

# Geodata study

## Niger

Background Geodata and Sath  
model overview

Mid term report

August 2022

**Akvo.**

# Table of contents

<b>Table of contents</b>	<b>I</b>
List of figures	III
List of tables	IV
List of boxes	IV
List of abbreviations	IV
<b>Summary</b>	<b>VII</b>
<b>1. Introduction</b>	<b>1</b>
<b>2. Methodology</b>	<b>2</b>
2.1 General overview of the study	2
2.2 Definitions	3
2.2.1 Data	3
2.2.2 Geodata	4
2.2.3 Data value chain	4
2.2.4 Data ecosystem	5
2.2.5 Data value and commercialization	5
2.3 Approach and references	7
<b>3. Geodata landscape overview</b>	<b>9</b>
3.1 Background information	9
3.1.1. Institutional context and general background	9
3.1.2. Geodata in water and agriculture	10
3.1.3. Water and Agriculture data ecosystems in the Sahel	13
3.1.4. Data commercialization in water and agriculture	14
3.2 Stakeholder analysis	15
3.3 Youth employment creation programs and link with geodata	17
3.4 Reflections	18
<b>4. Focus on NBA and the SATH model</b>	<b>21</b>
4.1 NBA presentation	21
4.2 Understanding of the SATH model	22
4.2.1 Description of the SATH Model and data input	22
4.2.2 Quality of the model	23
4.2.3 SATH generated output data	25
4.2.4 Dissemination channels	25
4.2.5 Information flow and conclusions	28

4.3 Opportunities around SATH generated data	29
4.3.1 Current data users and data use	29
4.3.2 Potential SATH generated services and users	30
4.3.3 Possible business models for commercialisation of SATH generated data	33
4.3.4 Quick assessment of NBA - Opportunities within NBA?	35
4.3.5 Alternative fundings	36
4.3.6 Main reflexions around SATH model added value	36
<b>5. Conclusions and recommendations</b>	<b>38</b>
5.1 Main findings scoping phase	38
5.2 Main recommendations	39
5.3 Proposed commercialization strategies	42
5.4 Work plan	44
<b>References</b>	<b>45</b>
<b>Annexes</b>	<b>48</b>
Annex 1: Definitions	48
Annex 2: Background information geodata in the Sahel	56
Annex 3: Mapping of major geodata projects	65
Annex 4: Stakeholder mapping	73
Annex 5: Some analyses from the website	76
Annex 6: NBA Presentation	81
The legal framework:	81
The Institutional Framework:	81
Specific objectives:	82
Annex 7: Understanding of the SATH Model	84
Description of the SATH Model	84
Annex 8: Potential SATH-generated services and users	89
Annex 9: Alternative funding	91

## List of figures

---

01	Data to wisdom
02	Data flows in the water sector
03	Data driven opportunities for farmers organizations from CTA working paper.
04	Findings from the geodata stakeholders mapping and interviews
05	Initiating data flows
06	Large-Scale Hydrological Model (LSHM) data structure and information flow
07	Screenshots of the SATH website
08	Graph presented in NBA bulletin
09	SATH-data flow and dissemination channels
10	How data features can maximize the value of public intent data
11	Features of well-functioning institutions for effective data governance
12	A positive feedback loop can connect enables and features of public intent data with greater development value
13A	Hydrological data at the Kandadji station, 2 March 2022
13B	Hydrological data at the Kandadji station, 18 August 2022
14A	Hydrological data at the Garbé-Kourou station, 2 March 2022
14B	Hydrological data at the Garbé-Kourou station, 18 August 2022
15A	Hydrological data Niamey station on the Niger, 2 March 2022
15B	Hydrological data Niamey station on the Niger, 18 August 2022
16	Upstream precipitation and evapotranspiration at Niamey station
17	Evapotranspiration date 16/08 close to Niamey
18	Precipitation date 16/08 close to Niamey
19	Drought index period 11/7-10/8 close to Niamey
20	Overview of WMO-GTS stations
21	Overview of the Hydromet stations with observed discharge along the basin
22	Large-Scale Hydrological Model (LSHM) data structure and information flow

## List of tables

---

01	Indicators on digital penetration in the Sahel
02	Geodata use in agriculture sector for various stakeholders
03	Hydroclimatic data ecosystem governance
04	SATH output data
05	Overview of potential applications of the SATH model
06	Summary of WAPOR datasets
07	SWOT analysis for the NBA
08	Commercialization strategies based on the SATH-generated data
09	Indicators on digital penetration in the Sahel
10	Geodata use in agriculture sector for various stakeholders

---

## List of boxes

---

01	Digitalisation
02	Data space definition
03	Mali data Exchange feasibility study (Mali DEX)
04	Water accounting
05	WASH data ecosystem
06	WAPOR dataset compared with SATH output
07	Hydro power sector and willingness to pay
08	Types of geodata

---

## List of abbreviations

---

AEPHA	Accès à l'Eau Potable, Hygiène et Assainissement
AETI	Actual Evapotranspiration and Interception
AfDB	Banque africaine de développement
ANPTIC	Agence Nationale de Promotion des TIC

---

ANSI	American National Standards Institute
ARC	Africa Rainfall Estimate Climatology
B2B	Business to Business
B2C	Business to Customer
B2G, B2A	Business to Government
CHIRPS	Climate Hazards Group InfraRed Precipitation with Stations
DCAS	Digital Climate Advisory Services
DEM	Digital Elevation Model
DGRE	General Directorate of Water Resources
DGIS	Dutch Ministry of Foreign Affairs
DRR	Disaster Risk Reduction
EARS	European Alliance of Rescue centers and Sanctuaries
EWBMS	Energy and Water Balance Monitoring System
FAO	Food and Agriculture Organization
FRACC	Regional Climate Change Adaptation Fund
G4AW	Geodata for Agriculture and Water
GFDRR	Global Facility for Disaster Reduction and Recovery
GIZ	Gesellschaft für Internationale Zusammenarbeit
HYCOS	Hydrological Cycle Observing System
IHE	Institute for Water Education
ITU	International Telecommunication Union
IWRM	Integrated Water Resource Management
LCC	Land Cover Classification
LSHM	Large Scale Hydrological Model
MCA	Millennium Challenge Account

MCC	Millennium Challenge Corporation
MNRB	Medium Niger River Basin
NBA	Niger Basin Authority
NSO	Netherlands Space Office
OECD	Organization for Economic Co-operation and Development
OGP	Open Government Partnership
PERSIANN	Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks
RFE	African Rainfall Estimation
RVO	Rijksdienst voor Ondernemend Nederland
SRTM	Shuttle Radar Topography Mission
TAMSAT	Tropical Applications of Meteorology using SATellite
TARCAT	African Rainfall Climatology and Timeseries
TRMM	Tropical Rainfall Measuring Mission
UNC	National (river) Users' Committee
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
WASH	Water, Sanitation and Hygiene
WBR	World Bank Report
WMO	World Meteorological Organization

# Summary

With the study of the geodata landscape in the Sahel, as well as the study of the SATH model, the Niger Basin Authority (NBA) are exploring commercialization opportunities for SATH generated data and the extent to which this offers opportunities for youth employment and entrepreneurship.

As part of this study, Akvo has looked at the existing initiatives on geodata in water and agriculture in the Sahel through conducting a literature review and interviews with key stakeholders. Looking at the focus of the SATH model - on producing hydroclimatic data - the study then focuses on geodata for hydroclimatic information. The mapping of the main stakeholders in the data value chain, ranging from public agencies to private sector (international consultancies on hydroclimatic service providers), provided a better understanding of the (potential) role of civil society (including research) but also of the strengths and weaknesses of the hydroclimatic data ecosystem. Next to the NBA, several government institutions in Niger, Mali and Burkina Faso are using the hydroclimatic data for water resource management as well as for agriculture and disaster risk reduction. The various uses show the benefit of this data to society in the Niger river basin, as the data benefits the public sector (allowing improved policies and planning), provides opportunities for the international and local private sector (to develop (data) services (B2G, B2B, B2C)) and supports civil society (general information on climate change, accountability).

Our research shows that NBA is already engaged in a Public Private Partnership (in the SATH model) where the management and exchange of data is a successful focus for building cooperation. This is an excellent starting point for developing a mature hydroclimatic data ecosystem. However, in order to successfully commercialize SATH generated data, several parts of the ecosystem need to be strengthened further. For example, we have found that there is a need for better multi-stakeholder coordination of the data-for-development ecosystem, and that there is a lack of local private sector involvement. To further mature the hydroclimatic data ecosystem, local, national and international businesses, donors and funding institutions need to better understand what business opportunities there are in providing data services, which could result in higher youth employment in the area.

To assess the possibility of developing a data commercialisation strategy to support NBA's financial sustainability, we zoomed in on the NBA institutional set-up and the environment it operates within. The SATH model and NBA can provide additional value for various data users. The data input model, with data coming from nine countries, leaves the aggregation role for NBA and is an added value to many other hydroclimatic data models, so it should be further strengthened. NBA, with its observatory, also has a role to play in the diffusion of the data and opening channels of information. The study found that the development of SATH products and services should be done in the framework of the observatory.

Commercialization strategies could be further detailed on developing better services for the users of the river (in the framework of the “NBA Charte de l’eau”). Based on our findings, the SATH data generates most value for the direct users of the river, such as organizations involved in hydro electricity power generation or irrigation schemes, who experience immediate negative economic consequences from extreme climate events like droughts and floods. As early warnings might minimize their losses, we recommend NBA to focus on these stakeholders to develop commercialisation strategies. Further use could also be explored from the private sector in local data services and integration. It is, however, difficult at this stage to make a financial estimation of the sustainability of these commercialization strategies because the study didn’t have access to the financial data around the SATH model by NBA and its partners. Moreover, the low maturity of the digital ecosystem in the Sahel makes it hard to draw any conclusions. As evidenced in various examples from the literature review, support to the development of local data services could be an opportunity to link with youth employment (in the data value chain, the agri value chain, and even in local climate data services).

A second commercialization strategy is to zoom out to the public intent of the hydroclimatic data ecosystem and support its stakeholders in developing the value of the data for the society, by enhancing public data. This strategy looks at NBA support, but also in its role within the larger ecosystem. Strengthening the input data and the dissemination of the output data would still be relevant. But this commercialization strategy also supports stakeholders (private sector, civil society) to allow for more data sharing and optimization of the data ecosystem (by increasing its maturity). Support to private sector development, as well as coordination mechanisms (at national level and regional level), should allow a role for the users and citizens in general in the ecosystem.

In the next steps of the project, we will further detail the two commercialization strategies identified that could be developed. Exploration of the adverse consequences (result 3) and cooperation possibilities (in close partnership with the users) should help to summarize the main risks, timeline and support (including capacity building and data governance) required to pursue this scenario (result 4). Opportunities for youth employment will be also explored in these commercialisation strategies (result 5).

# 1. Introduction

Data, and geodata in particular, are becoming increasingly important in development. Many countries and donors invest in data and digitalisation programs in a wide range of sectors, including agriculture and water. Data and digitalisation are already spurring economic development in developing countries and are expected to further boost youth employment. There is a need to have an overview of the geodata landscape in the Sahel, and to learn from successful projects elsewhere.

The River Niger is the third 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 km<sup>2</sup>, of which 1,500,000 km<sup>2</sup> actively contributes to river runoff. Its basin is located between 28°N in Algeria and 4°N in the Guinea Gulf, where it enters the Atlantic. From west to east, the basin extends from 11.5°W in the Fouta-Djalon plateau, Guinea, to 15°E in Chad. The River Niger has its source in the Guinean ridge of Fouta-Djalon. It runs north east and forms a vast flood plain in Mali called the Inner Delta. Where the river leaves the Inner Delta, it runs south east through Niger into Nigeria, where it receives the Benue River before flowing into the Atlantic Ocean.

The Autorité de Bassin du Niger/Niger Basin Authority (ABN/NBA) is an intergovernmental organization that promotes cooperation between member states (Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria) and contributes to the improvement of the living conditions of the people in the river basin through the sustainable management of water resources and associated ecosystems. ABN developed models based on hydro-climatic data to predict floods and drought in the Niger Basin funded by the Dutch Ministry of Foreign Affairs (DGIS): the SATH model. The main purpose of this study is *to explore the commercialization of (SATH) generated data to ensure sustainable operations of a key regional socio-economic institution in the Sahel: the Niger Basin Authority (NBA).*

RVO, NSO and Invest international, together with the Dutch Embassy In Niamey and the ABN, have tasked Akvo and its partners to explore commercializing NBA's SATH generated data to ensure sustainable operations. This exploration will give perspective to ABN beyond the termination of the SATH program. A thorough analysis of the adverse consequences of making data commercially or open source available is necessary as it might crowd out sectors or players.

In addition, this study aims to assess whether (youth) employment can be fostered through geodata in general and hydro-climatic data in particular, and will aim to identify suggestions and recommendations regarding youth employment.

This report is an intermediary report to cover the scoping phase. The methodology and approach have been developed in Chapter 2, the geodata landscape in the context of Niger in Chapter 3, and the analysis of the SATH model in Chapter 4.

## 2. Methodology

### 2.1 General overview of the study

Akvo has been tasked with developing a study into possible commercialization strategies on SATH generated data for the Niger Basin Authority (NBA) in order to sustain the operation of the model beyond the termination of the SATH program. Creative solutions and business models will be explored and both positive and adverse effects of commercialization will be analyzed. In addition, the study will assess whether youth employment can be fostered through geodata.

The overall study has been based on three data sources. The analyses were done by triangulating the different data sources:

- Literature review based on the Term of References, research and interviews
- Semi-structured interviews with main stakeholders involved with the SATH model
- Knowledge and experience of the thematic experts

As part of the study, the investigation into the SATH model and its commercialization potential was carried out. We examined whether the output of SATH has potential for commercialization and under what conditions. This report is about the results of the scoping phase.

#### **Main activities**

- Preparation of a market research strategy and prioritization of stakeholders
- Interviews with key stakeholders to better understand the SATH project (input data, model, output data, information flows) and the NBA institutional setting
- Conducting a literature review to create a detailed overview the geodata landscape in the Sahel
- Preparation of the Scoping report including revised work plan

#### **Methodological limitations**

The study was based on data and information collected by the team. It should be noted that not all requested information was shared with the project team. Some organizations considered that some (financial) data and information was too sensitive because it was related to their own businesses. This lack of access was not only a limitation during the scoping study but may also be one for the results of the next phase of the study.

In addition, because the focus of the study is the NBA and the SATH model, we decided to focus our analysis on the hydroclimatic data value chain inside the geodata ecosystem. We realize this focus limits the scope of the study, but it allows a more in-depth analysis of the immediate environment of the SATH model.

## 2.2 Definitions

To correctly interpret the main findings and recommendations in this study, it is important to create a common understanding of the data-related concepts used in this report. In this subchapter, the concepts of data (2.2.1), geodata (2.2.2), the data value chain (2.2.3), the data ecosystem (2.2.4), data value (2.2.5) and commercialisation of data (2.2.6) and their interrelations will be explained. In this section, the definitions have been summarized and the details can be found in the annex 1 of this report.

### 2.2.1 Data

Data is a description of a fact, acquired through measurement, observation or reporting. It can therefore be very different in nature: qualitative, quantitative, structured, unstructured, and from different sources. Quantitative data refers to numbers and elements that can be measured objectively. Qualitative data refers to characteristics that are complex to measure and analyzed subjectively. Raw data is always unprocessed, uninterpreted and uncontextualized. With digital transformation, data is at the heart of digital technologies and exploration of data with new technologies (such as big data, Machine Learning and Artificial Intelligence) open up new possibilities of information creation.

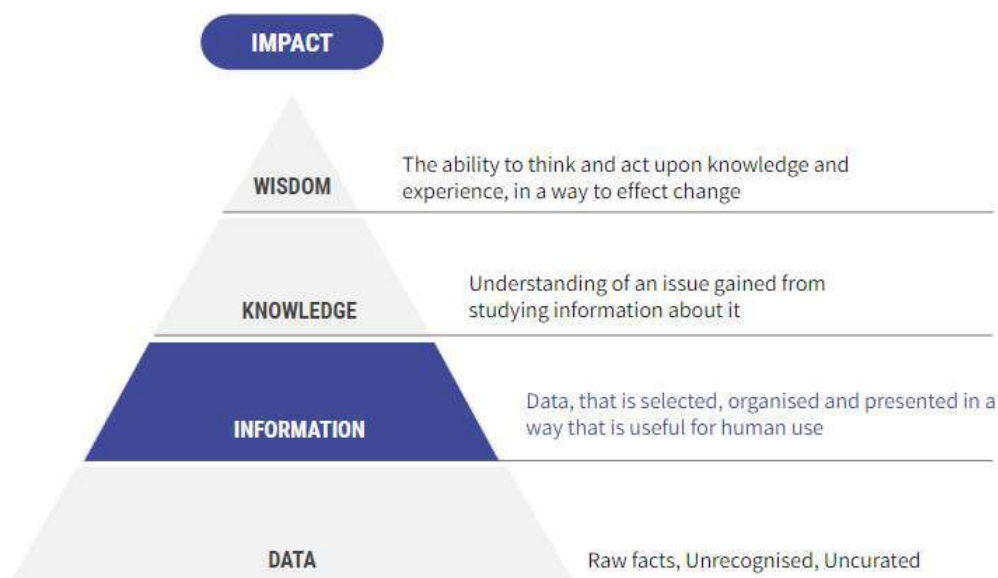


Figure 01: Data to wisdom

## Box 01: Digitalisation

According to the Digital Agenda for Foreign Trade and Development Cooperation (BHOS) from 2019 by DGIS, digitalisation is leading to an explosive growth in cross-border data flows, trade in digital services and trade in goods through digital platforms. Current tensions in the trade system and the race for worldwide technological dominance are making it very difficult to make progress in multilateral negotiations. The divergent attitudes of the world's largest economic blocs – China, the EU and the US – to fundamental interests and values like the protection of personal data and privacy, contribute to this deadlock.

The influence of digitalisation on the economy is so radical that we now talk about a Fourth Industrial Revolution. In the next ten years, various crucial developments are expected to converge, i.e. rapid internet connections, widespread mobile technology, a glut of cheap data, development of the Internet of Things, an exponential increase in computer processing power and, above all, the further development of artificial intelligence. This will lead to numerous new innovations, whose impact we cannot yet foresee.

### 2.2.2 Geodata

Geodata are spatially referenced data that describe the extent and properties of given spaces and objects at a given time, in particular the position and nature of these elements. This means that they can be used to locate objects more or less precisely according to their spatial characteristics. According to Savinykh & Tsvetkov (2014), Geodata is defined as information about processes and phenomena on the earth's surface, including groups of data classified and integrated into a single system.

Savinykh & Tsvetkov (2014) indicate that geodata serves most countries as the basis for creating and developing the infrastructure of spatial data which seems to be currently an important strategic resource of national development. Geodata is also key to climate change adaptation.

Another classification is between cultural (administrative boundaries for example) and physical geodata (environmental or hydrography data). This study is more related to weather and climate data for agriculture and the water sector with the more specific objective to predict floods and droughts. For example, it is noticeable that a lot of weather data uses temporal GIS data formats because of how important time is related to weather. In this study, since the environmental and hydrography data are especially what interests us most in this study, we talk about hydroclimatic data.

### 2.2.3 Data value chain

The data value chain describes the process of data creation and use from first identifying a need for data to its final use and possible reuse. The data value chain has four major stages:

1. Collection/production

2. Validation, Analytics and processing
3. Data Sharing, and integration
4. Use for impact.

Various stakeholders have various interests in the data value chain and can play a role at different stages. The exact steps can also vary depending on the focus of the data value chain. It is therefore important to understand which roles are played by which stakeholder, at which stage of the value chain. Because various stakeholders can be involved at various stages, some important notions are to be considered when looking at geodata in the value chain: *Quality of data - Accessibility of data - Granularity of the data - Credibility of the data.*

#### 2.2.4 Data ecosystem

In the African Union Data Policy Framework (Abou-Zeid, 2022),<sup>1</sup> a data ecosystem is defined as ‘*the underlying value chain associated with data as a factor of production, the governance of data systems and the protection of data subjects*’ as well as the technical infrastructure organizations use to collect, store, analyze and leverage data. In itself, data has little value, it is only through processing, transmission and sharing (between stakeholders) that value is added. The transformation of data into useful information to guide decision-making revolves around the data value chain where the private sector and certain public entities are adequately equipped with enabling frameworks to support a coherent data ecosystem.

In the World Bank report *Data for a better lives* (2021), the importance of a social contract - an agreement between stakeholders creating, reusing and sharing data on how to mitigate harm and how to distribute the created value - is stressed. It also highlights the potential for a ‘*functioning data ecosystem with components played by the Public sector, private sector and the civil society. Research institutions and international organizations also play an important role. The pillar on which such partnerships are built on infrastructures policies, laws and rules, economical policies and institutions. To facilitate the data flow, data should be produced, protected, open , quality controlled and used and re-used. Finally, human resources, trust building, incentive, funding and data requests are the basis to work on.*’

#### 2.2.5 Data value and commercialization

Data does not automatically generate value. Instead, there are different uses of data and different methods to measure the economic and social value of data and data flows (OECD, 2019<sup>2</sup>). In the economic sense, it is what the stakeholders of the value chain do that leads to value creation both internally and externally across the extended-data network. Theoretically, this value can be quantified by assigning monetary value taking in consideration several cost and income-generating variables, such as how organizations charge for user-generated data or reconciling data management costs such as collecting, maintaining and

---

<sup>1</sup> <https://au.int/sites/default/files/documents/42078-doc-AU-DATA-POLICY-FRAMEWORK-ENGL.pdf> 2022

<sup>2</sup> OECD (2019) Data governance in the public sector. 23-57 <https://doi.org/10.1787/9cada708-en>

publishing data. Valuing data from a socio-economic benefits perspective – or non-market-based data value – arises when there are fundamental conditions or enablers that allow governments to deliver more effective public services, offer effective environmental stewardship, and when citizens live healthier and economically secure lives through leveraging data (World Bank, 2021). An example of public data value creation includes using data to inform resource allocation needs to enhance service delivery. The public sector can also create market value by opening certain data sets and establishing new revenue streams. There are innovative interplays between public and private actors that can improve the overall data ecosystem to meet socio-economic development needs and enhanced welfare. The World Bank report makes the distinction between the public intent (data collected for public purpose) and private intent (data as part of routine business process).

Today, the commercialization of data is an important source of revenue for many companies. Geographic data is among the data that illustrates the concept of non-personal data. Data can be commercialized and resold later on. The Dutch expertise and research capacities in using data for agriculture and water management is an opportunity to develop public private partnerships in various countries. Indeed, in order to facilitate economic value creation, we see more and more public private partnerships in which businesses support the government in their role in the value chain.

The study's term of references specified that 'commercialization does not solely refer to the sale of a certain dataset or research on how to generate revenue from the dataset. We are interested to understand possible ways for utilizing this dataset, for example services, also when it does not generate revenue directly. We are looking forward to hearing who could benefit from'.

### **Box 02: Data space definition**

In the Data Act approved in 2022, The European Union Parliament clarifies who can create value from data. It is clear that data and its socio-economic potential enhanced by the creation of common European data spaces have an essential role to play both in Europe's digital transformation and economic recovery plans. As envisioned in the European strategy for data, the different data spaces will be interconnected so that they progressively lead to a genuine European space in which data is broadly shared and used, while fully respecting the rights of individual persons and businesses over data. This will allow the full benefits of data to be reaped for the European economy, society and research.

It announced the creation of data spaces in 10 strategic fields: health, agriculture, manufacturing, energy, mobility, financial, public administration, skills, the European Open Science Cloud and the crosscutting key priority of meeting the Green Deal objectives. The ultimate goal is that together, the data spaces will form a single European data space: a genuine single market for data.

