

2019

**Water Monitoring and Flow Forecasting
System for the Niger River Basin
(ORIO10/NE/22)**

**Case Study in the Evaluation of the
ORIO Programme (First draft)**

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Executive Summary

The standard ORIO trajectory consists of three phases: the development phase, and the implementation and Operation and Maintenance (O&M) phases. This report evaluates the first two phases of a Satellite Based Water Monitoring and Flow Forecasting System in the Niger River Basin (ORIO10/NE/22), which consists of a combination of systems and services put together to create a data infrastructure covering the entire Niger River basin. It will be operated by the Niger Basin Authority (NBA). The O&M phase has not started yet.

The project includes the following activities:

- a) The establishment of a Meteosat based Energy and Water Balance Monitoring System (EWBMS) at NBA to provide a 3 km resolution data infrastructure for the entire river basin;
- b) The implementation of a satellite based Flow Forecasting System (FFS) for the Niger basin using the Large Scale Hydrological Model (LSHM), and the EWBMS rainfall and actual evapotranspiration data fields as input;
- c) The establishment of a Drought Monitoring System (DMS), providing hydrological, agrometeorological and climatological drought information for the entire Niger basin;
- d) To implement a Crop Yield Forecasting System (CYFS), using the EWBMS radiation and evapotranspiration data fields for the entire basin as inputs;
- e) To display the climatic results in a *Niger Basin Satellite Monitoring Bulletin*, providing dedicated products on water availability and needs for the entire basin;
- f) To test, validate and calibrate the systems provided;
- g) To develop a website for the project;
- h) To train NBA operators to run the EWBMS-LSHM satellite data system, and to collect and disseminate the data, and to train NBA's partner organizations in understanding and using the information provided by the system.

This ex-post evaluation is based on the following sources of information: (i) documents from the ORIO archives, (ii) documents delivered by the project Manager in Niamey, and (iii) site visits and interviews with NBA staff, NBA's partner organizations, international donors and local institutions during the field visit in Niamey from 13 – 21 July 2019.

The impact of the intervention was assessed qualitatively and quantitatively, reconstructing a counterfactual, by studying the relevant documentation, measuring the results of the transactions, and by interviewing beneficiaries, stakeholders of the project in Niamey and representatives of the two Dutch companies involved in the project.

The client is the Niger Basin Authority(NBA), an inter-governmental organization of nine West African countries forming the Niger River basin. NBA is authorized by the Ministry of Hydrology, Republic of Niger.

The project has three phases adding up to a total of € 5.6 million, with € 2.8 million covered by ORIO grants. The development phase of the project was fully paid with an ORIO grant, whereas ORIO's contribution to the implementation phase was 49.9%. The remainder of the funding of this phase consisted mainly of in-kind payments provided by NBA to cover staff and logistical costs. In addition, NBA has acquired the required funds from the African Development Bank (AfDB) amounting to € 1 million.

Efficiency

The implementation phase of the ORIO-SATH project was successfully executed. All the satellite equipment is delivered, installed, calibrated and validated, the website is operational and most of the planned trainings were provided.

The 13 trainings events and workshops have attracted many participants and have received a very good evaluation from the participants. Seven trainings/workshops are still remaining, and are expected to be delivered before the end of this year.

The project has experienced delays. It was originally planned to be implemented in three years; it is now in its fifth year. Reasons for this delay includes: delays in the data transfer by NBA in the first year, lack of documentation on NBA's database architecture, absence or unavailability of key-staff during missions by the Dutch partners, problems with the development of software, calibration and validation plus local logistical problems to implement the trainings.

Effectiveness

NBA is now capable of operating, processing and disseminating the data collected by the satellite systems. NBA operators have acquired new skills in collecting, processing, disseminating, developing the website and new climatic products.

The NBA SATH site displays the information produced by the satellite systems in bulletins accessible via internet to NBA's partner organizations and stakeholders. The majority of the interviewees are satisfied with the project and the information available in the website.

Although in general all planned outcomes of the project for the two evaluated phases have been achieved, some minor problems have been identified, such as no availability of crop data in the website and some complaints that the information in their website is not always up to date.

Seven training/workshops are still remaining. These are expected to be delivered before the end of the year. Assuming that the remaining trainings will be provided as planned until December of this year we can conclude that project has been effective. If NBA manages to solve or reduce some of its internal problems, such as the high turnover of staff, its weak financial structure and the third phase will be implemented successfully, the project has good chances of producing positive long-term effects.

Sustainability

Technical. The technical components and capability for operating, managing, exploiting and disseminating climate data is currently present and operational at NBA. The sustainability of the installed technical infrastructure depends on regular maintenance and replacement of mostly ICT equipment. The technical sustainability of the installed systems also depends on the capacity of NBA to find a solution for keeping its staff trained after the Dutch project staff is phased out, and if it also will be able to cover the operational, maintenance and logistical costs of the installed systems.

Maintenance is the crucial element for long-term sustainability of the benefits of the project. NBA operators reported not to be able yet to conduct the maintenance of the systems. As the Operation & Maintenance phase of the project is going to be focused on this issue, it is important that the Dutch companies sit together with NBA manager and operators to discuss and prepare a roadmap on how maintenance should be delivered. This should include clarification of the role of NBA operators regarding tasks, responsibilities and level of maintenance to conduct in the SATH systems after involvement of the Netherlands' companies is phased out.

Financial. At present, the financial arrangement of NBA is fragile. It does not have financial autonomy and relies completely on country member contributions that often are not paid regularly. A study is being conducted on the design of a new financial scheme for NBA. GIZ is working with NBA on the development of a water charter that will provide a legal framework to allow NBA to sell climatic data and collect money from big water users. NBA hopes, as stated by the Executive Secretary, to have this

charter in place before 2021. The continuation of the benefits (outcomes) of the project in the mid- and long-term after its completion relies heavily on the capacity of NBA to finance its operations, maintenance and logistical costs required to keep the installed systems working.

Institutional. The NBA's institutional arrangement is complex and makes it an inefficient organization. This causes delays in the communication channels and the decision making process. In the case of Niger, for example, the official information transmitted by NBA from the SATH systems needs to be sent by letter to the Ministry of Hydraulics and later sent to the other Niger organizations. This legal requirement and long chain of communication reduces one of the most important benefits of the SATH project that its capacity to generate climatic data and measurements.

Relevance

The ORIO-SATH project is very relevant for NBA and the country members. It has introduced at NBA a climatic satellite system able to provide on time climatic data and making earlier alerts that helps to reduce the physical damages and save life of communities settled in vulnerable areas related to water extremes effects. NBA has acquired skills on collecting, processing and disseminating climatic data.

It is relevant for the Niger River basin to produce climatic data and products that are key information to improve the planning and management of the water resources within the river basin. The improvement of the management of water resources are key issues present in the planning and economic development policies of the countries of the Niger River basin and are also included in the Netherlands Government development cooperation policy.

Additionality

It is difficult to affirm that the SATH project would have been financed without the support of ORIO. NBA could not have funded the project itself and it is not sure that other international multilateral organization such as AfDB would have funded the project.

Yet, the project has already initiated mobilization of additional funds for NBA. It has contributed to NBA to develop a project with AfDB of € 1 million used to pay the ORIO-SATH operational and logistic costs. It has helped NBA to develop a project with the World Bank to monitor the management of barrages; with a company from Toulouse and NASA to develop an altimetry monitoring system using satellite data, and with GIZ to improve NBA's chain of communication. The project complements the data collected by the HYCOS systems that use a model based on flow-flow by providing data on precipitation, allowing NBA to have on line data using the mode based on precipitation-flow.

Policy Coherence

The project is coherent with the Niger government policy on poverty reduction and the promotion of local and national economic development. The application documents for the ORIO grants also highlight the importance of adequate management of the Niger water resources for improving the development of the countries of the Niger basin, and consequently helping to reduce poverty.

The ORIO SATH project products allow the government to better plan, manage and reduce the impact of water extremes events which contributes to improving local economic development and reducing poverty.

1. Introduction

This case study evaluates the implementation of a Satellite Based Water Monitoring and Flow Forecasting System in the Niger River Basin. The project consists of a combination of systems and services put together to create a data infrastructure covering the entire Niger River basin and operated by the Niger Basin Authority (NBA).

The project will enable NBA to timely and accurately determine river water resources, to foresee and monitor drought, to predict the effects of drought on agriculture and to allocate water to drought areas. The data and information obtained with the installed systems will be disseminated as a public service, which will help to improve living and farming conditions in the basin.

The objectives of the project are:

- The establishment of a Meteosat based Energy and Water Balance Monitoring System (EWBMS) at NBA to provide a 3 km resolution data infrastructure for the entire river basin;
- The implementation of a satellite based Flow Forecasting System (FFS) for the Niger basin using the Large Scale Hydrological Model (LSHM), and the EWBMS rainfall and actual evapotranspiration data fields as input;
- The establishment of a Drought Monitoring System (DMS), providing hydrological, agrometeorological and climatological drought information for the entire Niger basin;
- To implement a Crop Yield Forecasting System (CYFS), using the EWBMS radiation and evapotranspiration data fields for the entire basin as inputs;
- To display the climatic results in a *Niger Basin Satellite Monitoring Bulletin*, providing dedicated products on water availability and needs for the entire basin;
- To test, validate and calibrate the systems provided;
- To develop a website for the project;
- To train NBA operators to run the EWBMS-LSHM satellite data system, and to collect and disseminate the data, and to train NBA's partner organizations in understanding and using the information provided by the system.

1.1 Sources of Information

The evaluation used the following sources of information:

- Documents retrieved from the ORIO archives such as progress reports, feasibility studies, technical reports and evaluations.
- Documents and data provided by NBA in Niger
- Interviews with Implementing companies in the Netherlands and in Niger in June, July and August 2019
- Site visits to various locations in Niger (Niamey) in July 2019
- Interviews with NBA staff, NBA's partner organizations, international donors and local institutions during the field visit in Niamey.

