IVM Institute for Environmental Studies

Adaptive Water Management at the Local Scale

Synthesis report Ghana

Irrigated farming and agroforestry by farmer groups and river basin management: an adapation to the changing climate and environment in the Dayi Basin, Volta Region, Ghana

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1 Introduction

1.1 ADAPTS Background

Climate change is expected to result in gradual changes in temperature, rainfall patterns and sea level rise, but also increased climate variability and extreme events, threatening water availability and food security for millions of poor people. Adaptation strategies to deal with these impacts are urgently needed for communities and national governments alike.

In 2008, the Institute for Environmental Studies, ACACIA Water, and Both ENDS started the ADAPTS project, funded by the Dutch Ministry of Foreign Affairs. The overall aim of ADAPTS is to increase developing countries' adaptive capacities by achieving the inclusion of climate change and adaptation considerations into water policies, local planning and investment decisions.

ADAPTS cooperates with local communities, civil society organisations, local and national governments, scientific institutes, and the private sector. It proves that adaption is already taking place at the local level. ADAPTS combines local and global knowledge in the area of water management and empowers vulnerable communities in designing and implementing cost effective and sustainable adaptation measures. Through dialogues with local and national governments it helps to ensure the inclusion of their knowledge and visions into the development of climate proof water policies and investments. To increase the adaptive capacities in developing countries, ADAPTS focuses on:

1. ***Knowledge development:*** developing climate change information and studying how local water management can be made climate proof.
2. ***Local Action:*** the identification, support, documentation, analysis and dissemination of innovative, locally-based interventions to ensure that local knowledge and visions are included into basin and national policy dialogues.
3. ***Dialogue**:* establishing policy dialogues between local and national stakeholders on the issues of sustainable water management and climate change adaptation.

The project was implemented in six river basins around the world. Projects with a three year duration have been carried out in Ethiopia, Ghana and Peru. One year projects are being carried out Botswana, Brazil and Vietnam. This report deals with the ADAPTS study in Ghana.

1.2 The Ghana Case

The main goals of the Ghana project were to assess changes in water availability in the Dayi River basin and to support local farmers in setting up irrigated agriculture and agroforestry, as a local climate adaptation initiative. Next to this, the project aimed to support the development of a Basin Management Plan and to include climate change, water use for irrigation (licensing system) and agroforestry (Buffer zone of rivers and lakes), and also to explore ways to involve local actors in the basin's development. The project was implemented by the Ghanaian NGO Development Institute (DI), Water Resources Commission of Ghana (WRC), Acacia Water, Both ENDS, and Institute for Environmental Studies (IVM).

2 Area Description

2.1 Physical Environment

The Dayi river is located in the Volta Region, east of the Volta Lake. The river runs for the Akwapim mountains along the Ghana-Togo border to the Volta Lake (Figure 1). The catchment is a flat valley surrounded by mountain ranges with height from 300 to 1000 m. The length of the valley is about 60 km and its largest width is about 20 km. The catchment covers an area of approximately 2180 km2: the main part is located in Ghana, around 422 km2 in Togo. Rainfall in the basin has decreased in this area. At Kpandu station at the lower end of the basin (Figure 1) rainfall gradually went down from 1400 to 600 mm/yr in the period from 1985 to 2006. At Hohoe more upstream in the valley rainfall fell down from 1700 to 1500 mm/yr with the largest change around the late seventees and early eighties of the last century. The major Dayi river and some tributaries in the eastern part are perennial, some with spectacular waterfalls. The subsoil consists mainly of old sedimentary rocks like shales and quartzites and volcanic rocks. The rocks are covered by a weathering layer and younger unconsolidated deposits as loams, sands and gravels along the major rivers. The vegetation of the area can be divided into three zones, reflecting the rainfall distribution and the altitude. These are the moist semi-deciduous forest, savanna and mountain vegetation. Moist semi-deciduous forest once existed on the lower slopes of the highland but crop cultivation has reduced this to secondary forest. Patches of wooded savannah can also be found.

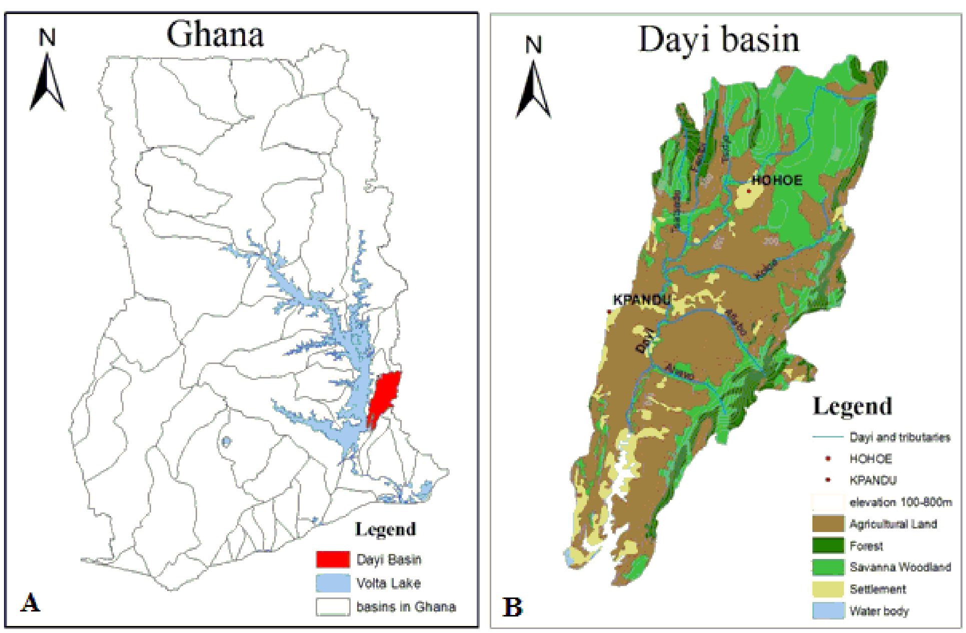


Figure 2-1A. Location of the Dayi River Basin (red) in Ghana.
Figure 2.1B. The Dayi Basin with an Indication of Landuse (WRC, 2009)

2.2 Socio-Economic Situation

2.2.1 General Characteristics

The Volta Region has a population density of 79.5 persons per km2 and a population growth of 1.9% after correction for out-migration. The region has some urban centres such as Ho and Hohoe but is largely dominated by an archipelago of traditional communities. Around seventy percent of the regional population lives in rural areas (GSS, 2005). Unemployment rates are 7-8%, but 83% of the economically active population works in the informal private sector. In total, around 80% of the economically active population is self-employed, and because the population is rather young (41% is aged 0-14 years), the dependency ratio is high: 92 dependents on 100 working people (Alfa et al., 2009).

The Dayi Basin is is a rural relatively densely populated area (123 persons/km2; Groen et al., 2008). The main city in the research area is Hohoe. Main economic activities are subsistence and some cash crop farming. The major part of the basin belongs to the Hohoe District, which has a population of 144,550 (Hohoe District, 2009). The southwestern part belongs to te Kpandu and Lower Dayi District and in the north there is part belonging to the Jasikan District. The Hohoe District is one of the 18 municipalities in the Volta Region (GSS, 2005). Municipalities are centrally appointed administrations that contain traditional communities with a chief as leader.

There are two medium sized communal irrigation schemes (15 to 30 farmers and about 10 to 20 acres). One is at Kpandu with an intake from Lake Volta and sprinkler irrigation. The system is run by the Irrigation Development Authority (IDA). The other one is at Ve Koleonu, where water is lifted from the Dayi River, distributed via lined channels and brought to the fields by furrow irrigation. The system funded by the WB was never finished and is operated now by the farmer group.

Development Institute and EDYM are the main NGO’s active in development of sustainable agriculture and agroforestry.

2.2.2 ADAPTS Socio-Economic Survey

Socio-Economic Facts and Perceptions

In May and June 2009 a socio-economic field survey was carried by IVM. Five villages were selected based upon their representativeness for the three most distinct ecological zones in the basin.

The villages of Kukurantumi, Abrani, Koloenu, Have and Woadze (from top to bottom) are neatly spread out along the Dayi River, comprising upstream, midstream and downstream areas (Figure 2.1). The villages of Have and Woadze represent the mountainous downstream area. Koloenu represents the mid-stream transitional savannah, where forests are largely cleared and turned into large scale arable land. Kukurantumi and Abrani represent the upstream forested area. For the study information from 109 respondents of all villages have been used. For a detailed account we refer to (Pauw et al., 2009)

Ecological zone	Position in river basin	Community	Features
Forest (N=35)	Upstream	Kukurantumi, Abrani	Tree-cropping (cocoa production), Dayi River as main water source
Transitional savannah (N=35)	Midstream	Koloenu	Grasslands, forest zone, vegetables cultivation, area interspersed by rivers
Mountain range (N=37)	Downstream	Woadze, Have	Uphill agriculture, deforested hill slopes, root crop production predominant

Table 1 Locations and Characteristics of Socio-Economic Survey (Alfa et al., 2009) N is number of respondents.

A typical household has one male and one female member, and two to four children. Most respondents see themselves as farmers, although there are many who also have other sources of income. Fifty respondents (47%) have additional sources of income generation, such as processing food, selling fish and eggs, selling livestock, or a pension. Based on several basic socio-economic indicators the survey indicates that in general the upstream households have the lowest socio-economic development level, midstream households show the highest socio-economic development level.

Although all villages are connected to the water net, only 30% of them use pipe water as their main source of domestic water. The rest fetch free water from the rivers.

The amount of irrigated land constitutes less than 4% of the total agricultural land being used (excluding fallow land). Thirty-one respondents grow irrigated crops, 17 of which live in the midstream zone. Unlike the harvests of tree crops and rain fed crops, virtually the entire harvest of irrigated crops is used for commercial purposes. The most important crops are okra, garden eggs and pepper. The majority of the respondents grow rain-fed crops such as cassava (80 %) and maize (77 %). Of the harvest of rain fed crops, around 15% is used for own consumption and the rest is brought to market. The production of beans, rice and peanuts is almost exclusively the domain of the midstream households; they also grow most of the maize produced. The more drought resistant crops of Cassava, yam and cocoyam are grown more by the upstream and downstream communities. The midstream households grow the largest number of different crops, their harvests have the highest value and revenues are the highest. Highest revenues are from drought sensitive vegetables like okra, tomatoes, garden eggs and pepper.

