate-resilient agriculture and ecosystem restoration and/or protection in the Oueme Basin. The call for proposal will be launched based on current FNEC's procedures. and successful micro-projects will be selected by FNEC, based on the check-list that will be developed at project onset with FAO support(developed under 3.2.1). The check-list will ensure the selection of projects aligned with OCRI approach, with a strong climate change adaptation and ecosystem restoration angle, and gender-responsiveness FAO will also strengthen FNEC's capacity to monitor the implementation of these micro-projects on the ground, produce detailed progress reports, and ensure financial transparency**.**

With regards to the difference of improved access to credits and loans, supported under Output 2.2, FNEC does not provide loans, but grants, to the micro-projects that will not need to demonstrate financial returns, but rather provide environmental and public goods – like increased ecosystem services and reduced climate-related impacts in the Oueme Basin.

Sub-activities are as follows:

3.2.3.1 Open call for proposal
3.2.3.2 Review received projects and select the successful ones

<u>OUTPUT 3.3 Awareness of ICRM in basins' benefits raised among farmers and public and private institutions</u>

There is limited knowledge in Benin of how to sustainably manage basin areas, while providing socio-economic benefits from upstream to downstream communities, and reducing climate change vulnerability. A lack of understanding of the environmental and socio-economic benefits of ICRM – which mixes waterworks with CRA and resilient land management adapted to upstream and middle basin areas – impairs investments opportunities from farmers, public and private institutions, in project interventions. Under this Output, and based on the communication strategy of the OCRI platform, all training material, knowledge products and M&E data from project implementation will be shared within and beyond the 5 target municipalities – with particular attention to reach out to other Basin Authorities in Benin. This will support the upscale of OCRI in new areas. Moreover, innovative adaptation practices will be encouraged to further enhance the climate-resilience of farmers, and attract private sector investments in climate-resilient agriculture.

Activity 3.3.1 Organise knowledge dissemination events and products on OCRI including gender mainstreaming.

The dissemination events will include:

- Farmers' field visits for neighbouring communities, during project's year 4 to 6, to showcase OCRI's results;
- Visits of other basin's authorities (Mono, Volta and Niger) in the Oueme Basin to showcase: i) on-the-ground project impacts; ii) operationalisation and functions of the OCRI platform; iii) revised regulatory framework for climate-resilient watershed management,
- Radio shows to broadcast information about climate change related risks in Upper to Lower Ouémé regions, including how mismanagement in the Upper and Middle Ouémé can increase risks of erosion and floods downstream; information about SAP, OCRI projects and other similar initiative in the Ouémé Basin will be shared, as well as the lessons learned and best practices from these projects. The information will be prepared and packaged based on the communication strategy developed under Activity 3.1.1. Radio hosts will be trained and, if possible, the radio hosts trained under the SAP project will be used to broadcast information in the Ouémé Basin. Radio programs will be broadcast in local languages of the targeted municipalities as follows: Copargo (Taneka, Dendi, Lopa and Solla languages); Djougou (Dandi language); Glazoue (Mahi, Idatcha languages); Zagnanado (Fon, Mahi languages); Zogbodomey (Mahi, Fon languages);
- Knowledge products to raise awareness of CCA in basins for governmental institutions including other basin authorities, agro-businesses and cooperatives, and smallholders in the whole Ouémé Basin. The products will be packaged adequately for the various audience – policy-makers, businesses and farmers – following the communication strategy developed under Activity 3.1.1. The may include flyer, briefs for policy-makers, posters with simple design.

The selection process of the farmers that will participate in field visit will be based on the best performing FFS / FBS groups, in terms of field results (quantity and quality of best practices and technologies adopted) and demonstrated capacity in the management of VSLAs and cooperative activities. Lead farmers of these groups will be selected for these visits.

Sub-activities are as follows:

3.3.1.1 Organize 5 field visits for 100 farmers per municipality (5), living in neighboring communities that did not directly beneficiate the project

3.3.1.2 Organise 1 x 1-week visit for representatives of Benin's other basins

3.3.1.3 Synergise with SAP project to train 10 radio broadcasters to disseminate climate change related information and organize radio broadcast with local radio in each municipality

3.3.1.4 Develop and package knowledge products on the projects, according to the needs of each targeted group

3.3.1.5 Organise sensitization campaings on CC in Glazoue and Djougou (MAEP USD 21,200)

Activity 3.3.2 Organise OCRI Annual Symposium.

The Symposium will be organised jointly by MCVDD and MAEP; IFAD and The Symposium will be an opportunity for agribusinesses, entrepreneurs, and cooperatives to showcase their innovative climate-resilient practices and their benefits. During this participative symposium, participants will be invited to present project ideas to improve their productivity and the profitability of their business, in the context of climate change. Authorities of other basins in Benin will be invited to attend the symposium.

Sub-activities are as follows:

3.3.2.1 Identify relevant participants from agri-business (producers, sellers, manufacturer, etc.) and policy-makers to attend the symposium

3.3.2.2 Organise 1 symposium per year from project Y2, with support from MCVDD and MAEP

3.3.2.3 FAO supports OCRI Annual Symposium

Project contribution to climate change adaptation

Table 24 describes the project's contribution to climate change adaptation.

Table 37: OCRI contribution to climate change adaptation

Sector	Climate threats /Risks	Current and future impacts	Middle Ouémé			Upper Ouémé		OCRI Adaptation per Activity
			Zogbodomey	Zagnanado	Dassa Zoumè	Djougou	Copargo	
Agriculture	Rainfall regime instability	Shortening of agric. Season, perturbation and changes to crop calendars	+++++	+++++	+++++	+++++	+++++	Activity 1.1.1 & 1.2.3
	Increased frequency of extreme rainfall events	Increased soil erosion			+++++	+++++	+++++	Activity 1.1.1, 1.1.2 & 1.2.3
	Rainfall reduction / Temperature/evapotranspiration rise High winds	Reduced soil available water	++++	++++	++++	++++	++++	Activity 1.1.2 & 1.2.3
		Reduced crop productivity/yield, production and income by 3-25% by 2050 depending on GCM	+++++	+++++	+++++	+++++	+++++	Activity: 1.2.3, 2.1.1 & 2.1.2

		model in UV and MV (Lawin et al. 2015)						
		àReduced food safety and security	+++++	+++++	+++++	+++++	+++++	
		àReduced Youth opportunity and jobs	+++++	+++++	+++++	+++++	+++++	
Basin water cycle and resource	Increased rainfall patterns	Drought (decrease in water availability is by -25% to -39% and -20% at - 27% in the horizons 2020, 2050 and 2080 (Biao, 2017)	+++	+++	++++	++++	++++	Activity 1.1.1
	Increased frequency and intensity of extreme rainfall events in the horizons 2020, 2050 and 2080 (Biao, 2017)	Flooding, river bank erosion	+++++	+++++		++++		Activity 1.1.2
	Temperature (+3.6 from 2000 to 2100) and evapotranspiration increased	Disruption of the watershed balance				++++	+++++	Activity 1.1.1 & 1.1.2
Ecosystems	increased frequency of extreme rainfall events and flooding	Soil erosion and vegetation cover reduced Loss of biodiversity	++++	++++	++++	++++	++++	Activity 1.1.2
	Rainfall reduction / Temperature/evapotranspiration rise	Vegetation cover reduced Deterioration of biodiversity	+++	+++	+++	+++	+++++	Activity 1.1.2

		(habitat modification) (Lawin et al. 2015)						
		Reduction of productivity and quality of pastures land and fodder	+++	+++	+++	+++	+++	Activity 1.1.2 & 1.2.3

8.1.3 Synergies with other projects

338. The proposed project will build on, scale up, and complement past and ongoing regional and national initiatives and projects as described below.

Enhanced climate resilience of rural communities in central and north Benin through the implementation of ecosystem-based adaptation (EbA) in forest and agricultural landscapes (*UNEP-SAP, 2019-2024, USD 10 million, ongoing)*

339. Multiple synergies and complementarities are identified between OCRI and this project. The SAP project promotes CRA and sustainable water management, therefore SAP experience can inform the selection of adaptation technologies for OCRI. Moreover, SAP will provide climate-resilient crops and tree seedlings to plant on fields and in forests; the most efficient seeds will be used in OCRI for CRA and agro-forestry. Field visits will also be organised for OCRI beneficiaries to showcase successful experience from the SAP project and promote the uptake of project interventions (e.g. in Dassa-Zoume and Djougou, which are SAP sites located in the Ouémé Basin). Successful SAP farmers in the Ouémé Basin will also be invited to annual municipal forums and OCRI symposium, which serve to connect farmers with traders, and promote innovation for adaptation.

340. SAP will train radio broadcasters to disseminate climate change-related information; these broadcasters will also disseminate OCRI-related information and raise awareness of ICRM in the Ouémé Basin.

341. SAP aims to develop climate-resilient forest management plans, 2 of which will be for forests nearby the Ouémé River. OCRI will ensure the inclusion of these plans into the Ouémé Master Plan. SAP project manager will also be invited as guest on OCRI platform and at the project steering committee, to ensure synergies and avoid duplications.