1.2 Research Team

Dr. Ogenis Brilhante, senior staff member of the Institute for Housing and Urban Development Studies (IHS), Erasmus University Rotterdam, conducted the evaluation of this project. The interviews were conducted in Niamey with the help of the local expert Ms. Fannata Souleymane Mamadou Mari.

1.3 Structure of the Report

The structure of this report is as follows. After this introduction, the second chapter describes the three project phases, the context in which these phases took place including the implementation of ORIO-SATH system at NBA and a short description of the main stakeholders. The third chapter provides explanation of the results chain and the method to evaluate the results. The subsequent chapters assess the project by looking at efficiency (chapter 4), effectiveness (chapter 5) and sustainability (chapter 6). Chapter 7 presents the evaluation results concerning relevance, additionality and policy coherence. Chapter 8 summarizes the main findings.

2 Project Overview

2.1 Niger River Basin

The Niger is the 3rd longest river in Africa, (4,200 km), the 14th in the world and the 9th in terms of drainage basin area, being 2,170,500 km², of which 1,500,000 km² actively contribute to river runoff. Nine West and Central African countries (Benin, Burkina, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria and Chad) form the Niger River basin. The management of the water resources of this river basin is undertaken by the Niger Basin Authority (NBA). Figure 1 shows a map with the countries in the Niger River basin.

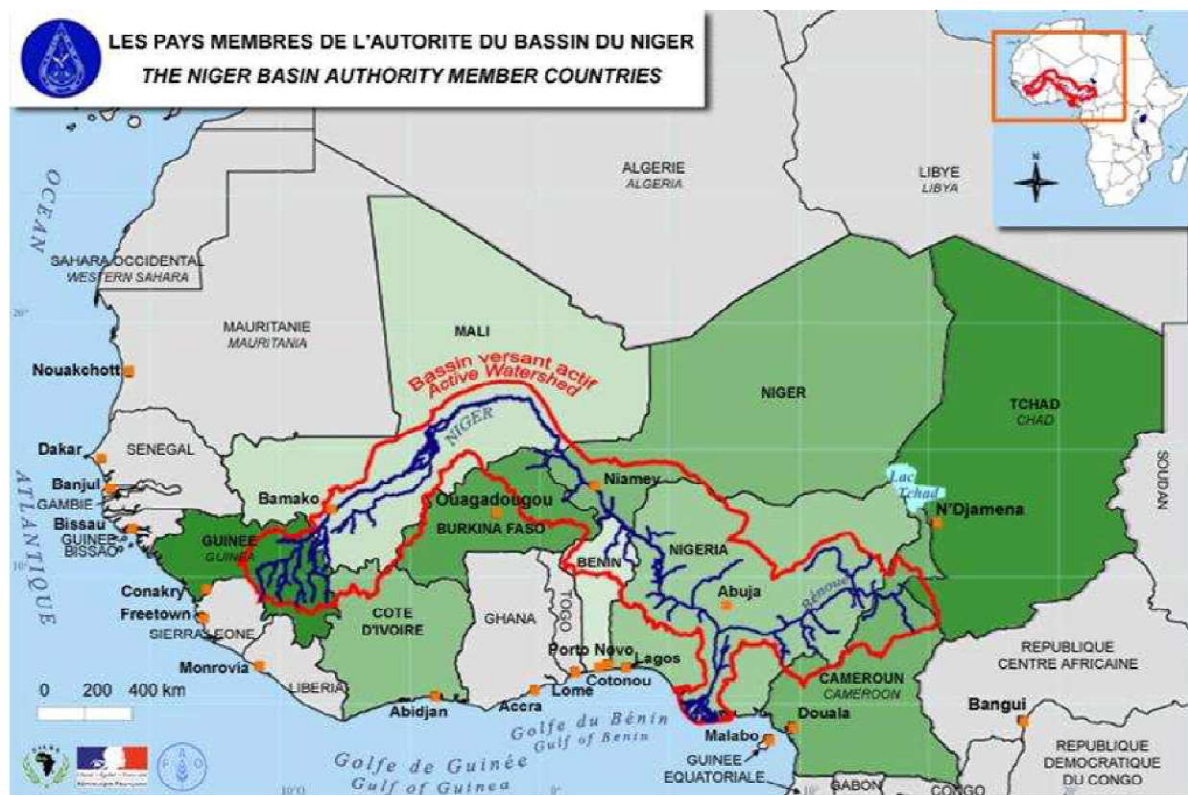


Figure 1: Niger River basin

Source: Detailed Implementation Plan report, Niger River Basing Authority

The Niger River plays a key role in the region. It provides the needs of riparian populations in terms of various forms of food production (agriculture, horticulture and livestock, etc.). The flood plains of the river produce rice, cotton, wheat and market gardening. The region also serves as habitat for more than 130 aquatic species, including fish, hippopotami, crocodiles and manatees. The abundant plant biomass associated with the extension of these wetlands constitutes a unique reservoir of biodiversity and an essential barrier to desert encroachment

The population of the basin is composed of a multitude of ethnic groups and is unevenly distributed in terms of space occupation (table 1). There is a high annual population growth rate of about 3 per cent.

Nowadays, the population in the basin amounts to approximately 104.5 million people, of which about 80% live in Nigeria. By 2025, this population is expected to double¹.

With the exception of Côte d'Ivoire, Cameroon and Guinea, all countries of the river basin have an annual GNP below 450 US\$ per capita.

In terms of availability of water resources, given a mean annual flow of 160 km³ over the last three decades and a population currently estimated at 100 million inhabitants, there is about 1600 m³/yr. per inhabitant. With the current growth rate of the population and the further increase of water use related to the extension of irrigated cropping and increased welfare, water scarcity is expected by 2025, i.e. less than 1000 m³/yr. per inhabitant.

The major physical and environmental problems in the river basin are: low rainfall, an increase in evapotranspiration, drought encroachment, reduction in the catchment area of the River Niger, excessive river siltation, ground water depletion, oil spillage, demographic pressure and socio-economic development.

2.2 The Client

The client is the Niger Basin Authority (NBA), an organization authorized by the Ministry of Hydrology of the Republic of Niger. NBA is an inter-governmental organization of West African countries that form the Niger River basin. NBA, established in 1964, is one of the oldest African Intergovernmental organizations. The Authority defines its main objective as the promotion of cooperation among member countries to ensure the integrated development of resources. The organization originally defined its mission as the cooperative management of water resources, most notably, but not limited to, the Niger River. While concentrating on water and hydroelectric resources, NBA helps the country members to harmonize the development of energy, agriculture, forestry, transport, communications, and industrial resources of region.

NBA's institutional arrangements involve organizations and representatives of the hydraulic and hydrology sectors of the nine member countries of the Niger River basin. These organizations, led by the General Secretary, set the vision, program and objectives of NBA.

There is a local NBA agency in each member country to coordinate local organizations dealing with the management of the river basin's water resources. The NBA headquarter is in Niamey, Niger.

The funds to support NBA come from country members. These funds consist of two categories: (1) an operational budget (staff salaries, fees, electricity, etc.) and (2) a project and program budget. The operational costs are for 95% covered by the member states; the remaining 5% comes from donor contributions and extraordinary sources of income. The project and program budget is covered by NBA donors and includes investments as well as the salaries of staff assigned to these projects and programs.

NBA has been active in developing several projects with multilateral donor organizations such as AfDB, World Bank, AFD (French cooperation), GIZ (German cooperation). Examples of these projects are: *the Niger-HYCOS Project developed to collect and disseminate hydrological information in the basin*; *the Sedimentation Control Programme developed to produce a master plan to control sand and silt accumulation in the Niger Basin*; *the NBA Observatory to develop knowledge about the Niger Basin's ecosystems including studies on strategic evaluation of the management of environmental and socio-economic data and disseminate information*; and *the GIRE Projects, which is a programme to reverse soil and water degradation trends in the Niger Basin*.

2.3 The Phases of the ORIO Co-funded Project

¹Synthesis of Multi-Sectoral Studies, NBA, 2005

The Niger ORIO project includes three phases: the development, implementation, and operation & maintenance. Operation and Maintenance is not part of this evaluation, because it has not started yet. The Niger ORIO project was submitted twice. The initial submission was not continued once the appraisal was terminated due to political problems in Niger that has resulted in the exclusion of the country from the ORIO country list. After the country has returned to democracy and the Niger added to the ORIO list again, the project was re-submitted. The development phase of the re-submitted project started in 2011 and finished in 2012. NBA, EARS and IHE staff developed the first phase together. The final content of this new re-submitted phase did not differ much of the content of the submitted initial proposal. Most of the changes referred to adaptation to new requirements of ORIO. In October 2013, The Ministry of Hydraulics of Niger, NBA and ORIO-EVD signed the grant arrangement of the project. The implementation phase started in May 2014.

The Implementation phase involved the delivery of technical and non-technical parts. The technical parts consist of MSG satellite receivers, computers, software and their calibration and validation. The non-technical parts include preparation of manuals to operate and maintain the installed systems, the development of a website to disseminate the information collected by the systems and to implement training for NBA operators in running the EWBMS-LSHM system and NBA's partner organizations in understanding and using the information provided by the system.

Table 1, shows the project costs. These costs add up to an amount of around € 5.6 million, with € 2.8 million covered by the ORIO grants. The development phase was fully covered by a grant from ORIO; the cost of implementing the project are for about 50% paid from an ORIO grant. In order to be able to pay its in-kind contribution to the implementation phase NBA made a request of additional funds to AfDB in 2013. In 2016, the project assessment report was approved by AfDB, and in March 2017 the additional grant agreement of € 1 million was signed.

These AfDB funds were used:

- To reinforce the ground stations;
- To buy one vehicle for the transport of NBA staff to visit the ground stations;
- To buy 50 laptops and 50 printers to be distributed to the partner's organizations in river basin plus the accessories;
- To buy 12 hydrometric stations for help with the calibration and validation of the SATH;
- To buy GIS software;
- To pay one study to make the reconstruction of the historic-meteor data from 1982 to 2012;
- To buy tables and desks for the offices of NBA to put the SATH equipment's;
- To pay NBA staff's participation in various international events to disseminate the project;
- To help to reinforce the communication among the partner organizations and disseminate the information generated by the system.