A large majority of respondents states that their income has decreased in the past five years. They argue that price fluctuations have decreased the market prices of their crops and increased the price of seeds or pesticides and (inorganic) fertilizers. Some people have fallen ill because of poor health or age and therefore could not maintain their living standards.

Vulnerability and Adaptation to Climate Change

Of five climate related hazards (heat, rainfall variability, drought, prolonged dry season and floods, the first three are the most important according to most respondents in the case study area. They consider a lack of water, a failing harvest and the subsequent outmigration of youth as the three most important consequences of these climate related hazards. Hunger is seen as the worst consequence of climate related hazards by 85% of the respondents. The respondents consider themselves as dependent on the climate, as well as vulnerable to climate related hazards, and afraid of future hazards.

The government documents show some interest in climate change adaptation but merely focus on development. The interrelated degradation of soils and deforestation are important issues in policy documents, as well as irrigation.

Exactly these topics are also brought up by the respondents, both in open and closed questions of the questionnaire. Reforestation, prevention of land degradation, irrigation and planting of tree crops are seen as good measures to prevent the negative effects of climate related hazards, both for individuals and communities as a whole. Crop diversification is also stated to be a successful measure to cope with climate related hazards.

The respondents' motivation to adapt is correlated significantly to their experience in farming and on the costs of adaptation. Richer farmers appear more motivated to adapt than the poorer ones.

All in all it can be concluded that the farmers have an above medium risk perception towards climate related hazards. The subsequent motivation of the respondents to adapt is correlated significantly to their experience in farming and on the costs of adaptation. Richer farmers appear more motivated to adapt than the poorer ones.

It is remarked that the perception by the local people of the interconnection between local environmental problems and climate change is not always correct. Reforestation can be an adaptive measure, for instance because it prevents erosion during heavy rainfall or because it slows down runoff. Once erosion has taken place less water may infiltrate leading to floods and reduced base flows. Deforestation, on the other hand, is not the cause of global climate change –something many respondents think-, but it can add to reduction in recycling water to the atmosphere. This might however lead to a reduction in rainfall in another area.

3 Changes in Climate, Landuse and Hydrology

3.1 Climate and Climate Change

Ghana has a tropical climate with a dry season from December to April and a bimodal wet season that shows peaks in June and September (Figure 4). Average rainfall varies from 1100 tot 2000 mm/yr. Potential evaporation is around 1500 mm/yr. A result variations in yearly rainfall have a large impact on groundwater recharge and river base flow, which also shows interannual variations. Presently base flow is around 1 to 2 m3/s at Hohoe and increases to about 6 m3/s at Gbefi, further downstream.

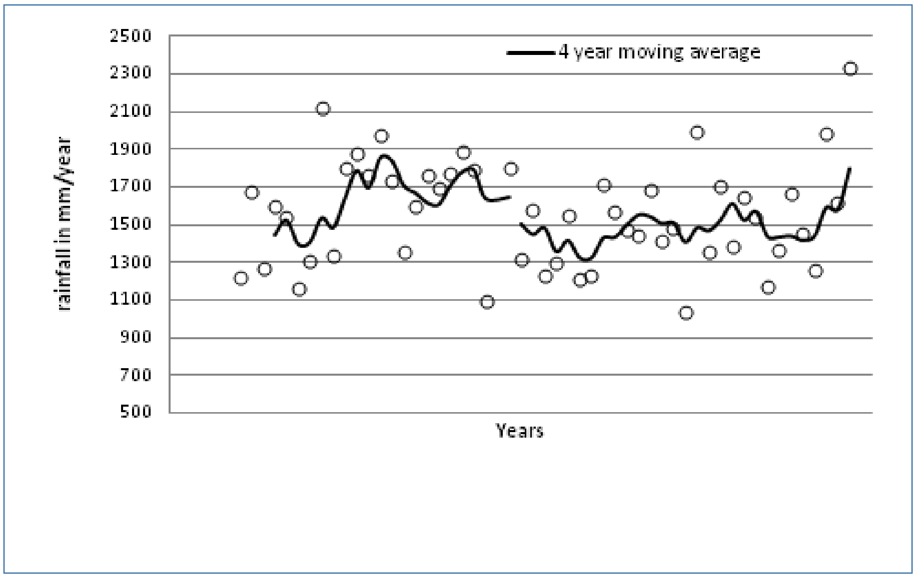


Figure 3-1 Annual Rainfall at Hohoe

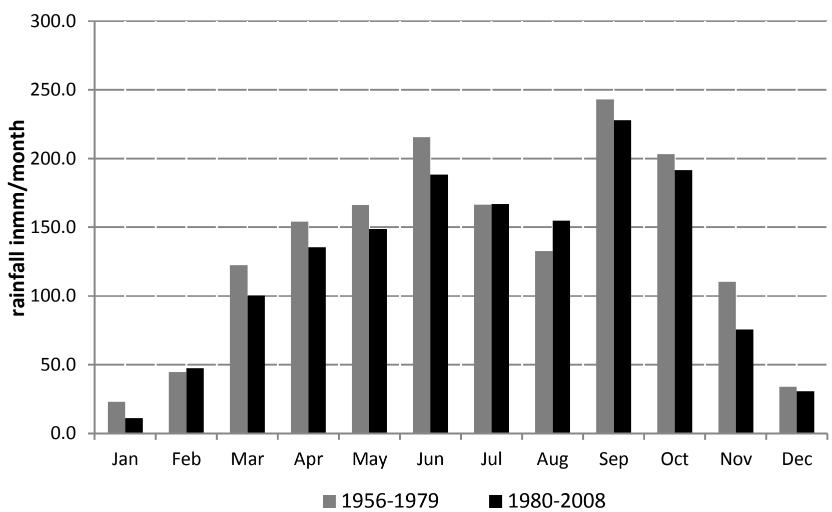


Figure 3-2 Average Monthly Rainfall at Hohoe

The socio-economic study (Pauw et al., 2009) and discussions during the various missions made clear that population in the Dayi River Basin is well aware of climate and environmental change (deforestation). They state that rainfall has decreased over the past decades and has become less reliable. The first rainy season starts late and the late rainy season ends early. As a result two cropping periods are no longer possible. Farmers are dependent on the rains in April and May to plant their seedlings.

Rivers and springs disappear or are no longer perennial. Local population also mentions that deforestation during the last decades is the cause of this decrease of rainfall and river base flow and the cessation of spring flow. In their perception reforestation would bring more rain.

The facts underline the perceptions of the local population to a large extent. Rainfall data show that annual rainfall at Hohoe changed from approximately 1700 mm/year in 1975 to 1400 mm/year at the present (Figure 3-1). Early and late rains decreased (Figure 3-2). In entire Ghana, lower rainfall amounts over the years due to longer dry seasons have led to more and more tributaries and main rivers drying up quickly, leading to a lower surface and groundwater availability for the increasing population (Alfa et al., 2009).

Mean annual daily temperature has increased by 1°C in the period 1961-2000 (and is projected to increase by 2.5-3.0 °C by 2050. A recent projection from the Netherlands Climate Assistance Programme (NCAP, 2011) indicates a further decline of rainfall and a shortening of the rainy season, combined with increasing temperatures throughout the year (Figure 3-3). On the other hand trends in temperature indicate an increase of rainfall for the whole of Ghana in the rainy season (Pauw et al., 2009).

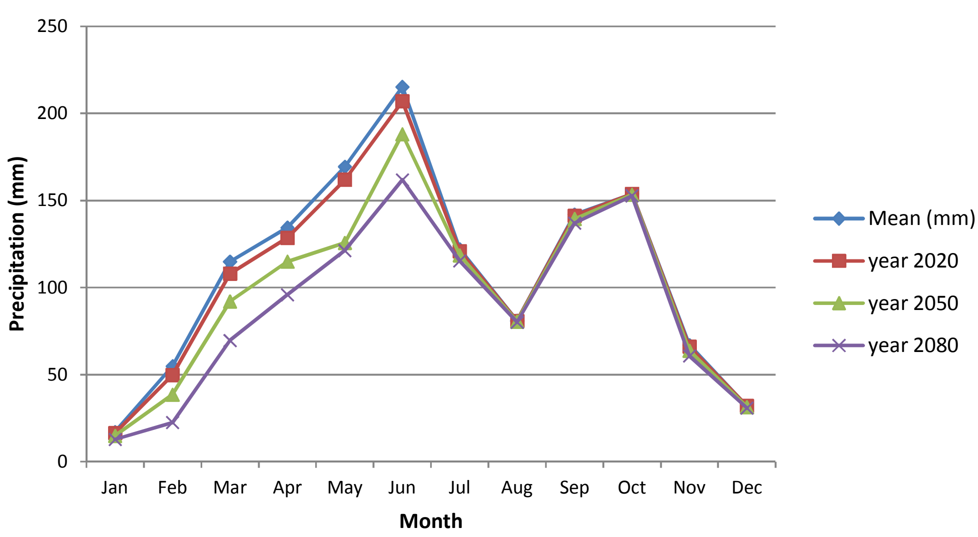


Figure 3-3 Monthly Rainfall for Ghana as a Whole, Predicted by NCAP (2011)

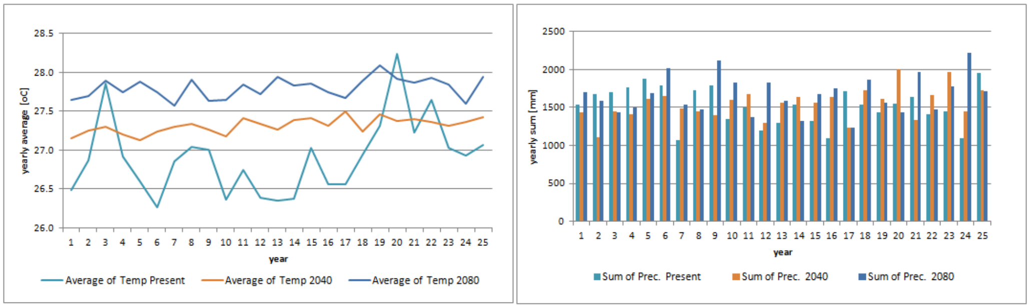
There is discussion whether the observed changes are part of climate change or part of the variability of the West African rainfall regime. Another point of discussion regarding trends and causes of climate change is the difference between perceptions and scientific knowledge. Nevertheless it is clear that rainfall patterns are changing. Farmers, who depend on the rains, are vulnerable to these changes.