342. Finally, under the SAP project, knowledge products on EbA will be shared through EBAFOSA176; opportunities to link EBAFOSA to OCRI platform will be explored (e.g. using EBAFOSA as the communication facility for OCRI).

[176] https://www.ebafosa.org/index.php/about-us/102-ebafosa/1144-ebafosa-report-2019-2

343. It should also be noted that SAP will provide benefits to OCRI farmers, through reforestation and riverbanks restoration interventions in Upper/ Upper-Middle Ouémé (Djougou and Dassa-Zoume), which will benefit in particular communities located in the Middle and Lower Ouémé ; while OCRI interventions in Upper Ouémé will also benefit downstream SAP beneficiaries of Dassa-Zoume.

344. The table below indicates the areas of synergies between the UNEP SAP and the OCRI:

Table38: Synergies between UNEP SAP 05 and OCRI projects

OCRI project Output/Activity	SAP project Output/Activity	Synergies	Comments
Activity 1.1.2 Strengthen degraded river banks and restore land with tree.	*Activity 1.2.1. Plant trees using selected species to buffer against the impacts of climate change such as floods and soil erosion, and to enhance the provision of non-timber forest products.*	Benin SAP project will implement reforestation along degraded riverbanks in Djougou, Dassa and Tchaourou, which are located in the Oueme Basin of Benin; Djougou is also a commune included in the OCRI project. Hence, SAP's reforestation in these areas will benefit farmers located in OCRI project sites. As OCRI also plans to strengthen river banks with trees in Djougou, coordination with SAP project will be ensured at project's onset through consultations between both project managers. The goal is to complement SAP interventions through additional reforestation interventions in key degraded riverbanks in and around Djougou.	Indeed, SAP005 has planned to carry out restoration plantations in the Management Unit of Baku. Djou within the OSN classified forest. Djougou will receive support for the realization of cashew orchards, support to soybean producers (improved seeds, inicula and technical itineraries). In the months to come, the promotion of beekeeping and the processing of shea and néré will be developed.
n/a	*Activity 2.1.1. Develop agricultural response strategies to short- and medium-range forecasts.*	SAP will set up small weather stations – including one in Djougou and one in Dassa-Zoume (close to Glazoue) – to produce weather forecast and agricultural advisories for the farmers. OCRI farmers in Glazoue and Djougou will thus benefit from this and the advisories will be used, through the OCRI project, to inform agricultural techniques/ training in CRA.	
Activity 1.2.3 Implement CRA, including agroforestry, to enhance agricultural productivity under climate change. *Activity 1.2.4 Increase access of adapted quality seeds and plant*	*Activity 2.1.2. Implement climate-resilient agriculture interventions which increase agricultural yields under climate change conditions.*	SAP project will train 22,000 farmers in total on CRA (across 7 project communes); some of which will be based in Djougou. Training will not focus on a particular set of crops, but rather on resilient cultural techniques adapted to existing cultures. Training will also use demonstration plots as a key tool. OCRI will train 3 250 farmers in Djougou, focusing on key local crops like maize, chilies, tomatoes, etc. + cashew, mangoes and shea. OCRI will	The crops/value chains promoted (production, processing and marketing) by SAP005 are: cashew, shea butter, néré, soybean and sogho or millet. Not all crops are promoted at the same time and in all communes at the same time. For the current 2021-2022 agricultural season, Djougou is working on soybeans and cashews.

propagation material		make use of the demonstration plots established by SAP project in Djougou as one of its farmer field schools. As SAP will test climate-resilient agriculture options (including small water management techniques, off-season market gardening) on its 7 project sites, OCRI will be able to use best practices from SAP to inform choice of practices. SAP will also facilitate access to climate-resilient seeds, through collaboration with INRAB and partnerships with seed suppliers in its target communes. The resilient seeds will thus be made more easily available to the beneficiaries, which include farmers in Djougou. OCRI will thus benefit from better access to quality seeds, through efforts made by SAP (although SAP seeds might differ from OCRI's target cultures).	
Activity 2.1.1 Increase income of 2,500 farmers through training on business and marketing techniques and equipment using FOA farm business schools (FBS) methodology	*Activity 2.2.1. Train several cooperatives located in project sites on basic business and financial management and connect them to local and national wholesale traders.*	SAP and OCRI plan to support local cooperatives (2 to 3 per site for SAP) on sale and marketing techniques; this training could be synergize in Djougou.	Two cashew and shea processing cooperatives have already been identified and will receive equipment and capacity building for better processing and marketing
2.2.2 Organise municipal forums to connect farmers and small businesses to local and regional buyers	*n/a*	Through OCRI, municipal forums will be organized twice a year, as opportunities for producers to showcase their innovative climate-resilient production practices, and their resilient products, as well as to conclude trade agreements between farmers and buyers of resilient agri-products, or receive new demands for alternative products from the buyers, based on market demands. This will benefit farmers trained under SAP in Djougou.	
Activtiy 3.1.1 Establish and activate the OCRI platform	*Activity 3.1.1. Establish a national knowledge hub to disseminate lessons learned, cost effectiveness and benefits information on gender-sensitive EbA and*	SAP will set up a knowledge hub on CCA, while OCRI will establish the OCRI platform: besides linking stakeholders with interest in key value chains, the platform will also serve to communicate lessons learned and best practices on CCA – but with a watershed management approach. Therefore, the platform will include a link to SAP knowledge	

	climate-resilient agriculture interventions.	hub to ensure a better centralization of CCA knowledge in Benin.	
Activity 3.3.1 Organise knowledge dissemination events and products on OCRI.	*Activity 3.1.2. Organize awareness-raising campaigns for local communities on climate change and the services provided by forest ecosystems.*	SAP will organise awareness-raising campaigns on CC and the benefits of restored protected forests as buffer against CC impacts; these campaigns will reach farmers in Djougou, therefore OCRI project will not implement this awareness raising campaign in Djougou ??	All communes are targeted to understand and develop EbA actions. This implies awareness and explanation campaigns (including the impacts of CC) from the bottom to the top to promote the appropriation of this innovative approach for Benin
OCRI project Output/Activity	***IFAD project Output/Activity***	**Synergies**	
Activity 1.2.3 Implement CRA, including agroforestry, to enhance agricultural productivity under climate change. Farmers in the target sites will be trained and receive agricultural input	sub-component 1.1 improving access to improved agricultural input in Zogbodomey and Zagnanado		SAP005 does not operate in Zogbodomey and Zagnanado

Programme for Integrated Development and Adaptation to Climate Change in the Niger Basin *(PIDACC/NB - FP092, GCF-AfDB, 2018-2025, USD 209 million, ongoing)*

345. This large-scale, regional project targets 9 countries located along the Niger Basin, including Benin (Malanville). Its objective is to improve the resilience of populations and ecosystems in the Niger Basin by managing natural resources sustainably. Improved natural resource management and land use, as well as reforestation are promoted to better manage the Niger Basin.

346. Lessons will be drawn on integrated water and basin management approach from the PIDACC to inform OCRI's interventions. More specifically, technical learnings will be drawn from the rehabilitation / construction of small hydraulic infrastructure under PIDACC, comprising several small multi-purpose dams. These include the following: i) extension of dike protecting the irrigated perimeters of Malanville, including the installation of flood protection structures through the construction of protective embankments, in particular along the river to protect the rice fields against inundation; and ii) building of community adaptation infrastructures (product storage facility, product processing units and market sheds). Moreover, exchange of experiences with the communities that are preparing their community-based climate change adaptation plans for sub-areas of the Niger Basin will inform the development of the Ouémé Master plan and municipal plans under OCRI, to ensure a comparable approach throughout the country. To facilitate synergies and exchange of experience, the PIDACC project manager will be invited as guest on OCRI platform and to the PSC.

Agricultural productivity and diversification project (APDP) *(World Bank – Phase 2177, 2017-2023; Additional funding provided in 2017: USD 45 million, ongoing)*

347. APDP will restore and improve productivity and value addition for selected value chains in Benin. The following interventions are implemented in the 12 Departments of Benin: (i) promotion of large-scale adoption of improved technologies (production, post-harvest, processing and storage), including climate-smart production systems, to reduce vulnerability of farming activities to climate change and weather vagaries of farming activities; (ii) development of production and market infrastructure to enhance productivity through efficient water management, reduction of post-harvest losses and better access to market through warehouses and other facilities; and (iii) support to value chain coordination and access to finance through sustainable use of the financial management instruments. OCRI will use the lessons learned and best practices on land irrigation and climate-smart agriculture to design its interventions. Moreover, synergies will be sought on phase 2 of APDP, to support relevant value chains and access to finance for agricultural cooperatives. To ensure this, APDP project manager will be invited as guest on OCRI platform.