## 2.3 Approach and references

Various reports have been published in recent years that show the importance of data for development. As early as 2014, the UN report, A world that counts. Numerous reports have followed, such as:

- Data Driven Development – Banque Mondiale (2018)
- The digitalisation of African Agriculture Report (2018-2019) – CTA/Dalberg (2019)<sup>3</sup>
- The age of Surveillance Capitalism – Shoshana Zuboff (2019)<sup>4</sup>
- The digital agenda of the Dutch Ministry of development cooperation (2019)<sup>5</sup>
- Agenda 2063 and 2030: Is Africa on track? African Governance report, Mo Ibrahim Foundation (2019)<sup>6</sup>
- UN Secretary General's data strategy (2020-2022)<sup>7</sup>
- Data collection in fragile states (IBRD/WB 2020)
- Program data: the silver bullet of the humanitarian and development sectors (Cartong sept 2020) (FR)
- Status of digital agriculture in 47 Sub-saharan African countries by FAO and ITU (2022)<sup>8</sup>



Akvo has been involved in digital development in the water and agriculture sector since 2008. Most of our current approach and methodologies are based on the up-to-date expertise in digital development. For this study, a basis of our approach is the World Bank Report published in 2021, *Data for better lives*.

### Box 03: Mali data Exchange feasibility study (Mali DEX)

The Mali-DEX feasibility study has been undertaken by Akvo to allow users to have (real-time) data and to act in an informed manner in many sectors such as water, agriculture, education, health, etc. It looks at: 1) Unlocking data for the good of all, 2) Providing better value investments in all sectors based on data, 3) Increasing results and development impact and report on them, 4) Improving the provision of services to the population, 5) Strengthening the development of the private sector (SMEs and start-ups), 6) Contributing to the employment of young people and women and 7) Increasing inclusion and participation while building capacity (literacy and skills)

<sup>3</sup> [Rapport sur la numérisation de l'agriculture africaine, 2018-2019](#)

<sup>4</sup> [https://en.wikipedia.org/wiki/The\\_Age\\_of\\_Surveillance\\_Capitalism](https://en.wikipedia.org/wiki/The_Age_of_Surveillance_Capitalism)

<sup>5</sup> [Digitale Agenda voor Buitenlandse Handel en Ontwikkelingssamenwerking | Rapport](#)

<sup>6</sup> [AGENDAS 2063 & 2030 : IS AFRICA ON TRACK?](#)

<sup>7</sup> [UN Secretary-General's Data Strategy 2020-22](#)

<sup>8</sup> <https://www.fao.org/3/cb7943en/cb7943en.pdf>

and ensuring data protection and security. Several business models have been studied and finally the initial investments based on an appropriate revenue model were estimated in order to achieve economic equilibrium and financial profitability after five years in Mali.

Based on this, we have developed our own digital assessment and design thinking tools for digital solution development and insight ecosystem support. Our assessments include looking at the data ecosystem level and providing data scans at organizational and program level. We take inspiration from the principles for digital development:<sup>9</sup>

- Design with the user
- Build for sustainability
- Reuse and improve
- Understand the existing ecosystem
- Be data driven
- Address Privacy & Security
- Design for scale
- Open Source
- Be Collaborative



<sup>9</sup> <https://digitalprinciples.org/>

# 3. Geodata landscape overview

## 3.1 Background information

The success of commercialisation strategies of SATH generated data is dependent on several factors. While providing insight into the (potential) value of the SATH data for different stakeholders along the data value chain will provide the foundation for the commercialization strategy, contextual factors (e.g. data sharing policies, technical infrastructure, trust between stakeholders, etc.) will inevitably influence successful implementation of the commercialization strategy. This chapter explores the institutional context for data in the Sahel (3.1.1), looks at the current use of geodata for decision-making in the water and agricultural sector (3.1.2), assesses the data ecosystem in the Sahel (3.1.3) and examines to what extent data commercialisation is already happening in the water and agricultural sector (3.1.4).

This chapter can be found in annex 2 and we have taken out the main information as a summary below :

### 3.1.1. Institutional context and general background

There are a lot of initiatives for digitalisation in the Sahel, with ANSI for Niger, ANPTIC for Burkina Faso and AGETIC for Mali representing the public sector leading the initiatives. There is a global recognition that the Sahel is lagging behind in terms of digital infrastructure and human capacity as well as on public private initiative for data governance. From the report *status of digital agriculture in 47 Sub-saharan African countries* by FAO and ITU<sup>10</sup> (2022), we selected the following indicators to have an idea of the digital penetration in the Sahel (extracted from the report).

Country	Niger	Mali	Burkina Faso
<b>Mobile (device ownership) (% of the population)</b>	37.29	55.01	50.86
<b>Active mobile broadband subscriptions (per 100 inhabitants)</b>	3.93	35.07	31.7
<b>Mobile social media penetration (% population)</b>	2.08	8.56	7.76
<b>Literacy rate youth (% 15-24)</b>	43.46	50.13	58.87
<b>and notation digital skills among population (index ranking 1–7: not at all/ to a great extent)</b>	3.6	3.6	2.89

Table 01: Indicators on digital penetration in the Sahel

<sup>10</sup> <https://www.fao.org/3/cb7943en/cb7943en.pdf>

### 3.1.2. Geodata in water and agriculture

Geodata has specific use for various sectors and can be the basis for multiple decision making processes. In the paragraph below, we look at examples of geodata specific to each sector to better understand the use of geodata in the Sahel.

- Water

In the field of water, information is needed for strategic planning and decision making on policies/governance/regulatory framework and investments. The main categories of data in the water sector that can be analyzed for understanding and action are:

- Natural systems (precipitation, groundwater, surface water, rivers, lakes, etc) including water quality (in time and space).
- Water-related infrastructure (dams, irrigation networks, WASH systems, etc)
- Mobilisable and mobilized water quantities (in time and space)
- Users and their consumption (in time and space)

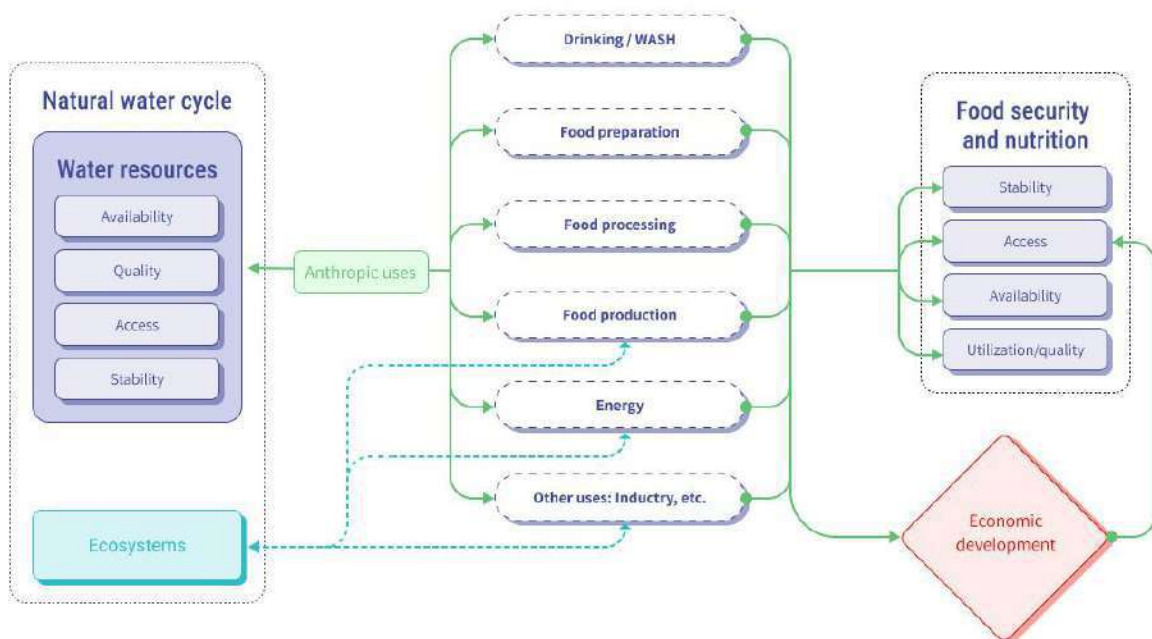


Figure 02: Data flows in the water sector

#### Box 04: Water accounting

FAO (2012) describes water accounting as the systematic acquisition, analysis and communication of information relating to stocks, flows and fluxes of water (from sources to sinks) in natural, disturbed or heavily engineered environments. A critical aspect of water accounting is that it considers and assesses both the supply and the

demand sides of water supply systems. From the perspective of water accounting, water supply and demand can be characterized as follows:

- Supply side:
  - The availability of rainfall, surface water, groundwater and unconventional water resources (e.g. treated waste waters) in space and time.
  - Capacity, condition and O&M procedures of water supply, storage and treatment infrastructure.
- Demand side:
  - Different users demand for water in space and time, and the extent to which these demands are satisfied.
  - Patterns of consumptive or non-consumptive water use in space and time.
  - Water service levels that are experienced by different users in space and time and the benefits they derive in monetary and non-monetary terms such as improved health and well-being.

- Agriculture

As in the water sector, information is needed for strategic planning and decision making on policies/governance/regulatory framework and investments on various topics such as land, labor, capital and management. Data can relate to the farmer, its parcel, the type of culture, environmental data as well as market data. The figure below summarizes the different types of agricultural data.

Information needs in agriculture are highly dependent on the type of actor. The table 02 shows how geodata can be used at different actors (extract from RVO study on digital farming in Kenya <sup>11</sup>):

Actor	Geodata use
<b>Farmer</b>	<ul style="list-style-type: none"> <li>- increase yields</li> <li>- lower costs</li> <li>- reduction of losses</li> <li>- Increase income</li> </ul>
<b>Agri-Business</b>	<ul style="list-style-type: none"> <li>- Make supply-chain more effective</li> <li>- Increase quality and lower external risks</li> <li>- Sustain sourcing</li> <li>- Traceability</li> </ul>
<b>Government</b>	<ul style="list-style-type: none"> <li>- Tools for policy development</li> <li>- Set conditions for sustainable agriculture</li> <li>- Promote economic growth</li> </ul>
<b>Research</b>	<ul style="list-style-type: none"> <li>- Analysis and research</li> <li>- Study effects of agriculture on climate change and biodiversity</li> </ul>

<sup>11</sup> <https://www.rvo.nl/sites/default/files/2019/12/Digital-Farming-in-Kenya.pdf>

	- Recommend good agricultural practices
<b>Technical Assistance</b>	- Increase quality of extension services - Reach more farmers

Table 02: Geodata use in agriculture sector for various stakeholders

For the agri-business sector, there is a lot of data that can be interesting to support and advise farmers. This has been summarized in the scheme below.

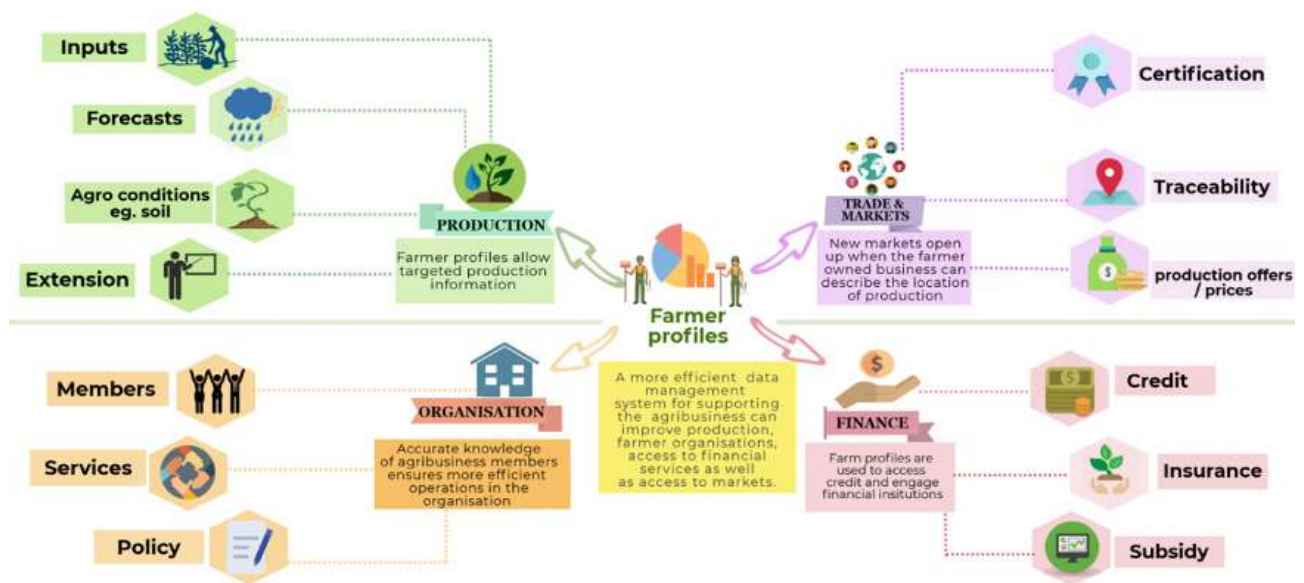


Figure 03: Data driven opportunities for farmers organizations from CTA working paper.<sup>12</sup>

- Climate Change

Although this report will not cover a detailed assessment of the effects of climate change in the Sahel, what we do know is that extreme events of flooding and droughts seen today will gradually become the norm. This will put more pressure on already fragile support systems granting access to safe water resources for human consumption, agriculture and live-stock operations and with some events in addition causing direct harm to infrastructure and people's lives. Although detailed scenario modeling of these impacts are not covered here, the fundamental effect of climate change on people's lives and livelihoods is that it will introduce another source of uncertainty on how to best prepare and manage water resources. Having better access to high-quality and timely data for informed decision making is one of the best tools we can provide to help combat this uncertainty. To this end, more fully leveraging the outputs of a model like the SATH model and making it available to key user groups, either through commercial or open-data sharing mechanisms, has an immense potential value-add. Particularly if access to this data can lead to

<sup>12</sup> [https://www.academia.edu/80363253/Data\\_driven\\_opportunities\\_for\\_farmer\\_organisations](https://www.academia.edu/80363253/Data_driven_opportunities_for_farmer_organisations)

multiplication of data value generation by inspiring new innovative approaches to use and build on this data and generate new business and job opportunities.

### 3.1.3. Water and Agriculture data ecosystems in the Sahel

While looking at the water and agriculture data ecosystems in the Sahel, the question whether water and agriculture data is seen as a public good by the public actors needs to be asked - the answer influences the governance of these data ecosystems. Water and agricultural data are not a pure public good because they are excludable, allowing the entity that originally collects and holds the data to prevent others from accessing it.

There are plenty of examples across the water and agricultural sector in the Sahel of the unwillingness of public data holders to share data with other government entities and the public. In the private sector, firms may not want to sell or exchange their data with others, perhaps because governments and firms lack the capacity to share or exchange their data in a safe manner, or more simply because of a lack of incentives (or legal requirements) to make the data available.

In the World Bank report *Data for a better lives* (2021), a fundamental reason for the lack of incentives to share, sell, or exchange data is the considerable economies of scale that accrue to holding data and the associated economic or political power that they bring to the data holder. Although the returns to the first few bits of data are essentially zero, there is a point past which the returns from additional data, and from improvements in the systems supporting these data, are substantial and increasing until they ultimately level off. In addition to economies of scale, data are characterized by economies of scope because combining different types of related datasets can yield insights that otherwise would have been unavailable from one type of data alone. This is especially true for hydroclimatic data and use around climate change adaptation.

In their report on digital transformation of food systems Wageningen University and Research, in 2021, shows how the agriculture system - from farm to fork - becomes increasingly digital.<sup>13</sup> The abundance of data from various sources supports decision making in the data value chain, while digitalization also means that you can pass the data through the whole chain.

#### Box 05: WASH data ecosystem

Akvo has been involved in data value chain for WASH in West Africa since 2013, partnering with national governments and UNICEF on country level and regional level. WASH data is still not readily available at the public level. Some of the common challenges encountered are:

<sup>13</sup> <https://edepot.wur.nl/552346>

- Data is in silos. There is a lack of awareness among stakeholders of what data exists, and how it can be used and integrated. Many data flows are based on development programs, being lost once a program is finished.
- Very few monitoring systems are open to all stakeholders: many systems are still closed, data being collected and accessed only by the public sector. Very few examples where data is shared for better accountability or data flow exchange is maintained with private sector
- Since water supply is often seen as highly political at local level, data is still often ignored for decision making at local level.

While the ministries of water (ministry of environment in Burkina Faso) are in charge of both the hydro climatic data and WASH data, there is very little use of hydroclimatic data in the WASH sector, and vice-versa. The WASH sector relies primarily on primary data sources. But it can be expected that with Climate Change, hydroclimatic data shall become more and more important for water security and planning in the WASH sector. Expensive data collection for WASH could also give indication to hydroclimatic models (such as water pumps failing because of drought in an area could be an indication for hydroclimatic models.)

### 3.1.4. Data commercialization in water and agriculture

While a business ecosystem is a dynamic evolving landscape of stakeholders having multiple interactions with each other with data having public intent or private intent, there are not so many players involved in the business ecosystem in the water sector. Because public intent data are a prerequisite for many government functions, government agencies are the primary producers of these data by means of censuses, administrative data collection, and more. There is a potential for citizens, civil society organizations, non-governmental organizations, academic institutions, and international organizations to contribute critically to the production of public intent data using surveys, crowdsourcing platforms, and other means, but they are not involved yet.

Because there aren't so many players involved yet, we are looking at the opportunities of new revenue streams (for NBA with the SATH output for example) but it can be expected that more organizations can play a role in creating a business ecosystem. It is interesting to understand the various relationships that can be created for the business models. Through the literature review, the most common business models have been selected:<sup>14</sup>

- Direct payment: the customer pays for the provided service (on a subscription or case-by-case basis); the service provider sells his product to the consumer, at a price higher than the cost of his production (with a margin). In the subscription model, the customer pays a monthly/annual lump

<sup>14</sup> <https://www.rvo.nl/sites/default/files/2019/12/Digital-Farming-in-Kenya.pdf>

sum for a service whether it is used or not. It is a way to build customer loyalty and have a regular income for the service provider (from a liquidity perspective).

- Freemium model: Some of the services are free and some are reserved for members.
- Cashback or rewarded loyalty model: The more the consumer consumes, the more benefits he gets. Some service provision is free (add-on to another service).
- Inclusive model: the service is bundled with payment for other services.
- Service subsidized model: the customer pays (subsidized) for no fee at all for service provision and a third party subsidizes (donor, advertising, etc).

In the G4W business and scaling study, the four commercialization barriers identified are:

1. Insufficient entrepreneurial leadership & lack of business competences.
2. Insufficient user-centered design approach to transforming smallholders into happy and active users.
3. Insufficient paying customers to ensure stable and sufficient revenues.
4. Long-term reliance on subsidies, even when commercially launched in the market.

## 3.2 Stakeholder analysis

This section reviews different sources or websites on the global level and specifically in the Sahel in the field of geodata (see table in annex 03) for agriculture and IWRM initiatives. Reviewing some of the work on geodata from the main actors allows us to better understand its use. Some projects making use of hydrological models and/or EO/satellite have been described: ABN - Niger-HYCOS, Agrhymet - FANFAR, WAPOR, Digital Earth Africa, and Hydromet network (see annex 03).

As part of the study, and through interviews with main stakeholders (IHE, EARS, Deltares, Hoefsloot, Hortihub, GIZ, various ministries in Niger), we summarized the findings from the geodata stakeholders mapping and interviews in the figure below, on the various stakeholders involved in the hydroclimatic data value chain in the Sahel.

Based on the summary table to be found in annex 4, we developed the scheme below.

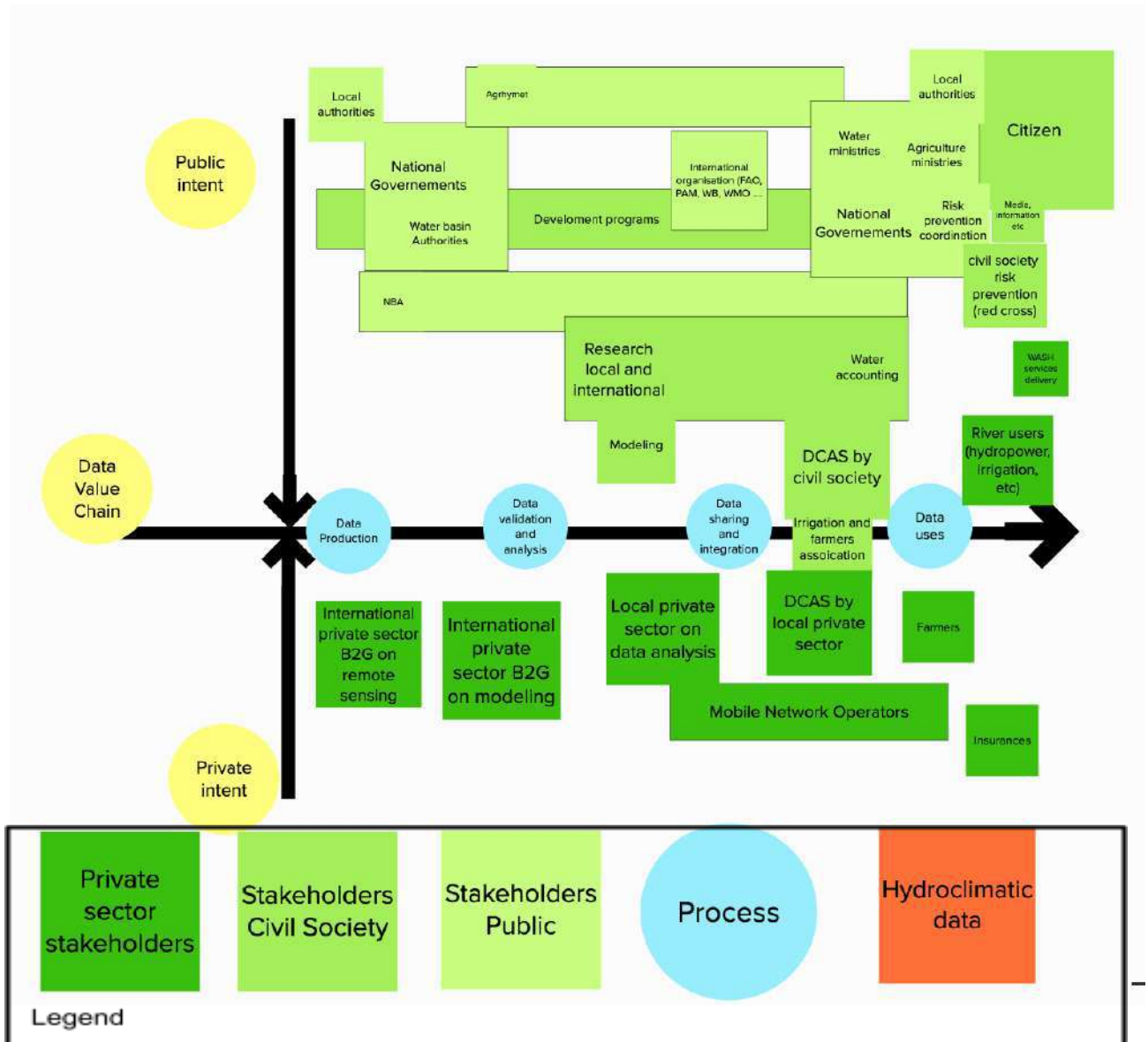


Figure 04: Findings from the geodata stakeholders mapping and interviews

Some interesting characteristics of the hydroclimatic data value chain in the Sahel, and more specially in Niger, can be highlighted:

- While the public sector and research are playing the main roles along the hydroclimatic data value chain, international stakeholders are mainly involved in the analysis of the data. Compared to other regions, we found very little involvement of the private sector.
- There are two main channels for data production - hydromet station and Earth Observation. The first channel is mainly managed by the government, while the second is mostly done by international organizations/consultants for the public sector or NGOs/international organizations.