In order to get insight in future flood frequency and river base flows records of daily rainfall are needed. With these records, routed through a rainfall-runoff model of the Dayi River, the runoff pattern can be simulated for future climates. For the ADAPTS Ghana project The Vrije Universiteit of Amsterdam (VUA) has developed a tropical rainfall generator. The rainfall generator uses historical rainfall data from several locations and a temperature rise based on a certain climate scenario to create the new dataset with nearest neighbor resampling procedures (Buishand & Brandsma, 2001). For the Ghana case a scenario with a temperature rise of 3 ^{0}C in one century is used. This resulted in three time series of 25 years with data of temperature and precipitation representing the present situation, the 2040 climate and the 2080 climate.

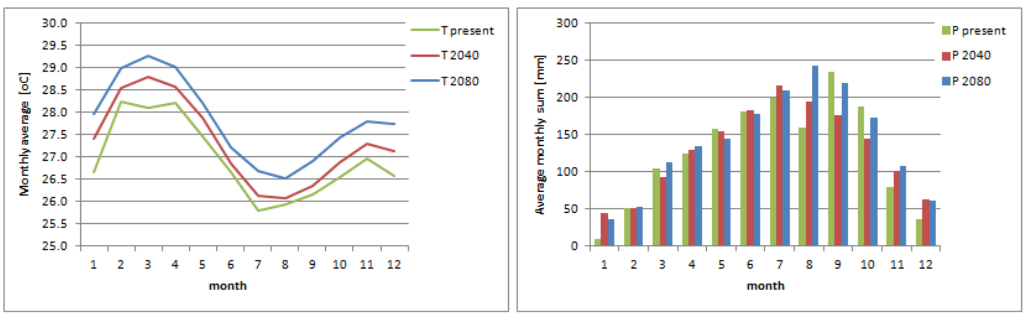
The rainfall generator gives on average an increasing yearly rainfall sum when comparing the present situation with the 2040 and 2080 climate (Figure 3-4). This increase mainly occurs in the months March and April and August till November (Figure 3-5). For September and October the precipitation for the 2040 scenario is lower than for the 2080 scenario.

Table 2 Average Sum of Precipitation and Average of Temperature for a Period of 25 Years, representing the Present Situation, the 2040 Climate and the 2080 Climate

	Average Rainfall/Year (mm)	Average Yearly Temperature (°C)	Average Sum of Simulated Discharge (mm)
Present	1520	26.9	413
2040	1548	27.3	397
2080	1666	27.8	490



3-4 Yearly Average Temperature and Yearly Sum of Precipitation in VU Rainfall Generator for Present Situation, 2040 Climate and 2080 Climate.

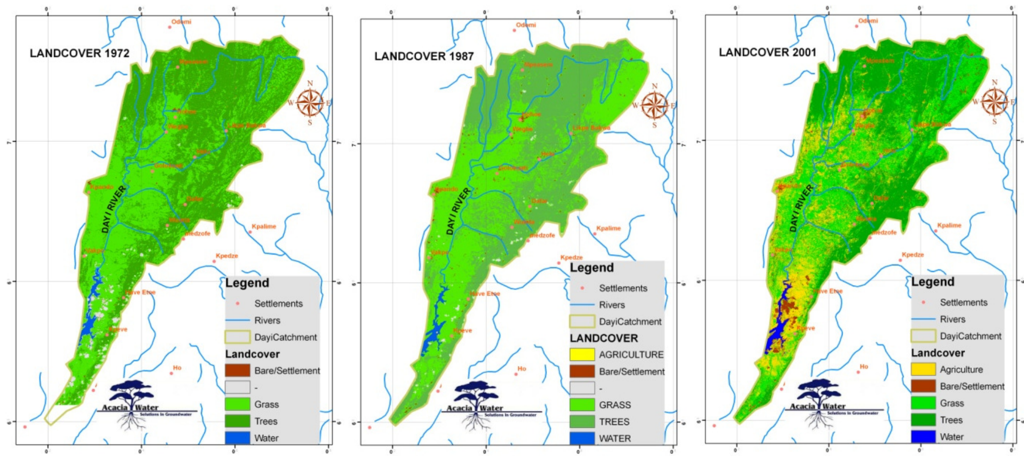


3-5 Monthly Average Temperature and Average Monthly Sum of Precipitation in VU Rainfall Generator for Present Situation, 2040 Climate and 2080 Climate.

3.1 Landuse Change

Local population states that deforestation in the last decades caused the decrease of river and spring flow. A spatial and temporal analysis of land cover is carried out using satellite images. LANDSAT images show that deforestation intensified after 1987. However large-scale erosion is not visible and deforestation does not seem to have had a large impact on river flows and the local climate.

It is clear that agriculture land use has shown a remarkable growth between 1987 and 2001 especially in the areas close to the lake (Figure 3-6). Also the bare patches (which could be fallow land at the image capture time) or settlement areas have shown an increase. The forest/grass ratio seems to have decreased from 1972 to 2001 based on the LANDSAT images. However, there is no visible effect on the size of the lake itself over this entire period.



3-6 Interpreted Landcover Temporal Changes based on LANDSAT Images

LANDSAT NDVI indexes which are an indication of vegetation presence and characteristics are more or less stable over the years. Apparently the deforestation has been compensated with secondary forests and dense cropping patterns.

Long term annual and monthly NDVI show a marginally higher vegetation density presence in October than in February for the same areas in different directions of the catchment (upper head water and lower downstream parts). This is expected because October is approximately the end of the rainy season and February approximately is the middle of the dry season. Eighteen year average of the NDVI for January, March and September for the whole catchment show the expected highest vegetation index in September and lowest in March.

Steep slopes are present close to the ridge boundaries and on the headwater side of the catchment area. Agriculture spread over the entire catchment and in 2001 also takes place on steep slopes. Presence of settlements close to such areas can be seen as an explanation of agriculture spread due to economic pressure from farmer communities.

3.2 Hydrological Scenario Studies

3.1.1 Hydrology General

The path followed by the Dayi River is indicated in Figure 3-7. The river flows from Togo to the Volta Lake. The tributaries also originate in the higher elevated areas. The Ahavo, Aflabo and Koloe Rivers originate in the East close to the Togolese border and pass through an area mainly consisting of quartzite and sandstone. Close to their confluence with the Dayi River they pass over calcareous rock. The Aflabo and Ahavo rise close to the highest points in the catchment where acidic rock is found. The Tsatsadu and Fentbi Rivers run from the steep and densely forested slopes in the north-western side of the catchment. A third tributary, the Tsidje or Feku River, with a similar flow direction, North to South, rises in the lower lying area. Because of these confluences discharge of the Dayi river increases towards the south. In 2004 baseflow at Gbefi was 4 to 5 times as high as baseflow at Hohoe (Beyen and Rutgrink, 2010).

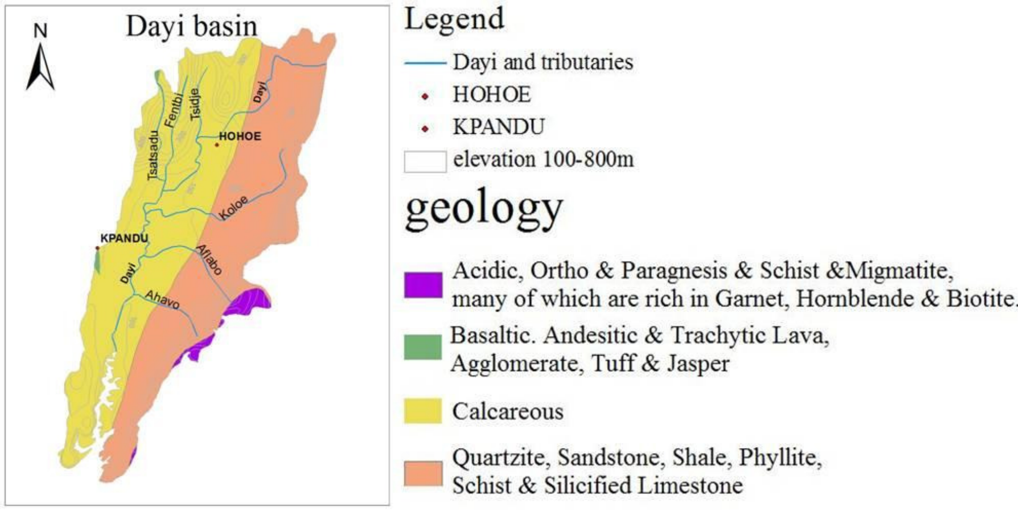
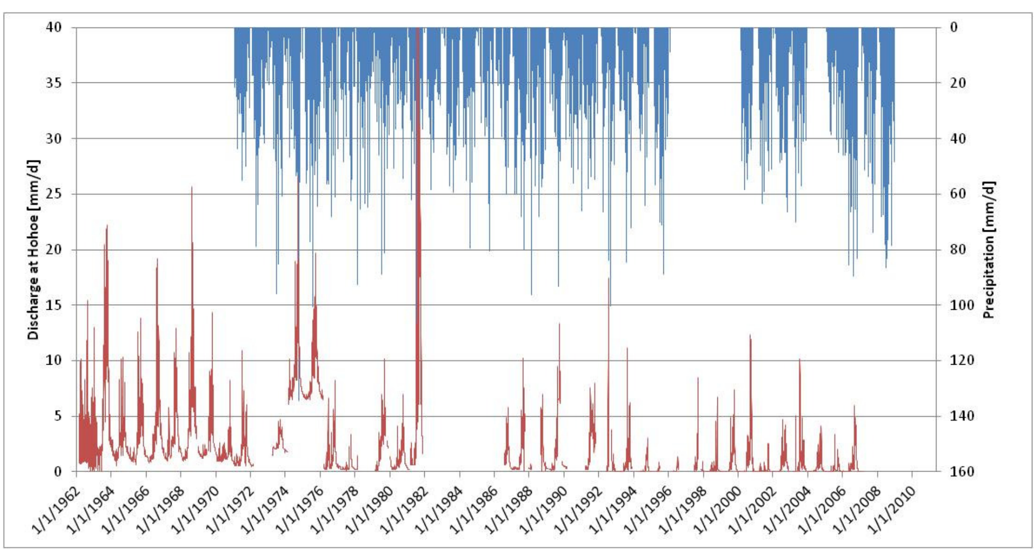