Transforming Financial Systems for Climate *(The "TFSC programme" AFD, 2019-2026, USD 767 million, ongoing)*

348. This regional project aims to create a market for investments in climate technologies, especially sustainable energy, in 17 countries including Benin, by removing the financial and technical barriers faced by local finance institutions to enable borrowing by, mainly, the private sector. To this effect, TFSC will provide loans, via local finance institutions, to borrowers who want to invest in climate-resilient technologies. OCRI will seek ways to access TFSC support and further remove barriers to accessing credits for smallholders, and incentivize investments in climate-resilient agriculture in the Ouémé Basin. Synergies will be sought in particular to design the Financial Facility of OCRI, facilitate access to micro-credits and loans for cooperatives investing in CRA, and secure long-term private sector investments in the project interventions. To facilitate knowledge exchange and synergies with TFSC, the project manager will be invited as guest on OCRI platform.

Adaptation de l'Agriculture au Changement Climatique[178] *(GIZ, 2014-2019, completed)*

349. The project promoted sustainable management of degraded watersheds in North Benin – nearby Parc national de la Pendjari et du Parc national du W – as a pathway to reduce climate change vulnerability and improve agricultural productivity. The lessons learned and best practices for sustainable irrigation and water management, CRA and resilient watershed management, will be used to inform OCRI interventions.

Projet d'appui à la gestion des forêts communales *(PAGEFCOM PHASE II, 2017-2022, USD 12.9 million, ongoing)*

350. Phase 2 of PAGEFCOM aims to enhance water availability in the Departments of Borgou and Donga, in addition to the departments of Collines, Atlantique and Zou (included in PAGEFCOM I). OCRI will ensure synergies with this work, using the best practices identified under PAGEFCOM.

[177] http://documents1.worldbank.org/curated/en/500471486593559453/pdf/PIDISDS-APR-Print-P160029-02-08-2017-1486593555416.pdf

[178] GIZ, 2017. Adaptation de l'agriculture au changement climatique (PACC). Available at: https://www.giz.de/en/worldwide/31841.html

Capacity building in the energy, agriculture, forestry and other land use sectors for increased transparency in the implementation and monitoring of the NDC (CBIT, 2021-2024, US$1,779,863)

351. Under its Activities 3.1.1 and 3.1.2, CBIT will contribute to build capacity, within the GoB, to monitor and evaluate progress towards climate change adaptation. For this, a national adaptation M&E tool will be developed, as well as adaptation-specific indicators; and capacity will be built among staff members of the MCVDD and MAEP. Given that the proposed OCRI project will work directly with staff members of these 2 ministries, which field agents – particularly extension officers from the forest services – will be engaged to conduct regular M&E on the project's interventions, OCRI's Component3 will directly benefit from the training and tools developed under the CBIT project. Local forest extension officers will be trained on M&E for adaptation under CBIT; and they will then be engaged on monitoring the impacts of the ecosystem restoration and agroforestry in OCRI project sites, using the national adaptation M&E tool and its indicators, developed under the CBIT. This will also ensure that OCRI reporting is harmonized with the reporting on the INDC.

Agricultural Development and Market Access Support Project PADAAM *(IFAD, 2019-2024, US$1,971,797)* – **COFINANCE in Glazoue**

352. Project PADAAM is directly contributing to several interventions identified in OCRI, pertaining to improving agricultural productivity for maize and vegetables, engaging the private sector and strengthening value chains with intervention sites located in Middle Oueme and the transition area of Glazoue. Under Component 2 of PADAAM, irrigation systems for counter-season horticulture will be provided in Glazoue; this will support OCRI's activity 1.1.1 that aims at improving water availability for agriculture. Moreover, PADAAM will strengthen riverbanks through reforestation using cashew trees thereby supporting OCRI's reforestation activities under activity 1.1.2. Support to maize production will also be provided by PADAAM, using farmers' filed schools for training which can also be used under OCRI (activity 1.2.3), and setting up nurseries to produce high-quality maize seeds (OCRI 1.2.4). To strengthen the maize value chain, PADAAM will provide processing equipment and storage/ post-harvest units to the cooperatives, thereby cofinancing OCRI's activity 2.1.1. finally, partnerships between producers and sellers will be created to facilitate the sale of agriproducts, which will benefit OCRI's activity 2.1.2 .

Market Gardening Development Support Project– PADMAR *(IFAD, 2018-2024, U$S 49.2 million)* **– COFINANCE in Zogbodomey and Zagnanado**

353. Project PADMAR is directly contributing to several interventions identified in OCRI, pertaining to improving the productivity of horticulture from production to sale, with a focus on supporting women. Several PADMAR activities will cofinance OCRI, namely: improving water access to produce counter-season vegetables and protecting fields against floods (contributing to OCRI activity 1.1.1), providing trainings and agricultural inputs for vegetable production (contributing to OCRI activity 1.2.3), and training farmers to enhance their access to micro-credits (contributing to OCRI activity 2.1.2).

Regional Programme for the Integration of Agricultural Markets– PRIMA *(IFAD, 2021-2026, US$ 108.6 million)* – **COFINANCE in Glazoue and Djougou**

354. PRIMA aims to stimulate the regional markets in Benin and Togo, by supporting key agricultural products, through enhance productivity, access to processing and storage equipment, training for cooperatives and improved access to financial services. Although

support to specific agriproducts will be determined based on market demands, PRIMA will likely include OCRI's supported crops with regional market potential, including cassava and vegetables. PRIMA will support sustainable land and water management in Glazoue and Djougou, to reduce soil erosion and facilitate counter-production, thereby supporting OCRI activity 1.1.1. It will also set up tree nurseries to support reforestation of degraded riverbanks, hence supporting OCRI's activity 1.1.2. Training on CRA and agroforestry, using cashew trees and mango and set up of tree nurseries, will also be supported by PRIMA, using the FFS approach. This will cofinance OCRI activity 1.2.3. and 1.2.4. Training to strengthen cooperatives in Glazoue and Djougou, in particular for the processing and storing of agriproducts and to enhance their access to financial services like micro-credits, will also be implemented by PRIMA, supporting OCRI activities 2.1.1 and 2.1.2. Finally, PRIMA will organise awareness raising campaigns on climate change in these 2 municipalities, thereby cofinancing OCRI activity 3.2.1.

8.1.4 Operation & maintenance

355. The project will support the establishment or revitalization of agricultural cooperatives and strengthen their capacity, along with those of local extension officers, to maintain waterworks and land management beyond the project's lifespan. At the level of each site, the operation and maintenance will involves:

- Train cooperatives and extension officers on infrastructure technical management (monitoring of works, organization of plot work, collection of water fees, management of hydraulic infrastructure, monitoring of irrigations, monitoring of structures, organization of routine maintenance work);
- Provide local stakeholders with management tools and infrastructure maintenance manuals as well as train its members to better exercise their roles;
- Facilitate and support the establishment of a water charge to guarantee the maintenance and repairs of the main hydraulic structures;
- During the works phase, train producers in the mastery of plot development techniques (bunkering, construction of bunds, leveling of plots, etc.) as well as in the conduct of water and the maintenance of plot infrastructure.

356. Each beneficiary cooperative will designate a member to be associated with all the stages of project implementation and will represent the cooperative at site supervision meetings and reception of the works. The members of the committee will receive training to fulfill their respective roles and will be provided with small earthmoving equipment (shovels, diggers, pickaxes, wheelbarrows, cutters, etc.) to carry out infrastructure maintenance work. Training for producers will be carried out during the works (in the form of a field school), to enable them to make their plot development and at the time of the first development to better manage water and ensure the maintenance of plot infrastructure. Technical training will be provided with the support of the Directorate of Rural Engineering (DGR). The O&M costs for the project duration have been estimated at 1,200,000 USD, which will be covered through co-finance from the GoB: the amount was calculated as an annual 3% of the costs of the project infrastructure. These costs will be carried out by the GoB during (as cofinance) and after project implementation. The GoB will have sufficient financial capacity to cover these costs in the long term as indicated in the Economic and Financial Analysis (Annex 3).

8.1.5 Beneficiaries

357. The proposed project is an agriculture and ecosystem restoration project. Direct beneficiaries of agriculture support are estimated as the number of farmers and their families (based on

GCF approach). As OCRI will train 16,250 farmers, and the average people per household is 4.6 in the project target area, it means OCRI will have 74,740 people directly benefiting from its agricultural activities.

358. However, OCRI doe not only foster climate-resilient agriculture and value chains; it also implements ecosystem and land restoration through waterworks and reforestation. These interventions will contribute to improved ecosystem services and access to water – which are key to all farmers living in the target areas – and reduced flood risks not only over the target 95,000 ha, but also downstream project area.

359. Hence, the proposed OCRI project will directly benefit 330,000 people and indirectly benefit 6 million people in Benin (Table 26). Direct beneficiaries are people living in the communities where climate-resilient agriculture, agroforestry and/or waterworks will be implemented on the ground – as it will improve agricultural productivity and protect them against floods and droughts. Indirect beneficiaries will also be less affected by climate change impacts, receive information and access to tools for implementing CRA, and potentially benefit from new job opportunities.