- Aggregation of data at regional level is done by only two stakeholders: NBA and Agrhymet (they have a different geographical focus). It is important to also think about their role in validation of data. It is a key role in the data value chain that NBA and Agrhymet are playing.
- For the data analysis, very little happens at the local level in the Sahel compared to other regions (drones, etc) or for providing digital climate advisory services (integrating hydroclimatic data with other data).
- There is very little integration at local level: local data (social) enterprises are well placed to play a role in this - as the Mali Data Initiative has demonstrated.
- This data value chain shows interesting existing contracts and cooperation between the various data value chain stakeholders between public sector and private stakeholders.

### 3.3 Youth employment creation programs and link with geodata

We looked in more detail into the relation between development, geodata, digitalization and youth employment, as this will be an important item for result 5. This chapter is an introduction and will be developed further in the second part of the study.

During the ICT and geodata for agriculture and water conference in Ouagadougou, funded by NSO and RVO, **challenges** hindering youth involvement in agriculture include family and community pressures, lack of perceived profitability, access to land, access to finance, access to education, technical training, and resources. However, there are potential **opportunities** to improve engagement with youth in agriculture mentioned by the USAID. These include: shifting the perception of farming within rural families and communities, exposing youth to agriculture early on, incorporating all aspects of the value chain (rather than just farming), increasing the profitability and productivity of farming, and introducing agriculture problems to youth to resolve them (Bakker & Figuères, 2019 and Brand & Galdava, 2019).<sup>15</sup>

In terms of opportunities, we can also explore the strategy of FAO (2020), which is expected to contribute to increased opportunities for young people in EAC Partner States to directly work or do business in the agricultural sector. One of the solutions was a **training course**, focusing on agricultural entrepreneurship and value chain development in integrated ecosystems. The trainees developed business plans for expanding their businesses, had an opportunity to build business/support networks, and based on a set of criteria, the participants were provided with small grants.

From this initiative, the best six youth champions-in-agriculture were recognized during an award ceremony, and received support to participate in an Africa-wide Conference on “Youth Employment in

<sup>15</sup><https://g4aw.spaceoffice.nl/files/files/G4AW/Regional%20Conference%20-IT%20and%20Geospatial%20Data%20for%20Agriculture%20and%20Water-/A4%20leaflet%20Conclusions%20of%20the%20conference%20HR.pdf>

Agriculture as a Solid Solution to ending Hunger and Poverty in Africa: Engaging through Information and Communication Technologies (ICTs) and Entrepreneurship”.

We can also explore some opportunities for youth through the European Parliament’s strategy (Seth et al., 2020). Precision agriculture (PA) or precision farming methods promise to increase the quantity and quality of agricultural output while using less input (water, energy, fertilizers, pesticides, etc.). The aim is to save costs, reduce environmental impact and produce more and better food. The methods of PA rely mainly upon a combination of new sensor technologies, satellite navigation and positioning technology, and the Internet of Things. PA has been making its way into farms across Europe and is increasingly assisting farmers in their work. Need skills include **technological skills** such as working with robots, with processed data, choosing appropriate solutions according to the farming project, computer sciences, advanced machinery: auto-steered equipment, drones, complex apps (RTK, Satellite imagery, etc.).

### 3.4 Reflections

With the information on the geodata sector in water and agriculture, as well as a better knowledge of the stakeholders in the hydroclimatic data value chain, the scoping phase can conclude that stakeholders from the public sector, the private sector and civil society are already collaborating to a certain extent. Public private partnerships are taking place (for example ORIO with NBA) mainly around B2G models, and more opportunities exist in the ecosystem.

To have a better overview of the hydroclimatic data ecosystem, the study also looked at the governance side, as summarized in table 03 below.

Hydroclimatic data ecosystem	Strengths	Weaknesses	Opportunities	Threats
Enabling environment ( <i>infrastructures policies, laws and rules, economical policies and institutions</i> ).	Need of data from various public actors (drought and flood monitoring), river users and data services to farmers.	Infrastructures: from Internet connection to data infrastructure, the Sahel region is the least developed in the world.  Institutions in charge of hydroclimatic data at regional level have financial sustainability problems and have human resources	Public intent of hydroclimatic data (potential for high economic value for the society).  Already a history of PPP implemented with the stakeholders to draw learnings from.  Incentive to use hydroclimatic data exists with multiple users.	Various laws and rules in the countries with no harmonization.  At the local level, there is little capacity to integrate hydroclimatic data with data from various sources, to be able to adapt the information to all.  Funding is done in silos, no

		problems		coordination.
Data governance	Public, private and citizens are already involved in the data chain and research.	No involvement of the end-user in the design of the data value chain.	Some data exchange and standardization is happening already as well as sharing strategies.	At the moment, there is no clear leadership in the data governance space and therefore a lack of coordination or strategic vision.  Lack of trust between actors (Agrhymet and NBA, for example).
Data management	Experience with shared data management and data exchange.  The local professionals working with hydroclimatic data, especially at the different governmental levels, are already knowledgeable on how to apply and interpret hydroclimatic data.	Human and infrastructure capital is low.  A lot to improve in the data value chain from the input data, to data output format to facilitate use by multiple users.	Hydroclimatic data interest many users to improve their data and many links can be made to climate change adaptation for the water and agriculture sector.  Youth employment opportunities exist in the hydroclimatic data value chain (from civil society's involvement in data production to private data services - including to the farmers).	Work is still being done in silos, for example with Agrhymet and NBA, and no integration happening.

Table 03: Hydroclimatic data ecosystem governance

In the World Bank report, three levels are defined with establishing fundamentals, initiating the flows and optimizing the system.

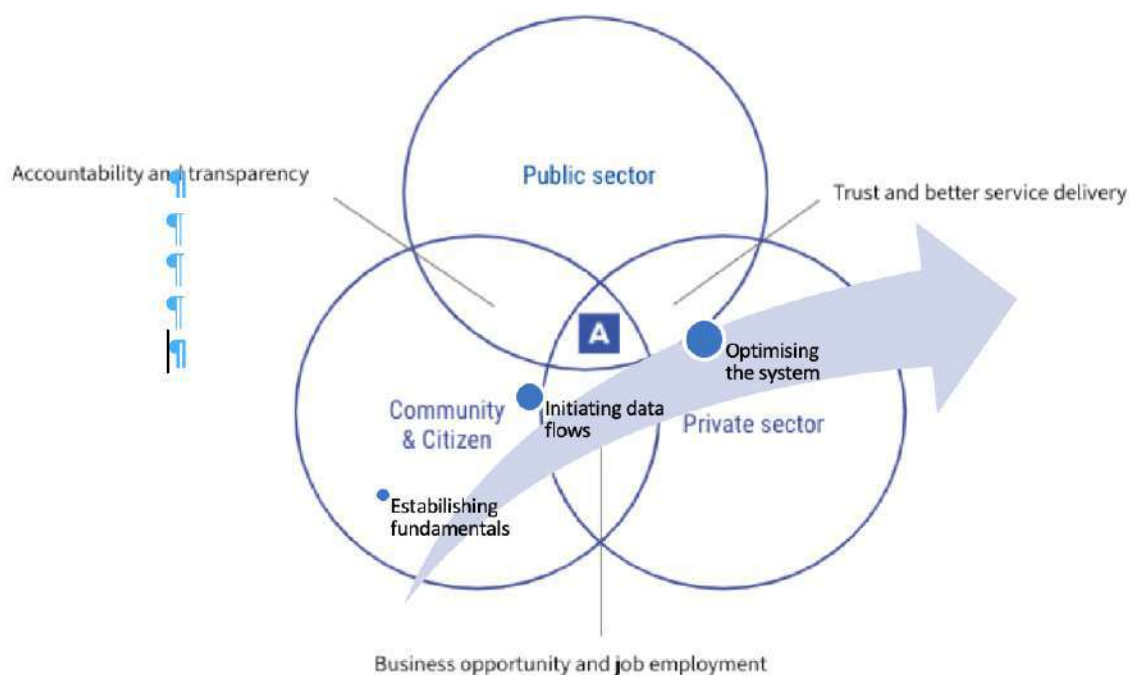


Figure 05: Initiating data flows

The overview and assessment of the ecosystem in this study is not complete (a full ecosystem assessment study takes more resources and time) but can help to assess the level of maturity of the ecosystem and its players. While the hydroclimatic data ecosystem is mostly dominated by public and research players (government, NBA) due to the importance of the public intent of hydroclimatic data (high value for society), private sector players are also involved and already playing a role. For this reason, the maturity of the ecosystem shows signs of data flows already initiated and could be seen as a good basis for further strengthening of this insight ecosystem.

Recognising the public intent of hydroclimatic data should allow focus to support the public sector, but also private sector development in improving data flow and use of this data of high value. This general overview gives some indication of the role NBA could play in the general ecosystem and the study is now going to dive into NBA and the SATH model details.

# 4. Focus on NBA and the SATH model

## 4.1 NBA presentation

In the 1960s, the independent countries of the Niger Basin decided to coordinate their efforts in order to exploit the natural resources of the basin, among which water is the first. The Niamey Act, related to navigation and economic cooperation between the countries of the Niger Basin, was signed on October 26, 1963. It was replaced by the Niamey Agreement, related to the River Niger Commission and to navigation and transportation on the Niger River, which was signed on November 25, 1964. The Commission of the Niger River was renamed the Niger Basin Authority (NBA) on November 21, 1980. The member Countries are: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria and Chad. The NBA is an intergovernmental organization responsible for promoting cooperation amongst member states and contributing to the improved living conditions of the basin populations through sustainable management of water resources and associated ecosystems. The NBA has the ambition to be recognized as transparent and appreciated for its capacities to reinforce the solidarity between the member states and to generate benefits that affect the populations.

While the Satellite Based Water Monitoring and Flow forecasting System in the Niger Basin is based at NBA headquarters in Niamey (Niger), information is shared amongst all of the member countries). More details about data and information flows are given in the description of the SATH model hereafter.

The water charter (*Charte De L'Eau*, 2020)<sup>16</sup> is meant to encourage cooperation based on solidarity and reciprocity for a sustainable, equitable and coordinated use of the Niger Basin hydrographic catchment area. In this perspective, a specific goal of the water charter is to promote research and technological development, information exchange, reinforcement of capacities, in particular as regards the IWRM and the use of adequate technologies for the management of the Niger Basin hydrographic catchment area. The SATH model is such a technological development.

The Observatory is an online information system that provides access to available data and information on Integrated Water Resources Management (IWRM) and related themes as climate change and precipitation data, water management, environment and natural resources. The Observatory aims to contribute to more informed decisions on the management of the Upper Niger River. The tasks of the Niger Basin Observatory are 1) to monitor the evolution of the Basin in its different components and 2) to produce regular information on the development of the basin. See annex 6.

---

<sup>16</sup> [http://www.abn.ne/index.php?option=com\\_content&view=category&layout=blog&id=74&Itemid=66&lang=en](http://www.abn.ne/index.php?option=com_content&view=category&layout=blog&id=74&Itemid=66&lang=en)

## 4.2 Understanding of the SATH model

As indicated in the term of references, it is paramount to have a thorough understanding of the SATH model and its generated output data to explore the commercialization potential. The model predicts floods and droughts, thus giving better insight in water availability. In turn, that information has the potential to provide evidence-based agricultural advice and advanced weather alerts to farmers. It is also expected to give input for long term land use planning. Below, you'll find some relevant information available online and based on the evaluation report of the SATH ORIO project (dated 2019), as well as conversations with NBA and key stakeholders (IHE and Deltares) to better understand the SATH model. (TANIMOUN & Foppes, 2022).<sup>17</sup>

### 4.2.1 Description of the SATH Model and data input

SATH is an information service system that uses satellite data and ground-station-data to provide hydrological information for the Niger Basin. The ground-based data refers to precipitation and river discharges. The hydrological information can be grouped in a flow forecasting component and a hydrological-drought component. The SATH system is composed of two large models that are combined in order to provide spatially distributed data. The first model is the Energy and Water Balance Monitoring System (EWBMS) and the second model is the Large-Scale Hydrological Model (LHSM), the combination of both models provides ultimately spatially distributed daily data on temperature, radiation, actual evapotranspiration, precipitation, runoff and river discharges. A set of this information covers the entire basin and therefore it is available at any location. The other set is available for specific stations. Besides satellite derived information and both models, SATH uses measured discharges at specific locations (HYDROMET) and precipitation data (WMO-GTS). Further information on the two models has been provided in annex 07.

The information collected from the HydroMet stations are crucial for the system results. The gauging stations are used for updating the curves of calibration, which are the curves used to convert a water level reading into flow rate measurement of the river. An in-depth study has been done by BRL ingenierie (funded by AFD) in 2020 on 'étude préliminaire sur la pérennisation du suivi hydraulique' (Preliminary study on the continuation of hydrological monitoring) which gives in detail the functioning of the various station and give an financial sustainability overview of what is needed. Three main types of hydrometric stations are currently deployed on the rivers of the Niger basin:

- Manual stations: these are standard stations equipped with scales. The data are transmitted by an observer..
- Automatic stations with GSM teletransmission (or GSM limnigraph).
- METEOSAT automatic stations with satellite transmission: this is the same type of station as the automatic stations with GSM transmission. The main difference is the transmission

---

<sup>17</sup> [https://www.rvo.nl/sites/default/files/rvo\\_website\\_content/opendata/iati/ORIO/ORIO10NE22\\_01.pdf](https://www.rvo.nl/sites/default/files/rvo_website_content/opendata/iati/ORIO/ORIO10NE22_01.pdf)

mode. In the case of the satellite remote transmission station, the data is sent to the METEOSAT satellite.

For the manual stations, the data is collected and shared via excel files, specifying the location, the catchment and the country of the station. The information collected from the Hydromet stations is shared on a monthly basis by the country-members through hydrology services. In case of need, NBA requests the information with more frequency than once per month. Some stations' information is also collected directly by the NBA.

The model runs a forecast component whenever the water level exceeds a determined threshold level. This component is an autoregressive component that can forecast the discharge and water levels in the river up to six days ahead. The thresholds are location specific as they correspond to the station characteristics. Ultimately, the LHMS provides daily-data of the river discharge and water levels over the entire river and its tributaries. Figure 06 summarizes the LSHM data-structure and information flow.

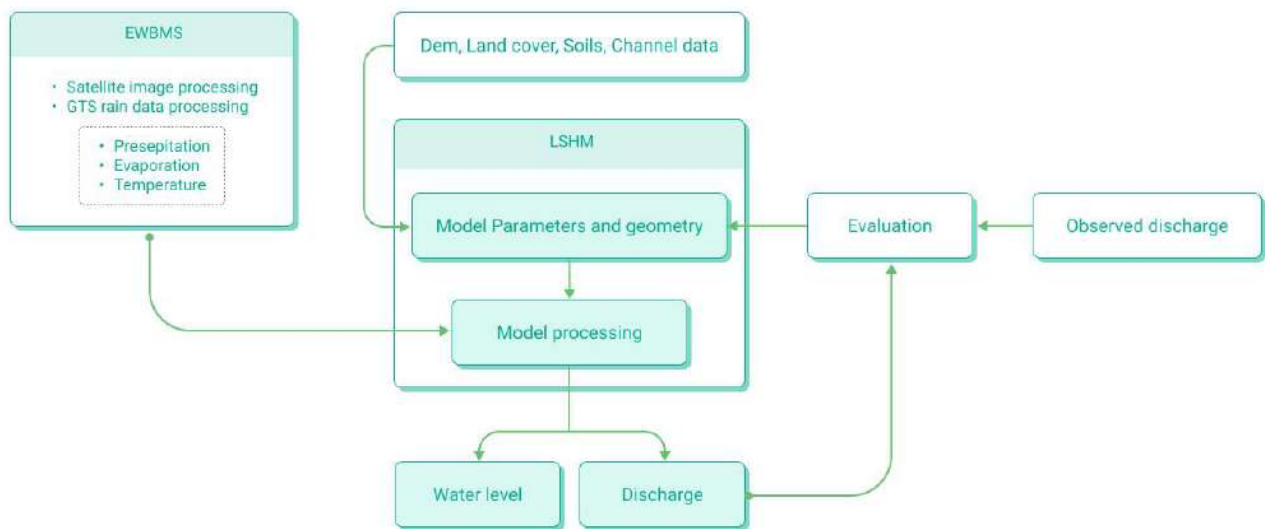


Figure 06: Large-Scale Hydrological Model (LSHM) data structure and information flow

#### 4.2.2 Quality of the model

Both models EWBMS and LSHM and their components have been validated and the results are presented in the SATH scientific Intermediate Report (July, 2021). The most important results of the validation are summarized in the following paragraphs.

Three major components from the EWBMS model were validated:

- A. The radiation balance, which has a reasonable accuracy on a daily time-scale. This is reflected by a range of the coefficient of determination<sup>18</sup> ( $R^2$ ) between 0.65 and 0.85
- B. Actual evapotranspiration, has an accuracy of ( $R^2$ ) 0.3, due to the assumptions used to deal with clouds. On a decadal scale, the estimates improve to 0.6 to 0.8
- C. Precipitation, shows in average reasonable accuracy results, with a correlation coefficient ( $r^{19}$ ) of 0.4 to 0.6. The latter results are comparable to other precipitation products (CHIRPS, RFE2.0). Notably the report shows that the EWBMS model is not well able to model daily rainfall amounts larger than 30mm, this is the case in areas with low density of reporting GTS stations.

The validation of the LSHM model classified its results in three groups. The first one with 11 stations that have an NSE<sup>20</sup> higher than 0.8. These stations are identified to be suitable for forecast production. The second group has 3 stations and the correlation NSE is between 0.7-0.79. The remaining 32 stations have a moderate to poor performance classification. The correlation factor of NSE is less than 0.7 and in many cases 0. The reason given is the lack of observation data, balance errors at EWBMS and lack of observation stations for the EWBMS system.

The system is large and has several model elements that build the SATH-system. This combination of several modules is a strength of SATH. However, it makes the system also vulnerable to delay if any of the modules is not working properly.

Here the study elaborated on a couple of elements that are critical to the proper operation of the system:

- The GTS rain data needs to be working properly. This set of information is critical for both drought and flood events. This affects EWBMS, LSHM and SATH altogether.
- Precipitation outputs from EWBMS have a limited accuracy during “extreme” events. This happens when there is precipitation larger than 30mm. If one of the major strengths of the system is to provide alerts in case of floods, due to extreme precipitation, then the occurrence of this event needs to be analyzed and contingency plans need to be studied.
- Observed gauge stations are crucial for the water levels and discharge computations. This information is used for continuous calibration.
- There are two aspects that are critical to ensure the information is ingested by the model. The first one is the collection of the information. This is sensitive to agreements within the member countries to collect the information and to maintain the stations operational. Internal agreements between member-countries and NBA needs to be in order and the internal agreements between member-countries authorities and the collecting personals needs to be in order as well. Secondly,

---

<sup>18</sup> Coefficient of determination,  $R^2$ , ranges from -1 to 1 where a perfect score is 1.

<sup>19</sup> Pearson Correlation Coefficient,  $r$ , ranges from -1 to 1 where a perfect score is 1.

<sup>20</sup> The Nash-Sutcliffe model performance statistics,,NSE, ranges from -inf to 1.

sending the information is sensitive to working telecommunications agreements. This applies to remote transmission of the information via GSM and GPR.

### 4.2.3 SATH generated output data

The SATH-system delivers data outputs to their relevant stakeholders. Data outputs are the result of the models and can be further processed to give information. The following table summarizes the output data and presents its technical characteristics.

Name	Unit	Frequency	Grid Resolution
Actual evapotranspiration	mm	Daily	3 km
Actual precipitation	mm	Daily	3 km
Meteorological drought index (MD)	-	Monthly	3 km
Hydrological drought index (HDI)	-	Monthly	3 km
Climatic moisture index (CDI)	-	Monthly	3 km
Precipitation - Difference from average	mm	Daily	3 km
MDI - Difference from average	mm	Monthly	3 km
HDI - Difference from average	mm	Monthly	3 km
Monthly cumulative Eta	mm	Monthly	3 km
Monthly cumulative precipitation	mm	Monthly	3 km
Daily discharge	m <sup>3</sup>	Daily	9.5 km
Daily water levels	m	Daily	9.5 km

Table 04: SATH output data

In addition, the generated data is further processed into drought and flood information that are then shared by NBA through the dissemination channels.

### 4.2.4 Dissemination channels

The information obtained from SATH is available and distributed mainly via the website, an FTP account, bulletins and during training sessions. It is important to mention that before the information is distributed via either of the channels, NBA performs a quality control of the information. Such quality control is performed by NBA experts that includes a hydrologist expert and a modeling expert. In the case of the bulletins, the information to be shared is reviewed by a communication expert from NBA and a flood communication expert by GIZ. Furthermore, the bulletins are also reviewed by the Direction of the Niger Basin Observatory before sharing them.

- Website

The most accessible way to view the data is via the website of SATH-NBA (<http://www.sath.abn.ne/>). The website is updated every day during the rainy season, with priority to the water levels and discharge information. The website distinguishes between agrometeorological data and hydrological data/forecast.

The agrometeorological data consists of spatially-variant daily precipitation and actual evapotranspiration over the last 10 days. Furthermore, spatial-distributed drought and climate monitoring indexes are available over the past month (figure 07). The information is presented as maps.

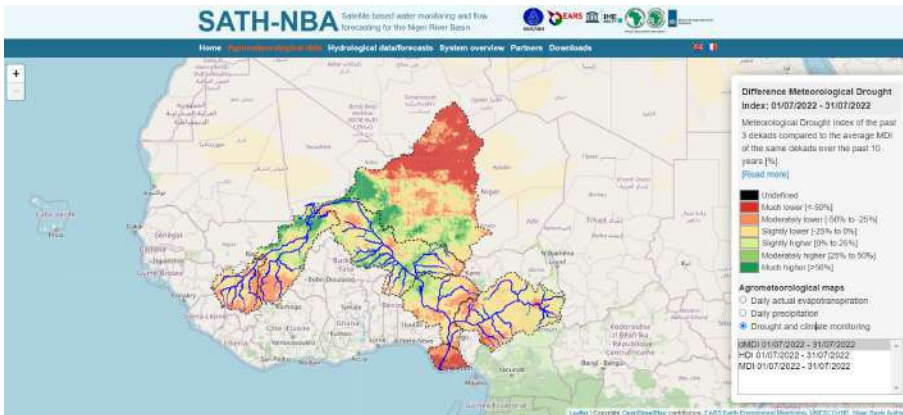
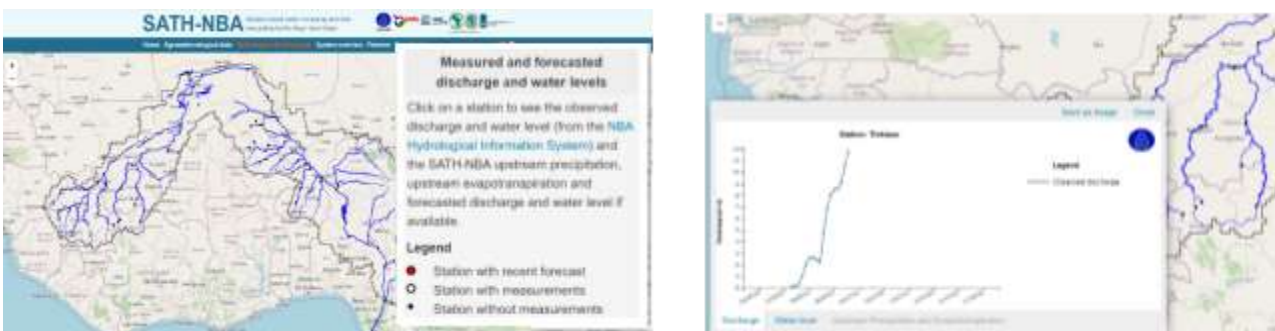


Figure 07: Screenshots of the SATH website

The hydrological data/forecasts present the different river discharge and water level measurements (figure 07). All the stations are visible and are categorized in three classes: station with recent forecasts, station with measurements, and stations without measurements.