Figure 3-7 Indication of Tributaries and a description of the geology in the Dayi Basin (WRC, 2009)

3.1.2 Rainfall Runoff Model

During October and November 2009 a field study was carried out on the runoff behavior of the Dayi River (Beyen & Rutgrink, 2010). Based on observations and existing data on daily runoff, rainfall, temperature and potential evapotranspiration a rainfall-runoff model was made for the catchment upstream if Hohoe. The model is made with the HBV code, which simulates catchment response by routing rainfall through three reservoirs (Seibert, 2005). In HBV model two vegetation and five elevation zones were discerned. The model was calibration by comparing simulated discharge and measured discharge (Figure 3-8) for different periods, for which both daily precipitation and daily runoff were available. Catchment parameters were optimized by calibration using Monte Carlo runs.



3-8 Precipitation (blue) and Discharge (red) data for Hohoe

The dataset shows quite some gaps and some unrealistic high values for discharge (1974 to 1977). There are only 5 periods with complete data (rainfall and runoff): 1976 – 1977; 1980 – 1981; 1986 – 1987; 2000 – 2002; en 2005 – 2006. Figure 3-8 shows that base flows before 1972 are considerably higher than those after 1976.

In figure 3-9 average rainfall and temperature data are presented for the last four decades. Note that the relatively high rainfall in the period 2001 – 2008 is the result of increased rainfall in the last 3 years. Also the increasing temperatures are apparent in this figure.

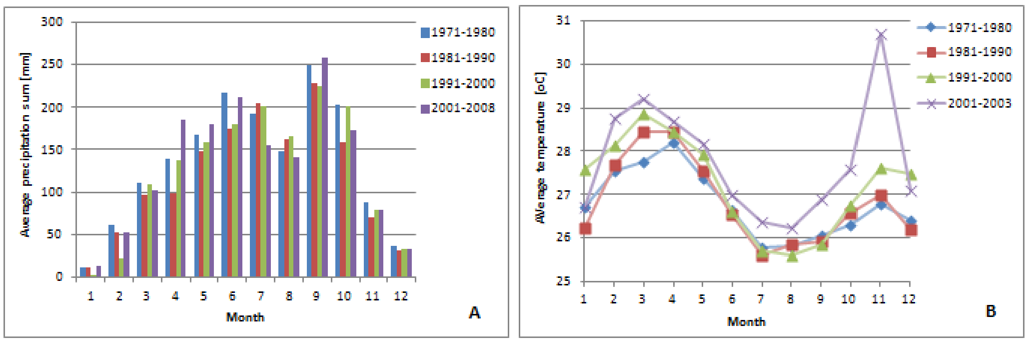


Figure 3-9 Observed Precipitation Average Sum (A) and Observed Temperature Average (B)

Calibration for the five periods resulted in efficiencies varying from 0.3 and 0.84. The period of 1986 – 1987 gave the best results. The more recent periods were difficult to calibrate, especially with respect to base flows during the dry season. At times base flows displayed a sharp drop in discharge. This might be an indication of upstream use of river water from the river. The suggested cause has not been verified. After 1980 base flow seems to be lower. For the runs 2000 – 2002 and 2005 – 2006 the model was not able to simulate the base flow (often zero). The '86-'87 run gives the highest efficiency.

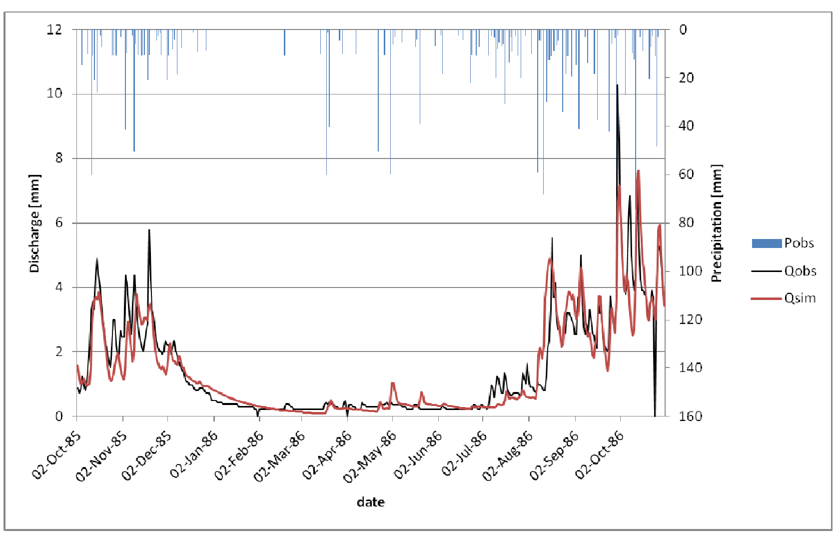


Figure 3-10 Observed Precipitation (mm), Observed and Simulated Discharge (mm) for the '86-'87 run.

3.1.3 Runoff for Various Climate Scenarios

The rainfall runoff model calibrated for 1986 – 1987 data was used to simulate runoff for different climate projections. The purpose of these scenarios runs was to study future base flow. The base flow in the dry season is the main source of water and sets a limit to the sustainable development of irrigated agriculture.

Simulations with the HBV model were carried out for periods of 25 years for the present situation (1971-1996, the 2040 climate (2028 – 2053) and the 2080 climate (2068 – 2093).

Table 3 Sum of Precipitation, Average of Temperature, Average Sum of Simulated Discharge and Average Sum of Actual Evapotranspiration for a Period of 25 years, representing the Present Situation, the 2040 Climate and the 2080 Climate.

	Avg. sum of Precipitation [mm]	Avg. of Temperature [^{o}C]	Avg. sum of Simulated discharge [mm]	Avg. sum of act. Evapotranspiration [mm]
Present	1520	26.9	413	1104
2040	1548	27.3	397	1154
2080	1666	27.8	490	1176

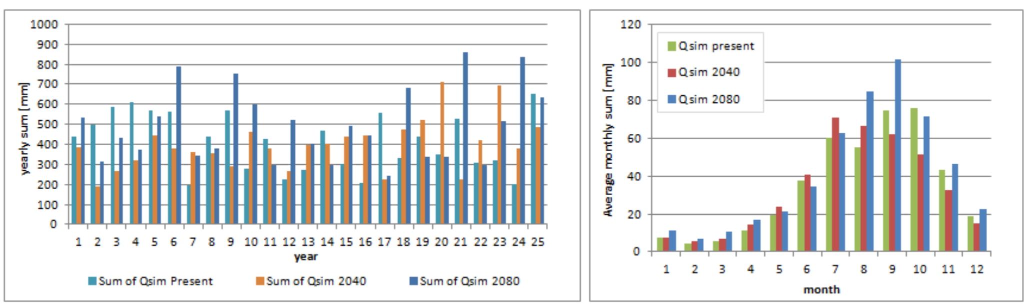


Figure 3-11 Yearly Sum and Monthly Sum of Simulated Discharge for the Present Situation, 2040 Climate and 2080 Climate.

Results show that the effect of climate change depends on temperature and precipitation. The increase in rainfall amount is not always high enough to compensate for the increase in the actual evapotranspiration caused by a rise in temperature. In the wet months September to December of the 2040 climate river discharges have decreased compared to the present climate, but they rise again above the present values in the year 2080. In August river discharges seem to grow continuously during this century. In July and also the preceding dry months the situation remains more or less stable. Given the uncertainty of the climate and runoff simulations we must conclude that there is no evidence that present base flows will change much in future.

3.1.4 Adaption Strategies

Within the project several adaptation measures were developed. Before implementing measures in the field, the effect of these measures were evaluated under current climatic conditions and under the conditions projected for the basin. For this evaluation the model WEAP was used (www.weap21.org). for this evaluation the basic water related elements of the Basin and their relations as they currently exist were used. This includes the specification of supply, demand and resource data, including information on dams and reservoirs, as extracted from sources such as the population census, satellite images and hydrological measurements. For climate change, the results of the Weather generator as well as two SRES scenarios were used. The two strategies that were evaluated are business as usual and construction of a wear at Hohoe. Under both strategies irrigation is practiced (Table 4).

Table 4 Average Demand site coverage (%) for Eight Demand Sites in the Four Sub Dayi Catchments, over the Period 2010-2050.

The blue cells show the results without a weir, the green cells show the results with the Hohoe weir (Pauw & Boateng, 2011).