Table 39. Project beneficiaries

Municipalities	**Surface area (km^2)**	**Total population**	**Proportion of the basin's inhabitants**	**Number of people living in the basin**
Copargo (Source Ouémé)	876	70,938	41%	29,085
Djougou	3,966	267,812	96%	257,099
Glazoué	1,750	124,431	100%	124,431
Sub-total Upper valley	**6,592**	**463,181**	**89,0 %**	**410,615**
Zagnanado	540	55,061	100%	55,061
Zogbodomey	139	92,935	88%	81,783
Sub-total Middle valley	**679**	**147,996**	**92,5**	**136,844**
Total	**7,271**	**611,177**	**89,6%**	**547,459**

360. According to official databases, 547,459 people in the target municipalities live in the catchment area (upper and middle valley); while an estimated 50% of the population is comprised of women (based on national statistic[179]), approximately 25.38% of households were headed by women in 2013 in the area under consideration. The average household size is 4.6 compared to the national average of 5.6. A vast majority of the population living in the five targeted municipalities live in the basin area of the Ouémé. Existing data also indicates that 61% of the population in Upper and Middle Ouémé relies directly on agriculture as main economic activity. These proportions show a strong dependence of the population of Upper and Middle Ouémé on the means of existence associated with the basin perimeter, and its ecosystem services and natural resources.

[179] https://www.indexmundi.com/fr/benin/population_profil.html

361. The proposed OCRI project will target, as direct beneficiaries, the full population living in the basin areas of Upper and Middle Ouémé, that directly rely on agriculture – that is 61% of the 547,459 people living in the basin. Hence, the project will have 330,000 direct beneficiaries, out of which 165,00 (50%) women – as women constitute approximately 50% of the population in the target area. The direct beneficiaries will beneficiate from several activities, amongst the following: i) the installation of waterworks to protect against floods and improve water access; ii) training on CRA to improve productivity under climate change conditions; iii) ecosystem restauration and management to enhance the production of goods and services, protect against climate change impacts and enhance crop productivity; iv) financial and business training to boost profits in climate-resilient farms; v) improved access to finance to invest in their climate-resilient farms; and vi) enhanced understanding of climate change impacts and adaptation options in the Ouémé Basin.

362. In addition to 330,000 direct beneficiaries, the project will indirectly profit to the whole population of the Ouémé Basin, that is 6 million people. This population will benefit from: i) protection against climate change impacts, in particular through reduced occurrence of floods through waterworks and reforestation on river banks in Upper and Middle Ouémé; ii) additional job opportunities in the value chains that will be supported by the project; iii) enhanced knowledge and understanding of climate change adaptation, through the awareness raising interventions supported by the project; and iv) strengthened governance system that promote integrated management in the Ouémé Basin, in the long-term; this will be insured through strengthening of the Ouémé Master Plan, revised Local Development Plans and improved capacity to mainstream adaptation into agriculture and development plans amongst local stakeholders.

363. The beneficiaries will be selected according to the following criteria:

- The common selection criteria for facilitators are as follows: a) have agricultural training of some kind, formal or informal, or have some level of advanced skills, knowledge and experience in agriculture/forestry; b) be technically competent for the agroecosystem at hand; c) be available to facilitate the FFS process; d) be able to share experiences and connect well with other community members; e) have good people skills and an aptitude for informal and participatory ways of working; f) have at least some reading and writing skills; g) speak the local language; h) live in the local community; i) ave a dynamic and confident personality.

- Beneficiaries of the farm training activities will be selected based on the following criteria: owning a plot size <2 ha, their willingness to participate, their availability and their interest in developing climate-resilient farms; the sharing of same needs/priorities related to the production; and the strong motivation to follow the entire training cycle. These selection criteria will be further refine at project onset by FAO.

- FBS will be selected based on the following criteria: a) FFS groups which demonstrated most interest and capacity on business/marketing topics and VSLA related activities; b) FFS groups (or at least important number of members of the groups) which are already organized or connected with cooperatives or structured producer organizations; c) FFS groups which are producing the crop/tree included in the selected value chains and are willing and aware about the steps needed to sell products to the markets.

8.2 Project costs and efficiency

Table 40: Cost Summary

Output	Total cost	Funding by GCF	Funding by MCVDD	Funding by FNEC	Funding by MAEP	Funding by FAO	Relative amount
Mgment cost	**$1 683 100**	$863 100	$193 800	$0	$504 000	$122 200	**4,8%**
Component 1	**$21 375 576**	$12 135 535	$0	$0	$8 595 240	$644 801	**60,5%**
Component 2	**$5 993 975**	$2 144 135	$336 000	$0	$3 513 840	$0	**17,0%**
Component 3	**$6 261 925**	$3 311 025	$2 470 200	$187 500	$21 200	$272 000	**17,7%**
Total	**$35 314 576**	**$18 453 795**	**$3 000 000**	**$187 500**	**$12 634 280**	**$1 039 001**	**100%**

Table 41: Costs per Components, Outputs and Activities

Component	Output	Indicative cost Options	GCF financing		Co-financing		
			Amount Options	Financial Instrument	Amount Options	Financial Instrument	Name of Institutions
Low carbon climate Resilient Crop production enhanced and Ecosystem services restored in the Upper and Middle Ouéme	1.1.Waterworks and tree plantation to protect river banks and secure water access	USD 16,633,276	USD 8,507,635	Grants	USD 644,801	In kind	FAO
					USD 7,480,840	Grants	MAEP (IFAD)
	1.2.25,250 Farmers capacitated to implement climate resilient agriculture, agro-forestry and sustainable land management	USD 4,742,300	USD 3,627,900	Grants	USD 1,114,400	Grants	MAEP (IFAD)

Climate-resilient and gender-sensitive value chains, supporting farmers' livelihoods in the Upper and Middle Ouémé	2.1.Farmers and cooperatives' income stream diversified, enhanced, and secured in the face of climate change	USD 4,797,975	USD 1,634,135	Grants	USD 3,163,840	Grants	MAEP (IFAD)
	2.2.Private sector incentivized to invest in climate resilient agriculture and resilient management techniques in Ouémé Basin	USD 1,196,000	USD 510,000	Grants	USD 336,000	In kind	MCVDD
					USD 350,000	Grants	MAEP (IFAD)
An enabling institutional and financial environment established to promote and upscale climate-resilient management in Benin's Basins	3.1.OCRI project institutionalised through a multi-stakeholder platform, regulatory frameworks and capacity building	USD 5,076,775	USD 2,606, 575	Grants	USD 2,470,200	In kind	MCVDD
	3.2. Strengthened FNEC's capacity to ensure continuous support to climate-resilient farming in the Oueme Basin	USD 327,000	USD 139,500	Grants	USD 187,500	Grants	FNEC
	3.3.Awareness of ICRM in basins' benefits raised among farmers, and public and private institutions	USD 858,150	USD 574,950	Grants	USD 21,200	Grants	MAEP (IFAD)
					USD272,000	In kind	FAO
Project management & maintenance	PMU	USD 1,6,83,100	USD 863,100	Grants	USD 193,800	In kind	MCVDD
					USD 122,200	In kind	FAO
					USD 504,000	Grants	MAEP (IFAD)

Indicative total cost (USD)	USD 35, 314,576	USD 18, 453,795	USD 16, 860,781

Assessment was made of the net present value (NPV)[180]. The NPV determines the present value of net benefits by discounting the streams of benefits and costs back to the beginning of the base year. The analysis below is presented in more detail in the attached EFA (Annex 3) in Excel (single crop based projections, tab "Indicators for Proposal), where it is projected over 30 years. With a Discount Rate of 10%, the Net Present Value of the project (including investment costs) is of USD 69.4 million. This also means that for farmers, the interventions are economically viable, and therefore sustainable. The internal rate of return (IRR) of the project calculated over a period of 30 years amounts to 18%. These results do not take into account the non-quantifiable economic co-benefits (see Section D.3) or the ripple effect of the success of several groups on the local and national economy. Annex 4 also highlights the project's cost per beneficiary at US$ 107. Figure 13 shows the annual project cost-benefit balance. The project investment is of US$35,314,576, spread over six years. The project breaks-even after eleven years from project start. The annual project impact increases considerably after Year 10 to an annual improved production value of around US$ 30 million in Year 15, because by then trees start producing.

The impact farmers' income is calculated by dividing the annual project impact (in increased production value over the baseline) divided by the number of direct beneficiaries. If we assume a daily wage of FCFA 3000-5000 (~US$ 9, upper value is chosen; 250 working days per year), this will lead to an **additional employment of 2,800 jobs by year 10 after project start, and 8,900 additional jobs by year 30 after project start**.

8.3 Institutional arrangements

Project Governance Structure

Accredited Entity (AE): FAO

364. The FAO will serve as the Accredited Entity (AE) for the Project. FAO as the AE will be responsible for project implementation and administrative oversight and technical supervision, corporate management for GCF intervention, project reporting, and project completion and evaluation in accordance with the detailed provisions outlined in the GCF policies as well as Accreditation Master Agreement (AMA) and Funded Activity Agreement (FAA) between FAO and GCF. As such, the FAO will be responsible for overall management of the Project, including: i) All project evaluation aspects; ii) Administrative, financial and technical supervision throughout implementation of the Project; iii) Supervision of effective management of funds to achieve the results and objectives; iv) Quality control of Project monitoring and reporting to the GCF; v) Project closure and evaluation. The FAO will assume these responsibilities in line with the detailed provisions listed in the Accreditation Master Agreement (AMA) between FAO and the GCF.