Forecast of the river discharge and water levels are only performed when the water level exceeds a certain threshold value. Otherwise, there is no forecast data available. The information is available as a time series for water levels and discharges.



More examples are given in annex 05.

- Online Database accessible via an FTP connection

The previous dissemination channel shows the data in a processed manner via two formats (maps and time series). The raw geodata is also available via an online database accessible via an FTP connection. Information in this database includes raster information on evapotranspiration, precipitation and the climatic and hydrological indices MDI and HDI. The information of measured and forecast water levels and discharges is not included in the database. This can be accessed from the website. The frequency of updates is the same as the website and is updated everyday during the rainy season. New users can apply for credentials to access the data.

- Niger Basin Satellite Monitoring Bulletins

The information is also made accessible via bulletins. These bulletins are brief PDF reports that present the forecasted water level and river discharge for a station. The representation is coupled to the established thresholds. The main objective of the bulletins is to inform and alert authorities when risk scenarios are being reached. The alert system knows three different levels: yellow, orange and red. The latter is the most threatening situation. The bulletins are prepared by NBA based on the inputs of local authorities in the member countries.

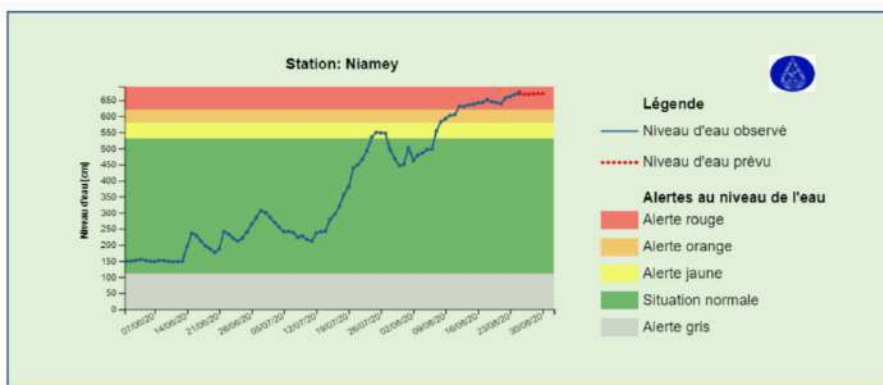


Figure 08: Graph presented in NBA bulletin

- Training and workshop events

The technical information available is being shared through training sessions. More importantly, during the session's potential uses and applications are being discussed with the attendees. Every year training is given to different ministries and managers from the different member countries. The participants also analyze during the workshops the possibilities to integrate the SATH-system information in their mandates. The SATH-NBA project reinforced the capacity of NBA and national technical experts to use real-time hydrological data to effectively monitor the impact of drought on water resources and inform agriculture and livestock activities in the basin countries.

## 4.2.5 Information flow and conclusions

In conclusion, the SATH system data flow could be summarized as follows in the figure below, with main data input being from the satellite image processing and GTS rain data processing. The particularity of the model is that calculated results are being validated by observed discharge (through Hydromet stations).

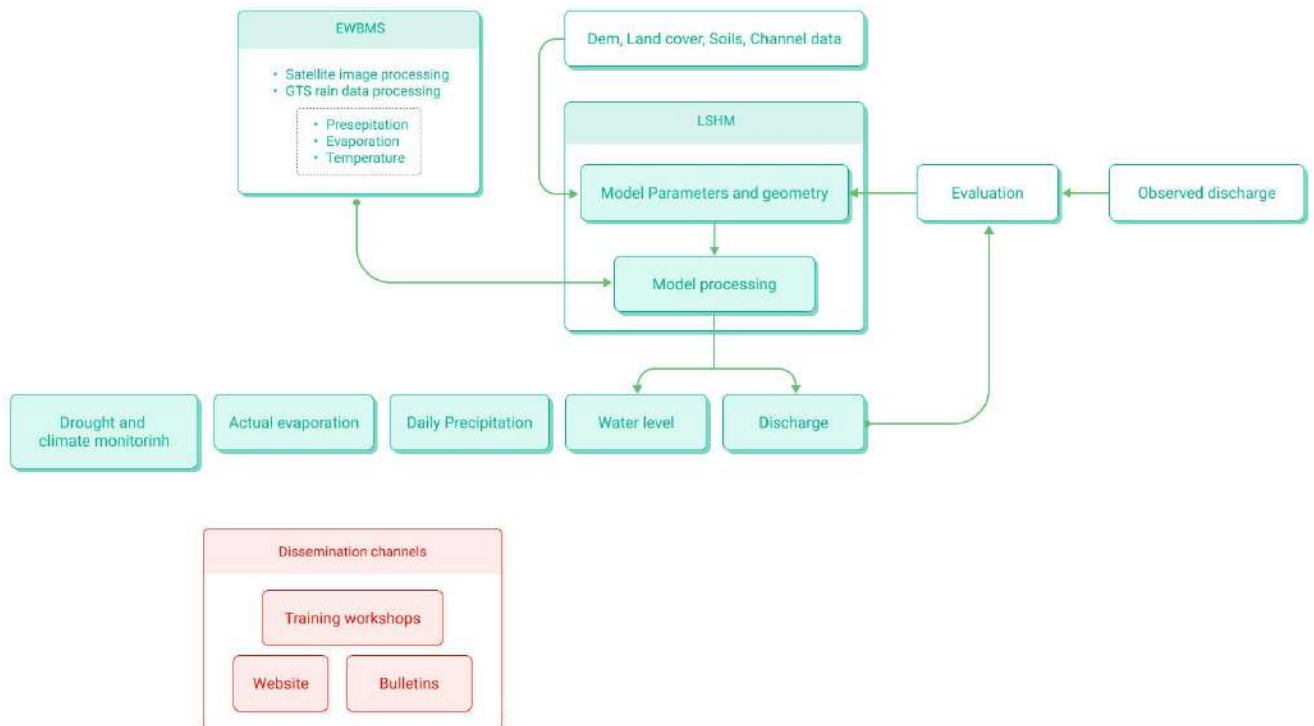


Figure 09: SATH-data flow and dissemination channels

The study found challenges in the data value chain in the SATH model at various levels:

- For the input data, challenges exist with the observed discharge (collected automatically or sent by the national hydrological services). An in-depth study (BRL, 2020) looks at the challenges, costs and scenarios to maintain the hydromet network.
- For the data processing, challenges exist for the maintenance and financial sustainability of the model (unfortunately, financial information for operation and maintenance were not shared).
- For the data output, challenges exist mainly with the process of data publication to the various dissemination channels. Website and bulletin are updated manually and are submitted to approval process (that can cause delays in publishing the information).

Despite the difficulties, some interesting points have been observed:

- The Hydromet network is a vital component of the SATH-system. This successful integration of the Hydromet information gives a competitive advantage to the SATH-system in comparison to other projects. Future services would benefit from the combination of ground-based stations and satellite products. However, many challenges exist (as mentioned above).

- The frequency of updating the information in the system is suitable for the services proposed. The information is being calculated on a daily basis, making the information very suitable for the services that focus on “normal conditions”. The forecast information covers several days ahead and gives actionable advice in case of emergencies.
- The quality of the data output is continuously being validated and improved with the local measurement-stations. The accuracy of the information shows to be high for the detail of services that could be developed. For instance, the FANFAR project still needs to improve its accuracy in the coming years. With this added value, NBA plays an important role of validation of data at the regional level in the data value chain.
- The SATH model provides data output covering the entire basin at an intermediate spatial resolution. Such resolution allows to have an overview of the Niger Basin as a whole and to provide relevant information at country level. Most of the existing projects that have similar spatial coverage of the entire basin have much higher spatial scales of information (less detailed).

## 4.3 Opportunities around SATH generated data

### 4.3.1 Current data users and data use

The SATH-system products and services are mostly meant to support the various governments of the country members and for NBA as an overarching institution. The generated information supports the water resources management activities, including planning, managing resources and reducing the impacts of extremes. The targeted end-users of the SATH information are broad and include not only relevant ministries in the member countries but other stakeholders such as NGOs and universities. Here we describe the users of the information divided in groups.

- NBA executive Secretariat

The Niger Basin Authority (NBA), being the responsible institution of the water resources management of the basin, is the owner and the primary user of the information. NBA is responsible for major functions relating to the integrated management of water resources (IWR). This entails the possession of the knowledge of the area and the water resources management, the support with hydrological monitoring of the member countries and the communication with agencies (NGOs), international institutions, and other donor initiatives. The information produced by the SATH-system is transmitted by NBA to the ministry in charge in each country. This ministry makes the information available to the other organizations.

- Governmental Institutions

The service is mainly being received and used by the different member countries through specific ministries. For these users the SATH service has become an essential tool in the working process when carrying out a range of tasks concerning the management of water resources in the river basin, flood forecasting and early warning systems and the drought monitoring and early warning information. Within the governmental institutions of the member countries, there are different ministries that have received training on the usage of the SATH service and have access to the data. At least four governmental

institutions per member country (could) use the information provided by the SATH, according to NBA. For Niger, for example, the Ministry of Hydraulic and sanitation transfers the information to the Ministry of Transport, Agriculture, Environment, Urbanism, Livestock, Planning, Humanitarian Action and disaster management.

- International Cooperation, NGOs and humanitarian sector

The SATH information forms in many cases the basis for future project developments, such as the GIRE3, which is developed with the AfD. Furthermore, the data is used to indicate vulnerable areas and prioritize measures. It supplements projects and program activities implemented in the basin. The study showed examples of where GIZ or the Red Cross used information generated by the SATH model.

- Research and universities

The SATH-system uses state of the art techniques and modeling. Therefore, research institutions in the region are also users of the SATH information. Namely, the University of Abdou Moumouni is strongly involved with the SATH service. The university uses the data for research and education and moreover the students gather data and evaluate the outputs of the service.

#### 4.3.2 Potential SATH generated services and users

The SATH-system products and services are mostly meant to support the various governments of the country members and for NBA as an overarching institution. The generated information supports the water resources management activities, including planning, managing resources and reducing the impacts of extremes. In order to broaden the application possibilities of the SATH output, we made an analysis of who can use the information and which information. We focus on the river users, as they are in the direct focus of the NBA. Currently, the information provides high quality products and data related to “warning” of extreme hydrological conditions: flood and drought. Based on our findings, we believe that the services can be expanded to services related to “normal” conditions. Such “normal” conditions services would support the mandates of the different member countries and authorities such as providing and having access to a transparent water allocation information service in the basin and optimization of available resources for other sectors such as hydropower and the agricultural sector.

Table 05 below shows the potential application of the SATH model. At every intersection field an example is provided on the potential “information-services” based on the SATH-model. The services to be developed should aim to provide an interpretation of the output data and information provided by SATH-system. This was indicated as an opportunity during the workshop at NBA and later during the discussions with the developers of the system.

<b>Information River Users</b>	<b>Water Resource Management</b>	<b>Risk Management</b>	<b>Resilience Climate Management</b>
<b>Governments</b>	Water allocation	Main current usage	Water allocation
<b>Hydropower</b>	Potential locations	Operational management of stations	Optimisation
<b>Navigation</b>	Navigable water levels	Low water level warnings	Planning calendars
<b>Fishery</b>	-	-	Suitable farming location
<b>Agricultural</b>	Crop water requirements	Flood & Drought risk for farming	Adjusting cropping calendars

Table 05: Overview of potential applications of the SATH model

More details on the service for the river users are shared in the annex 7.

While the potential applications above are targeting direct users of the river, there are also extended potential uses within the agricultural sector. Several EO services can be identified allowing to boost agricultural productivity (*Unlocking the Potential of Earth Observation to Address Africa's Critical Challenges*, 2021)<sup>21</sup>. Some of them are listed here after.

- Water saving

The primary cause of water losses in the African agricultural business is through evaporation, caused by high temperatures, inefficient storage of water reserves and non-optimal irrigation plans. Satellite imagery can help smooth these problems. In combination with meteorological and spatially explicit training data and hydrological modeling, it can be used to derive information about the past and current state of main crops to make future predictions. Hence, it would improve water crop development.

- Surface water and biomass availability

Traditionally, pastoralists have always sent out scouts in search of water and pastures. Due to climate change and insecurity in some areas, however, their movements have become uncertain, expensive and risky. Availability of geodata has come to offer great opportunities to improve resilience among affected pastoralists. Satellites can detect biomass and surface water with an accuracy (10 meters) that is good enough for the purpose. Services have been developed combining EO and field data, allowing the pastoralists to obtain geolocalized information on biomass quality and availability, surface water availability, herd concentration, and market prices for livestock and staple grains along the different transhumance routes. (Example G4AW STAMP+ Mali)

- Increased crop yields

EO can be used to improve crop monitoring at field and farm level and could be the basis of accurate models set up to identify and remove factors causing lower yields – for example, sowing too late vis-à-vis

<sup>21</sup><https://www.weforum.org/reports/unlocking-the-potential-of-earth-observation-to-address-africa-s-critical-challenges>

current season weather, making informed decisions of when to irrigate, and/or plan for harvesting. EO data can provide information related to the use of fertilizers.

- Improved control of pesticides usage

Through the implementation of best practices and the prevention of the spread of natural diseases, the use of pesticides could be reduced. EO data can play a focal role in setting up development models aimed at monitoring the evolution of diseases and the massive movements of insects. Such models would be crucial in forecasting how much and where these phenomena spread, to focus and limit pesticide intervention instead of resorting to broad, spray-all campaigns.

- Reduce insurance costs

Satellite data can improve transparency on agricultural activity and output as it helps assess crop conditions and environmental risks. This enables insurance companies to develop index-based insurance products to compensate farmers for their loss. EO data may also help develop algorithms to assess farmers' creditworthiness, allowing access to necessary resources to improve production.

**Box 06: WAPOR dataset compared with SATH output**

The WAPOR database contains more than 20 layers which have been available since 2009 at three different scales. A continental scale with information at a 250 m resolution, the national scale has a 100-meter resolution and the sub-national scale has a 30 meters resolution. In terms of frequency of information, most of the information is yearly or seasonal. The detailed catalog can be found here: [https://wapor.apps.fao.org/catalog/WAPOR\\_2/1](https://wapor.apps.fao.org/catalog/WAPOR_2/1). Considering possible synergies with the SATH-system we have selected the following sets in table

Table 06: Summary of WAPOR datasets

Name	Unit	Frequency	Grid Resolution	Scale
Biomass water productivity	Kg/m <sup>3</sup>	Yearly	250 m	Continental
Biomass production	Kg/ha	Monthly	250 m	Continental
Precipitation	mm	Daily	250 m	Continental
Primary Production	gC/m <sup>2</sup>	Monthly	100 m	National
Biomass Production	Kg/ha	Seasonal	100 m	Product

For the purposes of warning-services the SATH-system provides data with a higher frequency, daily, although the information is available at kilometers scale. For such a “warning-drought” service which is related to agricultural

production, SATH-information can be combined or enriched with the monthly biomass production dataset from WAPOR. The consequences of drought in agriculture are not sudden and a monthly high monitoring resolution could show trends earlier.

Considering the precipitation that is used by the LHMS model to develop water level warnings, the Daily Precipitation data set from WAPOR, could be combined with the precipitation information that the EWBS delivers, specially for the extremes (>30 mm) where the EWBS results are not so good.

#### 4.3.3 Possible business models for commercialisation of SATH generated data

As explained with the ecosystem approach, the commercialisation of the SATH generated data is considered in the study as broader than just selling data sets and/or results of modelisation/research. There are also possibilities to create business opportunities for third parties that may be provided access to the SATH generated data. Based on the potential SATH generated services and users, we can identify potential business models for commercialisation of the SATH generated data. We defined three main types of business models, that could be further detailed out in the next phase of the study :

1. The first business model would be for NBA to develop direct services based on the identified users and services. For example, in the study presented in box 07, they didn't look at whether NBA could get paid directly by hydro producers in exchange for data services. Here the business model would be based on an inclusive model (the service is bundled with payment for other services) and would facilitate some cost recovery for NBA. For each user of the river, it is in the mandate of the NBA to provide information, in exchange of payment.

#### Box 07: Hydro power sector and willingness to pay

A specific study<sup>22</sup> was conducted in 2019 to assess the feasibility and implementation of a hydropower levy in the Niger basin. It was found that two hydropower producing countries remained unfavorable to the introduction of such a fee because it would place an additional financial burden on energy consumers. Furthermore, in terms of how hydro producers should pay the NBA, the option of direct payment was rejected. This option would have required a revision of the agreement establishing the NBA and this process was considered too long.

Therefore, the payment option that was chosen was to use the States to collect the fee from the producers. (...) The issue here is for the NBA Executive Secretariat to convince the States (owners and other concessionaires) to concede part of these fees for the services rendered by NBA.

2. The second business model could be in the direction of services using SATH model output to boost agricultural productivity. NBA could be interested to look for services that could generate direct payment (from farmers for example). However, since NBA does not have the direct mandate to

<sup>22</sup> CACG et al., « Assistance technique à l'Autorité du Bassin du Niger à la réalisation de l'étude sur le financement durable de l'ABN et pour la finalisation de l'annexe n°2 de la charte de l'eau et de l'outil de gestion coordonnée des barrages - Rapport final définitif ».

provide services outside the governments or the river users, it would probably be easier to find intermediaries (data services providers) who would develop a business model around the integration of SATH data with other data sources. In that case, NBA should look into a business model around G2B services where NBA could provide data against subscription or Data as a service model : some data could be for free on a monthly basis and businesses could subscribe with NBA to get access to more frequently updated data. Additionally it is possible to find service providers able to deliver various kinds of services when data is made available. Some of these services providers knowledgeable and experiences with the provision of services can be found on the Space directory from the Dutch government ([www.nl.space.nl](http://www.nl.space.nl)<sup>23</sup>). Other countries have similar portals such as Luxemburg<sup>24</sup> for example. Most of these providers are private companies.

3. Finally, another business model could be around a subsidized model where the customer gets access to open data (subsidized) for no fee at all for service provision and a third party subsidizes, as it is done with WaPOR data set for example. The possible source of funding mentioned by NBA is the Regional Climate Change Adaptation Fund (FRACC): it is a proposed international financing mechanism to fund environmental services in the Niger River Basin. It should be noted that hydroclimatic data would fit perfectly into the FRACC's funding targets because it is understood that to better preserve a resource, it is necessary to know it better. This mechanism plans to channel different sources of funding, including :
  - Voluntary contributions from public and private users in the basin;
  - levies on water charges and taxes collected by the basin countries via national water funds
  - Financing from international donors;
  - Financial returns on the initial capital of the FRACC.

One of the most important business challenges for the commercialisation of the SATH generated data is to create a stable flow of incomes for the organization in charge. Several issues have been identified in the past such as customer retention, business commitment and increased competition. It is said that data only becomes valuable if the data set is large, accurate, frequently updated and covers relevant information to a customer.

Further analysis should be done in the Result 4 of the study, depending on the commercialisation strategy chosen. We will look then at defining further the customer segments and willingness and ability to pay.

---

<sup>23</sup> <https://www.nl.space.nl/en/spacedirectory/>

<sup>24</sup> [https://space-agency.public.lu/en/expertise/space-directory.html?r=f%2Faem\\_theme%2Ftags\\_theme%3Aspace\\_agency%5Cdata\\_data\\_analytic\\_s&](https://space-agency.public.lu/en/expertise/space-directory.html?r=f%2Faem_theme%2Ftags_theme%3Aspace_agency%5Cdata_data_analytic_s&)

### 4.3.4 Quick assessment of NBA - Opportunities within NBA?

Based on Akvo's methodology to data scan, the study could identify a few key points in the way NBA deals with data. This data scan is not complete and Akvo's preferred approach to do this scan participatory didn't fit in the scope of the study, but table 07 below gives some indications on where to look for improvement, based on the interviews with stakeholders :

Areas*	Strengths	Weaknesses	Opportunities	Threats
<b>Data strategy</b>	Aggregator of data at regional level Data cooperation approach (recognised need to add value to the data as a service)	Each program have their own reporting mechanism	Observatory in development	No data strategy existing for sharing data with users
<b>Data use</b>	PPP history Role of NBA in the value chain is recognised	No real interactions with the data users going out of NBA (apart for some workshops)	Many services are possible with various users	Weak data input network
<b>IT infrastructure</b>	Already advanced technologies are being used	Difficulties for maintenance (decisions to move to SaaS subscription)	Development of Cloud services ?	No financial overview
<b>People and culture</b>	Added value of staff at NBA (compared to national capacity)	Very little data culture due to the environment	many programs involving various organizations for capacity building and knowledge sharing	Very little innovation on-going or connexion with local data private sector

\* We left the category : 'Organization strategy and KPIs' out as the organization is undergoing restructuring

Table 07: SWOT analysis for the NBA

As for the ecosystem maturity assessment (see chapter 3.4), various models exist to classify the data maturity at organizational level. NBA has initiated some vision and strategies around data and information management through the observatory: through its mission of organizing the collection, processing and analysis of data, the monitoring of indicators and the sharing of information, the observatory should be able to avoid silos and stabilize or even operationalise these elements in a sustainable manner. For the time being, all these points mentioned above are not yet functioning as desired. The NBA or its Observatory must therefore be given the mandate and the human resources in quantity and quality, as well as the technical infrastructure necessary to achieve its mission. In conclusion, there is a better level of data maturity at NBA than in most of the water ministries in the region and NBA is also playing a role in

building capacities of the countries. In developing further its data maturity, NBA should reach stages where data is central to the strategy and better outcomes can be created.

#### 4.3.5 Alternative fundings

Last but not least, possible alternative financing options through donors and partnerships may support NBA to sustain the SATH model. NBA already approached some organizations in the past to contribute, such as AfdB, GIZ, Dutch government, AfD, etc. NBA considered that their involvement could be temporary to allow a transition for a fully externally-funded model to a commercial one. A few examples of NBA projects have been mentioned in the literature survey. Relevant for the future of the commercialisation of the SATH generated data may be bilateral and multilateral donors already funding NBA and/or interested in digitalisation. The overview is in Annex 9 and Result 4 of the scoping study will explore if and how the Dutch financial instrumentarium could support the commercialisation of the SATH generated data.

#### 4.3.6 Main reflexions around SATH model added value

The scoping phase showed opportunities around SATH use and possible services and products that could be further developed as seen in the chapter 4.3.2. Some business models can be further explored whether NBA develops the services themselves or through data intermediaries such as local private sector. Some elements of the added value of the SATH model on further use are very relevant :

- The SATH information system provides **consistent and integrated information** for the benefit of two major sectors: water and agriculture. Most of the existing NBA projects and initiatives focus on applications either on IWRM or on agriculture.
- While the SATH model provides **quality data and information related to “warning” of extreme hydrological conditions** (flood and drought through water levels and discharges), extra data output that combine and include extra sources of information can be developed to services as shown in 4.3.3. Quality input data is needed in both cases.
- The SATH-system has **a centralized system for data management**. This includes data provided by the measuring stations in the entire river basin. Such a working data storage system facilitates the management and maintenance of the network and shows how important is NBA’s role as an **aggregator of data** at regional level. In general, NBA also plays an important role and has added value to national hydrological services due to their technical capacity. The study (BRL, 2020) also showed the role of NBA in improving the hydromet sector in its countries to illustrate the example of the key role played by NBA in the hydroclimatic data sector. In general, NBA also plays an important role in the region in impulsing good practices and improving the management of hydroclimatic data at national level.
- The SATH information system has **its own dissemination channels** with a website, bulletin, FTP servers. It could be good to fit SATH output in the general objective of the observatory and develop

the observatory channels in which SATH output could fit instead of having different channels for SATH output.