Average demand site coverage (%) over the period 15 November 2011- 28 February 2050								
Part of Dayi	West	Upper			East		Middle	
Demand site	Kpando Livestock	New Baika	Hohoe domestic	Ve Koloenu	Ho livestock	Ho irri devt	Vakpo	Afeyi Irri devt 2
Reference without weir	66.7	72.8	72.8	77.1	52.2	n.a.	77.1	n.a.
>A2	87.3	84.2	84.2	90.3	77.0	n.a.	90.3	n.a.
>> Strong irrigation	84.7	84.2	84.1	89.7	76.6	70.6	89.7	82.9
>Weather generator	86.7	88.5	88.4	91.4	72.2	n.a.	91.4	n.a.
>>strong irrigation	84.5	88.4	88.3	91.1	71.9	67.1	91.1	83.7
Reference with weir	68.8	99.9	100	100	52.2	n.a.	100	n.a.
>B1	88.5	99.9	100	100	77.8	n.a.	100	n.a
>A2	89.5	100	100	100	77.0	n.a.	100	n.a.
>>strong irrigation	87.3	100	100	100	76.6	70.6	100	92.3
>Weather generator	88.3	99.9	100	100	72.2	n.a.	100	n.a.
>>strong irrigation	85.6	99.9	100	100	71.9	67.1	100	92.3

Figure 3-12 shows for the Weir strategy the unmet demand under all climate scenarios, from half November until the end of February, averaged over 2012-2050. The water demand is not fully met from half December until the end of February, with a peak in January. The unmet demand of the reference scenario is larger than for the A2, B1 and weather generator scenarios. The low flows in the dry season causes demands not to be met. The water demand can be met until half December, when irrigation increases and rains recede. After that the unmet demand increases to its top in January and reduces again at the beginning of February. The unmet demand increases under the 'strong irrigation' scenario, both under the A2 and weather generator scenarios. The maximum shortage is approximately 200 cubic meters on 31 January in the A2-strong irrigation scenario.

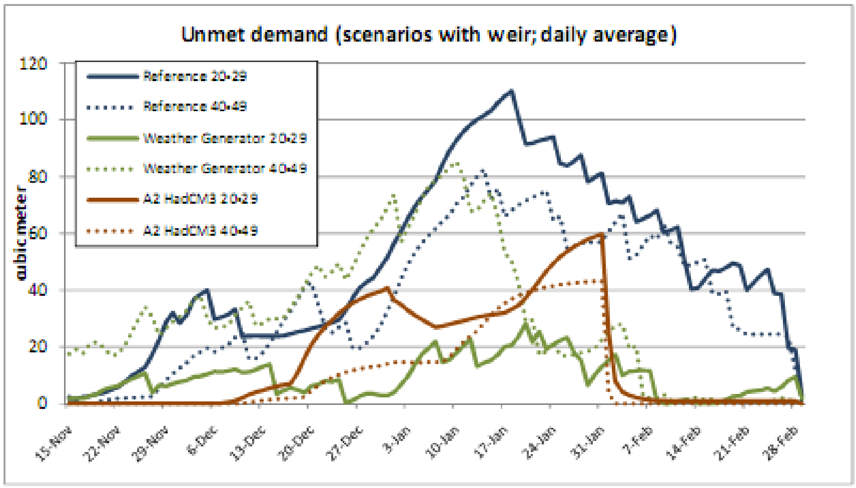


Figure 3-12 Unmet Demand for all Climate Scenarios with Weir; 2012-2050 (Daily Average).

The steep curves in the A2 scenarios denote the transition to another month and can be explained by the fact that this model produced monthly values that were averaged over the days (Pauw & Boateng, 2011)

The main results of this analysis are that unmet water demands very high in the stategies without a weir. Under current circumstances they exist already and will increase in the future. The unmet water demands will largely disappear under current and projected climatic circumstances, due to the buffering effect of the Hohoe weir. This will have beneficial effects under current circumstances as well as under different climate scenarios. The weir will not have an impact on high runoff and flooding events.

Based on the analysis under different climate projections, it is not expected that climate change is a major hurdle for irrigation development in the upper and middle catchment of the Dayi River because of the weir near Hohoe. The total irrigation needs remain minimal compared with the water demand of Hohoe town. Given the uncertainties, this irrigation is a no-regret adaptive measure which can be implemented.

4 Interventions

4.1 Local Action

4.1.1 The ADAPTS Irrigation and Agroforestry Schemes

The Woadze Model is an environmentally friendly agriculture model developed by the Development Institute. The purpose of the Woadze model in the ADAPTS project context was to reduce the vulnerability of communities in the Dayi River Basin (DRB) as a result of climate change stressors through sustainable management of natural resources (forest, river basin, biodiversity, soil and water) in the basin.

The approach being used by the Woadze model is the integrated river basin management (IRBM); conservation, soil and water management, livelihood security through strengthening the capacity of farmers in the DRB to transit from rain fed to irrigation agriculture by the provision of basic tailored made water use facilities and a secured financial system. There were several principles considered in developing the 'Woadze Agricultural Model'. Some of these principles include:

- An integrated approach
- Ensuring Conservation
- Ensuring Environmental protection
- Adhering to issues of sustainability
- Community led
- Generation of public goods
- Enabling secured livelihoods
- Setting of the development process

In practice on the ground the Woadze model has five clearly demarcated zones from the river bed upwards. These consist of;

1. *Buffer Zone:* Establishing a zone of no cultivation 30-50m contour from the river bank and the kinds of enrichment planting will be informed by the existing plant species at the bank of the river.

2. *Zone for checking Erosion/land degradation:* Using Vertiver grass planned after the buffer zone.

3. *Agro Forestry:* This will be a mixture of timber and non-timber species. The kinds of plants/crops in this mixture are determined by the crop suitability of the area. The entire DRB had three diffused ecological zones; upper stream (high forest), middle stream (savannah woodland) and downstream (forest and savannah). Plants/ crops to be planted will be according to this ecology and what the farmers have selected.

4. *Cultivation Area/Production Zone:* This is the zone for vegetable production and other high value crops where irrigation agriculture is practiced regularly.

5. *Fire Belt:* This is preventive and proactive measure against wild bush fire.

4.1.2 Technical and Agronomical Aspects

In the beginning of 2010 Acacia Water carried out a study of appropriate technologies and management systems for the envisaged ADAPTS farmer groups. This was presented and discussed with the farmers in May 2010. All groups preferred the option of sprinkler irrigation. The existing Kpandu irrigation system (operated by IDA), which delegates of all groups visited in June 2010, served as an example.

The systems consist of a central pump, which lifts water from the river and pumps it under high pressure via pipes and feeders to the sprinklers. The advantage is that land does not need to be leveled as in case of gravity irrigation. All command areas are located along the Day River and have been cleared of all trees and graded, apart from the 50 m wide uncultivated buffer zone and agroforestry zone along the river bank.

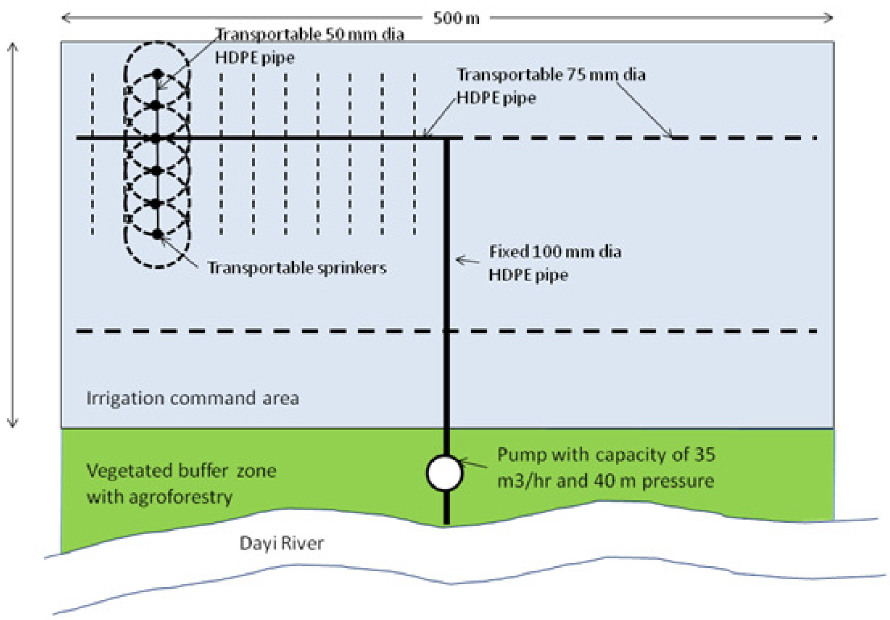


Figure 4-1 Sprinkler System

Where the buffer zone needs reforestation trees with a direct economical value are planted (fruits, timber, moringa).

Before construction selected sites in the communities had their fields surveyed and demarcated for documentation purposes. The soils at the sites were also evaluated to determine the nutrient status of the soils. The vegetable selected for production were also based on soil susitability. All the six selected groups in the project communities had their capacities enhanced in the following through training workshops and field visits;

- Nursery establishment and management
- Tree planting skills
- Group formation and development
- Financial management and book keeping
- Procedures for vegetable production for export market
- Irrigation system installation and management.
- The project provided all the inputs and equipment needed for farm operations to the groups.

4.1.3 Marketing of Crops

Introduction

Marketing is an essential element within the ADAPTS program. The degradation of natural resources and the reduced rainfall demand new sources of income for the Dayi households. This also entails creation of new market outlets. In the proposed transformation the ADAPTS farmer groups and NGO's have to play a vital role as they should organize farmers and mobilize resources towards these market outlets. In doing this the farmers group have to take the current market position of Dayi Basin into account, which changed from a market economy in the first half of the twentieth century towards a degree of self sufficiency in the second half of the 20^{th} century. Only after 2000 some new markets developed.

Before 2000

In the first half of the twentieth century the economy Dayi Basin became tree based, with cocoa as main marketing crop. The city of Hohoe became an important commercial center for cocoa and developed in the most important urban centre of the area. Migrant workers contributed substantially to this cocoa sector. Other important tree crops were oil palm and plantain, although it is unclear if the area was ever self sufficient in these crops. In the seventies and eighties the cocoa economy started to stagnate and lapsed into a severe crisis. In this period the balance of economic activities changed from Hohoe to Ho that became the capital of the whole of Volta area. This was especially so after the introduction of the district system in 1988. Dayi area became a region dominated by cultivation of annual crops, mostly for consumption in the area. Significant is the spread of cassava cultivation by women that eventually became a marketing crop of some importance. In 2010 it was reported that whole salers from Accra bought cassava at Ho market.