The implementation phase is expected to be concluded in December 2019.

The third phase, "Operation and Maintenance" will also be developed by all parties and will need the NBA approval. The Dutch partner eLeaf/EARS has stated that there are still significant and necessary changes to be discussed with NBA, especially in relation to the duration and structuring of NBA's own contribution. Currently, it is foreseen that 50% of the O&M costs are covered by a grant from ORIO. The third phase will have a duration of five years.

	Development Phase	Implementation Phase	Operation and Maintenance	Total eligible project costs
Project costs	41,280	4,043,831	1,531,180	5,616,291
ORIO grant	41,280	2,016,227	765,590	2,823,097
% ORIO grant	100.0%	49.9%	50.0%	50.3%
% paid of total grant	95,2%	79.0%	-	

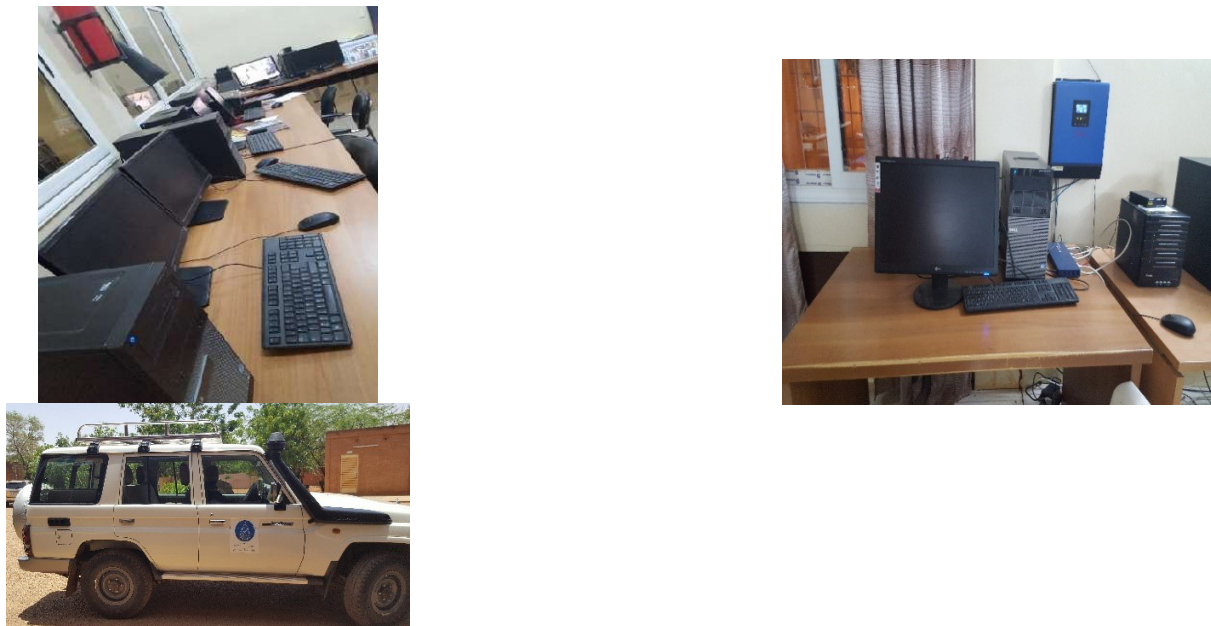
a) The third phase has not yet started

The implementation of the project went smoothly although some delays have occurred. Originally planned for 3 years, the implementation is now in its fifth year, and is not yet fully completed. The expected technical deliveries are installed, validated and calibrated (Figure 2 and figure 3).

Several of the operation and maintenance manuals have been developed and provided to NBA staff. Currently available manuals include system descriptions of the various components as well as how these are integrated into the broader NBA network infrastructure, and operational guides with procedures to manage the system including fixing a range of possible problems. There have also been several rounds of training of key operators of the system in conjunction to the manuals. Nevertheless, continued efforts to enable independent operation and maintenance on the side of NBA are indeed necessary. This will certainly receive the necessary attention in the third phase.

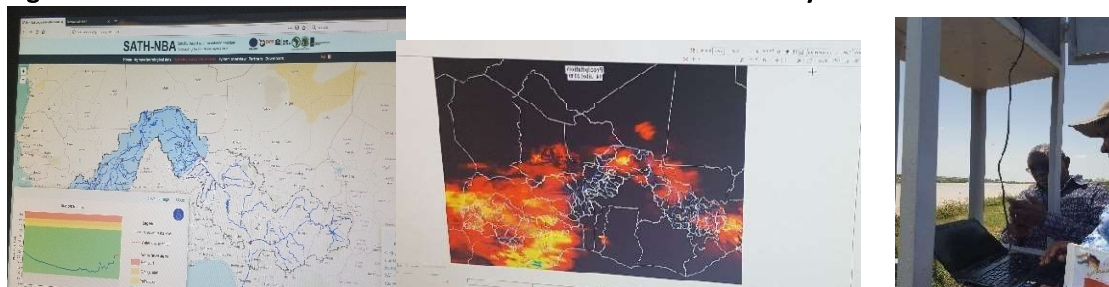
The NBA project website, sath.abn.ne, has a provision for the climate and drought and crop monitoring data. However, at the moment the crop data is not yet operational. It will be operational again before the end of the year,

Figure 2: SATH and Logistic Equipment’s installed and Present at NBA in Niamey



Source: Field visit to Niamey July 13 -21, 2019

Figure 3: Data Collection and Information from the SATH Installed Systems



Source: Field visit to Niamey July 13 -21, 2019

2.4 Stakeholders

Apart from NBA and the two Dutch companies EARS (now eLEAF) and UNESCO-IHE there are other important stakeholders involved in the project. These are the Inter-states Forecasting Centre (IFC), the NBA Observatory, the Niger-HYCOS project and the national institutions in charge of operational hydrology in the nine countries of the Niger River Basin.

Other stakeholders include: political decision makers, local leaders, agricultural and fishery Services, navigation companies, dam managers, regional and international institutions, environmental monitoring organizations and NGOs, media and scientists of the country members and the international donors presented in the Niger River Basin.

To clarify the vague definition of end-users proposed in the project development phase, a regional workshop organized in Niamey in 2015 decided to consider all NBA's partner organizations as end-users for this project.

2.4.1 Ministry of Hydrauliques and Satiation

This Ministry is the focal point of NBA in Niger and all matters related to hydraulics are in the mandate of this ministry. All information related to water issues is first transmitted to the Ministry of Hydrauliques and Sanitation which then transmits it to the other national organizations and to the community observers.

This ministry has been actively involved in this project since its preparation; besides being the national coordinator of the project in Niger, it is also a key partner and user of the data and the information generated by the project. NBA transmits official data collected by the satellite system to this ministry, which makes those available to the other Niger organizations.

2.4.2 Ministry of Finance

The Ministry of Finance is member of the NBA observatory, responsible for all sub-regional projects in Niger and coordinates together with the Ministry of Hydraulics & Sanitation the focal structure of NBA for this project. According to the Ministry; the deliverables of the ORIO-SATH project are helpful to formulating suggestions for decision-making as part of financial allocations and even for formulating certain policies.

2.4.3 Directorate of Hydrology under the Ministry of Hydraulics

The Directorate of Hydrology is in charge of the operation and maintenance of the hydrometric ground base network, including the gauging, collection, formatting and diffusion of the data. The directorate is a partner of NBA and the hydrologic data produced by the ground base network of stations helps to calibrate the SATH-ORIO system. The information generated by this project complements the day-to-day work of this directorate thanks to the abundant, rapid, reliable, uniform and objective collection of basic

hydrological data from the satellite monitoring system. The information from this project enhances the quality of the hydrological available measurements and allows the ministry to improve the development of computerized systems of data access and management.

2.4.4 National Directorate of Meteorology of Niger

This directorate is in charge of the collection, management and distribution of meteorological data in Niger. It cooperates with the ORIO project since its start, helps with the validation and calibration of the systems, receives regularly updated data of the project and disseminates this data to the other national organizations.

2.4.5 Coordination Cell of the alert system of Prime Minister's Office.

This institution is responsible for producing, informing and advising the Prime Minister on climate risks. At this moment, this Coordination Cell is also responsible for food crises. SATH information; produced in real time; is very important for this ministry because it helps to reduce the agricultural losses caused by droughts and floods. In the past, this institution used information produced by the Ministry of Hydrology. This information was not in real time but now we have the SATH information in almost real time.

2.4.6 Ministry of Humanitarian Action and Disaster Management

This ministry is in charge of the management of disaster and humanitarian help for the affected disaster areas, and is a partner of NBA. The outputs of ORIO project are included in the mandate of this ministry and are used to provide forecasts and give alerts on time to avoid damage from disasters. With the satellite information, the ministry has improved the quality and the speed of providing earlier alerts. The information received from the project is analysed and transmitted via portables to the observers in the riparian communities.

2.4.7 Association of the Users of the national Chain of Natural resources for the portion of the Niger River

This association is part of NBA and plays the role of interface between NBA, the riparian populations and decision-makers. The association is in charge of informing villages and communities about flood warnings and other natural disasters. Before the ORIO project it took a long time to the hydrologic information arrive to this organization. Now we receive the information almost in real time, what has substantially improved the alert system. The received information is analysed and transmitted to the regional representatives and later to the local residents via portable and laptops.

2.4.8 French Cooperation (AFD), Niamey Agency

The French international cooperation agency, AFD, has been working in Niger since 2016 with projects in the water sector. AFD was involved with NBA in the Niger Hycos project (to set ground base hydrological stations to collect and disseminate hydrological data through the Niger River Basin), and the CEFEC project focusing on capacity building. The SATH project has allowed AfDB to develop a new project with NBA in the remote sensing area and it is in a process of developing a new project with NBA called GIRE3.

2.4.9 German Cooperation (GIZ)

GIZ has supported NBA for the last five years. It is currently working with NBA to improve its capacity on the communication on rain alerts, the creation and exploitation of an early warning system using the ORIO SATH and Hycos data, the improvement of its website and in reorganizing its financial model.