365. As Accredited Entity of the Project, the FAO's supervising role will be attributed to the FAO Regional Office for Africa (RAF), located in Accra with support by the Office of Climate Change, Biodiversity and Environment (OCB) and other technical divisions located FAO headquarters in Rome (HQ), as required. To perform the AE functions, FAO will set up a dedicated FAO-GCF Project Task Force (PTF) comprising relevant staff from the FAO Country Office in Benin, the FAO Regional Office for Africa, and FAO Headquarters. Members of the PTF will perform the

[180] The NPV was calculated based on crop prices for 2022.

necessary supervision and oversight functions, including supervision and backstopping missions during the entire implementation period, as required. The project supervision function will remain independent of the Executing Entity functions performed by FAO Benin. The above-mentioned segregation of responsibilities within FAO will ensure that the Organization can independently and effectively perform the types of Accredited Entity functions. FAO will contract with MCVDD to act as co EE.

Executing Entities (EE):

366. **FAO:** FAO is one of the executing entities of GCF proceeds. FAO and MCVDD will set up the Project Management Unit (PMU) and local Project Implementation Unit (LPIU) in the Upper and Middle Ouémé. FAO will establish a Farmer Field School (FFS)Technical Unit technically and methodologically backstopped by FAO, based in MAEP, that will provide technical advise on the implementation of agriculture activities. This Technical Unit will be chaired by MAEP. FAO will ensure strong coordination of implementation of project activities with MAEP and MCVDD. National partners will be contracted as procured parties by FAO in accordance with FAO's procurement rules (Manual Section 507). FAO has been established its Office in Benin in 1977. Since then it has implemented projects in the country in all areas of relevance to FAO and funded by partners such as GEF.

367. **MCVDD:** MCVDD is one of the executing entities of GCF proceeds. MCDDV will be an executing entity to whom FAO will transfer funds through the applicable modality, which foresee all necessary provisions for monitoring and supervision, including regular supervision missions, third-party regular spot checks and audits to ensure financial management, procurement and other. MCVDD will work with project-financed staffs, project-recruited subject-matter specialists, to deliver support to targeted beneficiaries in the field. On behalf of the client-country, MCVDD will receive project-financing and technical support, including capacity building and access to knowledge and information to implement the project. As agreed during the stakeholder consultation stage, MCVDD retains the leadership role in hosting the PMU at central level and has the core mandate to implement land restoration (including protection of Ouémé water sources through tree planting on the banks, and waterworks) as well as the rigorous project M&E using the FarmTree App. A capacity assessment of MCVDD has been carried out in 2018.

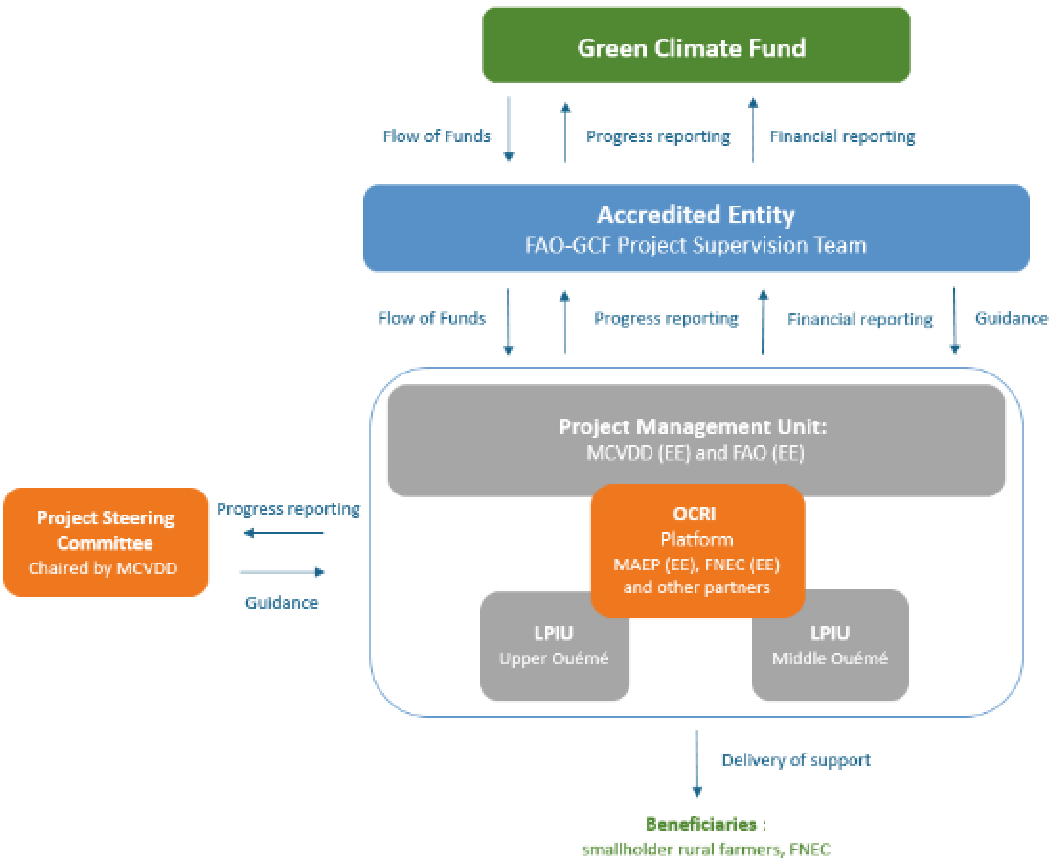
368. **MCVDD** houses the NDA; it is in charge of developing and implementing national policies on environmental issues, climate change, reforestation, ecosystem restoration, urban development and coastal protection. It is the nodal ministry for all matters relating to climate change and coordinates implementation of the National Action Plan on Climate Change (2008). This Ministry has extensive experience in executing donor-funded projects on natural resources management, reforestation and forest and water management including 'Projet de Gestion des Ressources Naturelles' (PGRN) and 'Projet Bois de Feu' phase 1 & 2. More recently, MCVDD has been involved in the execution of the GCF UNEP SAP project. MCVDD will chair the PMU and the SC.

369. **FNEC:** The FNEC will cofinance the OCRI project and will be executing entity for the activity it cofinances. FNEC has been, since 2003, a financial instrument placed under the supervision of

the MCVDD. FNEC is semi-autonomous legal entity. Its creation responds to a need to support and finance initiatives related to environmental protection and climate change. Using different sources of funds, in particular green taxes, FNEC opens call for project proposal to a large array of proponents including NGOs, local associations, cooperatives and private sector organisation. The projects must be aligned with FNEC's strategy and list of project theme; these are only funding through grants. FNEC has been accredited with the Adaptation Fund since 2011; and with the GCF as Direct Access Entity since 2019. FNEC will also receive technical support to strengthen its mandate.

370. **MAEP:** MAEP will be the executing entity for the activities it cofinance through IFAD resources. MAEP capacity assessments has been performed in 2018. MAEP intervenes through the Directorate of Rural Engineering (DGR) which is egally controlled by MAEP and the Lowlands Unit under its supervision, the Directorate of Livestock, the Directorate of Fisheries andthe Directorate of Forestry and Natural Resources (DFRN) - legally controlled by MCVDD. The MAEP, with these local delegations - at the village level - is the institution responsible for agricultural and pastoral hydraulics, water and soil conservation, aquaculture, forest management and reforestation.

Figure72: Implementation arrangements OCRI.



Project Management Unit (PMU)

371. A PMU will be set up by FAO and MCVDD. It will be established with office space procured by the MCVDD. A National Project Coordinator (NPC), responsible for project implementation and coordination with all project stakeholders, and operational leadership of the PMU, will be recruited based on a competitive process; his recruitment will be validated by FAO and MCVDD. The PMU will be responsible for providing support to the implementation of day-to-day activities at the national/central level in close coordination with the EE. Under the leadership of the NPC, the PMU will also coordinate with the LPIUs and Focal Points the implementation of activities at sub-regional level and ensure these are aligned with the implementation of activities in the five municipalities. The PMU full-time staff will include: (i) National project coordinator; ii) local office manager; iii) project assistant; and iv) Procurement and Finance Officer. In addition, the following expertise will be mobilsed to support project implementation: i) International Chief Technical Advisor; ii) Environmental and Social Safeguarding Expert; iii) IT Communication Specialist; (iv) Gender Specialist; and (v) Monitoring Specialist. The PMU will be advised by the FFS Technical Unit based in MAEP with regards to the agriculture activities. PMU will report to FAO as AE and the Steering committee chaired by MCVDD.

Local Project Implementation Unit

372. MCVDD and FAO-Benin will initially jointly form the Project Implementation Units at two levels: (i) the national-level Project Management Unit (PMU); and (ii) two Local Project Implementation Units (LPIUs) for the Upper Ouémé and for the Middle Ouémé, part of the OCRI platform. The LPIUs will comprise government staff members, whose capacity will be strengthened under Component 3, and project-recruited staff. FAO will also provide technical and administrative support to the government and the LPIUs. This arrangement will ensure that a) high and quality technical standards are adhered to; b) project delivery can proceed securely and efficiently despite the complex governance framework; and c) government partners play a leading role in project delivery and capacity development.