- To be able to develop some of the services mentioned in 4.3.2, users or local data services would need to access SATH data output in an automated way and this is not possible at the moment with the existing dissemination channel. A user who wants to use SATH output has **some manual steps** to do through the website or the FTP server for example, to be able to use the data. This should be made more user-friendly.

# 5. Conclusions and recommendations

## 5.1 Main findings scoping phase

The findings in this report are based on an in-depth assessment of the geodata sector in the Sahel, with a particular focus on hydroclimatic data, to be able to undertake a detailed assessment of the data ecosystem and stakeholders around the SATH model output. During the assessment, we found that the hydroclimatic data that is generated by the SATH-model generates value for civil society, the public sector and the private sector. There are several areas for improvement, however, as the dissemination of the data is not tailored to the different user groups, value adding data services are underdeveloped, and the data is not yet combined with data from other sources. In chapter 3, the following characteristics of the hydroclimatic data value chain in the Sahel, and more specially in Niger, were described:

- A healthy data ecosystem involves data exchange between the private sector, public sector, academia and civil society. In the hydroclimatic data ecosystem, civil society and private sector involvement is lacking. NBA has a key role in it, as the intermediary between national hydraulic services (with low capacities) and the existing international private sector (through PPP).
- NBA and Agrhymet play a key role in the data value chain, because they are the only institutions that aggregate data on a regional level (while having a different geographical focus) and they play a role in data validation, in support of the country's hydrological services. For the data analysis, very little happens at the local level in the Sahel compared to other regions (drones, etc) or for providing digital climate advisory services (integrating hydroclimatic data with other data).

In chapter 4, with the closer analysis of the SATH model and its opportunities, the study concludes:

- The SATH model provides data to the NBA that is valuable input for implementing its main tasks 1) to monitor the evolution of the Basin in its different components and 2) to produce regular information on the development of the basin. Furthermore, the model advances regional cooperation and technological development for IWRM in the Niger Delta, as envisioned under The Water Charter (Charte De L'eau, 2020).
- There are several critical elements to the SATH model that need to be in place for it to be operational. Data input needs to be reliable (GTS rain data needs to function properly and precipitation data from EWBMS needs to be accurate under extreme rainfall) and the right institutional agreements on data and information exchange need to be in place (between member-countries, within member-countries and with telecom providers).
- Challenges exist at various levels of the data value chain of the SATH model: At data input level on the quality of the data, on data processing level for the financial feasibility of the system, and on the data dissemination level with the (manual) process of data publication and dissemination.
- The SATH system has several unique characteristics that give it a competitive advantage.

- While the SATH model provides high quality data and information related to “warning” of extreme hydrological conditions, the study showed some potential additional services and products under “normal” conditions for data users that are direct ‘customers’ of the NBA, such as the ministries and the river users. Other potential services for the agriculture sectors/farmers were also found.
- Various business models could be possible, from delivering extra services to potential users (directly or in PPP), to focusing on delivering data for the river user as part of their mandate. The NBA believes that the FRACC could further fund the SATH model and other hydroclimatic data as ‘to better preserve a resource, it is necessary to know it better’.

## 5.2 Main recommendations

Based on the findings of the scoping phase, some recommendations can be formulated for the main beneficiaries of this study e.g. NBA, RVO, Invest International, NSO and the Dutch Embassy in Niamey about possible commercialization strategies.

- Recommendations to the NBA:

The main recommendations for the NBA is to continue to maintain the quality of the SATH model in order to produce high quality data for services and products. For this, the study defined the following key elements:

- Continue to play a key role in reinforcing the input data and model and specially the Hydromet network. Some reflections and possible strategies have already been proposed to NBA in previous studies, with scenarios looking at delegation of services at national level, for example. While the Hydromet is ultimately the responsibility of the nine governments, NBA should play a role in advising these governments as well as trying out new approaches. Specific pilot projects with citizen or local private sector involvement could be led by NBA because they have more experience in PPP and capacities than national hydrology services may have. The national level would still be in charge of the implementation.
- Review the SATH information flows and output diffusion and consider developing the observatory diffusion channels into which SATH output would integrate. The NBA has started to develop its strategy in sharing data so, in this view, NBA should also seek to have SATH output diffusion enter the official NBA channels, instead of having its own channels.
- When developing further services with the data output, review the format of data needed. More and more, in a mature ecosystem, data flow is automatic. So it could be important to consider developing Application Programming Interface with data input and data output to facilitate the transfer of data (and thus, further use of the data without the necessity of manual steps). The more automation in the publication of the data, the quicker the data flow can take place (preventing delays in publishing the information).

In addition, in view of developing commercialization strategies, we have some more recommendations when considering developing new products and services for potential users:

- The current format and use of SATH output showed that the SATH output has not been designed with the final users. For the development of more uses, we recommend working with users to better define data needs, formats and gain a thorough understanding of the information required.
- By mandate, the NBA should focus on river users. We recommend the NBA to focus its services on those users. For other potential data users (such as farmers), we recommend to associate with third parties that would specialize in farmer services or local data service integration (through PPP for example).

- Recommendations to supporting partners (Embassies, RVO, Invest Internationall, NSO)

While the study showed the importance of the public actors in the hydroclimatic data value chain, it is recommended to extend support to a wider range of actors than just the NBA to ensure a data ecosystem is built that can support commercialization of the SATH model data in a sustainable way. It means to support the public sector (NBA and national government) but also private sector and civil society in creating agreements and collaborating on data governance and data management.

*“In view of today’s increasingly sophisticated application of digital innovation to drive data-based innovations, it is quite conceivable that the economic value of unanticipated secondary uses of data may far exceed the value of the primary use of data—that is, the use for which they were originally collected. These characteristics raise the prospect of serious underinvestment in data collection from a social perspective because the entities bearing the cost of data collection will not necessarily be the ones capturing its full economic value” (WB report Data for better lives 2021).*

In this view, we recommend developing support to each party for enhancing the economic value of hydroclimatic data :

- Support NBA in continuing to play a key role in the Sahel hydroclimatic data ecosystem by reinforcing the SATH model to maximize its value, especially in improving the accessibility, understandability and interoperability (Figure 10).

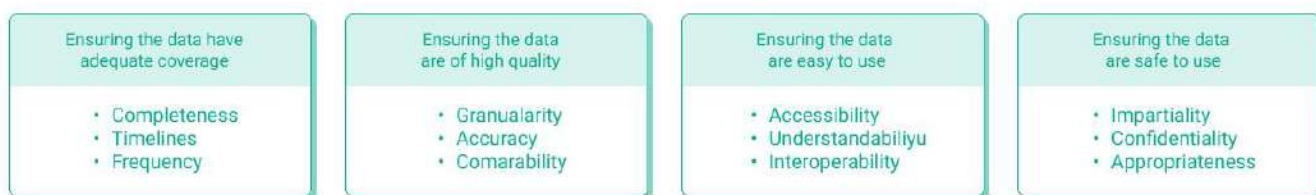


Figure 10: How data features can maximize the value of public intent data

- Support the improved data governance of the hydroclimatic data ecosystem. Given the NBA's technical capacities and experience with both PPP and multi-governmental programmes, they can play a leading role in the development of improved data governance, together with other institutions. This will also foster stakeholder engagement.



Source: WDR 2021 team.

Figure 11: Features of well-functioning institutions for effective data governance. Source: WDR 2021 team.

- Support development of data services around the SATH model (both for the river users as well as the agriculture sector - including farmers). There is potential for (local) private sector development and also youth employment.
- Support the involvement of civil society in the Niger Basin in the gathering, production and use of the hydroclimatic data to create more value for society.

By recognizing the possibilities of the hydroclimatic data to have an important economic value for society and enhance this ecosystem, it could also create youth employment opportunities in the digital domain and more particularly around data services (for water, agriculture and climate change). It is also an important opportunity to link with agricultural technologies and develop Climate Smart Agriculture.

Finally, further development of the hydroclimatic data ecosystem in the Sahel could become very strategic in the support of digital strategy in the Sahel, as well as for climate change adaptation in the region.

**Figure 2.6** A positive feedback loop can connect enablers and features of public intent data with greater development value

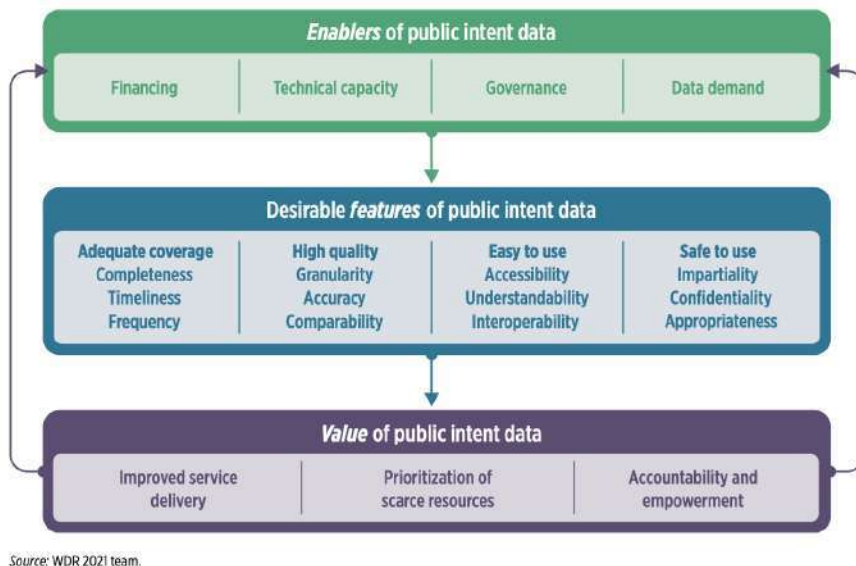


Figure 12: A positive feedback loop can connect enables and features of public intent data with greater development value. Source: WDR 2021 team.

### 5.3 Proposed commercialization strategies

The scoping phase has shown that opportunities exist for products and services using SATH-generated data to create further value for use, both for public use (better knowledge on drought and floods, for planning and monitoring, and climate change adaptations) and private (for instance creating advisory services to farmers/farmer organizations or local private users of the Niger river). Some recommendations have been made on the level of support possible (focusing on NBA or on the bigger hydroclimatic data) depending on the ambitions/funding possibilities.

While looking at the geodata landscape, and more precisely hydroclimatic data ecosystem in the Sahel, it becomes clear that thinking about commercialization of SATH products and services should consider the broader ecosystem of hydroclimatic data and its stakeholders along the data value chain. We have defined two levels of support in the scenario: one focusing on the support to NBA, and one to foster the maturity of the hydroclimatic data ecosystem to accelerate development and contribute to adaptation in the context of climate change.

To look at the opportunity to further support commercialization of products and services based on SATH-generated data, it is important to look at the bigger ecosystem of hydro climatic data, opportunities for more sustainable outcomes that can be designed from the beginning. While the term of reference focuses on the commercialization strategy for NBA, we propose to explore two strategies.

Strategy	1 - Commercialization by NBA	2 - Commercialization by third party
<b>Value proposition</b>	Financial sustainability of the NBA.	Business opportunities for private sector Possible societal value: civil society, private sector and government collaborate on the data ecosystem.
<b>Stakeholders supported</b>	Support NBA to further develop its SATH outputs.	Support NBA in playing a role in the governance of hydroclimatic data in coordination with other public stakeholders. Support local private sector development and data intermediaries while creating opportunities for youth employment.
<b>Customers segment</b>	Recommendation to focus on river users.	The customer group is larger (not only direct river users).
<b>Adverse consequences to be looked at</b>	Competition with other institutes (like Agrhymet) or open data.	Competition for resources. Adverse consequences could be turned into cooperation opportunities.
<b>Opportunities and Strengths</b>	The NBA is already moving in this direction with the Chartre de l'eau and the Fond that is to be created.  Possibilities to develop B2G contracts with the private sector to develop the services (with Dutch sector for example).	Opportunities for youth employment Opportunity to combine more data available by other stakeholders.  Opportunity for NBA to strengthen its role of aggregator and possibly validator of data.
<b>Weaknesses and Threats</b>	The main weakness of this scenario is the lack of visibility of financial sustainability.  The main threat identified is the lack of experience of NBA to develop services in cooperation with the end users and lack of local data services to support NBA.	The main threat is the lack of existing coordination mechanisms between the various regional initiatives around hydroclimatic data.  Need to have a country focus to adapt to local context to provide relevant products and services.

Table 08: Commercialization strategies based on the SATH-generated data

## 5.4 Work plan

In the next steps, we will further detail the two commercialisation strategies identified considering possibilities for youth employment that could be developed. Exploration of the adverse consequences (result 3) and cooperation possibilities (in close partnership with the users) should help to summarize the main risks, timeline and support (including capacity building and data governance) required to pursue this strategy (result 4). Opportunities for youth employment will be also explored in these commercialisation strategies (result 5) by having interviews with them, identifying main barriers and analyzing synergies. This will lead to proposed capacity building and advice for youth employment in relation to data.

The following steps will be taken for once a scenario is chosen :

- Adverse consequences - or collaborative effect
- Advice on commercialisation
- Roadmap for implementation and follow up actions (including design strategy)
- Capacity assessment of NBA ( and if possible some main stakeholders- strategy 2)
- Identification of funding stream - Discussion with various embassies and identification with RVO, Invest International and other relevant (private and public) organizations
- Elaboration of final report

All these activities will be done from now to October. Completion of the study, result sharing during stakeholders workshop and finalization of the report are expected by the end of October 2022.

# References

- About the project | WaPOR, remote sensing for water productivity | Food and Agriculture Organization of the United Nations.* (n.d.). Fao.org. Retrieved August 30, 2022, from <https://www.fao.org/in-action/remote-sensing-for-water-productivity/overview/about-the-project/en/>
- Abou-Zeid, A. (2022). *AU DATA POLICY FRAMEWORK: An Integrated, Prosperous and Peaceful Africa.* African Union.
- Addison, C., Figuères, C., Owesiga, H., Muwonge, D., Nsimidala, E., Sezibera, A., Boyera, S., Besemer, H., Pesce, V., Birba, A., & Muyiramy, D. (2020). Data-driven opportunities for farmer organisations. *CTA Working Paper.*
- Africa Disaster Risk Financing Initiative: Activity Report 2018-2019.* (n.d.). GFDRR. Retrieved August 30, 2022, from <https://www.gfdr.org/en/publication/africa-disaster-risk-financing-initiative-activity-report-2018-2019>
- AFRICAN GOVERNANCE REPORT. (2019). *AGENDAS 2063 & 2030: IS AFRICA ON TRACK?* MO IBRAHIM FOUNDATION. [https://mo.ibrahim.foundation/sites/default/files/2019-10/African\\_Governance\\_Report\\_2019.pdf](https://mo.ibrahim.foundation/sites/default/files/2019-10/African_Governance_Report_2019.pdf)
- Akuku, B., Haaksma, G., & Derskson, H. (2019). Digital Farming in Kenya. *Netherlands Enterprise Agency.* <https://www.rvo.nl/sites/default/files/2019/12/Digital-Farming-in-Kenya.pdf>
- Bakker, A., & Figuères, C. (2019). Recommendations conference on ICT and geodata for agriculture and water. *NSO.* <https://g4aw.spaceoffice.nl/files/files/G4AW/Regional%20Conference%20-IT%20and%20Geospatial%20Data%20for%20Agriculture%20and%20Water-/A4%20leaflet%20Conclusions%20of%20the%20conference%20HR.pdf>
- Brand, N., & Galdava, E. (2019). ENGAGING YOUTH IN AGRICULTURE: through Information and Communication Technologies. *USAID.* <https://www.usaid.gov/sites/default/files/documents/15396/Feed-the-Future-CaseStudy-Youth-Ag-ICT.pdf>
- BRL Ingénierie, (2020), Etude préliminaire sur la pérennisation du suivi hydraulique (Preliminary study on the continuation of hydrological monitoring) funded by AFD*
- Business Models Part II: What are G2B, B2G, G2C, C2G, G2G and G2E?* (2021, October 6). Frachtbox. Retrieved August 30, 2022, from <https://www.frachtbox.com/blog/business-models-part-ii-what-are-g2b-b2g-g2c-c2g-g2g-and-g2e>
- Charte de l'Eau.* (2020, June 10). Autorité du Bassin du Niger. Retrieved August 30, 2022, from [http://www.abn.ne/index.php?option=com\\_content&view=category&layout=blog&id=74&Itemid=66&lang=en](http://www.abn.ne/index.php?option=com_content&view=category&layout=blog&id=74&Itemid=66&lang=en)
- Dembélé, M., & Zwart, S. J. (2016). Evaluation and comparison of satellite-based rainfall products in Burkina Faso, West Africa. 37(17), 3995-4014. 10.1080/01431161.2016.1207258
- Digital Climate Advisory Services (DCAS) for smallholder resilience - World Business Council for Sustainable Development.* (2021, January 26). WBCSD. Retrieved August 30, 2022, from <https://www.wbcd.org/Programs/Food-and-Nature/Food-Land-Use/Scaling-Positive-Agriculture/Resources/Digital-Climate-Advisory-Services-DCAS-for-smallholder-resilience>
- Digital Agenda for Foreign Trade and Development Cooperation (BHOS) (2019), DGIS, <https://www.government.nl/documents/policy-notes/2019/07/31/digital-agenda-for-foreign-trade-and-development-cooperation-bhos>
- THE DIGITAL TRANSFORMATION STRATEGY FOR AFRICA (2020-2030). (n.d.). *African Union.* <https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf>
- FAO. (2020). PROMOTING YOUTH EMPLOYMENT IN THE AGRICULTURAL SECTOR IN EAST AFRICA. *TCP/SFE/3601.* <https://www.fao.org/3/ca8679en/CA8679EN.pdf>

- FAO. (2021). Using remote sensing in support of solutions to reduce agricultural water productivity gaps. *FAO*.
- FAO, & ITU. (2022). *Status of digital agriculture in 47 sub-Saharan African countries*. FAO. <https://doi.org/10.4060/cb7943en>
- GEODATA FOR INCLUSIVE FINANCE AND FOOD. (n.d.). NpM. Retrieved August 30, 2022, from <https://www.inclusivefinanceplatform.nl/geodata-for-inclusive-finance-and-food/>
- Maru, A., Berne, D., Beer, J. D., Ballantyne, P., Pesce, V., Kalyesubula, S., Fourie, N., Addison, C., Collett, A., & Chaves, J. (2018). Digital and Data-Driven Agriculture: Harnessing the Power of Data for Smallholders. <https://doi.org/10.7490/f1000research.1115402.1>
- Massazza, G., Bacci, M., Descroix, L., Ibrahim, M. H., Fiorillo, E., Katiellou, G. L., Panthou, G., Pezzoli, A., Rosso, M., Sauzedde, E., Terenziani, A., Filippis, T. D., Rocchi, L., Burrone, S., Tiepolo, M., Vischel, T., & Tarchiani, V. (2021). Recent Changes in Hydroclimatic Patterns over Medium Niger River Basins at the Origin of the 2020 Flood in Niamey (Niger). *Water*, *13*(1659). 10.3390/w13121659
- MIP. (2021). PROGRAMME INDICATIF MULTIANNUEL 2021-2027 EN FAVEUR DE LA REPUBLIQUE DU NIGER: INSTRUMENT DE VOISINAGE, DE COOPÉRATION AU DÉVELOPPEMENT ET DE COOPÉRATION INTERNATIONALE — EUROPE DANS LE MONDE. [https://international-partnerships.ec.europa.eu/system/files/2022-01/mip-2021-c2021-9242-niger-annex\\_fr.pdf](https://international-partnerships.ec.europa.eu/system/files/2022-01/mip-2021-c2021-9242-niger-annex_fr.pdf)
- OECD. (2019). Data governance in the public sector. *The path to becoming a data-driven public sector*, 23-57. 10.1787/9cada708-en
- Programmes du COMPACT Niger > Millennium Challenge Account. (n.d.). Niger (MCA-Niger). Retrieved August 30, 2022, from <https://www.mcaniger.ne/programmes-du-compact-niger-projet-des-communautes-resilientes-au-climat/>
- Rapport sur la numérisation de l'agriculture africaine, 2018-2019. (2021, April 21). CTA. Retrieved August 30, 2022, from <https://www.cta.int/fr/digitalisation/all/issue/rapport-sur-la-numerisation-de-l-agriculture-africaine-2018-2019-sid0d88610e2-d24e-4d6a-8257-455b43cf5ed6>
- Satellite Data for Sustainable Development. (n.d.). Digital Earth Africa. Retrieved August 30, 2022, from <https://www.digitalearthafrika.org/why-digital-earth-africa/satellite-data-for-sustainable-development>
- SATH-NBA. (n.d.). Retrieved August 30, 2022, from <http://www.sath.abn.ne/>
- Schrijver, R. (2016). *Precision Agriculture and the Future of Farming in Europe: Scientific Foresight Study : Study*. European Parliament.
- Seth, A., Norton, K., & Akkireddy, J. (2020). Digital Agriculture Maps 2020 State of the Sector in Low and Middle-Income Countries (D. Tricarico & N. Pshenichnaya, Eds.). *GSMA AgriTech Programme*.
- Space directory. (n.d.). NL Space. Retrieved August 30, 2022, from <https://www.nl-space.nl/en/spacedirectory/>
- Tamagnone, P., Massazza, G., Pezzoli, A., & Rosso, M. (2019). Hydrology of the Sirba River: Updating and Analysis of Discharge Time Series. *Water*, *11*(156). 10.3390/w11010156
- TANIMOUN, B. A., & Foppes, S. (2022). Satellite Based Water Monitoring and Flow Forecasting in the Niger River Basin. *SATH*. [https://data.rvo.nl/sites/default/files/rvo\\_website\\_content/opendata/iati/ORIO/ORIO10NE22\\_01.pdf](https://data.rvo.nl/sites/default/files/rvo_website_content/opendata/iati/ORIO/ORIO10NE22_01.pdf)
- UNITED NATIONS. (2020). Data Strategy of the Secretary-General for Action by Everyone, Everywhere : with Insight, Impact and Integrity, 2020-22. *DATA STRATEGY*. [https://www.un.org/en/content/datastrategy/images/pdf/UN\\_SG\\_Data-Strategy.pdf](https://www.un.org/en/content/datastrategy/images/pdf/UN_SG_Data-Strategy.pdf)
- Unlocking the potential of Earth Observation to address Africa's critical challenges. (2021, January 15). The World Economic Forum. Retrieved August 30, 2022, from <https://www.weforum.org/reports/unlocking-the-potential-of-earth-observation-to-address-africa-s-critical-challenges>

*What is Geodata? A Guide to Geospatial Data - GIS Geography.* (2022, June 4). GISGeography. Retrieved August 30, 2022, from <https://gisgeography.com/what-is-geodata-geospatial-data/>

Williams, N., & Edosio, U. (2022). Africa Digital Transformation Action Plan (2022 - 2026). *African Development Bank Group*. [https://www.afdb.org/sites/default/files/2022/04/04/africa\\_digital\\_action\\_plan\\_brochure\\_04042022\\_final\\_1.pdf](https://www.afdb.org/sites/default/files/2022/04/04/africa_digital_action_plan_brochure_04042022_final_1.pdf)

Wolfert, S., Wassenaar, L. v., der Burg, S. v., Ryan, M., Klerkx, L., Rijswijk, K., McCampbell, M., Athanasiadis, I., & Beers, G. (2021). Navigating the Twilight Zone : Pathways towards digital transformation of food systems. *Wageningen University & Research*. <https://doi.org/10.18174/552346>

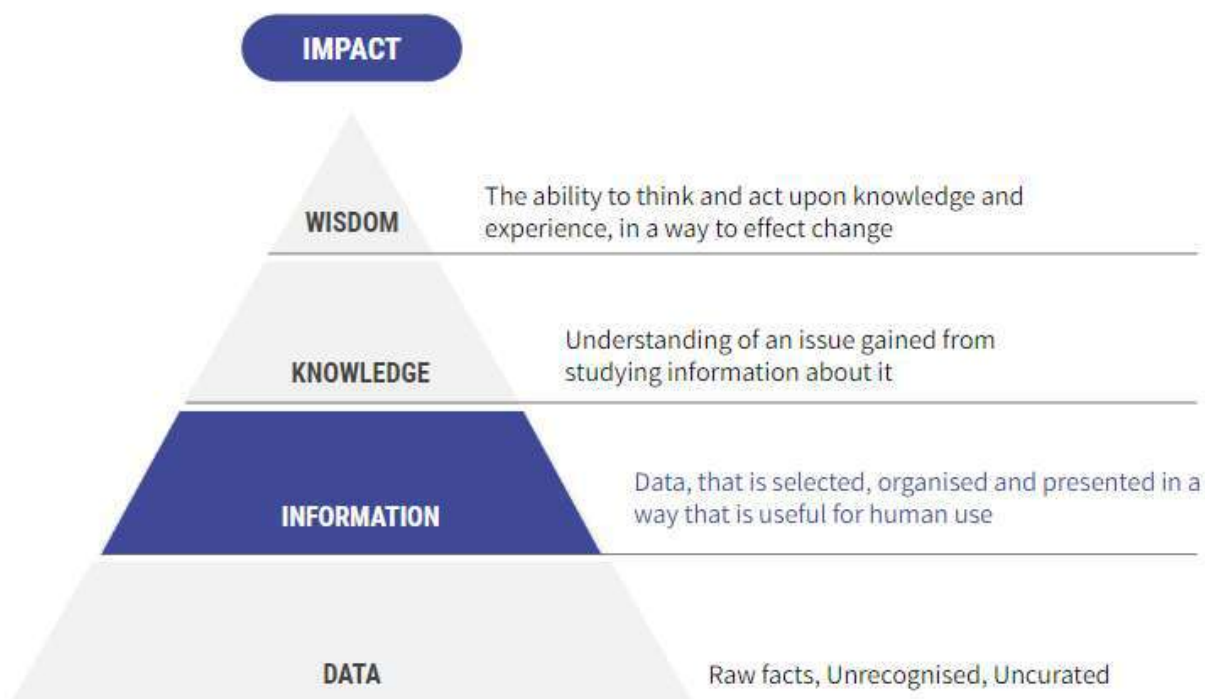
# Annexes

## Annex 1: Definitions

- **Data**

Data is a description of a fact, acquired through measurement, observation or reporting. It can therefore be very different in nature: qualitative, quantitative, structured, unstructured, and from different sources. Quantitative data refers to numbers and elements that can be measured objectively. Qualitative data refers to characteristics that are complex to measure and analyzed subjectively. Raw data is always unprocessed, uninterpreted and uncontextualized.