After 2000

In this century irrigated vegetable growing developed at some locations in Dayi Basin. An important example was the site at Kpandu bordering Lake Volta that started in 1978 under GIDA guidance. The project was not successful and irrigated acreage lagged behind expectations. The farmer group became independent but nevertheless developed into an important supplier of okrah. In 2010 tens of buyers visited the location at harvesting time, some from Togo and Accra.

In 2004 the Ve Koleone irrigation scheme was started, but collapsed due to the top down approach. From 2006 the Ve farmers group continued with irrigation on part of the land and was in 2010 the main supplier of okrah, garden eggs and pepper to the market of Ho.

Some farmers enter into contract farming for a specific type of pepper with an export trader. He supplies seeds, knowledge on cultivation techniques and buys the harvest against high prices. Participating are large farmers that can invest in good land management.

The Woadze farmer group produced in 2008 for the market at Ho. Transport was done by the truck of DI. The harvest of 2009 failed due to break down of the pump and diseases. The harvest of the 2010, 2011 season was a success, but market outlets are unknown. Replicability of these pilots may be constrained by the limited presence of water in Dayi river (to be elaborated)

Some marketing of tree crops exist in Dayi. Moringa receives considerable attention by the Edyem company. In 2008 they packed daily 250 bags of moringa tea to be sold in city markets under a certificate. Edyem is buying at contract arrangements, but prices do not seem to be high. Also the New Baika farmer group ventured into processing moringa, but as they did not succeed in obtaining certification, price remained low, as it could only be sold on the local market.

An important enterprise for fresh fruit is the Kingdom Fruit Company that grows pine apples on rainfed basis. It was supported by SNV in developing out grower arrangements with farmers. Further on in Dayi area occasional mango plantations can be observed in the savanna areas. Also cashew nut can be grown in the savanne areas. Marketing outlets are not known. Individual households produce citrus fruit on small scale. Oranges are sold also in Togo, by groups of farmers hiring a truck.

4.1.4 Cost Benefits of the ADAPTS Schemes

At this stage three irrigation and agroforestry schemes according to the Woadze model have been realized. The investment costs of these schemes are given below in Table 1.

Table 5 Investment Costs of ADAPTS Schemes

Cost item	**Budgetted costs**		**Actual costs**	
	GHS	EUR	GHS	EUR
Land development	22,800	12,128	26,328	14,004
Irrigation system & Installation	39,400	20,957	54,039	28,744
Buffer zone & Agroforestry	8,450	4,495	8,150	4,335
Production materials			2,580	1,372
Man hours DI for organization	32,752	17,421	48,576	25,838
Total investment costs	103,402	55,001	139,673	74,294
Investment costs/scheme	34,467	18,334	46,558	24,765
Investment costs/ scheme excl. DI costs	23,550	12,527	30,366	16,152

Presently the average costs per scheme amount to 24,800 euro. The initial costs estimates for the ADAPTS schemes proved to be too low. One of the reasons was that longer feeder pipes for the sprinklers appeared to be necessary to cover the command areas. Also more intensive training was required for operation of the schemes and farming practices. The project is of the opinion that prices of irrigation equipment can go down by dealing with suppliers in case this local action will spread out. Also training costs can be reduced as farmers have organized themselves and advise each other. The project tam expects that in future total costs for a scheme can be reduced to 20000 euro or less.

The ADAPTS project supplied the funds for the investmenst costs of the schemes. As the actual costs proved to be too high, schemes for all five identified farmer groups could not be realized. For reasons of solidarity and economical profitability of this local action the ADAPTS team and the farmer groups decided to convert the grant into an interest free loan with a pay-back period of three years.

The costs and benefits of growing pepper are presented in Table 6. All costs are included including the yearly down payment of the ADAPTS loan and the labor input by the farmers themselves as salary. The pepper is not offered to the local market but sold to an exporter. With a gross profit of 2600 GHS or 1400 euro per acre, pepper growing is obviously quite profitable. A conservative estimate of 6 GHS per box is used while it can at times also be 7 GHS per box.

Table 6 Costs and Benefits per Acre for Pepper Farming in ADAPTS Scheme

Items	Unit	Quantity	Unit costs	Amount	
			GHS	GHS	EUR
Costs					
Pre - planting Costs					
Land Preperation(Ploughing)	Acre	1	100	100	53
Seed	Acre	1	280	280	149
Sub-Total				380	202
Planting Costs					
Transplanting	Acre	1	40	40	21
Fertilizers	Bag	6	52	312	166
Fert Application	Times	3	10	30	16
Spraying	Times	10	5	50	27
Chemicals (fung., insect., plant busters)	Acre	1	50	50	27
Weeding	Times	5	30	150	80
Sub-Total				632	336
Other costs					
Harvesting cost	Box	1100	1.2	1,320	702
Fuel	Month	6	60	360	191
Maintenance of system/ Group dues	Month	6	30	180	96
Wages for farmer	Month	6	100	600	319
Loan servicing Per season	Season	1	500	500	266
Sub-Total				2,960	1,574
Total Cost Production per season				**3,972**	**2,113**
Revenue from harvesting	Box	1100	6	**6,600**	**3,511**
Gross Profits per acre				**2,628**	**1,398**

Similar cost benefit analyses have also been carried out for other vegetables, which are sold to local market women and traders. For garden eggs and ocra these analyses result in profits of 1262 GHS (671 Euro) and 934 GHS (497 Euro) per GHS acre, respectively. Prices of vegetables fluctuate strongly between the rainy and dry season. For gardens eggs farm gate prices fluctuate between 5 and 30 GHS per box, while for ocra the range is from 5 to 20 GHS per box. In the cost benefit analyses conservative estimates of 10 and 8 GHC per box have been applied for garden eggs and ocra respectively.

4.2 Governance and Policies

One major challenge in Ghana is coordination of sectoral policies and therefore governance institutions with respect to natural resources. In particular agriculture uses, land, forest and water as resource input but how the uses of these resources are decided on in a coordinated manner leaves much to be desired The ADAPTS project was therefore an opportunity to coordinate the activities of Ministry of Food and Agriculture, Water Resources Commission, Environmental Protection Agency, Ministry of Lands and Natural Resources, land owners and traditional authorities could work together harmoniously at the local level at the Dayi River Basin within one institution such as the Dayi Basin Board. This was done through stakeholder engagement; government agencies, traditional authorities and farmer organization. To be able to achieve consensus on the sustainable use of resources in the Dayi Basin the empowerment of farmer groups was very critical.

4.2.1 Farmer Management

To ensure that farmer groups participate actively in the resource management in the basin and engage government agencies meaningfully from informed position, they were taken through several training. These included resource mapping and monitoring using participatory rural appraisal (PRA) methods. Other empowerment training included participatory climate change and vulnerability assessment, leadership and organizational development skills. The rest were governance and policy advocacy skills. The technical skills were nursery establishment and management; market oriented vegetable production and irrigation.

The project worked with existing farmer organizations in the various targeted communities whose capacities were enhanced through re-organization and institutional development as mentioned above which resulted in a an elaborate structure from the individual farmer to the group and then the Dayi River Basin area as a network of participating communities in the ADAPTS project.

Individual farmers in the groups are however, managed through the leadership of their various groups. The project officer is always available in the communities to give technical advise and support to the groups. Inputs are supplies to the groups through their leaders and the members decide on the modalities for the sharing.

4.2.2 Dayi River Basin Board

After meeting the ADAPTS team in 2008 WRC was proposed to play a key role in the up scaling of the Woadze model in the Dayi river basin. WRC decided to take up Dayi Basin for a fifth basin plan in Ghana. All important stakeholders in the basin were convened, included district government services, traditional leaders and farmers, women and youth organizations. Participants were asked to rate stakeholders for the board. Civic society was delegated two representatives (DI and a farmers association) compared to five district representatives. The election of the Dayi board was unique as it was more bottom up in comparison to the earlier three boards. This was also due the small rural scale of the board, were as others were in urban environments.

The Dayi Basin Board (DBB) was the fourth river basin management set-up to be established and was officially inaugurated in July 2010. DBB has a consultative and advisory role as it relates to the management of the the Dayi River Basin's water resources and represents a wide sphere of interest groups within the Basin, including the traditional authorities. The DBB membership includess the following:

- A Chairperson appointed by the WRC
- A representative of the WRC
- One person representing each of the following within the basin:
  - Woadze Sustainable Agric Farmers Co-operative, Hohoe
  - Forestry Commission, Volta Region
  - Gbi Traditional Council, Hohoe
  - Kpandu Traditional Council, Kpandu
  - Ministry of Health, Hohoe
  - Environmental Protection Agency, Volta Region
  - Department of Women and Children affairs, Volta Region
  - Jasikan District Assembly
  - Ministry of Food and Agriculture, Hohoe
  - Development Institute, Accra (NGO)
  - Ghana Water Company Limited, Hohoe
  - Ghana Fire Service, Volta Region
  - God Deliver Farm Association, New Baika, Jasikan
  - Hohoe Municipal, Hohoe
  - Kpandu District Assembly

- The Basin Officer as ex-officio member to be appointed by the WRC in charge of the Board's Secretariat. The composition and process of Dayi Basin board formation was a change in the paradigm in the top-down approach of WRC. The Dayi Basin board is made of CSOs; not only government appointees as all the board before and operates by not only what the central government in Accra thinks but but taking into consideration the needs of the stakeholders in the basin.

4.2.3 Dayi River Basin Management Plan

The WRC has elaborated the present RBMP for the Dayi River Basin as part of WRC's mandate to "*propose comprehensive plans for utilization, conservation, development and improvement of water resources*" [1] with due consideration to stipulations in the National Water Policy.