373. Two LPIUs will serve as operational arms of the PMU, located in the Upper and Middle Ouémé, each headed by a Project Technical Director (PTD), recruited based on a competitive process by MCVDD. The two LPIUs will be under the supervision of MCVDD. Each LPIUs is headed by a Project Technical Director (PTD). They are recruited based on a competitive process by MCVDD. The PTD will supervise the day-to-day project operations in each LPIU, liaising with the Focal Point in each municipality. The location of the LPIU offices will be jointly identified in coordination with the Agriculture and Environment departments and the communes to ensure synergies and liaison among all stakeholders. LPIU staff will include GoB staff – which will be capacitated under Component 3 – and project subject-matter specialists (local), including: (i) Water Management Specialist; (ii) Environmental Specialist; (iii) Agronomist; (iv) FFS Specialist. The LPIUs will be 'attached' to the OCRI platform (set up under Component 3). LPIUs will be in charge of stakeholder coordination in their area, knowledge dissemination, field implementation with the municipal Focal Points, and M&E of results. The LPIUs may procure services of NGOs/CBOs or specialized structures with the necessary expertise to implement specific activities (e.g. construction of micro-dams), in line with FAO procurement procedures. The Ouémé Basin Authority (OBA) will also be involved once operational, but

through the OCRI platform and the project steering committee (PSC), and will be included in the project's capacity-building efforts.

Project Steering Committee

374. The steering committee will provide guidance and recommendation to the PMU. The primary functions of the PSC will be: (i) aligning project activities with GoB policies and priorities; (ii) ensuring coordination of the project among departmental government partners and with partners in the communes; (iii) providing project implementation oversight; (iv) approving annual work plans and budget, and reviewing project progress; and (vi) guiding the resolution of implementation challenges. The PSC will meet twice a year or can be convened by the Chairperson, at the request of the EEs and on an ad-hoc basis, to discuss key oversight and/or implementation issues. The Chair will have the authority to invite other experts as the need arises. Minutes of PSC meetings will be made publicly available and circulated to all Committee members and project stakeholders. They will also be posted on the OCRI Platform site and the FAO website. The PSC (chaired by the Director General of the MCVDD and co-chaired by FAO) will comprise representatives from: MCVDD (NDA); MAEP; Ouémé Basin Agency (OBA); Ministry of Planning and Development (MoPD); Ministry of Finance; CCIB; IFAD; the relevant ATDA and DDAEP, FNDA, FNEC, FADeC and FNEDD, PNOPPA-Benin, mayors of the 5 municipalities. The project coordinator of the GCF SAP project will be invited as guest during the PSC to ensure synergies between the 2 projects.

Local Level Governance Structure

375. Each municipality will assign a Project Focal Point, based within the municipality offices, to oversee and monitor the implementation of the project activities in its municipality. The Focal points will liaise with the Mayor and local staff members from the local Agriculture, Water and Environment Technical Departments, as well as farmers organisations and project beneficiaries. The primary functions of the Focal Points will be: (i) ensuring project coordination with national government partners and among commune partners; (ii) monitoring project implementation at municipal level, identify problems or conflict and provide early resolution; (iii) participating in all supervision missions as well as ad-hoc missions, and (iv) reviewing AWPB and project progress at municipal level. The Focal Points will liaise closely with the PMU and the LPIUs to ensure effective and timely implementation and support them to overcome any challenges on the ground.

International/ National Technical Assistant Specialists

376. The project will recruit long-term and short-term international Chief Technical Advisor (CTA) and short-term experts, who will be based at the PMU and support the LPIUs to carry out specific sub-regional and local field activities. They will be responsible for liaising with FAO-led technical departments and for capacity development of EE and Service Provider staff. They will include: (i) Climate Change Specialist; (ii) Landscape Restoration Specialist; (iii) Water Engineer; (iv) FFS Specialist; (v) Capacity Development Specialist; (vi) Agroforestry Value Chains and Agribusiness Development Specialist; and (v) GIS Monitoring Specialist. International Technical specialists, such as a Lead Safeguards Advisor (LSA) from FAO will be contracted from Rome and/or around the world, on either a long-term or an ad hoc basis to support the implementation activities, safeguards compliance, the elaboration of ComDev/ICT, technical materials and training on FFS and/or CRA. FAO's Divisions which will provide

technical assistance are Forest Policy and Resources Division (FOA); Climate Change, Biodiversity and Environment - Climate risks team (OCB); Land and Water Division (NSL); Food and Nutrition Division (ESN); Plant Production and Protection Division – FFS group (NSPCD).

Coordination mechanisms between IFAD and FAO.

Coordination between MAEP projects financed by IFAD and FAO will take place at 3 levels:

a) At the local level, the two FAO Local Project Implementation Units (LPIU) will interact with an IFAD focal point in Upper-Ouémé and a focal point in Middle-Ouémé. At this level, quarterly meetings will be organized to monitor the respective work plans and indicators, verify the synergies of the actions implemented and make the necessary updates. The activities progress report of IFAD will be shared to allow FAO to report it to the GCF each February together with the Annual Activity Report.

b) At the national level, the coordinator of the FAO Project Management Unit (PMU) will coordinate with the IFAD national focal point. Half-yearly meetings will be organized to analyze the Annual Work Plan and Budget (PTBA) and prepare those for the following years;

c) A joint field supervision mission (FAO/IFAD/Government) will be organized annually in the common areas of intervention.

OCRI Platform

377. Under Component 3, the OCRI Platform will be established. Platform participants will be selected according to their capacity to generate local changes and will be empowered and trained on dissemination of CRA techniques in close collaboration with food value chain actors. The OBA, MAEP and MCVDD, local communes, CSOs and community leaders, including private sector will be directly involved in the planning, implementation, M&E and knowledge-dissemination. In addition, the Ministry of Finance, CCIB, FNEC and FNDA will be invited to join the platform; more specifically, FNEC's involvement in the platform will ensure long-term funding; synergies between FNEC and FNDA will also be sought to increase the resources available to FNEC. The platform will be a forum for developing public-private partnerships and will seek synergies and complementarities with ongoing and future initiatives. Other partner initiatives and players will be identified in the inception phase together with the specific approaches and tools that will be adopted in a participatory manner. A Memorandum of Understanding will be signed by key partners and initiatives, and a financial strategy developed to sustain the OCRI platform beyond the project.

Table 42: Funding source and executing entities of OCRI

COMPONENT 1: Low carbon climate Resilient Crop production enhanced and Ecosystem services restored in the Upper and Middle Ouéme				
Output	Activity	Sub-Activity	Funder	Executing Entity
Output 1.1 Waterworks and tree plantation to protect riverbanks and secure water access	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus 1,320 ha with MAEP cofinancing)	1.1.1.1 Construction surface water storage structures or harvesting structures (Small earth dams, water rising structures, etc.)	GCF	FAO
	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus	1.1.1.2 Rehabilitate 23 old surface water collection structures	GCF	FAO

	1,320 ha with MAEP cofinancing)			
	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus 1,320 ha with MAEP cofinancing)	1.1.1.3 Development of small irrigated perimeters with full water control	GCF	FAO
	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus 1,320 ha with MAEP cofinancing)	1.1.1.4 Development for the protection of water sources (river, head of streams, artesian boreholes, etc.)	GCF	FAO
	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus 1,320 ha with MAEP cofinancing)	1.1.1.5 Support for waterworks guidance	GCF	FAO
	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus 1,320 ha with MAEP cofinancing)	1.1.1.6 Set up 1,320 ha of irrigated land in Glazoue and Djougou	MAEP	MAEP
	1.1.1. Build water harvesting and retention infrastructures (target of 680 ha irrigated land plus 1,320 ha with MAEP cofinancing)	1.1.1.7 Secure government support to co.9nvest in waterworks	MAEP	MAEP
	1.1.2 Strengthen degraded river banks and restore land with tree (target of 5,000 ha plus 4,000 ha with MAEP cofinancing)	1.1.2.1 Conduct detailed biodiversity analysis in Upper and Middle Ouémé to identify site specific locally-relevant and resilient tree species- conduct technical and hydrological studies to identify best site for the micro-dams	GCF	MCVDD
	1.1.2 Strengthen degraded river banks and restore land with tree (target of 5,000 ha plus 4,000 ha with MAEP cofinancing)	1.1.2.2 Set up 5 community tree nurseries and provide technical support to produce high-quality seedlings	GCF	MCVDD