Data is only useful when it is categorized, filtered, organized, formatted and analyzed for structure and meaning. It can then be interpreted and transformed into information. Knowledge is formed by a collection of data and information combined/associated with expert opinions, skills, learning and experience. The figure below shows the relationship between these different terms. Data is the basis for generating information, developing knowledge and making decisions that will have an impact.



Finally, data should support producing information and knowledge. We consider information management as the systematic process of collecting, collating, storing, processing, verifying and analyzing data and information from one or more sources, and disseminating the relevant data and information to

stakeholders, in order to support effective and timely action. It enables situational understanding, coordination, strategic and operational decision-making, accountability, advocacy and fundraising. It also provides meaning and generates knowledge.

With digital transformation, data is at the heart of digital technologies and exploration of data with new technologies (such as big data, Machine Learning and Artificial Intelligence) opens up new possibilities in information creation.

### Box 01: Digitalisation

According to the Digital Agenda for Foreign Trade and Development Cooperation (BHOS) from 2019 by DGIS, digitalisation is leading to an explosive growth in cross-border data flows, trade in digital services and trade in goods through digital platforms. Current tensions in the trade system and the race for worldwide technological dominance are making it very difficult to make progress in multilateral negotiations. The divergent attitudes of the world's largest economic blocs – China, the EU and the US – to fundamental interests and values like the protection of personal data and privacy contribute to this deadlock.

The influence of digitalisation on the economy is so radical that we now talk about a Fourth Industrial Revolution. In the next ten years, various crucial developments are expected to converge, i.e. rapid internet connections, widespread mobile technology, a glut of cheap data, development of the Internet of Things, an exponential increase in computer processing power and, above all, the further development of artificial intelligence. This will lead to numerous new innovations, whose impact we cannot yet foresee.

- **Geodata**

Geodata are spatially referenced data that describe the extent and properties of given spaces and objects at a given time, in particular the position and nature of these elements. This means that they can be used to locate objects more or less precisely according to their spatial characteristics. According to Savinykh & Tsvetkov (2014), Geodata is defined as information about processes and phenomena on the earth's surface, including groups of data classified and integrated into a single system.

Savinykh & Tsvetkov (2014) indicate that geodata serves most countries as the basis for creating and developing the infrastructure of spatial data which seems to be currently an important strategic resource of national development. Geodata is also key to climate change adaptation.

## Box 08: Types of geodata

From GISGeography website<sup>25</sup>, consulted 23th june 2022:

- **Vector Files** : Vector data consists of vertices and paths. The three basic types of vector data are points, lines, and polygons (areas). Example of latitude and longitude
- **Raster Files**: Raster data is made up of pixels or grid cells. Commonly, they are square and regularly spaced. But rasters can be rectangular as well. Rasters associate values to each pixel. Example of Continuous rasters (have values that gradually change such as elevation or temperature), discrete rasters set each pixel to a specific class ( land cover classes)
- **Geographic Database**: to house vectors and rasters. To put all data in a single container. Esri geodatabases , geopackages and SpatialLite
- **Web Files**: built specifically to serve and display geographic features over the internet. GeoJSON, GeoRSS, web mapping services (WMS) , Esri's ArcGIS Online
- **Multi-temporal**: multi-temporal geodata not only has a time component but a geographic component as well. weather and climate data ( track how temperature and meteorological information changes in time in a geographical context), demographic trends, land use patterns, and lightning strikes

Another classification is between cultural (administrative boundaries for example) and physical geodata (environmental or hydrography data). This study is more related to weather and climate data for agriculture and the water sector with the more specific objective to predict floods and droughts. For example, it is noticeable that a lot of weather data uses temporal GIS data formats because of how important time is related to weather. In this study, since the environmental and hydrography data are especially what interests us most in this study, we talk about hydroclimatic data.

- **Data value chain**

The data value chain describes the process of data creation and use from first identifying a need for data to its final use and possible reuse. The data value chain has four major stages:

5. Collection/production: collecting data through census, survey, remote sensing, gaming, citizen science, local collector network, etc
6. Validation, Analytics and processing: Assembling and checking the veracity of information from multiple sources. Analyzing, modeling and interpreting this information;
7. Data Sharing, and integration : make data and information available for different use and re-use and integration with various data sources.

---

<sup>25</sup> <https://gisgeography.com/what-is-geodata-geospatial-data/>

8. Use for impact: Assembling robust evidence to support decision-making, policy development and new courses of action for business development. This step is circular : the more data and information is reused and repurposed, the more it produces information.

Various stakeholders have various interests in the data value chain and can play a role at different stages. The exact steps can also vary depending on the focus of the data value chain. It is therefore important to understand which roles are played by which stakeholder, at which stage of the value chain. Because various stakeholders can be involved at various stages, some important notions are to be considered when looking at geodata in the value chain :

- Quality of data: which quality is the data collected ? The various following parameters should be looked at : completeness, accuracy, timeliness, consistency, validity and uniqueness.
- Accessibility of data: is the data already available (collected and stored somewhere), is it freely available or does it require special permission to access (from whom, what permission)? In this context, we also encounter the following concepts of open data, shared data and closed data. Open data is data to which access is completely public and free of charge, as is exploitation and re-use. Closed data is the opposite and shared data is conditionally accessible.
- Granularity of the data: how often is the data collected (time)? To what extent is the data geographically detailed (space)? How detailed is the data (demographically)? When was the data collected? How long has the data been kept?
- Credibility of the data: who collected the data? What was the purpose of the collection? Has the dataset been cleaned up and if so, how?

- **Data ecosystem**

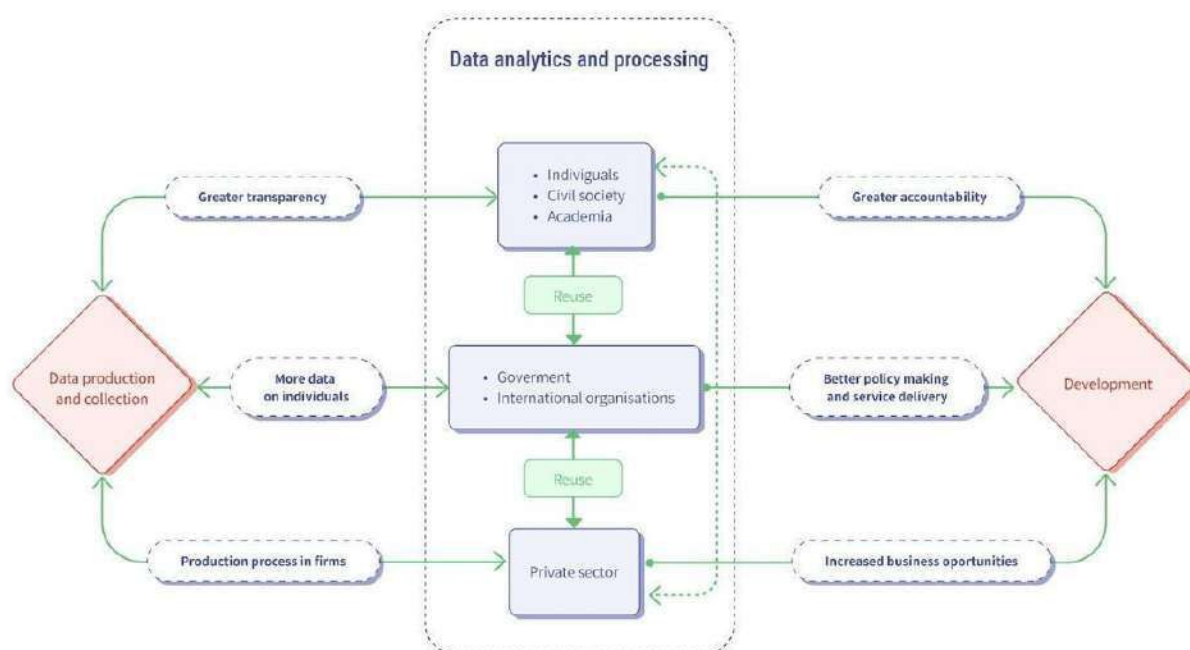
In the African Union Data Policy Framework (Abou-Zeid, 2022)<sup>26</sup> , data ecosystem is defined as ‘*the underlying value chain associated with data as a factor of production, the governance of data systems and the protection of data subjects*’ as well as the technical infrastructure organizations use to collect, store, analyze and leverage data. In itself, data has little value, it is only through processing, transmission and sharing (between stakeholders) that value is added. The transformation of data into useful information to guide decision-making revolves around the data value chain where the private sector and certain public entities are adequately equipped with enabling frameworks to support a coherent data ecosystem.

In the World Bank report Data for a better lives (2021), the importance of a social contract - an agreement between stakeholders creating, reusing and sharing data on how to mitigate harm and how to distribute the created value- is stressed. It also highlights the potential for a ‘*functioning data ecosystem with components played by the Public sector, private sector and the civil society. Research institutions and international organizations also play an important role. The pillar on which such partnerships are built on infrastructures policies, laws and rules, economical policies and institutions. To facilitate the data flow,*

---

<sup>26</sup> <https://au.int/sites/default/files/documents/42078-doc-AU-DATA-POLICY-FRAMEWORK-ENG1.pdf> 2022

*data should be produced, protected, open , quality controlled and used and re-used. Finally, human resources, trust building, incentive, funding and data requests are the basis to work on.'*



\* WDR 2021 , DATA FOR BETTER LIVES, World Bank

In the African Union Data Policy Framework (Abou-Zeid, 2022)<sup>27</sup> data can be understood (in economic terms) as a public good in that it is inherently non-rivalrous (at the technical level, it is infinitely usable without detracting from another person’s ability to use it). It is naturally nonexcludable, which means that there are no natural barriers to multiple people using the same data at once. Although there are attempts to render data excludable through technological and sometimes legal means, these are not inherent features of data.

Attempts to limit access, whether for purposes of commercialisation or security, can be regulated to be non-excludable. For example, data that are made open under an internationally recognised license or public statistics can be regulated to be accessible like free to air public broadcasting, as a classical public good.

● **Data value and commercialisation**

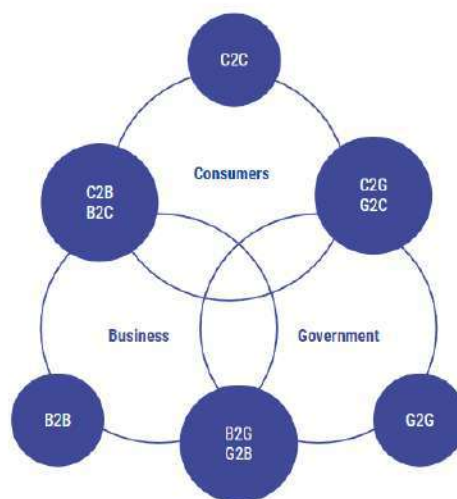
Data does not automatically generate value. Instead, there are different uses of data and different methods to measure the economic and social value of data and data flows (OECD, 2019<sup>28</sup>). In the economic sense, it is what the stakeholders of the value chain do that leads to value creation both internally and externally across the extended-data network. Theoretically, this value can be quantified by assigning monetary value

<sup>27</sup> <https://au.int/sites/default/files/documents/42078-doc-AU-DATA-POLICY-FRAMEWORK-ENG1.pdf>

<sup>28</sup> OECD (2019) Data governance in the public sector. 23-57 <https://doi.org/10.1787/9cada708-en>

taking in consideration several cost and income-generating variables, such as how organizations charge for user-generated data or reconciling data management costs such as collecting, maintaining and publishing data. Valuing data from a socio-economic benefits perspective – or non-market-based data value – arises when there are fundamental conditions or enablers that allow governments to deliver more effective public services, offer effective environmental stewardship, and when citizens live healthier and economically secure lives through leveraging data (World Bank, 2021). An example of public data value creation includes using data to inform resource allocation needs to enhance service delivery. The public sector can also create market value by opening certain data sets and establishing new revenue streams. There are innovative interplays between public and private actors that can improve the overall data ecosystem to meet socio-economic development needs and enhanced welfare. The World Bank report makes the distinction between the public intent (data collected for public purpose) and private intent (data as part of routine business process) of the data. A functioning ecosystem is the basis leading to digital revolution, when data and information can lead to transformative changes. In the Data Act approved in 2022, The European Union Parliament associated data ecosystems with data spaces. (see box XX)

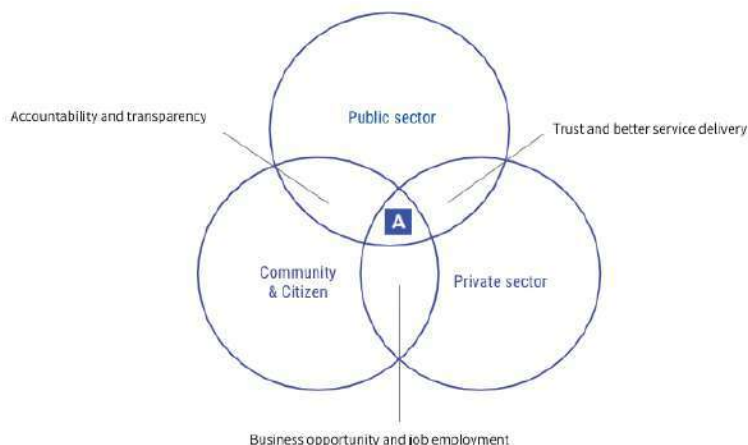
In the World Bank report data for better lives, it is explained that in view of today’s increasingly sophisticated application of digital innovation to drive data-based innovations, it is quite conceivable that the economic value of unanticipated secondary uses of data (reuse or repurposed data) may far exceed the value of the primary use of data—that is, the use for which they were originally collected. These characteristics raise the prospect of serious underinvestment in data collection from a social perspective because the entities bearing the cost of data collection will not necessarily be the ones capturing its full economic value.



Today, the commercialization of data is an important source of revenue for many companies. Geographic data is among the data that illustrates the concept of non-personal data. Data can be commercialized and resold later on. The Dutch expertise and research capacities in using data for agriculture and water management is an opportunity to develop public private partnerships in various countries. Indeed, in order to facilitate economic value creation, we see more and more public private partnerships in which businesses support the government in their role in the value chain. Several business development “pathways” are suggested varying from a public orientated business model (B2G or B2A), to public-private partnerships with an opening towards commercial partnerships (B2B, B2C). With digital development

news services around data also become available between citizens themselves. The figure<sup>29</sup> shows the various types of business linked to data services.

The study's term of references specified that 'commercialization does not solely refer to the sale of a certain dataset or research on how to generate revenue from the dataset. We are interested to understand possible ways for utilizing this dataset, for example services, also when it does not generate revenue directly. We are looking forward to hearing who could benefit from'.



From the WBR 2021, Data for better lives, public intent data hold great potential for designing, executing, and evaluating public programs and policy. Because public intent data are a prerequisite for many government functions, government agencies are the primary producers of these data by means of censuses, administrative data collection, and more. Citizens, civil society organizations, non-

governmental organizations, academic institutions, and international organizations contribute critically to the production of public intent data using surveys, crowdsourcing platforms, and other means.

The benefit are difficult to quantify, but these kinds of data with public intent can lead to better lives through three main pathways: first, by improving policy making and service delivery; second, by prioritizing scarce resources and targeting them to reach marginalized populations and areas; and third, by holding government accountable and empowering individuals to make better choices through more information and knowledge.

**Box 02: Data space definition**

In the Data Act approved in 2022, The European Union Parliament clarifies who can create values from data. It is clear that data and its socio-economic potential enhanced by the creation of common European data spaces have an essential role to play both in Europe's digital transformation and economic recovery plans. As envisioned in the European strategy for data, the different data spaces will be interconnected so that they progressively lead to a genuine European space in which data is broadly shared and used, while fully respecting the rights of individual

<sup>29</sup> <https://www.frachtbox.com/blog/business-models-part-ii-what-are-g2b-b2g-g2c-c2g-g2g-and-g2e>

persons and businesses over data. This will allow the full benefits of data to be reaped for the European economy, society and research.

It announced the creation of data spaces in 10 strategic fields: health, agriculture, manufacturing, energy, mobility, financial, public administration, skills, the European Open Science Cloud and the crosscutting key priority of meeting the Green Deal objectives. The ultimate goal is that together, the data spaces will form a single European data space: a genuine single market for data.

## Common European data spaces



## Annex 2: Background information geodata in the Sahel

### ● Institutional context and general background

As mentioned in the previous chapter, the African Union Data Policy Framework (Abou-Zeid, 2022)<sup>30</sup> approved in February 2022 gives some clarification in terms of objectives with data. With regards to the scope of the framework, it is important to bear in mind that the policy is concerned with data governance that includes personal, non-personal, industrial and public data. The framework has the ambition to enable states to :

- cooperate on matters of data governance to achieve common objectives related to the sustainable development of their economies and societies,
- foster and facilitate cross border data flows and increase business opportunities while ensuring an adequate level of personal data and privacy,
- establish collaborative trust mechanisms to allow for data to circulate as freely as possible between Member States while preserving the sovereignty of Member States and their ability to regulate the digital economy;

Finally, with the recognition of the strategic value of data, priority needs to be given to the collection and storage of quality data to realize public value and reduce existing information and associated power asymmetries within the public sector, between the public and private sector, and between both public and private sectors and citizens and consumers.

To understand the climate around data in the public sector (and more specially open data) in the Sahel countries, we consulted the Open Government Partnership (OGP) Eligibility [scores database](#) (updated on June 28th 2022), In order to participate in OGP, governments must exhibit a demonstrated commitment to open government by meeting a set of (minimum) performance criteria across key dimensions that are particularly consequential for increasing government responsiveness, strengthening citizen engagement and combating corruption and an adherence to the democratic governance norms and values set in the Open Government Declaration. It is interesting to note that Niger is now eligible (since 2020r) while Burkina Faso and Mali are not anymore (due to change in access to information law due to the military power in place), it is a good indication of the political will to move on the open government partnership ladder. While Burkina Faso is not officially qualifying at the moment, the civil society has been trained on participatory work plan setting and continues working on it.

There are a lot of initiatives for digitalisation in the Sahel, with ANSI for Niger, ANPTIC for Burkina Faso and AGETIC for Mali representing the public sector leading the initiatives. There is a global recognition that the Sahel is lagging behind in terms of digital infrastructure and human capacity as well as on public private initiative for data governance. From the report *status of digital agriculture in 47 Sub-saharan African*

---

<sup>30</sup> <https://au.int/sites/default/files/documents/42078-doc-AU-DATA-POLICY-FRAMEWORK-ENG1.pdf> 2022

countries by FAO and ITU<sup>31</sup> (2022), we selected the following indicators to have an idea of the digital penetration in the Sahel (Extract from the report )

Country	Niger	Mali	Burkina Faso
<b>Mobile (device ownership) (% of the population)</b>	37.29	55.01	50.86
<b>Active mobile broadband subscriptions (per 100 inhabitants)</b>	3.93	35.07	31.7
<b>Mobile social media penetration (% population)</b>	2.08	8.56	7.76
<b>Literacy rate youth (% 15-24) and notation digital skills among population (index ranking 1-7: not at all/ to a great extent)</b>	43.46 3.6	50.13 3.6	58.87 2.89

Table 09: Indicators on digital penetration in the Sahel

As an illustration of the efforts existing to improve digital infrastructure, in 2020, the World Bank announced a \$100 million as an ambitious program to use digital infrastructures and services to modernize its economy and strengthen access to basic services : *‘smart Villages for rural growth and digital inclusion’*. "Digital transformation in Africa can raise the growth rate by almost 2% per year and reduce poverty by almost 1% per year. If combined with investments in human capital, these gains can be doubled," says Joelle Dehasse, World Bank Country Manager for Niger. "In the context of Niger, this initiative will help build more resilient digital infrastructure and foster innovations to improve citizens' access to basic social services and their welfare, including in the poorest and most fragile regions."

- **Geodata in water and agriculture**

Geodata has specific use for various sectors and can be the basis for multiple decision making processes. In the paragraph below, we look at examples of geodata specific to each sector to better understand the use of geodata in the Sahel.

- Water

In the field of water, information is needed for strategic planning and decision making on policies/governance/regulatory framework and investments. For example, planning for Integrated Water Resource Management (IWRM) needs to cover a large geographical area (catchment) or time period

<sup>31</sup> <https://www.fao.org/3/cb7943en/cb7943en.pdf>

(multi-year planning) which requires reliable data. Information can also be of importance for risk assessment and understanding vulnerabilities. Data for WASH planning can be of different nature for urban/rural settings (covering networked and non-networked systems ). Operational management can be also found in utility (management WASH services).