2.4.10 RVO (Dutch Cooperation)

RVO is trying to identify opportunities and set up Dutch projects in Niger and in the Niger River Basin. It is currently involved in the management of the drinking water project. The ORIO SATH project has no direct effect on RVO's current work in Niger but the information provided by the satellite system is useful for monitoring the upstream of the river waters, which is important for the organizations working in the water sector. In this regard ORIO project data has been used in the management of the drinking water project which is currently being implementing.

2.4.11 AGES: German Support Project for Groundwater Management in the Niger Basin

AGES is a German-funded project aiming to create a groundwater network in Niger. The project has installed equipment's to monitor levels of the water table along the Niger River. ORIO SATH data has been very useful for our project since it provides us with the climatic parametric data that is important for the measurements of the water table. The ORIO data will also in the future allow NBA to hold retrospective historical data of the river basin.

2.4.12 EARS (eLEAF) Holding BV (NL)

EARS(Environmental Analysis * Remote Sensing) merged with eLEAF recently to become eLEAFHolding BV (NL). It is a private company and the main contractor of the project. eLEAF is a high-tech remote sensing company specialized in remote and near sensing techniques. It operates a receiving station, covering Europe and Africa, and operationally receives satellite data (Meteosat-7 and FY2c) covering Asia. The company has developed the Energy and Water Balance Monitoring System (EWBMS) which produces daily agro- and hydro-meteorological data fields. It has also developed sub-systems for crop yield forecasting and rainfall-runoff forecasting. Currently the company is the main actor responsible for the installation of the satellite base water monitoring and flow forecasting in the Niger River Basin (SATH).

2.4.13 UNESCO-IHE Delft Institute for Water Education

IHE Delft Institute for Water Education is the largest international graduate water education facility in the world and its goal is to increase the capacity of people and organizations to identify and solve their water-related problems. IHE has extensive international experience in implementing and developing capacity in climatic forecasting systems. In 2004 it successively installed and implemented satellite based water monitoring and flow forecasting together with EARS (eLEAF) in the Yellow River Basin Authority in China, and is currently the eLEAF partner organization in the ORIO-SATH project.

3. Evaluation Methods

The impact of the intervention was assessed qualitatively and quantitatively, reconstructing a counterfactual, by studying the relevant documentation, measuring the results of the transactions and by interviewing beneficiaries, stakeholders of the project in Niamey and representatives of the two Dutch companies involved in the project. A survey originally planned was excluded of this study because of political and unstable situation in the countries of the Niger basin. The following theory of change was used to structure this evaluation.

3.1 Theory of Change

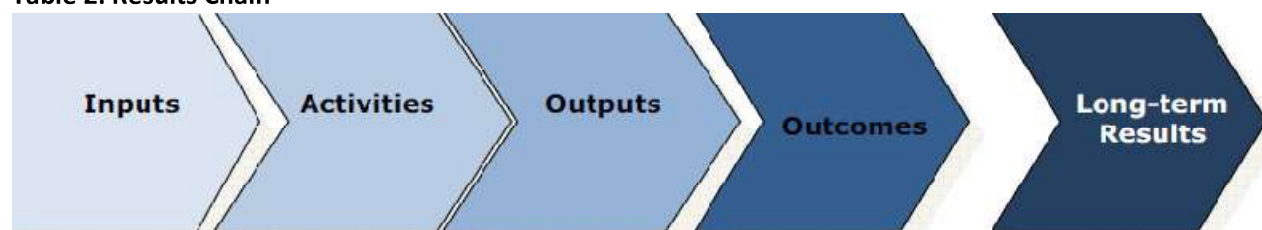
Table 2 summarizes the intended inputs, activities, outputs, outcomes and long-term results of the ORIO-SATH project. Figure 4 shows the theory of change prepared for this project with the proposed main causal relations. It shows the external elements considered to assess the short- and medium-term objectives of the project (inputs and outputs) and long-term objectives (impacts).

The short- and medium-term objectives are to deliver Satellite Based Water Monitoring and Flow Forecasting Systems for the Niger River Basin Authority (NBA), to strengthen NBA's management capacity to operate and maintain the system, and to disseminate the data to member countries.

The evaluation of the delivery of the outputs and outcomes of the project can measure the causal relations between the ORIO transactions and the objectives of the project. However, some internal and external factors can influence the achievement of these objectives such as the timely delivery of the equipment, manuals and training by the two Dutch companies and if no major changes have taken place in the internal organizational and management structure of NBA.

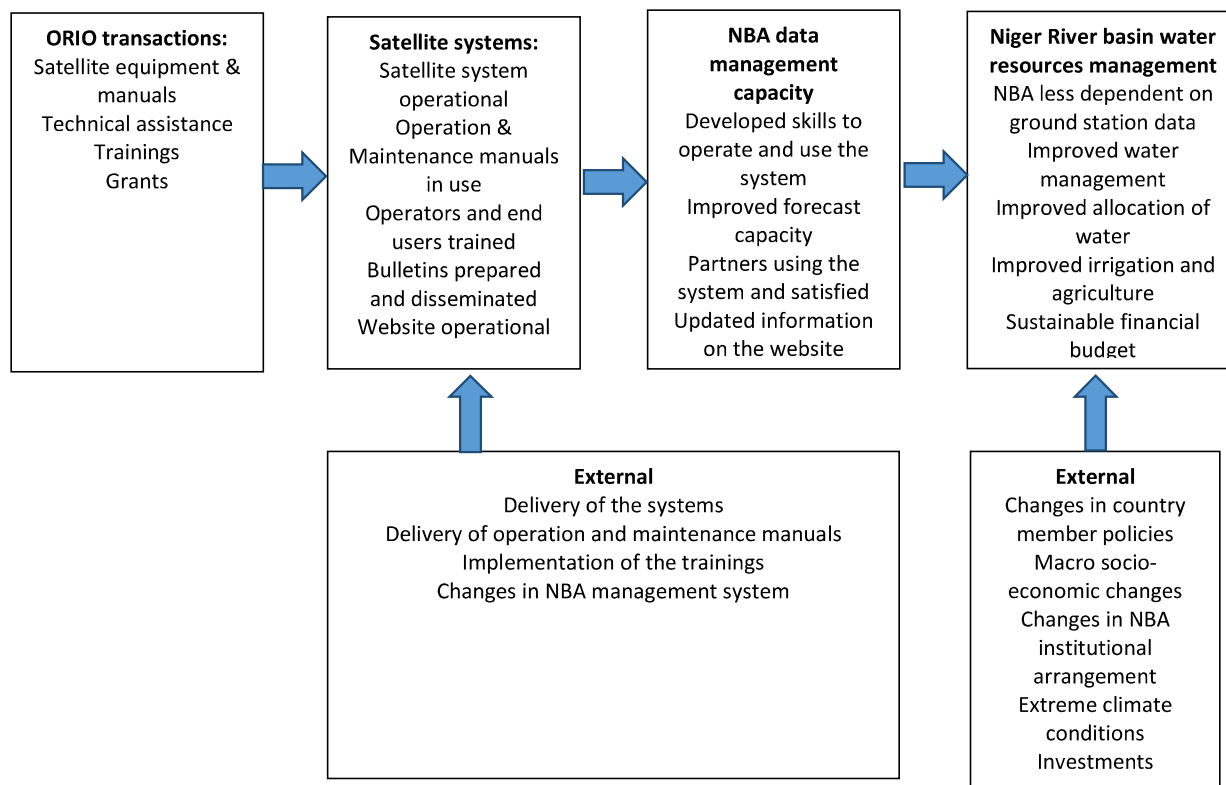
The long-term objectives of the project are to make NBA less dependent on ground station data and to enhance and strengthen its capacity to manage the water and natural resources of the Niger River basin. The achievement of these objectives will allow NBA to improve the allocation of water for irrigation, agriculture and livelihoods and consequently improve the living conditions of the riparian population. The causal relation between the ORIO supported activities and the long-term objectives (impacts) is expected to be weak as the impact also depends on several external factors such as socio-economic, environmental, political and policy changes in the nine member countries as well as unexpected climatic events, investments and changes in NBA management, financial and institutional arrangement and so on.

Table 2: Results Chain



Inputs	Activities	Outputs	Outcomes	Long-term Results
<ul style="list-style-type: none"> • ORIO grants • Financial and in-kind support from government of Niger • Meteosat Second Generation data receiver • Assistance and advice to prepare website and bulletin generation • Staff time and manuals for Training and workshops 	<ul style="list-style-type: none"> • Supply of data and manuals on receivers, computers, EWBMS software, licenses, HSS, DMS and CFS • Systems software, satellite receiver • System maintenance, installation of software updates • Workshops, seminars and training for NBA staff, members and end users • Niger Basin Monitoring Bulletin template and a Monitoring Bulletin instruction manuals • Testing, validating and calibrating the systems • Developing and operating a website for the project • Scientific reports prepared 	<ul style="list-style-type: none"> • The satellite based Flow Forecasting System (FFS), Hydrological Model (LSHM), the EWBMS, Drought Monitoring System (DMS), The Crop Yield Forecasting System (CYFS) installed, calibrated and validated • The system for maintenance of software updates installed and operational • Niger bulletins issued to end users and a Monitoring Bulletin instruction manual prepared and published • A website for the project developed and in operation • Ten NBA operators running the systems trained in operating the newly installed systems • Four workshops and five training seminars held for NBA operators and partner organizations • One hundred end users trained in using the information of the newly installed systems 	<ul style="list-style-type: none"> • NBA Authority has an installed and operational satellite based hydro-meteorological data collection system in accordance with the specification of the project • NBA has acquired skills in operating and using the newly installed forecast systems • NBA has improved capacity to collect satellite data on climatic forecast conditions • NBA has improved its capacity to use the newly generated data to prepare good quality river basin monitoring bulletins • NBA has improved its capacity to use the newly generated data to prepare good quality river basin monitoring bulletins • New forecast data is easily accessible to NBA members • NBA partners better informed and trained on the importance of climatic timely data collection and satisfied with the newly available information 	<ul style="list-style-type: none"> • Reduction of NBA's current lack of reliable ground station data • Management of Niger water resources improved for the benefit of livelihoods and economic activities in the Niger delta. • Improved water allocation for agriculture and irrigation • A sustainable financial operational budget for timely data collection and distribution of the data

Figure 4: Theory of change for the SATH project



3.2 Defining the Counterfactual

In any ex-post evaluation there is an interest in identifying a measurable outcome. The test of causal relations between outputs and outcomes is only possible if we can control other factors. The question then becomes whether it is possible to define the counterfactual: what would have happened without the intervention?