The RBMP is based on a number of dedicated assessment studies and information reviews, all unveiling implications relevant for decisions made during the process of prioritizing measures forming the RBMP. Guided by SEA procedures and application of "tools", consultative meetings and workshops have taken place during the course of preparation, specifically targeting the DBB members as well as District Assemblies and their planning officers.

The RBMP for Dayi River Basin addresses the basin-wide water management problems to be taken into account to achieve a future sustainable management of the Basin's water resources, and as such provide a framework for local water management planning at local level.

Consequently, the effects of the RBMP should not be restricted to a description of broad existing and projected future environmental and social impacts, but should also try to describe the effects of the IWRM planning on other existing plans and programs. The RBMP may entail legal and institutional consequences that might cause conflicting management structures, which then need to be coordinated and adjusted to ensure an efficient implementation of the plan.

The Dayi plan was the first in Ghana to incorporate climate change by providing elaborate info on rain fall patterns and the water runoff also in the dry season. The basin board was officially inaugurated during a meeting in Jule 2010 in Ho. Here WRC underlined the urgency of water quality as threatened for example by direct pollution by petrol stations. The paramount chief stressed the need to implement the national buffer zone policy by protecting the river boards and paying attention to construction activities. As this policy is still said to be under development no concrete activities could be agreed on. The ADAPTS irrigation pilots were brought forward as examples of the out reach of the Basin Board.

4.2.4 Policies on the Regional and National Scale

Since 1988 Dayi Basin falls within the boundaries of Ho district. Ho is the siege of the district administration, hosting departments of agriculture, irrigation, education, health and tourism. Ho district receives its revenues mostly from the national budget, but 16 per cent originate from local taxation (market tolls and tax of property and small business).

[1] *Water Resources Commission (WRC) Act No. 522 of 1996*

Relevant departments are the *Ghana Irrigation Development Authority* (GIDA). GIDA guided the Kpandu Torkor irrigation scheme in 1978 and was involved in the failed Kukurantumi dam in the 1980's and the WorldBank funded irrigation project at Ve Koleonu in 2004. GIDA still cooperates with the now independent Kpandu farmer group but lost contact with the Ve farmer group. GIDA officials still opt for large scale interventions as this guarantees supply of a sufficient volume for buyers. Small scale projects have the disadvantage of high costs for infrastructure, so according to GIDA development via ho and cutlass is not the answer for the development of the countryside. GIDA stated that water is sufficiently available; (no info was provided on elasticity of the market for irrigated crops; no info on ecological problem).

The *Department of Agriculture (DoA)* is implementing the policies of the ministry of Agriculture at district level and assists groups of farmers in improving cultivation of all crops, except for cocoa that is delegated the coca board. In 2008 DoA was not involved in irrigated agriculture in Dayi. DoA officials were aware of the recent pressure on okrah prices due to increased production, pleaded for diversification of crops, but were unaware of the number of pumps in Dayi area. DoA is aware of the ecological problem, but deals with deforestation due to slash and burn mainly by supporting communication programs, but delegated most of the responsibility to the chiefs. DoA pleaded for a balanced development of both food and tree crops in the area.

In Ghana the *Water Resources Commission* is mandated to monitor the availability and quality of water in the country. WRC was established in 1996 also due to an ecological and water crisis in Ghana. This crisis is directly linked to the water level of Lake Volta and to the hydro power provision of Ghana, as the Volta dam is the main supplier of energy in Ghana. In recent years a declining water level seriously impacted the energy supply in Ghana. A buffer zone is developed in order to guarantee a proper management of the rivers. WRC monitors the availability and quality of water in Ghana, also by issuing permits for large scale water abstraction to water companies, mining companies and irrigated agriculture. WRC operates from its national office in Accra and does not have regional offices. An important tool for WRC are basin plans, where the water situation is described, and basin boards installed to address threats to the water situation. The basin board can advise WRC and district authorities, but has no independent sources of revenues.

The *Volta River Authority* manages Volta lake and its hydro energy, although its responsibility is limited to the Volta lake and immediate buffer zone, but VRA increasingly recognize the necessity to manage the ecology of tributaries of Volta lake, such as Volta River. VRA is a main national player in developing a so called buffer zone policy in Ghana. Recently this bureaucratic institution tries to develop relations of cooperation with the communities. On a national level DI had already brought under the attention of the Water and sanitation Network the possibility of payment of environmental services by Volta Rivers Authority to the communities in the support zone of lake Volta. The limited base flow of Dayi river during the dry season seems to limit at least the amount of these payments.

4.3 Upscaling

4.2.5 Farmer to Farmer Support

This was a strategy initiated by the Development Institute to enhanced co-oporation among farmer groups paticipating in the project. It was designed in a way that some farmers from different project community visit other groups to share lessons learnt, challenges and achievements with each other. Opinion farmers in the groups teach on processes involved in cultivating a particular crop since some of the communities are known for a particular crop. Due to this intervention, the project groups in the various communities merged formed a broader network dubbed 'ADAPTS FARMERS NETWORK'. Leadership of the network is selected from the various groups.

4.2.6 ADAPTS' Agricultural Credit System

This was proposed to be the fuel to the project to ensure sustainability of the interventions and ensure financial security which is an added tool to reduce the vulnerability of women and men in the project area against climate change. This was structured as a direct credit to the farmer for their farm operations.

The second more immediate reason to introduce the credit system was the fact that only three irrigation schemes could be realized instead of the envisaged six schemes. This is because the construction costs appeared to be higher than expected. Therefore the ADAPTS team suggested to change the construction grants into loans with a pay-back period of three years. The farmer groups agreed as they saw the clear economical profitability and also felt solidarity towards the other two farmer groups. The construction fund of 75000 euro has now become a sort revolving fund managed by the Development Institute. In 2012 the first down payments of the three groups will enable DI to start up the fourth group. In 2013 the fifth group will follow.

The credit was not a cash credit but in form of input supplies and logistical support. It also took the form of direct payment for farm operation but as the farmer has chosen. It was the aim of the ADAPTS credit system to reclaim all the funds spent on each farmer group after agreed period. A cost-benefit analysis conducted revealed that the groups can pay for all the investments made in the communities within three years if they crop twice a year. These funds when collected would be paid into a revolving fund from which farmers' subsequent productions will be financed where part of it would be used to set up the scheme in other communities along the DRB.

4.2.7 Formal Credit Organizations and Private Investments

The provision of credit has increasingly been regarded as an important tool for raising the incomes of rural populations, mainly by mobilizing resources to more productive uses. As development takes place, one question that arises is the extent to which credit can be offered to the rural poor to facilitate their taking advantage of the developing entrepreneurial activities. In Ghana, formal credit organisations failed to design credit facility to farmers in general. Even when the credit facility is available, the interest rates are always prohibitive and farmer could not afford. Most of the funding for agriculture is sourced from the central government, NGOs and Donor partners through agricultural programmes and projects. To be able to generate sustainable value of the ADAPTS project there is therefore the need to support the Development institute and the ADAPTS Farmers Network to develop a credit system that will support the input supply, marketing challenges faced by poor farmers and to expand the project to other farmers in the Dayi Basin.

Also the DI and the ADAPTS Farmers Network will continue to look for credit facilities from international organzations (RABO Development).

4.2.8 Other Areas Favourable for Dissemination

The ADAPTS Approach has caught the attention of high level government officials like for example the sector Minister and the chairman of the WRC. The Sector Minister has asked to show this approach is viable in other basins through another pilot project. If that pilot is also successful, the ADAPTS approach of involving local actors and CSOs in RBMP development will become standard in Ghana.

The Development Institute has engaged sector related agencies and district, regional and national administrators about the ADAPTS Approach on various platforms. One of such platforms was the workshop organized by WRC on the Sustainability test IWRM Plan in May, 2011. In this workshop which was attended by the Deputy Minister of Water Resources, Works and Housing and Chairman of WRC, DI made detailed presentation on the ADAPTS approach and at the end, there was unanimous decision for WRC to adopt the approach for the elaboration IWRM action plans. The Water Resources Commission therefore invited DI in the elaboration of the IWRM action plans in November, 2011 to facilitate the process of incorporation of the ADAPTS Approach into the plan which was successful.

If there will be a follow up project to the ADAPTS project the ADAPTS team proposes to focus on the more drought prone northern region of Ghana. There communities rely fully on agriculture and WRC is already planning to start RBMP's in this region. Water availability is limited. So water harvesting would be needed (3R initiative of the Dutch Ministry of Foreign Affairs, DGIS). Also sustainable groundwater irrigation is an option. In such a project the Sahel regreening initiatives could be incorporated (http://w4ra.few.vu.nl/)

5 Dialogue and Dissemination

5.1 NGOs

ADAPTS aimed to replicate the Woadze model in other villages. In this replication NGO's (like DI) and farmers group played a key role, although each with its own a specific role. DI was involved with selecting suitable farmer groups in order to help them integrate their activities with ADAPTS. Such examples include building their capacity to market their products or providing them with irrigation facilities. The role each farmer group may plays depends upon their organizational level.

5.1 Farmer Groups

The Kpandu farmer group has reached a good level of organization and has built up considerable marketing power towards the buyers. Proof of this is that they sell their products at one place thereby forcing transparency, while buyers have to bid against each other which is a guarantee for high prices. In 2010 negotiations were ongoing with GIDA in order to expand the irrigation facilities.

In Ho the farmer group is the most important supplier of fresh vegetables with the success of their crops being directly dependant on the irrigation facility. Delivery of their product to market at times though is hampered due to the absence of a permanent road. In regards to the structure of the group, it is based on formal membership with an elected leader. Members pay a fee which in turn entitles them to membership in the association, the maintenance of pump and canals, and allows for rent to be paid to the absentee land owners. Inequality is limited as most labor is provided by the households. Men have some degree of dominance, but females play a key role in hire of labor and in marketing of products. In some households women even have the lead and control the budget.