Research and Innovation needs data and information to advance knowledge and to create new ideas. Especially with climate change, predictability in terms of natural systems needs to be supported by extensive research and historical data. Most changes are impacting water resources and more advanced models are needed to assess risk on (water-related) infrastructures to enhance climate resilience.

The main categories of data in the water sector that can be analyzed for understanding and action are:

- Natural systems (precipitation, groundwater, surface water, rivers, lakes, etc) including water quality (in time and space).
- Water-related infrastructure (dams, irrigation networks, WASH systems, etc)
- Mobilisable and mobilized water quantities (in time and space)
- Users and their consumption (in time and space)

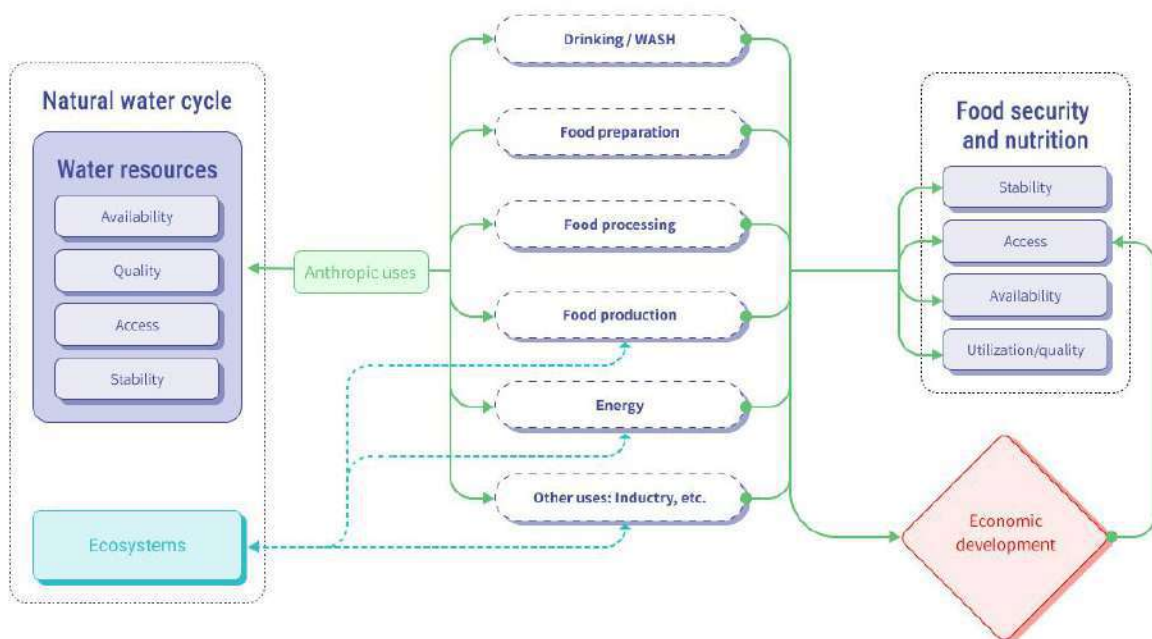


Figure 02: Data flows in the water sector

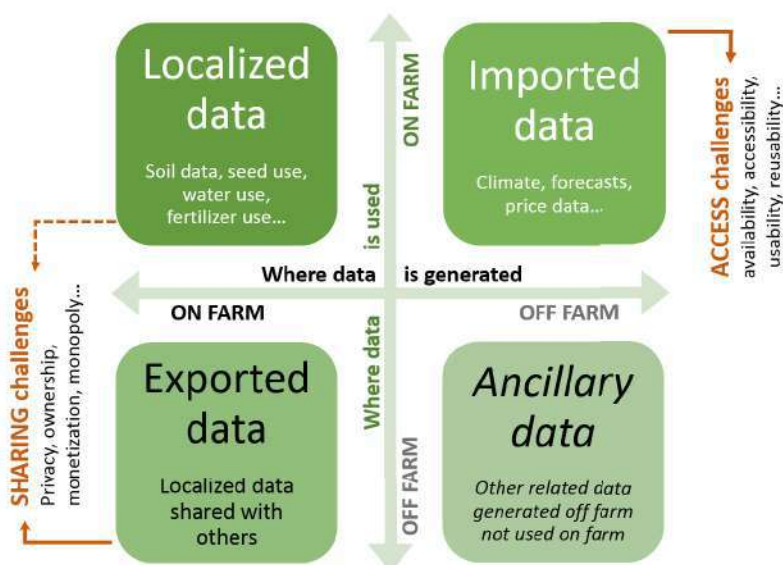
## Box 04: Water accounting

FAO (2012) describes water accounting as the systematic acquisition, analysis and communication of information relating to stocks, flows and fluxes of water (from sources to sinks) in natural, disturbed or heavily engineered environments. A critical aspect of water accounting is that it considers and assesses both the supply and the demand sides of water supply systems. From the perspective of water accounting, water supply and demand can be characterized as follows:

- Supply side:
  - The availability of rainfall, surface water, groundwater and unconventional water resources (e.g. treated waste waters) in space and time.
  - Capacity, condition and O&M procedures of water supply, storage and treatment infrastructure.
- Demand side:
  - Different users demand for water in space and time, and the extent to which these demands are satisfied.
  - Patterns of consumptive or non-consumptive water use in space and time.
  - Water service levels that are experienced by different users in space and time and the benefits they derive in monetary and non-monetary terms such as improved health and well-being.

- Agriculture

As in the water sector, information is needed for strategic planning and decision making on policies/governance/regulatory framework and investments on various topics such as land, labor, capital and management. Data can relate to the farmer, its parcel, the type of culture, environmental data as well as market data. The figure below summarizes the different types of agricultural data.



Source: CC BY 4.0 from Maru *et al.* (2018). Digital and data-driven agriculture: Harnessing the power of data for smallholders, Rome: Global Forum on Agricultural Research and Innovation<sup>32</sup>

Information needs in agriculture are highly dependent on the type of actor. The table 10 shows how geodata can be used at different actors (extract from RVO study on digital farming in Kenya<sup>33</sup>):

Actor	Geodata use
<b>Farmer</b>	<ul style="list-style-type: none"> <li>- Increase yields</li> <li>- Lower costs</li> <li>- Reduction of losses</li> <li>- Increase income</li> </ul>
<b>Agri-Business</b>	<ul style="list-style-type: none"> <li>- Make supply-chain more effective</li> <li>- Increase quality and lower external risks</li> <li>- Sustain sourcing</li> <li>- Traceability</li> </ul>
<b>Government</b>	<ul style="list-style-type: none"> <li>- Tools for policy development</li> <li>- Set conditions for sustainable agriculture</li> <li>- Promote economic growth</li> </ul>
<b>Research</b>	<ul style="list-style-type: none"> <li>- Analysis and research</li> <li>- Study effects of agriculture on climate change and biodiversity</li> <li>- Recommend good agricultural practices</li> </ul>
<b>Technical Assistance</b>	<ul style="list-style-type: none"> <li>- Increase quality of extension services</li> <li>- Reach more farmers</li> </ul>

Table 10: Geodata use in agriculture sector for various stakeholders

For the agri-business sector, there is a lot of data that can be interesting to support and advise farmers that can be summarized in the scheme below.

<sup>32</sup> <https://f1000research.com/documents/7-525>

<sup>33</sup> <https://www.rvo.nl/sites/default/files/2019/12/Digital-Farming-in-Kenya.pdf>

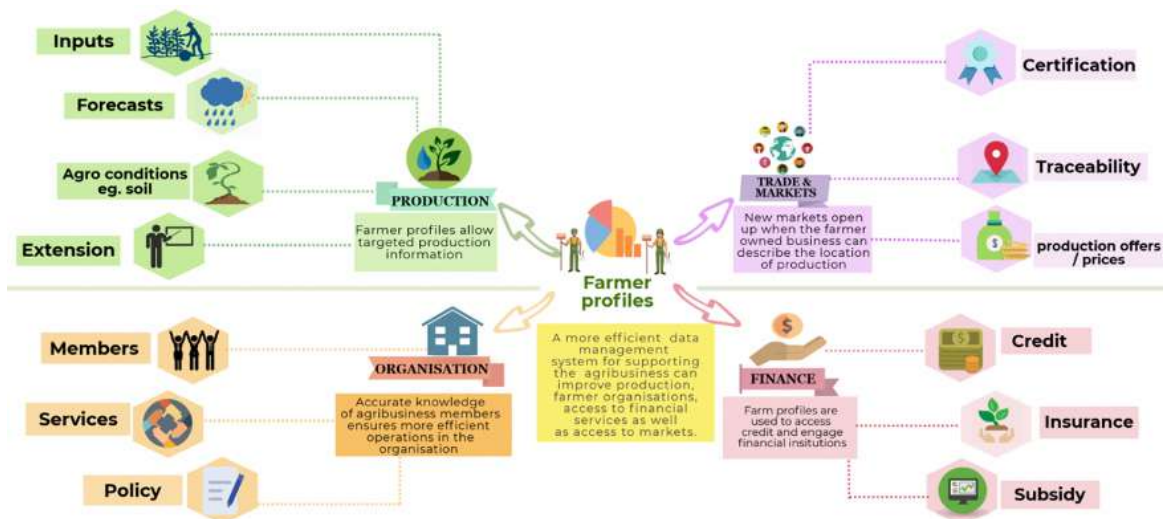


Figure 03: Data driven opportunities for farmers organizations from the CTA working paper<sup>34</sup>

- Water and Agriculture data ecosystems in the Sahel

While looking at the water and agriculture data ecosystems in the Sahel, the question whether water and agriculture data is seen as a public good by the public actors needs to be asked and its answer will influence the governance of these data ecosystems. Water and agricultural data are not a pure public good because they are excludable, allowing the entity that originally collects and holds the data to prevent others from accessing it.

There are plenty of examples across the water and agricultural sector in the Sahel of the unwillingness of public data holders to share data with other government entities and the public. In the private sector, firms may not want to sell or exchange their data with others, perhaps because governments and firms lack the capacity to share or exchange their data in a safe manner, or more simply because of a lack of incentives (or legal requirements) to make the data available.

According to WBR 2021, a fundamental reason for the lack of incentives to share, sell, or exchange data is the considerable economies of scale that accrue to holding data and the associated economic or political power that they bring to the data holder. Although the returns to the first few bits of data are essentially zero, there is a point past which the returns from additional data, and from improvements in the systems supporting these data, are substantial and increasing until they ultimately level off. In addition to economies of scale, data are characterized by economies of scope because combining different types of related datasets can yield insights that otherwise would have been unavailable from one type of data alone. This is especially true for hydroclimatic data and use around climate change adaptation.

<sup>34</sup> [https://www.academia.edu/80363253/Data\\_driven\\_opportunities\\_for\\_farmer\\_organisations](https://www.academia.edu/80363253/Data_driven_opportunities_for_farmer_organisations)

In their report on digital transformation of food systems<sup>35</sup> Wageningen University and Research, in 2021, shows how the agriculture system - from farm to fork - becomes increasingly digital. The abundance of data from various sources supports various decision making in the data value chain, digitalization also means that you can pass the data through the whole chain.

However, this requires a technical infrastructure of information systems between companies that exchange the data. Here standardization of data comes into play. If two companies use different product names for pesticide containing the same active ingredient, it becomes a problem to exchange the right information. Another characteristic of the new generation information systems is that the user of data is not the same organization as the provider of data. In many cases these are different organizations with different roles and interests.

For information systems facilitating different stakeholders, requiring different functionalities, developers are faced with a much more complex challenge. There is the complexity of combining and integrating the different functionalities for a variety of stakeholders and integrating the new application in their existing systems. This is where a new paradigm is needed to illuminate the function of food systems and the data economy and the role of data platforms and data ecosystems. This goes beyond the current paradigm of user-centric software design for single companies or supply chains, but is subjected to a much more complex ecosystem of stakeholders. In the chapter below, we look closer at commercialisation happening in the agriculture ecosystem.

#### **Box 05: WASH data ecosystem**

Akvo has been involved since 2013 on data value chain for WASH in West Africa, partnering with national governments and UNICEF on country level and regional level. WASH data is still not readily available at the public level. Some of the common challenges encountered are around

- Data is in silos. There is a lack of awareness among stakeholders of what data exists, and how it can be used and integrated. Many data flows are based on development programs, being lost once a program is finished.
- Very few monitoring systems are open to all stakeholders: many systems are still closed, data being collected and accessed only by the public sector. Very few examples where data is shared for better accountability or data flow exchange is maintained with private sector
- Since water supply is often seen as highly political at local level, data is still often ignored for decision making at local level.

While the ministries of water (ministry of environment in Burkina Faso) are in charge of both the hydro climatic data and WAHS data, there is very little use of hydroclimatic data in the WASH sector, and vice-versa. The WASH

---

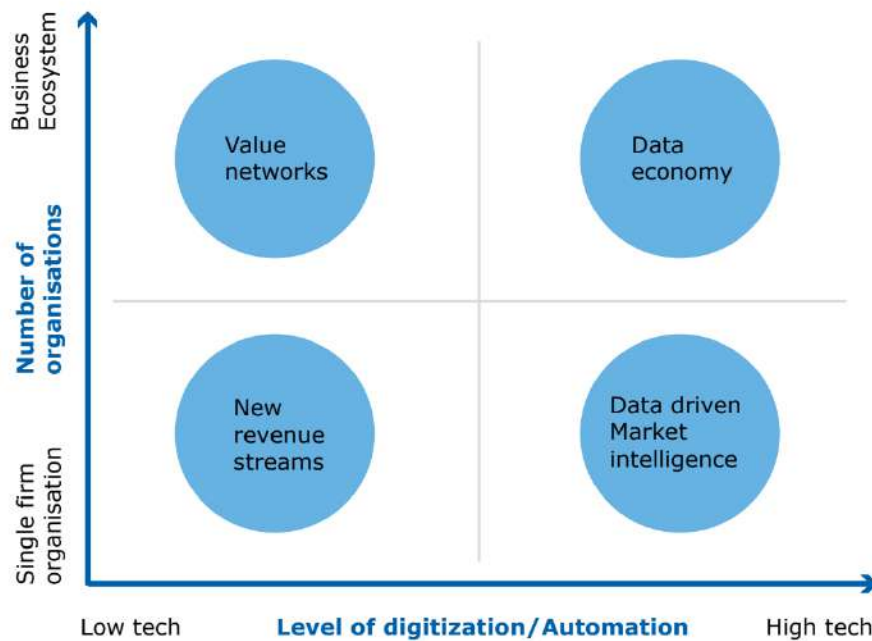
<sup>35</sup> <https://edepot.wur.nl/552346>

sector relies primarily on primary data sources. But it can be expected that with Climate Change, hydroclimatic data shall become more and more important for water security and planning in the WASH sector. Expensive data collection for WASH could also give indication to hydroclimatic models (such as water pump failing because of drought in an area could be an indication for hydroclimatic models.)

- Data commercialisation in water and agriculture

While a business ecosystem is a dynamic evolving landscape of stakeholders having multiple interactions with each other with data having public intent or private intent, there are not so many players involved in the business ecosystem in the water sector. Because public intent data are a prerequisite for many government functions, government agencies are the primary producers of these data by means of censuses, administrative data collection, and more. There is a potential for citizens, civil society organizations, non-governmental organizations, academic institutions, and international organizations to contribute critically to the production of public intent data using surveys, crowdsourcing platforms, and other means, but they are not involved yet.

In the agriculture sector, business ecosystems are evolving as new players take hold in the old field (for example, Amazon and Uber selling food products) and old players taking up new roles (for example, machine producers becoming farming consultants). In their report on digital transformation of food systems<sup>36</sup> Wageningen University and Research, in 2021, they defined two dimensions relevant to understand the dynamics in the landscape: 1) the level of digitisation/automation related to the goods and services in the business model; 2) the number of actors or organizations involved in producing the goods and services.



<sup>36</sup> <https://edepot.wur.nl/552346>

The increasing availability of data and digital capabilities post several implications for business models. To start with, governance has become complex in a business ecosystem in which roles and responsibilities and relationships are often not well defined and set in stone. Business must deal with multiple, sometimes contradicting values (e.g., efficiency vs. resilience). Governance must be arranged at multiple scales: corporate governance, network governance, platform governance, ecosystem governance.

Because not so many players are involved yet, we are looking at the opportunities of new revenue streams (for NBA with the SATH output for example) but it can be expected that more organizations can play a role and create a business ecosystem. It is interesting to understand the various relationships that can be created for the business models. Through the literature review, the most common business model have been selected<sup>37</sup> :

- Direct payment : the customer pays for the provided service (on a subscription or case-by-case basis); The service provider sells his product to the consumer, at a price higher than the cost of his production (with a margin). In the subscription model the customer pays a monthly/annual lump sum for a service whether it is used or not. It is a way to build customer loyalty and have a regular income for the service provider (from a liquidity perspective).
- Freemium model: Some of the services are free and some are reserved for members.
- Cashback or rewarded loyalty model : The more the consumer consumes, the more benefits he gets. Some service provision is free (add-on to another service)
- Inclusive model: the service is bundled with payment for other services
- Service subsidized model: the customer pays (subsidized) for no fee at all for service provision and a third party subsidizes (donor, advertising, etc).

In the G4W business and scaling study, the four commercialisation barrier identified are :

5. Insufficient entrepreneurial leadership & lack of business competences
6. Insufficient user-centered design approach to transforming smallholders into happy and active users
7. Insufficient paying customers to ensure stable and sufficient revenues
8. Long-term reliance on subsidies, even when commercially launched in the market

---

<sup>37</sup> <https://www.rvo.nl/sites/default/files/2019/12/Digital-Farming-in-Kenya.pdf>

## Annex 3: Mapping of major geodata projects

This section reviews different sources or websites on the global level and specifically in the sahel in the field of geodata (table below). it allows mapping of the different geodata. Reviewing some of the work on geodata allows us to better understand its use.

### Horti-hub project

The Horti-Hub project is a three year project (2021 – 2024), aiming to bring Dutch horticultural and entrepreneurial best practices, know-how and technology into Niger via the Horticulture Solutions Hub – the Horti-Hub Niger. The project is implemented by a consortium, consisting of Nigerien and Dutch private and public partners and knowledge institutes. This impact cluster aims to create (i) a stronger agripreneurship educational ecosystem, (ii) improved knowledge and collaboration among current and future vegetable farmers, (iii) increased awareness regarding Dutch horti solutions (inputs, irrigation, agritech, know-how) among farmers and (iv) an assessment of the sales market and a network for the 4 Dutch cluster partners. This will lead to higher local vegetable production in amount and quality, more employment opportunities by more agribusiness, better nutrition and food safety and a bigger market for Dutch enterprises that contribute to the Horti-Hub solutions (e.g. via quality inputs and technology

### ***IWRM initiatives***

For IWRM initiatives we can mention some projects such as Dutch Water board in Burkina Faso, Rain4africa (GWA project), the World Bank PISEN project in Niger, the GIRE3 AFD project. The ASPIRE project (adaptive social protection information for enhanced resilience) is finished but a new phase is in preparation. More information about all these initiatives can be found in the table below.

### ***Other hydroclimatic models***

In this section some projects making use of hydrological models and/or EO/satellite have been described.

**ABN - Niger-HYCOS** is an Information System for Water Resources Assessment and Management of the Niger Basin: A sub-regional component of the World Hydrological Cycle Observing System (WHYCOS).

The HYCOS-Niger Project is part of the World Hydrological Cycle Observing System (WHYCOS) a WMO guided program to improve water resources knowledge and monitoring services, strengthened international cooperation across national boundaries, and free exchange of hydrological data and information. The project shall strengthen the capacity of the National Hydrological Services (NHS) in NBA's member states and upgrade the HYCOS monitoring infrastructure and operations managed by NBA. It plays an important role in supporting the creation of an adequate hydrological monitoring network and information services. This will have bearings on the political, economic, and public activities in the Niger Basin and is expected to pave the way for enhanced regional food production, hydropower capacity, river navigation, water based industry, and other activities contributing to regional development. The Project has 3 years duration including the initial phase of 6 months preparatory study that started in April 2005.

The main project has a planned duration of 30 months from January 2006 to July 2008. Its total cost is estimated to be about 5.16 million Euro.

The project's core objective is to enable Niger Basin Authority (NBA) and the National Hydrological Services (NHS) of the member states to operate an appropriate and sustainable hydrological information services thus contributing to sound water resources development.

The primary beneficiaries of the Niger-HYCOS project are the users of hydrological information provided to them by the national hydrological services. Ultimately all people of the riparian countries of the Niger Basin who in different ways depend on the river are the beneficiaries of the Niger-HYCOS due to improved performance of the above-mentioned authorities and development actors leading to better water management, capital investments, and improved performance of water related sectors.

### **Agrymet - FANFAR (<https://fanfar.eu/about/>)**

FANFAR is an European Union-financed project striving toward the vision of achieving efficient flood management in West Africa. FANFAR seeks to realize the societal benefits of hydrological forecasts and flood risk information in order for societies to be aware of and prepared for upcoming floods.

FANFAR gathers a cascade of actors from various disciplines at regional, national and local levels from 17 countries in West and Central Africa as well as external partner countries.

The overall aim of FANFAR is to reinforce the cooperation between West African and European hydrological modellers, field observers, data managers, operative forecast analysts, emergency managers, developers of information and communication technologies (ICT), satellite experts, and decision analysts in order to provide a co-designed, co-adapted, integrated, and co-operated hydrological forecasting and alert pilot system for West Africa.

FANFAR co-designs the system through regular workshops with representatives from all West African countries, which together define and prioritize system requirements. FANFAR co-adapts the system through joint development using open-source code. FANFAR integrates all essential components of a forecasting system, such that updated forecasts and flood risk information are produced every day. The FANFAR system is jointly operated, supported, and tested by West African and European partners.

### **WAPOR**

As part of its 'Remote Sensing for Water Productivity' program, FAO developed and implemented the online WaPOR platform which provides free access to satellite-based data for monitoring of and reporting on agriculture water productivity over Africa and the Near East. The FAO WaPOR database is updated every 10 days and supports national governments and other organizations to monitor and report on (agricultural) water productivity and to identify and mitigate water productivity gaps, which contributes to a sustainable increase of agricultural production. (Other partners involved: VITO, ITC/TU Twente, WaterWatch Foundation).

source info:

<https://www.researchgate.net/publication/345242995> Water Accounting in the Niger River Basin

### Digital Earth Africa

Digital Earth Africa (DE Africa) is an operational platform to translate data from satellites into decision-ready information. For decades Africa's land surface and coastline images have been continually captured by satellites, recording a wide range of information about land and water resources. These images are a rich source of information, but they are difficult to acquire, scale up or down, and compute and analyze – their high-quality means managing many petabytes of data. (<https://www.digitalearthafrika.org/why-digital-earth-africa/satellite-data-for-sustainable-development>).

### Hydromet network

To step up hydromet modernization in Sub-Saharan Africa, the World Bank, World Meteorological Organization (WMO) and African Development Bank launched its Africa Hydromet Program in 2015, to support long-term planning for sustainable development and provide reliable and timely early warning services. The partnership now includes UNDP, AFD and WFP.

The regional program aims to improve hydromet services at the national, sub-regional, and Africa-wide levels. At the national level, the program seeks to modernize or build infrastructure such as radar, and automated weather stations, as well as strengthen institutions and service delivery. Sub-regional efforts include standardizing procedures to promote trans-boundary collaboration, while Africa-wide efforts ensure hydromet services across the continent will be linked to regional and global centers, improving data and promoting partnerships.