Before this project, NBA had no satellite systems. The organization only collected hydrological and some climatic data from ground stations. The data was not processed in real time and its capacity to collect and disseminate hydrological data was limited.

We could argue that if this project had not been implemented NBA would not have acquired the capacity to collect satellite data and improved its processing of climatic data and dissemination. In short, the situation would not have changed much compared to what existed when the ORIO project started. In reality, there are no ways to be sure how NBA’s processing of collecting and management climatic data would have developed without this project.

As we do not have a description of the NBA baseline situation prior to the start of this project, we have tried to remedy this situation by retrieving information from NBA documents and by including retrospective questions in the interviews carried out, and have tried to construct a 'quasi-baseline'. This qualitative approach helped us to evaluate the outcomes of the project by reconstructing the counterfactual and measuring the results of the transactions through in-depth interviews with NBA operators, key partner organizations (end-users) and other stakeholders present in Niamey.

3.3 The In-Depth Interviews

3.3.1 Organizations Interviewed

The interviews were carried out in two stages. First, we visited the two Dutch companies (EARS and IHE) in Delft to gain an initial insight into their experience with the implementation of the project allowing us to define and prepare the scope of the field visit and to draw up a preliminary list of names of organizations. Second, Mr. Bachir Tanimoune, the Project Manager, finalized the list including NBA's partner organizations in Niamey that are considered being the end-users in this project. Finally, the list also included other stakeholders such as international donors and chambers of commerce. Annex A1 presents the final list of the eighteen interviewed organizations together with a description of their positions and relationship with the project.

3.3.2 The Interviews and Site Visits

The interviews were conducted in French with various NBA staff, partners and stakeholders (international donors, projects and chambers of commerce) and were carried out during the visit of the research team to Niamey from 13 – 21 July 2019.

Interviews were semi-structured and prepared following the evaluation criteria as specified in the terms of reference and structured according to the theory of change shown in table 2.

Mr. Bachir Tanimoune, Project Manager of the ORIO project, answered the first questionnaire as a pilot interview. This served to slightly revise the master questionnaire. The subsequent questionnaires were adapted for each interview to be in line with the activities of the interviewed organizations.

Field visits in Niamey included the NBA technical agency, NBA Headquarters, some hydrological groundwater stations along the Niger River and NBA's partner organizations and stakeholders.

4. Efficiency

Under this heading we discuss the efficiency of the project in terms of the extent to which the inputs (funds, expertise, time, human resources, etc.) and activities carried out produced the agreed outputs. These include the installation of satellite equipment, technical assistance including delivery of manuals, training and setting up the website. The present evaluation not only pays attention to the question of whether outputs have been produced as foreseen, but also if these outputs were produced on time and cost efficiently. In other words have the resources been translated into outputs in an economical way?

4.1 Delivery of Outputs

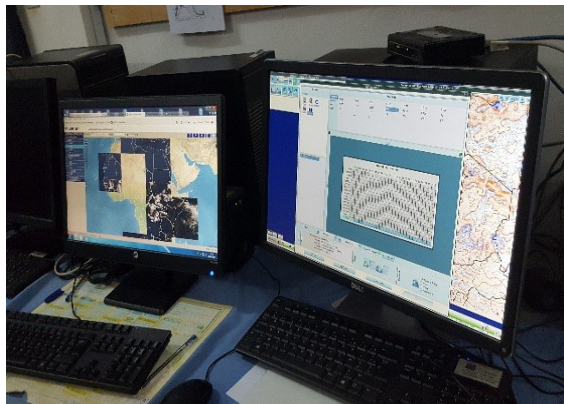
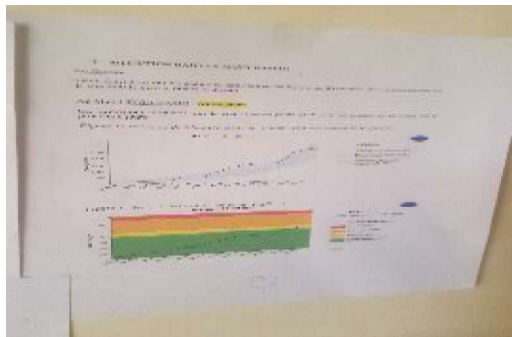
4.1.1 Satellite Equipment

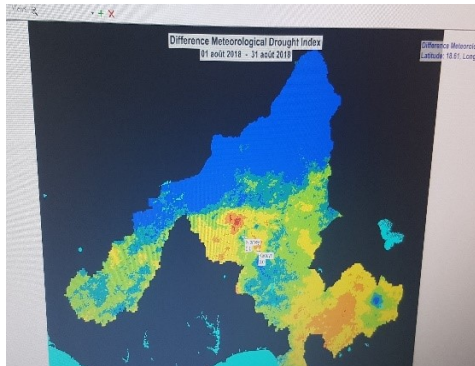
Desk research, interviews with key stakeholders and site visits confirmed that all expected outputs were produced as agreed with only minor changes. All the planned technical parts of the satellite system: Satellite Flow Forecasting System (FFS), the Hydrological Model (LSHM), (EWBMS), the Drought Monitoring System (DMS) and the Crop Yield Forecasting System (CYFS) have been installed, calibrated and validated (figure 5). At the moment, the crop yield monitoring system presents some problems. The installed crop monitoring system is not automatically generating crop information from the drought system. The project website, sath.abn.ne, has a provision for climate and drought monitoring data, but currently there is no data on crop available. It is on the agenda to get this module operational again (eLEAF) according to information obtained from the Dutch companies. The maintenance and updating of software is carried out regularly by eLEAF/IHE and is operational.

4.1.2 Website and Bulletins

The interviews with NBA's partner organizations and the visit to NBA confirmed that the website has been delivered and is operational (figure 5). The website contains SATH climatic and hydro meteorological data. However some interviewees reported that they are not regularly updated.

Figure 5: SATH Equipment and Website





Source: Field visit to Niamey July 13 -21, 2019

4.1.3 Trainings and Workshops

Trainings for NBA Operators

The project planned to train ten NBA staff to operate, retrieve, treat and disseminate the satellite information. In fact, according to NBA, twenty operators from NBA agencies in the Niger River basin were trained.

Two types of training were provided: on validation and analysis, and on the system. The trained operators are now in charge of operating the system including retrieval of the information and analyzing and disseminating it via the website.

A core group of NBA operators was first trained by the Dutch experts in Niamey using a TOT (training of trainers) format. Later these operators travelled together with the Dutch experts to the other countries of the Niger basin to train operators and staff of NBA partner organizations in these countries. At the end of these trainings, each trained operator representing a country received a password that allows them to access the SATH system.

The number of trainees ranged from 4 to 15 for the various activities which included general presentations, workshops and on-the-job training. Content matters dealt with the scientific and technical background of the systems, systems connectivity, software installation, systems operation, output production on website and development of operational procedures.

The trainings consisted of both formal and informal sessions over multiple days with a high level of interaction and input from NBA personnel. They often asked for additional time to be allocated to specific components of system and of its operation. This approach helped to maximize the effectiveness of the workshops. The feedback collected during the workshops was taken into account in developing all training and reference materials such as user manuals.

Trainings and Workshops for End Users (Partners)

The project planned to train one hundred end-users. At the regional seminar in Niamey end-users for the project were defined as the NBA's partner organizations in the member countries. According to NBA one hundred and eighty (180) technicians from partner organizations have received training, or thirty per country.

The project originally planned to implement four workshops and five national training sessions for operators and end-users. This number was changed to eighteen trainings: nine national workshops for decision makers and nine national trainings (on techniques). This change was approved by NBA and RVO (ORIO project).

The increased number of workshops and trainings did not imply extra costs. Costs were re-allocated with ORIO approval. Up to 2018, eight trainings/workshops have been implemented (in Niger, Benin,

Burkina Faso, Cameroon, Nigeria, Chad, Guinea and Mali) plus two national decision maker workshops (Niger and Ivory Cote) and one regional workshop in August 2015. There are still seven trainings planned to be delivered until the end of this year. No explicit difference was made between workshop and training. Both programs included technical and general information.

The trainings were evaluated via questionnaires. In most, if not all, cases to be completed at the end of the workshops. In every country workshop, the participants prepared and approved a joint training report for their respective organizations, which included recommendations for integration of SATH products in their mandate activities. A certificate was delivered at the end of these trainings.

Participants from the workshops and trainings were satisfied as we could see from the reports and from the interviews conducted with some trained participants. The German, French and Dutch donor organizations that have participated in some of these training also pointed out that the evaluation of these trainings were very positive. Copies of ToRs, programs and reports of these trainings can be found in annex B.

Delays and Costs

According to the progress reports and the interviews, at the two assessed transaction level, all outputs of the project were realized within the allocated budget. No extra cost was added.

Originally planned to be implemented in three years, the project is currently in its fifth year. The completion of the implementation phase is expected for December.

Reasons for this delay include:

- delays in the data transfer by NBA in the first year;
- lack of documentation of NBA database architecture;
- absence or unavailability of key-people during missions by the Dutch partners;
- problems with the development of software, calibration and validation;
- problems due to scheduling difficulties, EARS/E-Leaf corporate transition and logistical planning difficulties to implement the trainings.

4.1.4 Conclusions

The implementation of the ORIO-SATH project was successful in delivering the expected outputs. All the satellite equipment's are delivered, installed, calibrated and validated, the website is operational and most of the planned trainings were implemented.

Despite the minor problems identified in this evaluation such as the crop system information that is not yet producing data, the seven remaining trainings that have not been implemented yet, and the delays occurred during the implementation phase, we can conclude that these problems did not affect the overall efficiency of project.