	1.1.2 Strengthen degraded river banks and restore land with tree (target of 5,000 ha plus 4,000 ha with MAEP cofinancing)	1.1.2.3. Plant 5,000 ha of trees along degraded river banks and fields	GCF	MCVDD
	1.1.2 Strengthen degraded river banks and restore land with tree (target of 5,000 ha plus 4,000 ha with MAEP cofinancing)	1.1.2.4 Plant additional 4,000ha of trees in Glazoué, Zagnando and Zogbodomey	MAEP	MAEP
	1.1.2 Strengthen degraded river banks and restore land with tree (target of 5,000 ha plus 4,000 ha with MAEP cofinancing)	1.1.2.5 FAO provides Technical support to produce high-quality tree seedlings to enhance rural community resilience to climate change.	FAO	FAO
OUTPUT 1.2: 25,250 farmers capacitated to implement climate resilient agriculture, agro-forestry and sustainable land management over 95,000 ha	1.2.1 Train 15 Master Trainers and Facilitators (women and men)	1.2.1.1 Develop training courses	GCF	FAO
	1.2.1 Train 15 Master Trainers and Facilitators (women and men)	1.2.1.2 Select 15 Master trainers to train and capacity/ skills assessment	GCF	FAO
	1.2.1 Train 15 Master Trainers and Facilitators (women and men)	1.2.1.3. Implement 4 x 1-week training sessions	GCF	FAO
	1.2.2. Training of 250 Facilitators (at least 40% women)	1.2.2.1 Develop training curriculum and modules on CRA; agro-forestry; sustainable land management (with focus on river banks)	GCF	FAO

	1.2.2. Training of 250 Facilitators (at least 40% women)	1.2.2.2 Organise 10 training of facilitators sessions of a 5-month duration, to accommodate 25 facilitators per session (for a total of 250 facilitators trained)	GCF	FAO
	1.2.3 Implement CRA, including agroforestry, to enhance agricultural productivity under climate change and reduce emissions..	1.2.3.1 Set up 650 FFS and training beneficiaries in areas not covered by MEAP; or beyond the MAEP project period. Each FFS will include 20 training sessions and involve 25 farmers (at least 40% women)	GCF	FAO
	1.2.3 Implement CRA, including agroforestry, to enhance agricultural productivity under climate change and reduce emissions..	1.2.3.2 Technical support, coaching and supervision to the implementation of 650 FFS	GCF	FAO
	1.2.3 Implement CRA, including agroforestry, to enhance agricultural productivity under climate change and reduce emissions..	1.2.3.3 Provide training to additional farmers in Glazoué, Djougou, Zagnando and Zogbodomey (MAEP USD 1,269,200)	MAEP	MAEP
	1.2.4 Increase access of adapted quality seeds and plant propagation material	1.2.4.1 Rehabilitate/build and operationalise 1 nursery per target municipality	GCF	MCVDD
	1.2.4 Increase access of adapted quality seeds and plant propagation material	1.2.4.2 Organise and support 1 seed producer group per municipality	GCF	MCVDD

	1.2.4 Increase access of adapted quality seeds and plant propagation material	1.2.4.3 Train technicians and farmers to collect, handle and dispatch shea seeds and to produce seedlings.	GCF	MCVDD
COMPONENT 2: Climate-resilient and gender-sensitive value chains, supporting farmers' livelihoods in the Upper and Middle Ouémé				
OUTPUT 2.1: Farmers and cooperatives' income stream diversified, enhanced, and secured in the face of climate change	2.1.1 Increase income of 5,000 farmers through training on business and marketing techniques and equipment using FAO farm business schools (FBS) methodology (100 FBS plus 100 from MAEP cofinancing)	2.1.1.1 Train 2,500 farmers organized in agribusinesses and cooperatives – including 33% women. Each FBS will include 20 training sessions and involve 25 farmers.	GCF	FAO
	2.1.1 Increase income of 5,000 farmers through training on business and marketing techniques and equipment using FAO farm business schools (FBS) methodology (100 FBS plus 100 from MAEP cofinancing)	2.1.1.2 FBS coached and supervised: coaching, reporting, monitoring & evaluation process, by a group of local focal points (FBS experts); 1 month per FFS, funded by the FBS funder	GCF	FAO
	2.1.1 Increase income of 5,000 farmers through training on business and marketing techniques and equipment using FAO farm business schools (FBS) methodology (100 FBS plus 100 from MAEP cofinancing)	2.1.1.3 Provide at least 15 small processing/ packaging/ storing units to cooperatives	GCF	FAO
	2.1.1 Increase income of 5,000 farmers through training on business and marketing techniques and equipment using FAO farm business schools (FBS) methodology (100 FBS plus 100 from MAEP cofinancing)	2.1.1.4 Train and equip additional cooperatives for post-harvest, processing, storing and sale of agriproducts in Glazoue, Zogbodomey, Djougou and Zagnanado	MAEP	MAEP
	2.1.2 Improve access to micro-credit and investments for agriculture	2.1.2.1 Develop training material addressing current barriers to credit access	GCF	FAO

	2.1.2 Improve access to micro-credit and investments for agriculture	2.1.2.2 Organise 5 training sessions for each FBS to train 2,500 farmers	GCF	FAO
	2.1.2 Improve access to micro-credit and investments for agriculture	2.1.2.3 Establish Village Savings and Loans Associations to foster low-threshold small loan provision	GCF	FAO
	2.1.2 Improve access to micro-credit and investments for agriculture	2.1.2.4 Improve access to financial services for farmers in Glazoue and Djougou (MAEP USD 2,511,000)	MAEP	MAEP
	2.1.3 Train facilitators (selected educated young) and national/local climate change experts (from relevant institutions eg MCVDD, MAEP) on the use of assessment and/or monitoring Instruments for Resilience (FarmTree App are the identified tools) .	2.1.3.1 Select 10 facilitators (2 per target municipality) and 20 experts from MCVDD and MAEP (national and municipal services) to be trained on the tools	GCF	FAO
	2.1.3 Train facilitators (selected educated young) and national/local climate change experts (from relevant institutions eg MCVDD, MAEP) on the use of assessment and/or monitoring Instruments for Resilience (FarmTree App are the identified tools) .	2.1.3.2 Equip them and train facilitators through 1 x 5-day training session in Cotonou	GCF	FAO
OUTPUT 2.2: Private sector incentivized to invest in climate resilient agriculture and resilient management techniques in Ouémé Basin	2.2.1 Disseminate information products packaged for private sector, and organise field visits to demonstrate the socio-economic benefits of waterworks, CRA and agroforestry	2.2.1.1 Develop information products packaged for private stakeholders and finance institutions	GCF	FAO

	2.2.1 Disseminate information products packaged for private sector, and organise field visits to demonstrate the socio-economic benefits of waterworks, CRA and agroforestry	2.2.1.2 Disseminate financial products via the OCRI platform, flyers and booklets distributed, etc.	GCF	FAO
	2.2.1 Disseminate information products packaged for private sector, and organise field visits to demonstrate the socio-economic benefits of waterworks, CRA and agroforestry	2.2.1.3 Field visit in each project municipality for private stakeholders (including MFI, wholesaler, export companies, etc.) to showcase the benefits of project activities	GCF	FAO
	2.2.2 Organise municipal forums to connect female and mele farmers and small businesses to local and regional buyers	2.2.2.1 Further Identify relevant buyers in each municipal to invite to the forums	MCVDD	MCVDD
	2.2.2 Organise municipal forums to connect female and male farmers and small businesses to local and regional buyers	2.2.2.2 Liaise with the GoB and municipal authorities to provide support to the forums and to facilitate trade agreements between men and women farmers and buyers	MCVDD	MCVDD
	2.2.2 Organise municipal forums to connect female and male farmers and small businesses to local and regional buyers	2.2.2.3 Organize bi-annual forums (5 in total, from project Y3)	MCVDD	MCVDD
	2.2.2 Organise municipal forums to connect female and male farmers and small businesses to local and regional buyers	2.2.2.4 Ensure partnerships between farmers, processing companies and buyers in Glazoue, Zogbodomey and Zagnanado (MAEP USD 350,000)	MAEP	MAEP

COMPONENT 3: An enabling institutional and financial environment established to promote and upscale low carbon climate-resilient management in Benin's basins				
OUTPUT 3.1: OCRI project institutionalised through a multi-stakeholder platform, regulatory frameworks and capacity building	3.1.1 Establish and activate the OCRI platform ensuring adequate and meaningful participation of women and women's organizations at local and national level	3.1.1.1 f Further Identify relevant stakeholders to participate on the platform, including their roles and responsibilities	GCF	FAO
	3.1.1 Establish and activate the OCRI platform ensuring adequate and meaningful participation of women and women's organizations at local and national level	3.1.1.2 Design the platform operational strategy and multi-stakeholder coordination mechanism	GCF	FAO
	3.1.1 Establish and activate the OCRI platform ensuring adequate and meaningful participation of women and women's organizations at local and national level	3.1.1.3 Design the platform's financial and communication strategies – including an online portal to be hosted by MCVDD	GCF	FAO
	3.1.1 Establish and activate the OCRI platform ensuring adequate and meaningful participation of women and women's organizations at local and national level	3.1.1.4 Disseminate all training modules, knowledge products, and project's lessons learnt and best practices on the platform's online portal	GCF	FAO
	3.1.1 Establish and activate the OCRI platform ensuring adequate and meaningful participation of women and women's organizations at local and national level	3.1.1.5 Ensure government support to OCRI platform	MCVDD	MCVDD