The Bakai group was established in 2005 and as of 2010 had 15 members. Membership consists of couples and individual male and female farmers. As with the Ho group it is based on formal membership and a fee system, the fees are deposited into the group's bank account. The fees are used to rent land for their agricultural activities. Unfortunately, as of 2010 the group had yet to find a sustainable crop due to the failure of the planned irrigation scheme.

Initially 11 communities were identified from three districtsfor intervention: Hohoe, Kpando and Jasikan of the Volta region. The communities included Hove, New Biaka, Woadze, Vakpo, Bla, Akplamafu, Godenu, Gbi-Kledzo, Gbi-Kpoeta, Lolobi Kumasi and Gbefi.

This number was further reduced to six, based on the objectives and the criteria of the project. These were

- The size of land available to the farmers
- The number of members in the group
- The legal registration status of the group
- The financial status of the group
- The dynamics that exist in the group

After the assessment, six communities were selected to take part in the ADAPTS GHANA pilot project. The communities included Hove, New Biaka, Woadze, Vakpo, Lolobi Kumasi and Gbefi. Unfortunately the group in Lolobi Kumasi was unable to gain access to the required size of land along the river for the project. As a result they were replaced with a different farmer group from Gbi-Wegbe. Below is final list of the included groups:

Table 7 Communities Selected to take part in ADAPTS GHANA Pilot Project

NAME OF GROUP	LOCATION	CONTACT PERSONS /NUMBER
Woadze Sustainable Farmers Group	Woadze	Jeremiah Apawu, 0200246285 Gramasi Francis, 0540820180
Vakpo Central Vegetable Farmers Association	Vakpo	John Akpo, 0542524689 Emmanuel Kokoroko, 0205061611
Charismatic Farmers	Gbefi	George Anani, 0242758247 Ruth Sakpata, 0203148115
Koloe-Dayi-Hove	Hove Koloenu	Gabriel Tsawodzi, 0209158887
God Delivers Farmers Group	New Biaka	Thomas Gbevi, 0240335758
Multipurpose Farmers Group	Gbi-Wegbe	George Agbemavor, 0241956527

Despite the fact that six groups were selected, due to limited funds the project was only implemented with three groups, Woadze, Vakpo and Gbefi.

5.2 Stakeholders in Managing the Dayi River Basin

In parallel with the technical assessments and description of the water resource-related challenges, a consultative process was carried out with the involvement of "grass roots" basin-based stakeholders aimed at capturing the local perception of water resources management and climate change issues as well as to propose actions required in addressing water management/climate change issues and problems. A series of workshops were organized at Hohoe in 2009, 2010 and 2011 aimed at collating views of local people as to how to address climate change and water management issues confronting vulnerable communities within the basin.

The district-based planning by District Assemblies is the cornerstone of the decentralized governmental approach for which the overall legal framework and institutional delegation of responsibilities are proven and understood - although gaps in legislation, overlapping responsibilities, lack of capacity/resources and enforcement still exist.

The Strategic Environmental Assessment (SEA) process presented a participatory platform for thorough public discussions often in workshop settings. The SEA procedures and tools[2] have been adapted and applied as part of the Dayi Basin IWRM planning process.

In recent years, multi-stakeholder governance structures, such as River Basin Management Boards, have gained increasing importance for the management of water resources. To become more effective in decision-making, such platforms benefit from access to policy-relevant information about the bio-physical and the socio-economic parameters that determine the opportunities and challenges of water use. To enhance an efficient management of the DRB, many stakeholders were considered. This ranged from national institutions to the community members residing within the DRB. These stakeholders include; Water Resources Commission, Ministry of Food and Agriculture,

[2] *Support and Capacity Building to apply SEA Principles and Tools in preparing IWRM Plans at River Basin Level. WRC (October 2006).*

Traditional authorities, Security agencies (National Fire Service, Police etc). The rest are Environmental Protection Agency, District Assemblies, Forestry Commission, Wildlife Departments and NGOs. Farmers and fishermen are also not left out of the potential stakeholders in managing the DRB.

5.3 Water Resources Commission

The present Dayi River Basin IWRM Plan is the fourth of its kind, and this basin was chosen due to the impact of climate change on Water Resources and ultimately livelihoods. Other major Water Resources management issues include land and water quality degradation, water shortages in an otherwise perennial river. Water related hazards such as floods have become more frequent in the basin and the unpredictable rainfall pattern has adversely affected rain fed agriculture. In instituting proper water resources management mechanisms with regards to adaptation to climate change, the "ADAPTS Concept "of building resilience of vulnerable communities to better adapt to the impacts of climate change was adopted. It is WRC's sincere hope that this plan can be a useful catalyst towards accelerating concrete water management activities in the Dayi River Basin, and more importantly, may also serve as a source of inspiration to advance the approach of "ADAPTS" in other basins in Ghana as prescribed in the National IWRM plan.

6 Summary and Conclusions

The ADAPTS Ghana case can be considered successful in terms of increasing farmers capacity to adapt to climate change and in incorporating climate and social concerns into water management policy. Almost all targets defined in the proposal have been achieved. The only major difference between plan and implementation is that due to budget constraints only three communities have been involved in the field construction of irrigation schemes. The schemes were more expensive than was expected in the preparation phase. As the three farmer groups that have irrigation schemes now see the positive impacts, and because they feel solidarity to the other groups that did not get an irrigation scheme, they have decided to turn the project grant into a loan, to start a revolving fund for funding schemes in New Baika, Lolobi Kumasi or Ve Koleunu. DI will be the coordinator of this.

In regards to water policy: in 1998 The Ghanaian governed set about decentralizing water management throughout the country. The idea was to create separate water boards to manage the various river basins. At the start of the ADAPTS project three boards with river basin management plans (RBMP) were in operation in Ghana. Working closely with the WRC, ADAPTS helped in the creation of the new water board and RBMP in the Dayi Basin. The ADAPTS bottom up approach, stressing empowerment of local stakeholders in water, was officially incorporated in the WRC strategy on decentralization of water management. This approach is used for the first time in Ghana in the formation of the Dayi River Basin Board. The new RBMP was the first in the country to be created using a stakeholder consultation approach.[3] During its construction meetings and workshops were held between government officials, NGOs, civil society groups, ensuring that all had input into the plan's creation and are represented in the Basin Board. In addition it is also the first plan to include future hydrological circumstances, e.g. climate change and adaptation measures in its design. As such it should help lead to better water management in the basin over the future. Additionally the government is keen to upscale the approach used in the development of the Dayi Basin Plan to other basins in the country.

Runoff records do show that river base flows have decreased by some 80 % after the seventies of the last century. This is attributed to the decrease in rainfall in the same period. By assessing the effect of irrigation schemes on the flow of water, the project has contributed to explore the amount of water that can be used for irrigation without hampering downstream uses. ADAPTS also used information from Global Circulation Models to assess the limits under possible future climatic circumstances. This has shown how climate change and adaptation can be made practical for decision- and plan making.

In regard to increasing farmer capacity: At the farmer level the aim of the ADAPTS project was to help communities establish sustainable communal irrigation schemes in addition to rainfed agricultural production during the monsoon season. This was achieved in Woadze, Vakpo and Gbefi. At the start of the project there was some uncertainty as to which form of irrigation scheme, sprinkler, drip or gravity would be most suited to the selected areas. However, following a workshop with the farmers and group field visits to areas already employing various types of irrigation, it was agreed to proceed with sprinkler systems. Such a system is easily maintainable and consists of removable parts: pumps set up on the banks of the river bring water under

[3] At the writing of this report the RBMP was awaiting final approval from the central government.

high pressure via removable pipes to the sprinklers to the adjacent fields. Licenses for such irrigations systems are to be obtained under the RBMP to avoid negative impacts on downstream users under current and future circumstances. The ADAPTS project provided technical and agronomical assistance and the construction funds on a 3 year loan basis. At present three groups comprising a total of 45 farmers are employing this method. These farmers have organized themselves in the ADAPTS farmers association. The success of the new irrigation scheme can be measured in the increased output of cash crops being produced in the areas. The primary income earner for most is peppers at the moment. While previously their products were mainly sold on local markets, the ADAPTS farmer association has found buyers exporting the peppers to the UK and the Netherlands. This has directly translated into increased incomes and more sustainable livelihoods.

The loan installments will go to help finance the creation and implementation of the other irrigation schemes in New Baika, Lolobi Kumasi or Ve Koleunu that were left out due to a lack of funds at the start.

Because of the success of the ADAPTS schemes the Ministry of Water Resources Works and Housing and the Water Resources Commission of Ghana has adopted communal irrigation in combination with river basin management as an essential part of the new national water policy (National Conference of Water and Climate Change, Accra, May 2011; IWRM action plan of WRC, November, 2011).

The project in Ghana also has developed different datasets and models to assess the potential changes in climate in the region and its effect on hydrology. Especially the "weather generator" which generated daily rainfall and temperature records for future climates in the tropics, is innovative. These tools can be used as generic analytical methods for planning and management of water in rivers basins with scarce data.

The lessons learned from ADAPTS Ghana are twofold. First is that increased solidarity among farmers and the willingness to work and invest together as group can lead to substantial benefits for individual households and communities. Prior to the project, most farmers in the area operated independently, relying on the rain as their main source of water. The implementation of an irrigation scheme, a potential benefit for all, required that farmers banded together to help negotiate its future design and use. This exercise led to the creation of communal farmer groups that ultimately manage their water resources together. Moreover, the farmer groups also now manage the sale, export and profit from their crops allowing them greater market power. Despite the fact that the use of irrigation is being written into current water policy, irrigation schemes are expensive and for the most part do not operate on the individual level. Therefore if future irrigation schemes are to be successful, they first require the creation of farmer organizations which can have access to credit to finance their schemes. Provided that the schemes are profitable, the proceeds can go to repay their loan and/or finance new schemes. This dynamic, as mentioned above, is already taking place in the project's pilot area.

The second lesson learned from the project, as is evidenced from the new RBMP and water board, is that consultations and dialogue between government, stakeholders and knowledge institutes can lead to a more inclusive and robust water policy better geared to adapt to the impacts of climate change.

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