The funds, expertise, time and trainings implemented in the ORIO-SATH project have positively influenced the outputs of these transactions: NBA now can collect, process, and publish climatic data in their website. NBA operators and key staff of NBA's partner organizations have received trainings on how to collect, process, disseminate and use climatic data.

The climatic information is being displayed at NBA SATH website that has attracted the attention of NBA's partner organizations and other local and international stakeholders.

The implemented regional and national workshops have attracted many participants and were evaluated as very positive.

5. Effectiveness

This chapter evaluates the effectiveness of the ORIO project conditioned on what has been achieved in the implementation phase, which involves the delivery of a Satellite Based Water Monitoring and Flow Forecasting System in the Niger River Basin at NBA.

Effectiveness is understood as the extent to which the outputs created by the project have contributed to the achievement of the project's expected results and objectives in terms of the outcomes for NBA, NBA's partner organizations and other stakeholders.

The evaluation covers the short- and intermediate-term effects created or contributed by the project.

5.1 Overall Effectiveness

Before analyzing the impacts of the ORIOSATH project in more detail, this section first addresses the overall expectations formulated as part of the project design.²

Before the implementation of the ORIO-SATH project NBA was only able to collect hydrological information from its existent ground base stations. These stations were often vandalized and did not provide real time data. The SATH project would allow the creation of a climatic data infrastructure covering the entire Niger River basin enabling NBA to produce climatic real time data. This new climatic data would help NBA to timely determining the river water resources, foreseeing and monitoring droughts, predicting the effects of droughts on agriculture and allocating water to drought areas. As this new data and information would be derived from, a public service and belong to the public domain it would at the end help to improve the living and farming conditions in the Niger basin.

NBA Improved Capacity on Collecting and Disseminating Satellite Climatic Data

The installation and implementation of the new systems have improved NBA's ways of working and disseminating the new generated information compared with the situation previous to the project as confirmed by the respondents during the site visit.

Previously, NBA didn't have a facility to collect satellite data; now it has the infrastructure and the systems for collecting and processing Meteosat data, and to publish the resulting imagery on its website. This project allowed NBA to acquire and develop new skills that it did not have before; such as collecting and processing satellite rainfall and evapotranspiration data for the whole Niger River basin at nearly real-time and developing a system that allows to forecast water flows and provide early warnings in the case of risks of flood's occurrence.

Operators of NBA are now capable of operating, processing and disseminating data collected by the satellite systems. However, they are not yet able to maintain the systems and solve problems when these happen. In these cases they need to contact the Dutch providers. Operation and maintenance activities are core issues to be delivered in the third phase of the project, but this has not started yet.

Each trained operator representing a country member has received a password, called FTP, that allows him/her to login and to have access to all raw data produced by the satellite systems. From these systems, they can select the data for his/her country, exploit and disseminate it to the organization(s) within the country.

The project has helped NBA to improve the layout and the information of the existing website. It now incorporates the climatic and hydrologic bulletins. The site is also capable of providing warnings and alarms in case of occurrence of water extremes (floods and droughts). Overall, the project has increased

²Application Form of the ORIO Facility for Infrastructure Development, Version of 26 July 2010 and submitted on 11 October 2010; the ORIO 10/NE/22 – Development Phase Grant Appraisal Document; ORIO 10NE22:Project Implementation Plan ORIO Facility for Infrastructure Development, Submitted in September 28, 2012

the possibilities of NBA to present its climatic and hydrological results; however during the interviews some respondents stated that information in the bulletin is not always updated.

Accessibility and Satisfaction of NBA and Partner's Organizations with the SATH Project

The standard information from the SATH project can be accessed via the website. The only requirement is a working internet connection. This pertains to the information, which is what most of the user organizations need. The data itself can also be shared via internet. More elaborated information can be obtained per request to NBA.

To facilitate the accessibility and processing of the SATH data to the NBA's partner organizations, 50 laptops, printers and accessories were bought and distributed to them. In Niamey all the partners have already received this equipment.

Figure 6: Equipment distributed by NBA to its partners organization and hydro metrology station



Source: Field visit to Niamey July 13 -21, 2019

Without exception all interviewed organizations including NBA partners, international donors, project developers and the Chamber of Commerce consider the ORIO-SATH project very important and useful for them. They added that SATH information is complementary to their work, covers existent gaps and has improved their capacity to deal with climatic issues.

At time of the field visits this equipment was not yet operational in two organizations. Main reasons being a very poor internet connection and lack of adequate space with air conditioning to receive and operate the equipment. In two other organizations the equipment was installed but the staff was not able to retrieve and process the information. They found the information displayed in the NBA website too technical, difficult to understand and difficult to be used directly by their organizations. They preferred to have this information already adapted to their needs. Later we were informed that these two organizations did not send staff to the training workshops.

This evaluation has not found any organization dissatisfied with the project. Some have expressed that the information provided was adapted to their needs and others stated that the SATH data displayed in the website is not always updated.

NBA Capacity on Using Satellite Data: Determinant Factors and Synergies

The ORIO-SATH project has improved NBA's staff skills regarding dealing with climatic data. Key factors influencing this improvement are: the new skills of the NBA operators in collecting, processing and disseminating climate data including the development of their website and increase of NBA's processing capacity and availability of satellite data and derived products. The project has also improved NBA's capacity to measure river flows and levels at key ground stations. There are now for every country of the Niger basin at least two ground stations connected with the satellite forecasting system.

The ORIO-SATH project has a strong synergy with other projects currently implemented in the Niger basin such as the Niger Hycos project. This project measures the water level and the flow (discharge) situation in 138 installed ground stations in the Niger River basin and is in operation since already more than five years. The Niger Hycos project helps to calibrate the ORIO-SATH data systems and the information of the ORIO-SATH project complements the Niger Hycos information with data on the precipitations.

The outcomes of the ORIO SATH has already attracted some interest of internal organizations that have started to develop new projects with NBA having the SATH information as part of the project such as the NBA/Toulouse altimetry monitoring system using satellite data with NASA which is in the final stage of preparation. The ORIO-SATH data is expected to help to validate the data of this new system. According to the NBA executive secretary other African organizations are also interested in developing similar projects in their river basins. NBA was approached to help them to develop such projects.

Achievement of Planned Outcomes: Target Population and Standards of Knowledge

It could be said that the project has reached the target population: NBA's operators and partner organizations in the Niger River basin have received trainings and equipment to facilitate the retrieving and processing of the satellite data. Documentation delivered by the project manager corroborate the successful implementation of various trainings and workshops in the member countries. The interviews conducted the country visit also confirmed this information. The project website and the bulletins have facilitated the information to the target population and have enlarged the public target, including international donors.

Related to the question if the originally defined outcomes of the project are still realistic, the answer is that in general they are. They still meet the requirements of NBA and it has helped to reduce NBA's dependence on ground stations (very often vandalized) as confirmed by the respondents.

Some respondents from the NBA organization also have stated that the planned in-kind contributions of NBA to the implementation and O&M phases of the project are considered too large for the organization, and the original three planned trainings per country were not enough for the introduction of such a new technology

Respondents also mentioned that the outcomes of the ORIO-SATH project still meet the most recent requirements of NBA and the most recent standards of knowledge. In operational hydrology, the standards of knowledge do neither change that fast nor become outdated. New developments and research outcomes often require a decade or more before they can be meaningfully incorporated in essential routine services.

ORIO Project: Development of Social and Physical Infrastructure in the Region

We could not find any direct evidence of the influence of the project in the social and physical infrastructures in the region.

From the interviewees that have answered this question, only indirect links were mentioned such as NBA now being able to provide warning and alerts to climatic extremes events that help to prevent and reduce damages to roads, agriculture and irrigation projects and to urban infrastructures. These warning and alerts also help to reduce economic losses and save lives. The ORIO-SATH project manager stated that alarm systems of the project has helped the Niger government to prevent damages during the occurrence of flood in Niamey in 2017, and to reduce physical damages on the drought of 2018 by providing earlier alarms. He also cited that the Niamey drinking water treatment plant uses flood alert information from the project to prevent damages to its infrastructure facility, and the Candi dam Project has used data of the project systems to evaluate some proposed constructing parameters of the dam.

Economic Benefits for Increasing Economic and Financial Relation in the Region

We did not find any direct evidence that this project contributed to an increase of the Dutch economic and financial relations with Niger and neighboring countries. The Chamber of Commerce stated that before this project, the Netherlands only had projects related to the dairy sector. This situation has changed in recent years: currently there are 13 Dutch companies working in various fields in Niger such as logistics and solar energy. The Dutch Embassy has shown in a presentation at the Chamber of Commerce that the volume of Dutch trade with Niger has increased by 600% in the last four years.

5.2 Conclusions

The project's theory of change assumes the activities of the implementation phase would contribute to the following outcomes:

- NBA has an installed and operational satellite based hydro-meteorological data collection in accordance with the specification of the project;
- NBA has acquired skills to operate and use the new installed forecast systems;
- NBA has an improved capacity to collect satellite data on climatic forecast conditions;
- NBA has improved its capacity to use the newly generated data to prepare good quality river basin monitoring bulletins;
- New forecast data is easily accessible for NBA members;
- Members and stakeholders of NBA are better informed and trained on the importance of timely climatic data collection and processing systems for improving water and natural resource management of the river basin;
- End users (partner's organizations) are better informed and satisfied with the NBA's operation and dissemination of the new collected data.

NBA is now indeed capable of operating, processing and disseminating the data collected by the satellite systems. NBA operators have acquired new skills in collecting, processing, disseminating and developing the website and new climatic products.

The information produced by the satellite system is displayed in bulletins on the SATH site and it is accessible via internet to NBA partner organizations and stakeholders. The majority of the respondents in the interviews were satisfied with the project and with the information available on the website.

The target population of the project, NBA operators and partner organizations, have received training and have developed skills in operating and using the information of the system. Seven remaining trainings for partner organizations are expected to be implemented by the end of this year

In general all the planned outcomes of the implementation phase of the project have been achieved. Minor problems have been identified such as non-availability of crop data on the website and there have been some complaints that website information is not always up-to-date.