	3.1.2 Implement regional and local climate-resilient development plans in the Oueme Basin to ensure long-term investment in ICRM	3.1.2.1 Organise participatory workshop to discuss options for strengthening the SDAGE	GCF	FAO
	3.1.2 Implement regional and local climate-resilient development plans in the Oueme Basin to ensure long-term investment in ICRM	3.1.2.2 Revise the Operational Management Plan with all relevant stakeholders and validate through a workshop	GCF	FAO
	3.1.2 Implement regional and local climate-resilient development plans in the Oueme Basin to ensure long-term investment in ICRM	3.1.2.3 Organise 1x5-day training sessions on ICRM targeting extension officers and OBA staff members	GCF	FAO
	3.1.2 Implement regional and local climate-resilient development plans in the Oueme Basin to ensure long-term investment in ICRM	3.1.2.4 Revise local development plans	GCF	FAO
	3.1.3 Implement rigorous M&E on land restoration in the Ouémé Basin	3.1.3.1 Organize 1x 5-days training workshop to train 20 officers on M&E techniques with FAO support	GCF	FAO
	3.1.3 Implement rigorous M&E on land restoration in the Ouémé Basin	3.1.3.2 Train 10 extension officers to provide advises on climate-resilient agriculture	GCF	FAO
	3.1.3 Implement rigorous M&E on land restoration in the Ouémé Basin	3.1.3.3 Conduct mid-term evaluation	GCF	FAO
	3.1.3 Implement rigorous M&E on land restoration in the Ouémé Basin	3.1.3.4 Conduct end of project evaluation	GCF	FAO
	3.1.3 Implement rigorous M&E on land restoration in the Ouémé Basin	3.1.3.5 Carry out a project impact assessment study	GCF	FAO

OUTPUT 3.2: Strengthen FNEC's capacity to ensure continuous support to climate-resilient farming in the Oueme Basin	3.2.1 Develop a robust financial strategy for FNEC	3.2.1.1 Review FNEC's existing financial strategy and identify gaps and opportunities to expand it	GCF	FAO
	3.2.1 Develop a robust financial strategy for FNEC	3.2.1.2 Organise consultations with FNEC and MCVDD to discuss best options for increasing FNEC's resources	GCF	FAO
	3.2.1 Develop a robust financial strategy for FNEC	3.2.1.3 Organise validation workshop with GoB to validate the financial strategy	GCF	FAO
	3.2.1 Develop a robust financial strategy for FNEC	3.2.1.4 Through consultation with FNEC, identify relevant criteria to facilitate the selection of relevant climate change adaptation projects to be financed through FNEC's resources	GCF	FAO
	3.2.2 Build FNEC's capacity to design, select, implement and monitor climate change-related projects ensuring financial access for both women and men	3.2.2.1 Conduct a detailed assessment of FNEC's capacity to design, implement and monitor climate change-related projects	GCF	FAO
	3.2.2 Build FNEC's capacity to design, select, implement and monitor climate change-related projects ensuring financial access for both women and men	3.2.2.2 Design training modules and train 5 members of FNEC (2x1-week training)	GCF	FAO
	3.2.2 Build FNEC's capacity to design, select, implement and monitor climate change-related projects ensuring financial access for both women and men	3.2.2.3 Provide regular support to FNEC to design a bankable climate change project to submit to the AF or GCF	GCF	FAO
	3.2.3 Provide finance to 3 micro-projects that contribute to climate change adaptation and ecosystem restoration in	3.2.3.1 Open call for proposal	FNEC	FNEC

	the Oueme Basin (FNEC financed)			
	3.2.3 Provide finance to 3 micro-projects that contribute to climate change adaptation and ecosystem restoration in the Oueme Basin (FNEC financed)	3.2.3.2. Review received projects and select, contract and finance the successful ones	FNEC	FNEC
OUTPUT 3.3: Awareness of ICRM in basins' benefits raised among farmers and public and private institutions	3.3.1 Organise knowledge dissemination events and products on OCRI including gender mainstreaming	3.3.1.1 Organize 5 field visits for 100 farmers per municipality (5), living in neighboring communities that did not directly beneficiated the project	GCF	FAO
	3.3.1 Organise knowledge dissemination events and products on OCRI including gender mainstreaming	3.3.1.2 Organise 1 x 1-week visit for representatives of Benin's other basins	GCF	FAO
	3.3.1 Organise knowledge dissemination events and products on OCRI including gender mainstreaming	3.3.1.3 Synergise with SAP project to train 10 radio broadcasters to disseminate climate change related information and organize radio broadcast with local radio in each municipality	GCF	FAO
	3.3.1 Organise knowledge dissemination events and products on OCRI including gender mainstreaming	3.3.1.4 Develop and package knowledge products on the projects, according to the needs of each targeted group	GCF	FAO
	3.3.1 Organise knowledge dissemination events and products on OCRI including gender mainstreaming	3.3.1.5 Organise sensitization campaings on CC in Glazoue and Djougou (MAEP USD 21,200)	MAEP	MAEP
	3.3.2 Organise OCRI Annual Symposium	3.3.2.1 Identify relevant participants from agri-business (producers, sellers, manufacturer, etc.) and policy-makers	GCF	MCVDD

		to attend the symposium		
	3.3.2 Organise OCRI Annual Symposium	3.3.2.2 Organise 1 symposium per year from project Y2, with support from MCVDD and MAEP	GCF	MCVDD
	3.3.2 Organise OCRI Annual Symposium	3.3.2.3 FAO supports OCRI Annual Symposium	FAO	FAO

Flow of Funds

378. FAO as the accredited entity (AE) will receive the funds from the GCF at HQ level. MCDDV will be an executing entity to whom FAO will transfer funds through the applicable modality, which foresee all necessary provisions for monitoring and supervision , including regular supervision missions, third-party regular spot checks and audits to ensure financial management, procurement and other management requirements are in line with agreed standards and practices.

379. MCVDD as EE has been assessed in order to gauge its handling capacity and a mitigation plan has been agreed upon to tackle shortcomings. MAEP will execute the activites it co-finances and has also been assessed. FNEC will execute the activity it cofinances.

380. FAO, MAEP, FNEC and MCVDD in their role of EEs will manage project financial expenditures against budgets and execute payments.

381. Partners expected to receive GCF proceeds through funds transfer in accordance with FAO's procurement rules are organizations involved in the Project implementation as procured parties (MAEP, etc., see procurement plan for more details). Procured parties will be contracted in accordance with FAO rules and regulations of procuring goods and services (e.g. FAO Manual Section 507).

8.3.1 Capacity building needs

382. An assessment of the administrative, financial and technical capacity of DGEC/ MCVDD to implement the proposed OCRI project and maintain project interventions beyond its lifetime was conducted by FAO. Three main gaps and weaknesses were identified, and directly relate with the GoB's technical capacity to implement the OCRI project; these gaps will be addressed through targeted project interventions, as detailed below. A full overview of the technical, administrative, and financial weaknesses of DGEC/MCVDD is available in the OPA.

1) Limited capacity and tools within MCVDD to conduct M&E/ no reliable M&E mechanism

383. Under Activity 3.1.4 of the proposed project, local authorities in the target municipalities, as well as extension officers from MCVDD and MAEP will receive training on M&E related to

climate change adaptation projects. More specifically, they will become familiar with SHARP (Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists), a holistic resilience assessment tool. The tool will enable local stakeholders to measure the specific impacts of OCRI project in terms of increased climate resilience of the beneficiaries. The tool can also be implemented during the inception phase of a project to best identify where the proposed strategies are most needed and identify who need them the most; it provides a baseline against which project progress can be evaluated. While local stakeholders will be engaged to implement SHARP for regular OCRI M&E process, they will also be capacitated to conduct similar analysis for other/ future climate change adaptation interventions.

2) Limited capacity to collect, compile, archive and share with relevant stakeholder's data and information in the AFOLU sector

384. Under Activity 3.1.1, the OCRI platform will be established, including a knowledge website hosted by MCVDD. On this platform and website, the information, data, lessons learned and knowledge products, developed by the project will be shared, along with M&E reports and the training material. This platform will constitute a space for MCVDD to compile all climate change-relevant information on ongoing and past or future projects, their lessons learned and best practices, on the various benefits of adaptation, as well as tools and guidelines to mainstream adaptation into policies and development plans. Through the OCRI platform, partners from various institutions will have access to these data; and knowledge products will be shared with relevant stakeholders including in the private sector. The coordination mechanism of the OCRI platform, which will become self-sustained at project's end, will constitute a resilient mean of coordination and communication between various stakeholders and sectors in the Ouémé Basin, while the knowledge website will have public access to enable the dissemination of data and information towards all relevant sectors.

3) Lack of multisectoral coordination mechanism to implement climate change-related initiatives

385. As mentioned above, the project will establish a multi-stakeholder coordination mechanism through the OCRI platform. It will provide a space where government, producers, investors, and buyers of climate-resilient agriproducts can connect, discuss innovation, changing needs on market, production challenges linked to climate change as well as other market or financial barriers or opportunities to further develop climate-resilient agriculture in the Ouémé Basin. Moreover, it will support the generation of new knowledge on the benefits from ICRM in basins. The sustainability of the platform will be ensured through a financial strategy based on members' contributions (to be developed by the project).