Indirect impacts such as use of the information provided by the SATH systems were reported by some respondents in planning new projects and reducing damage during floods and droughts events.

No direct evidence was found that the project contributed to increasing Dutch economic and financial relations with Niger and neighboring countries.

From the above summary we can say that almost all planned project activities were successfully implemented. If we assume that the remaining 7 trainings will be implemented as planned until December of this year we could say that project is effective. If NBA is able to solve or reduce some of its internal problems and the Operation and Maintenance phase is successfully implemented, the project will most likely produce positive long-term effects.

6. Sustainability

In this chapter we review the sustainability of the ORIO-SATH project. It essentially answers the question whether the newly acquired climatic satellite systems and the skills for NBA to operate, maintain, manage and disseminate climatic data and information can continue independently after the completion of the project. This is a question of technical, financial and institutional sustainability.

While the Operation and Maintenance (O&M) phase has not yet started this evaluation cannot fully address the question of whether the benefits of the ORIO project will be continued after its completion. However, as all the planned satellite systems, including the website, are already installed and operational at NBA, and most of the planned trainings have already being provided, we will try to address the sustainability issue looking at how the current identified problems and bottlenecks can influence the long term benefits after the completion of the project.

6.1 Technical Sustainability

The technical components and capacity for operating, managing, exploiting and disseminating climate data is currently present and operational at NBA. The sustainability of the installed technical infrastructure depends on regular maintenance and replacement of mostly ICT equipment. In general, this should not be a disproportionately large financial burden for NBA especially considering that the outcomes of this project are part of NBA's mandate. However, continued O&M of the system depend on several factors, such as NBA's capacity to keep its trained staff in house or, if they cannot, to provide training for new staff, and its capacity to cover the operational, maintenance and logistical costs of the installed systems.

On the maintenance issue, the NBA operators interviewed unanimously stated that NBA is not yet able to carry out maintenance of the SATH systems. This reflects the fact that operation and maintenance activities are planned to be delivered in the third phase. Commenting on the SATH operation and maintenance issues IHE stated that direct operation was the responsibility of NBA and maintenance of ICT technology and equipment, including internet connectivity is also an NBA responsibility. Furthermore, the systems rely on timely data collection (satellite, rainfall and river data), which means that the associated databases have to be maintained (updated) on a daily basis to allow the systems to operate. This can be done automatically but only to a limited extent. Simple adaptations to the software, such as configuration changes, updates and, if required, calibrations can in principle be carried out by NBA. Modifications and extension to software code can be made on request by the Dutch organizations after the project finishes.

From the interviews conducted with NBA operators, the NBA ORIO Project Manager and the clarification on operation and maintenance responsibilities provided by the IHE experts, it seems that there is a problem on the understanding of NBA's task, responsibilities and extent it will be able to carry out maintenance on all components of the SATH systems. Some specialists in informatics at NBA said that the SATH systems is a "black box" and that they are not able to maintain it. They rely on support by phone from the Dutch experts every time a problem appears in the systems. As this is a crucial element for the long term sustainability of the benefits of the project, it is important to clarify before the beginning of the third phase, the tasks, responsibilities and level of maintenance NBA operators will be able to conduct and the ones that will continue to rely on the Dutch companies. Clear maintenance objectives and a plan should be prepared by NBA and the Dutch companies prior to starting this third phase.

6.2 Financial Sustainability

The continuation of the benefits of the project in the mid- and long-term after the completion relies heavily on the capacity of NBA to finance the operation, maintenance and logistical costs required to keep the installed systems working.

At present, the financial arrangement of NBA is fragile. NBA is financed by nine countries of the basin of Niger that in turn are among the poorest countries in the world. These countries often suffer from financial problems causing delays in the payment of their obligations to NBA which poses a problem for its long-term functioning. As a consequence of this unstable flow of funds, NBA is often taking loans from Banks to continue financing its activities. Regarding running costs for example, NBA depends on the acquisition of new projects to cover part of its personnel costs and the operational, maintenance and logistic costs of its equipment and installations.

NBA is aware of this fragile financial situation. A study is in progress on the design of new financial schemes for NBA. GIZ is working with NBA on the development of a water charter that will provide a legal framework to allow NBA to sell climatic data and collect money from big water users. NBA hopes, as stated by the Executive secretary, to have this charter in place before 2021. Some possibilities mentioned by GIZ to allow the generation of extra funds for NBA include: to create a link to the community levy, to create a compensation system for project management assistance such as the dam sector that generates electricity (currently there are three big dams being built) and a financial levy fund for states and international organizations aiming to build water related infrastructure in the region.

The current fragile financial situation of NBA will certainly have some impacts on the implementation of the third phase of the project that may also affect the long term sustainability of benefits of the project. According to the contract with ORIO, NBA needs to pay as in-kind contribution fifty percent of the costs of this operation and maintenance activities. For its in-kind contribution during the implementation phase of the project NBA had to develop a project with AfDB to be able to comply with its obligations. It is not clear yet how it will finance its in-kind contribution in the Operation and Maintenance phase of the project.

6.3 Institutional Sustainability

As described above, NBA's institutional arrangement involves organizations and representatives of the hydraulic and hydrology sectors of the nine countries of the Niger River basin. NBA is led by a general secretary who in consultation with the member countries sets the vision, program and objectives. In each member country there is an NBA's local agency in charge of coordinating the local organizations dealing with the management of the river basin water resources.

NBA's institutional arrangement is complex and makes it a slow organization. This causes delays in the communication chains and the decision making process. In the case of Niger for example, the transmission by NBA of official information from the SATH systems needs to be sent by letter to the Ministry of Hydraulics that later sends it to the other Niger organizations. This legal requirement and long chains of communication reduce one of the most important benefits of the SATH project that is its capacity to generate climatic data and measurements on time, maximizing the effect of the earlier alarms in case of extremes water events.

The current NBA's institutional arrangement does not allow the institution to have financial autonomy. It is currently creating a legal framework within the existent NBA structure to allow it to sell satellite data products to water resource users of the basin and simplify the current institution structure and shortening the actual long information chain of the organization.

The high turnover of staff at NBA was also identified as a threat for the continuation of the benefits of the project after its completion. Out of the ten operators trained by the project only five still remain in the organization. Better opportunities and salaries in other organizations, retirement and the lack of a career path at NBA were cited as causes of this problem.

The personnel problem at NBA has been aggravated because the organization has not contracted any new personnel since 2012. This means that most of its key staff are currently working without a permanent contract. The executive secretary of the NBA has acknowledged the existence of personnel problems during the interview conducted with him. He said that currently NBA has only 45% of the effective personnel it needs. He added that an external audit at NBA has recently been concluded, which made recommendations on the personnel issue. NBA and its partners will soon organize a summit of heads of state to discuss and adopt these recommendations. NBA expects that it will be able to fill its personnel gaps and put in place a career plan for executives after this summit.

Although NBA is trying to find a solution to its problem of trained staff retention, the guarantee of the continuation of benefits from the ORIO project is especially related to the operation and maintenance of the SATH systems. For this reason it also needs to document all the operational and maintenance activities and procedures and manuals. These manuals need to be available and accessible for all staff in charge of the operation and maintenance of the SATH systems. Finally, NBA needs to create a unit within the organization to train newly hired staff.

6.4 Continuation of the Project after its Completion

Most of the interviewees are very optimistic about the continuation of the project after its completion. Below we present some of the arguments they have used to justify why they think the project will continue after the ORIO funds finish:

- This project is the star project of NBA. It is very positive for NBA and it is considered a pioneer in Africa to set this system. It has exposed NBA to the other leaders of the African's River basins who are interested in this project, and request information from NBA;
- In view of climate changes, this project has become a priority to all states. The products of the project are part of NBA's mandate;
- The objectives and results of the project are compatible with the work and mandate of several Nigerian Ministries such as transport, the direction of meteorology, our Ministry (Hydraulics), Ministry of Disaster Prevention, etc.;
- At the political level the project is very useful and it has brought together almost all actors working on water in the Niger basin;
- The project has already helped NBA to attract other international donors that are interested in using data produced by the project: World Bank to monitor the management of barrages; Toulouse altimetry monitoring system using satellite data with NASA and GIZ to improve NBA's chain of communication and facilitate the information of the SATH reach the riparian communities.

6.5 Conclusions

The technical components and capability for operating, managing, exploiting and disseminating climate data are currently present and operational at NBA. The sustainability of the installed technical infrastructure depends on regular maintenance and replacement of mainly ICT equipment.

Maintenance is a crucial element for the long-term sustainability of the benefits of the project. NBA operators reported not be able yet to conduct the maintenance of the systems and we have detected a bit of dissatisfaction with this fact. As the third phase of the project is going to be focused on this issue,

it is important that the Dutch companies get together with the NBA manager and the operators to discuss and prepare a roadmap on how maintenance should be delivered defining tasks, responsibilities and the level of maintenance NBA operators will be able to conduct in the SATH systems after the Dutch partners are phased out.

The sustainability of the technical infrastructure also depends on finding a solution to key staff leaving the project and being able to cover the operational, maintenance and logistical costs of the installed systems.

The continuation of the benefits of the project in the mid- and long-term after the completion of the project relies heavily on the capacity of NBA to finance its operation, maintenance and logistical costs required to keep the installed systems working.

At present, the financial arrangement of NBA is fragile. It does not have financial autonomy and relies completely on country member payments that are not paid regularly.

A study is in progress to design new financial schemes for NBA. GIZ is working with NBA on the development of a water charter that will provide a legal framework to allow NBA to sell climatic data and charging the big water users for the acquisition of SATH data. NBA hopes to have this charter in place before 2021.

NBA's institutional arrangement is complex and makes it a slow organization. This causes delays in the communication chains and the decision making process. sent via letter to the Ministry of Hydraulics that later send it to the other Niger organizations. This legal requirement and long chains of communication reduce one of the most important benefits of the SATH project that is its capacity to generate climatic data and measurements

From the summarized results it is difficult to state if the benefits of the project will continue after its completion. As the activities of the project are part of the NBA's mandate, in theory, it will have the necessary political support to continue. The reality is however different: NBA has no financial autonomy and depends on other projects to finance its operational and logistic costs.

The continuation of project benefits in the near future looks realistic because NBA will carry on having the support of the Dutch companies for maintenance of the systems and help to solve eventual problems in the coming three years; besides the project has already started to attract interest of some international donors in developing projects with NBA.

In the long term after the completion of the project, the continuation of these benefits depends on the solution of important identified problems such as the fragile financial structure of the NBA, its capacity to keep its trained staff, the simplification of its bureaucratic and long decision structure; and finally, if it can develop and embed a new legal framework in its current institutional arrangement allowing NBA to be financially autonomous, and be able to charge private and public water resources for using climatic data products

7 Relevance, Additionality and Policy Coherence

This chapter analyses the three remaining evaluation criteria: the relevance of the installation, delivery of an operational satellite system to NBA, the additionality of the ORIO funds and the coherence with other policies

7.1 Relevance

The ORIO-SATH project is very relevant for NBA and for the member countries. It has introduced a climatic satellite system at NBA able to provide on time climatic data and making earlier alerts that helps to reduce the physical damages and safe life of communities settled in vulnerable areas to water extreme effects. Unanimously all interviewees pointed out that the project is very relevant. Here are some comments on it:

- The project has increased the visibility of NBA via the publication of almost real-time climatic information on its website and exposed NBA to the other leaders of other river basins in Africa, who are interested in this project;
- the objectives and results of the project are compatible with the work and mandate of several Nigerian Ministries such as Transport, the Direction of Meteorology, our Ministry (Hydraulics), Ministry of Disaster Prevention, etc.;
- the project has brought together almost all actors working in the Niger basin;
- the project has already helped NBA to attract other international donors that are interested in using data produced by the project. As an illustration: for the World Bank to monitor the management of barrages; Toulouse altimetry monitoring system using satellite data with NASA and GIZ to improve NBA's chains of communication and facilitate the information of the SATH reaching the riparian communities.

The products of the SATH project are part of the mandate of NBA and complements the activities of many NBA's partner organizations such as Ministry of Hydraulics, Hydrology, Meteorology and Catastrophes among others.

For the NBA staff the project is very relevant. Through the training and ToT experiences the NBA operators had during the project, they have acquired now new skills on collecting, processing and disseminating climatic data that they did not have before.

The project is relevant for the Niger River basin because the climatic data and products of the project are key information to improve the planning and management of the water resources within the river basin. The provision of climatic data on time and earlier alerts against the occurrence of water extremes events has helped to reduce physical, economic, social resources and lives in the affected riparian areas. These cited aspects are key elements found in the planning and economic development policies of the countries of the Niger River basin.

The Netherlands Government has a strong affinity with the water-related sector in its development cooperation policy. The ORIO SATH products and benefits are directly related to water resources management which also makes the project comply with the water aspects of the Netherlands government policy.

7.2 Additionality

Additionality is assessed, looking if the project could have being financed in the absence of the ORIO-grants; if it has initiated a mobilization of additional funding for the investment in NBA, in Niger or in the Niger River basin countries; if the technology chosen for the ORIO-SATH project was the most

appropriated for NBA and if the project has complemented other existing forecasting systems already installed in Niger River basin.

In relation to the question if the SATH project could have being financed in the absence of the ORIO-grants. Most likely not. A possibility could have been the African Development Bank through its water facility.

NBA has stated that the institution did not know about the technology. It was the Dutch company that introduced it to them, and has helped it to develop the proposal; secondly it is a fact that NBA could not have financed it alone.

The project has started mobilizing additional funding for NBA: it has received € 1 million from the AfDB to help the institution to pay the operational and logistical costs of the SATH project, including the reinforcement of some existing hydrological ground stations, equipment for NBA partners to have access to the SATH information among others. It has also helped to initiate the development of a project with the World Bank to monitor the management of barrages using the SATH data; Toulouse and NASA an altimetry monitoring system using satellite data, and with GIZ to improve NBA chains of communication.

For NBA the technology chosen for the ORIO-SATH project was the most appropriate. The technology used for the project has being tested in other international river basins and it has brought innovation to the organization in terms of data collection based on satellite information and has helped NBA to fill a gap to improve its mandate.

It was further stated that given the poor state of ground data collection in the Niger basin countries, the use of satellite information from a tested system in combination with a seamlessly integrated river modelling system result in the only technology that ensures routine information over the entire basin on a daily basis.

The SATH project has complemented the existing information provided through the Hycos project funded by the AFD. This project uses a model to measure the river water flows only. The SATH project measures the precipitation on river basin which complements the information given by the HYCOS system allowing NBA to measure precipitation and flow together.

The SATH project is also complementary with the existing GIZ project on improving the communication aspects of the organization with the partners and riparian population.

7.3 Policy Coherence

In Niger the reduction of poverty and the promotion of the local and national economic development are key issues of the national poverty and economic development. By providing earlier alerts on water extremes events (floods and drought) the SATH project has contributed to the reduction of physical, socio-economic and agricultural losses, and has allowed to evacuate persons before the occurrence of the extreme events helping to save lives which contributes to reduce poverty.

7.4 Conclusions on Relevance, Additionality and Policy Coherence

The ORIO-SATH project is very relevant for NBA and for the country members. It has introduced at NBA a climatic satellite system able to provide real-time climatic data and making earlier alerts that helps to reduce the physical damages and save lives of communities settled in vulnerable areas to water extremes effects. The NBA operators have acquired skills on collecting, processing and disseminating climatic data that they did not have before.

The project further collects and distributes key information to the benefit of the planning and management of the water resources within the river basin. The improvement of the management of

water resources are key issues present in the planning and economic development policies of the countries of the Niger River basin and are also included in the Netherlands Government Development Cooperation Policy.

On the additionality, it is difficult to affirm that the SATH project would have been financed in the absence of the ORIO-grants. The answer is most likely not. NBA could not have funded the project itself and it is not sure that other international multilateral organization as AfDB for example could have funded this project either.

The project has already initiated a mobilization of additional funding for NBA: € 1 million from AfDB to pay the NBA ORIO-SATH operational and logistic costs of SATH project; with the World Bank to monitor the management of barrages; with Toulouse and NASA to develop an altimetry monitoring system using satellite data, and with GIZ to improve NBA chains of communication. The project complements the data collected by the HYCOS systems that uses a model flow-flow by providing data on precipitation making possible NBA to have on line data on precipitation-flow.

The project fits well with the Niger policy on reduction of poverty and the promotion of the local and national economic development. The project products allow the government to better plan, manage and reduce the impact of water extremes events which contributes to improve the local economic development and reduce poverty.

8. Conclusions

In this report we have reviewed the results of the SATH satellite systems implemented at NBA, (the client of the project) to measure climatic data. The project is co-financed by ORIO via three steps. The conclusions presented here are primarily based on the results of the development and implementation phases but whenever it was possible we have tried to extend them to the project as a whole. The justification lies in the fact that the third phase is focused on reinforcing operation of the SATH systems which is already in place, and providing capacity in maintenance that is not yet delivered.

Desk research and interviews with NBA, NBA partners, local stakeholders and the Dutch companies have provided insight in the efficiency, effectiveness, sustainability, relevance, additionality and policy coherence of the project:

- The project has been **efficient** in delivering the outputs as planned. Close to 100% of the ORIO funds for the development and implementation phases has been disbursed and no extra costs were needed for the implementation. Nevertheless there were some issues causing delays: delay in data transfer, lack of documentation on the NBA database architecture and problems with the development of software, (calibration and validation, etc.). Seven trainings still remain to be delivered.
- The project is relatively **effective**, as not all planned outcomes of the project (7 planned trainings remain to be delivered) and some minor problems were identified (no availability of the crop data in the website and complains that the website is not always updated)
- The technical, financial and institutional **sustainability** of the project are sufficient, although some challenges remain, such as NBA's lack of financial autonomy, poor capacity of NBA paying its running costs and keep its trained staff and long chains of communication. The long-term sustainability can have problems if these mentioned challenges are not solved.
- The **relevance** of the project for improving NBA's own capacity and of its partner organizations on climatic data is beyond any doubts.
- The **additionality** is clear. Without the ORIO funds, NBA would not have been able to develop the project itself. The project has already started to help NBA to mobilize additional funds from other organizations;
- The **policy coherence** is sufficient. The products of the project help to improve the management of the water resources in basin and to reduce the impacts of water extremes events which indirectly contributes to stimulate growth and reduce poverty.

Annex A: List of the interviewed organizations and Persons

Organization	Position and relation to the project
NBA	Manager of the ORIO SATH project in Niamey
NBA	Interim Director of the observatory and modeling expert of ABN and SATH
NBA	Operator : informaticien and data base expert
NBA	Operator: expert in database processes and data collection
NBA	Platform Maintenance Specialist Gathering data
Ministry of Finance	Director of Studies and Programming
Ministry of Hydraulics and Sanitation	Director General of Water Resources, Coordinator of the NBA's Focal Structure in Niger,
Directorate of Hydrology	Director of Hydrology, part of the Ministry of Hydraulics
National Directorate of Meteorology of Niger	National director
Coordination cell of the warning system of the Prime Minister's Office.	Climatologist responsible for modeling climate risks
Association of the Natural Resources Chain of the Nigerian portion of the Niger Basin	President of the Users Association of the riparian communities of the Niger river
Ministry of Humanitarian Action and Disaster Management	Director of the Ministry of Humanitarian Action and Disaster Management
AFD: French Cooperation Agency in Niamey	Officer responsible for the energy project and environment
GIZ: German Cooperation	Officer responsible for the GIZ project supporting the ABN
The Netherlands Embassy	RVO representative
AGES: German project	Technical assistant of the "Support to Groundwater Management in the Niger Basin" project
Chambers of Commerce	Head of Service Trades Development
NBA	Executive Secretary of the NBA
IHE- Delft	Senior Lecturer in Hydrology
EARS/eLEAF-Delft	Acting Project Manager