The World Bank, WMO and GFDRL are also working on the Climate Risk Early Warning Systems (CREWS), launched at COP21 in Paris. This French-led multi-donor initiative aims to finance weather stations, radar facilities, and early warning systems in Least Developed Countries and Small Island Developing States. CREWS has already launched initiatives in Mali and Burkina Faso, and has recently approved additional funding for Niger and Democratic Republic of Congo. In Niger, this will help establish warning systems for rapid-onset events like river and flash flooding. In the Democratic Republic of Congo the project will ensure optimal use of the national meteorological and hydrological service capabilities to protect river navigation, urban development in 10 cities, and agriculture against severe weather.

We also looked at various data sources to see the geodata use in Niger.

Data sources(organizations, websites, ...)	Details
OpenStreetMAP Niger	Produce data about geolocation on infrastructures, buildings, roads, water points, transportation

MapTic Niger	Provides a mapping of flood zones and visible signs of climate change.
Jeunes Volontaires pour l'Environnement (JVE)	Sensitization of youth and women on the use of maps on the visible signs of climate change and tree planting
Niger Basin Authority (NBA), Direction générale des ressources en eau (DGRE)	Produces Hydroclimatic data and warning maps to help populations
IGNN (Institut géographique national du Niger)	Dissemination of geographical information and topographical maps
<a href="#">OCHA Niger</a>	Pastoral Early Warning System is Available for <a href="#">February and March 2021</a> , <a href="#">Decembre 2020 and January 2021</a> , <a href="#">October and November 2020</a> , <a href="#">August and September 2020</a>
<a href="#">SIEREM</a>	Data is provided by country and station. Choose type of country and type of station to get data
<a href="#">Climate change Knowledge portal</a>	Hazards and vulnerability data. They are working to complete sub-national aggregation as well as seasonal data
<a href="#">Niger River data</a>	Hydrological Data Series. Only water level is available for now
Agence Nationale de l'Aviation Civile et de la Météorologie.	Weather data, <a href="#">Under request</a>
<a href="#">Climate Data Online (CDO)</a>	Seems there are not enough data for African countries
<a href="#">Gridded Climate Data</a>	List of global geodata (Hydroclimatic data) in the world. There are lots of types of geodata for download

Projects	Descriptions	Objectives	Data and Methodology	Major challenges	Solutions/lessons to be learned
The Geodata for Agriculture and Water (G4AW) facility	The G4AW Facility promotes and supports private investments for large scale, demand-driven and satellite-based information services. The Facility started in 2013 until June 30, 2020.	aimed to create digital advisory services for smallholders, based on the use of satellite data in developing countries.	satellite data	- reach at least three million food producers with services that increase agricultural income, production, and productivity and/or provide greater resilience by 2020 - a big challenge was how to make satellite information locally relevant	1) A solution found is the AgriCoach application in the cs of the project <a href="#">Gap4All</a> (in Burundi) supported by G4AW.
Millennium Challenge Account – Niger	The Niger COMPACT Program is composed of two (2) major projects: The Irrigation and Market Access Project (consisting of four activities); The Climate Change Resilient Communities Project (with two activities)	The objectives of MCC and MCA-Niger are to promote poverty reduction and economic growth in Niger through a Compact Program comprising 2 projects: -component A aims to increase rural incomes -component B aims to increase the income of families dependent on small-scale agriculture and livestock in rural Niger, including populations in the south of the country, the most densely populated	The project was a continuation of Component A, a remote sensing study using the WATEX© system, with Component B, a hydrogeological study using the results of Component A.	Studying for the development of tools for groundwater resources management planning and capacity building in Niger This project has a dual purpose: - to increase prosperity and - to increase the resilience of the populations of the south of the country, the most densely populated part of Niger, to the consequences of climate change.	satisfying result
Africa disaster risk financing initiative (ADRF)	launched in 2015 and implemented by GFDRR and the World Bank, supports the development of risk financing strategies at regional, national and local levels.	strengthen the resilience of Sub-Saharan Africa Regions, countries and communities to the impacts of disasters, including the potential impact of climate change, to reduce poverty and promote sustainable development using several types of data and methods.	hazards and vulnerability data, drought risk, river flood risk, earthquake hazard, landslide susceptibility, volcanic eruption scenarios,	help African countries make informed decisions to improve post-disaster financial response capacity in order to mitigate the socio-economic, fiscal and financial impacts of disasters.	Despite the low landslide hazard and absence of reported major landslide events, this profile objectively quantifies the landslide hazard risk across the country for use

			cyclone and storm surge hazards.	<i>drought and floods pose the most significant and recurring risk to Niger</i>	in disaster risk management.
satellite based water monitoring and flow forecasting system for the Niger River Basin (SATH-ABN)	The SATH project is commissioned by the Niger Basin Authority (NBA). The project is financed by the Dutch Ministry of Foreign Affairs and the Niger Basin Authority and is carried out by the Niger Basin Authority, EARS Earth and Environment Monitoring and UNESCO-IHE.	The project aims to install a satellite based water monitoring and flow forecasting system for the Niger River Basin.	contribute to the production, wide dissemination and use of reliable and quality climate information	- Financial challenges, the donor-funded SATH project has been terminated	analyzing commercialization options
GLZ project, ABN support	GLZ provides tailor-made, cost-efficient and effective services for sustainable development.	- Analysis of the risk communication process in the Niger Basin Authority's Early Warning System - Flood warning: Interface of the NBA with its member countries and dissemination of the warning within the country on the example of Niger and Benin	it makes raw hydrological data available on the countryside which is then processed, evaluated and transformed into hydrological products and formats at NBA	The hydrological information products of the NBA are used in a weak way, the NBA does not act in the sense of a service provider but rather as an administration, there is still a real potential for improvement in terms of speed, quality and specific adaptation to the needs of the customer	One important thing is that NBA engages as a technical advisor in a mutual learning process through for example civil society structures that are represented in NBA (UNC)
The Water Productivity through Open-access of Remotely sensed (Wapor)	remote sensing for water productivity assists countries in monitoring water productivity, identifying water productivity gaps, proposing solutions to reduce these gaps and	rapid water accounting study for the Niger River Basin using mainly open access remotely sensed data from FAO's data portal to monitor Water Productivity through Open access of remotely sensed derived data (WAPOR v2.0) database.	precipitation data, Land Cover Classification (LCC) and Actual Evapotranspiration and Interception (AETI) data	- Achieving Food Security in the future while using water resources in a sustainable manner working with ten partner countries to build their capacity in the use of <a href="#">WAPOR data</a> for its different applications, and to generate solutions to local challenges linked	WAPOR opens the door for service-providers to assist farmers in obtaining more reliable yields and improving their livelihoods. irrigation authorities have access to information to

project, NBA support	contributing to a sustainable increase of agricultural production.			to water and land productivity as well as water management.	modernize their irrigation schemes and government agencies are able to use this information to
----------------------	--	--	--	---	--

***We have projects and studies that only use data for modeling or transformation***

The geodata for inclusive finance and food G4IFF inventory of technology	The Netherlands Space Office started a strategic cooperation in 2016 with the Dutch Platform for Inclusive Finance. The vision was that geodata, as being used in G4AW projects for advisory and insurance services, could also be used in inclusive finance.	Explores the added value of geodata to promote access to finance for agricultural activities. Focuses on the use of geospatial information to increase access to financial services for smallholder farmers.	The project focuses primarily on semi-commercial smallholders in loose value chains and, to a lesser extent, on those who are commercial in tight value chains, as they produce for markets and have (limited) access to technology and financial services.	-Lessons to be learned from the G4AW -Digital Transformation in Agriculture. -Support them in realizing higher yields, constant supplies and better-organized value chains	-Development of a considerable amount of products, services and platforms to support food security. -Implementation of solutions related to food security and based on Earth observation. -Operational applications and the associated business models and others still need further testing and validation.
The Digital Climate-Info for med Advisory Services (DCAS)	DCAS are tools and platforms that integrate climate information into agricultural decision-making.	DCAS wants to build the resilience of 300 million small-scale agricultural producers to climate change by 2030 using aWhere database.	Where database. DCAS are climate-related advisories and services delivered via digital tools and platforms	clearly defining the roles of private and public sector actors, clarifying expectations, and building mutual accountability seems to be the most challenging and important component to provide value to users and develop models to cover transaction costs	There are opportunities for the private sector in DCAS, including how to implement financially sustainable business models and recommendations for business.
GSMA AgriTech	supports the mobile industry, agricultural sector	improve and scale impactful and commercially viable digital solutions for	Qualitative data combined through	challenges of smallholders: poor access to agronomic, market and	The digital agriculture services are offered both

Programme	stakeholders, innovators and investors in the agritech space to launch,	smallholder farmers in the developing world.	primary and secondary sources	weather information; lack of access to finance for agricultural inputs and capital investments; poor access to infrastructure and modern equipment; fragmented or inadequate access to markets; and more frequent and extreme weather events due to climate change.	directly to smallholder farmers through a business-to-consumer (B2C) model, and indirectly as enterprise solutions targeting agricultural value chain actors such as agribusinesses and cooperatives under a business-to-business-to-consumer (B2B2C) model.
-----------	---	--	-------------------------------	---	--

**Research documents**

Massazza et al., 2021	“Recent Changes in Hydroclimatic Patterns over Medium Niger River Basins at the Origin of the 2020 Flood in Niamey (Niger)”	analyze the rainfall–runoff relationship on the Sahelian basins of the Medium Niger River Basin (MNRB) that are at the origin of the local flood using Hydrological Data Series, Rainfall Data and Runoff Coefficients and other methods	1) using <a href="#">gridded datasets</a>		
Dembélé & Zwart (2016)	“Evaluation and comparison of satellite-based rainfall products in Burkina Faso, West Africa”	assess the accuracy of remotely sensed precipitation products in a semi-arid zone in West Africa (Burkina Faso) and the implications for specific use in an operational EWS.	used several data and methods: ARC 2.0, CHIRPS, PERSIANN, RFE 2.0, TAMSAT, TARCAT, TRMM compared to ground data for 2001–2014 on a point-to-pixel basis at daily to annual time steps		specific application: ARC, RFE, and TARCAT for drought monitoring, and PERSIANN, CHIRPS, and TRMM daily for flood monitoring in Burkina Faso.

<p>Tamagnone et al. (2019)</p>	<p>“Hydrology of the Sirba River: Updating and Analysis of Discharge Time Series”</p>	<p>provide a revision and an update of the existing discharge dataset of the Sirba River with the aim of enhancing the reliability of these data</p>	<p>using the stage and discharge time series of the Garbey Kourou gauging station from 1956 to 2018 obtained from the database of the NBA and DGRE</p>		<p>research produces a revised and more reliable discharge time series that will be a new starting point for future hydrological analyses.</p>
--------------------------------	---	--	--	--	--

## Annex 4: Stakeholder mapping

Data Value Chain for hydro climatic data	Public Sector	Private Sector	Civil Society	Research
<p>Data value for decision making</p>	<p>Public intent to provide public data (hydro climatic data) use for water and agriculture Management/planning and Disaster Risk Reduction (DRR)</p>	<p>Private intent to provide B2G data services for :</p> <ul style="list-style-type: none"> <li>• Analysis at various level</li> <li>• provide data infrastructure for facilitating data sharing for example</li> </ul>	<p>Public intent data to be informed about drought, flooding, and improved resource planning</p>	<p>Public intent to understand better the impact of climate change on the water and agriculture sector. Public intent to inform general public on climate change effects</p>
<p>Design of the value chain</p>	<p>Government led supported by international WMO (input data) Information for general public National digital development agencies such as ANSI would like to play a role in this.</p>	<p>International consultancies are involved in the design through program-led funding mechanism (example of ORIO with Eleaf) There is very little evidence that the local private sector in Niger, Burkina Faso and Mali are involved in the data infrastructure or data analysis for B2G</p>	<p>The NGOs or international organization using hydroclimatic data most of the time have their own program-led designed for the data value chain (work in Silos and no integrations)</p>	<p>Data value chain design is often led by international research institutes (such as IHE in the case of SATH).</p>

		services.		
Data producers - International level - National level - Local level	Various international organizations produce E.O. data through remote sensing. Water ministries (Now environment ministry in BF) in each country. Usually hydrological services are in charge of compiling data through their decentralized administration Local basin authorities and local government are involved in data collection	International consultancies (Deltares, Eleaf, etc) on remote sensing technologies play an important role. Mapping services from the local private sector (flooding mapping with MapTIC). They also offer Analysis services. Examples (from Senegal) show also involvement of the private sector through drone services for capturing data on cultures.	Experience of citizen science with local NGO through GIZ to give information on the river level. This project is just starting. Data that is relevant to the hydroclimatic value chain is collected by NGOs, but that data is rarely shared with the other actors in the data value chain and is often lost at the end of the program.	Local research programs (by national universities) might comprise field data collection. International research teams associate with local researchers or with NBA to have the data.
Data Validation and analysis	Validation mechanisms happen at national level and aggregated level (with regional institutions). Analysis is done at regional level, supported by private actors (PPP) or research institutes. There is a little aggregation and analysis happening at River Basin Authorities as they have very limited means.	International consultancies providing remote sensing analysis often on a B2G or B2B (Examples of Hoefslot spatial solutions and the STAMP/Modhem program) National level : Mapping services from the local private sector (flooding mapping with MapTIC). They also offer data production services	International NGO develop their analysis (often through international consultants for analyzing satellite imageries) : OXFAM, SNV, etc.	Data use for further modeling of the climate change, with other data Develop risk analysis. Example of IHE analysis on water accounting for the Niger Basin.
Data sharing and integration	There are various data sharing platforms supported by international organizations such as WB, FAO. They are mostly based on official governmental	International private data sector (such as Google, Facebook, etc) provide more and more open information (such as land cover is now available real time by Google)	Red cross international network for example has done some vulnerability risk analysis through 501 Lab.	Participation in workshop with decision makers Further research and model, especially around climate

	<p>data or Remote Sensing information.</p> <p>Integration with other data streams, such as risk analysis on climate change, is not often done at international level.</p> <p>Data sharing also happens through paper-based information sharing like bulletin.</p>	<p>Telecommunication companies can play a role in sharing dating through low cost broadcast to mobile phone users - as in the STAMP model and with Hoefslot support for data analysis.</p> <p>Digital Climate-Informed Advisory Services where hydroclimatic data is mixed with other sources of data . Many actors supporting farmers see a potential in that, but little is developed yet. HortiHub is an example of interested parties to develop more services for farmers.</p>	<p>NGOs also often share information on the flood or drought risks to their beneficiaries.</p>	change
Data users	<p>Decision-makers and planners in technical services of the country, involved with water management, agriculture and prevention of disasters and food crises.</p> <p>Environmental agencies in charge of climate change adaptation</p>	<p>(International) users of the river such as hydroelectricity companies and fluvial transport companies</p> <p>Local level : Farmers - often through Agriculture cooperative, irrigation Local user of the river such as brick manufacturer</p>	<p>General population on drought and flood monitoring Program supporting agriculture</p>	Further research and model

## Annex 5: Some analyses from the website

At present, the website displays little information and the newsletters or bulletins are not readily available. It is to be seen that observed water levels are not always registered and/or forecasted (see figures 13 - A & B, 14 - A & B and 15 - A & B below).

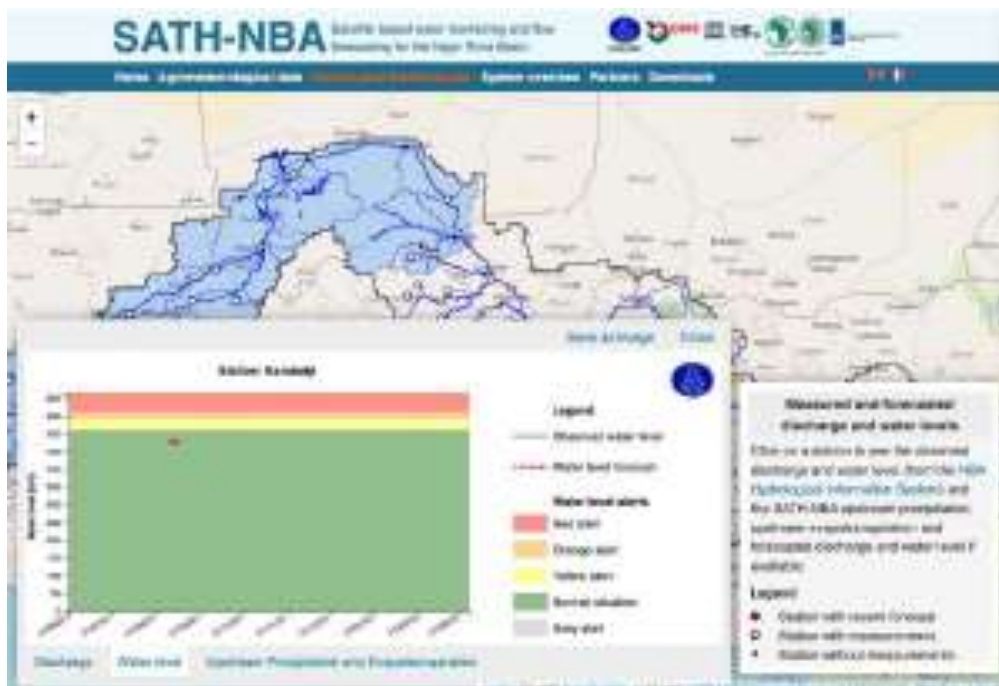


Figure 13-A: Hydrological data at the Kandadji station (at the border with Mali). Source: SATH-NBA website consulted on March 2nd, 2022.

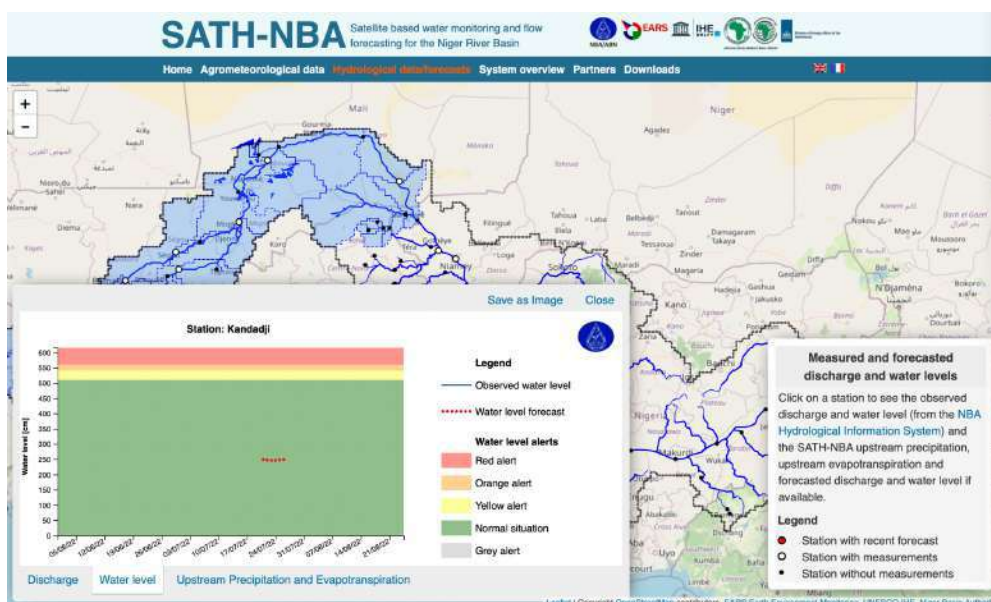
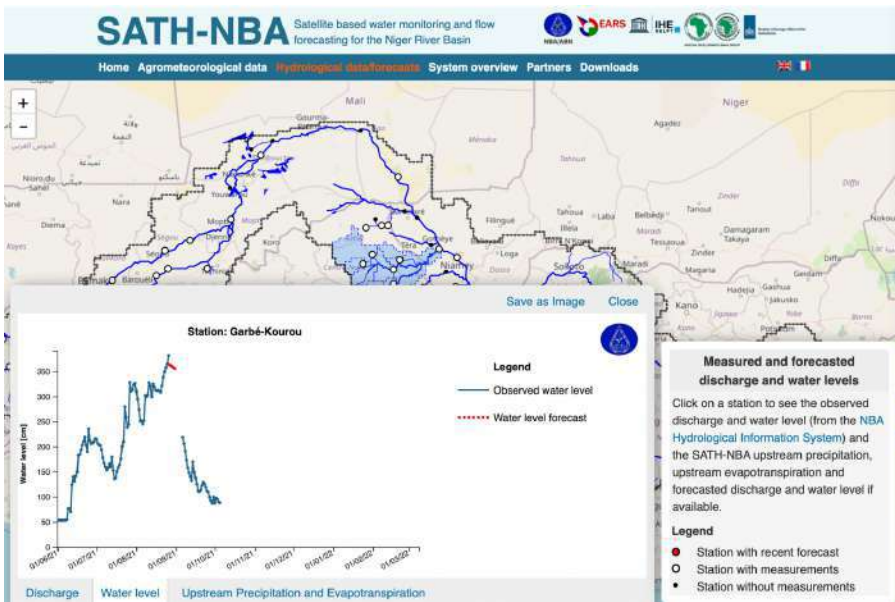


Figure 13-B: Hydrological data at the Kandadji station (at the border with Mali). Source: SATH-NBA website consulted on August 18th, 2022.

Figure 14-A: Hydrological data at the Garbé-Kourou station (on the Sirba, one major tributary). Source: SA



TH-NBA website consulted on March 2nd, 2022.

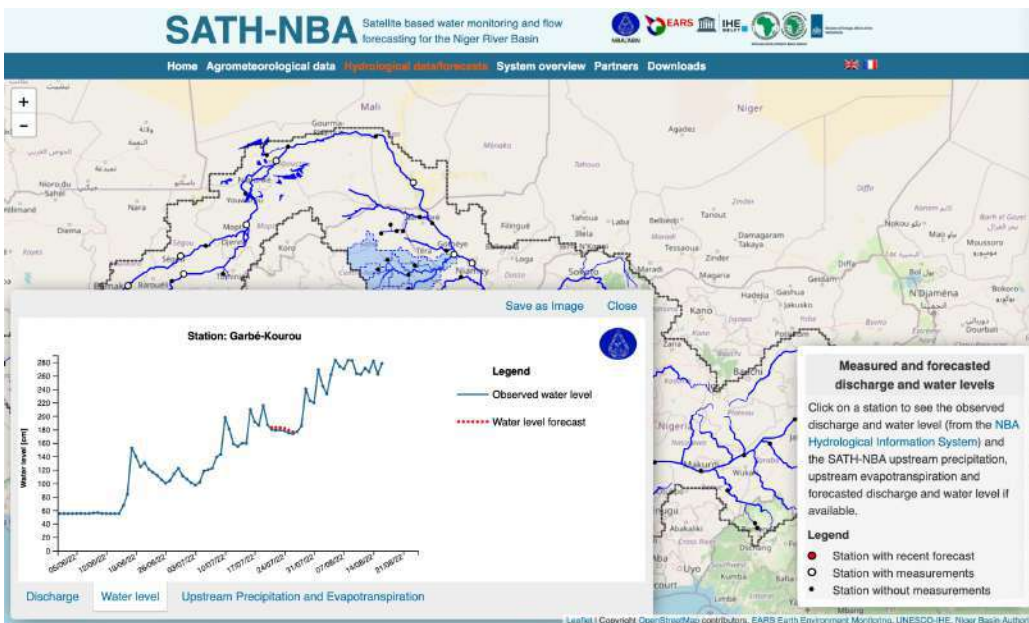


Figure 14-B: Hydrological data at the Garbé-Kourou station (on the Sirba, one major tributary). Source: SATH-NBA website consulted on August 18th, 2022.

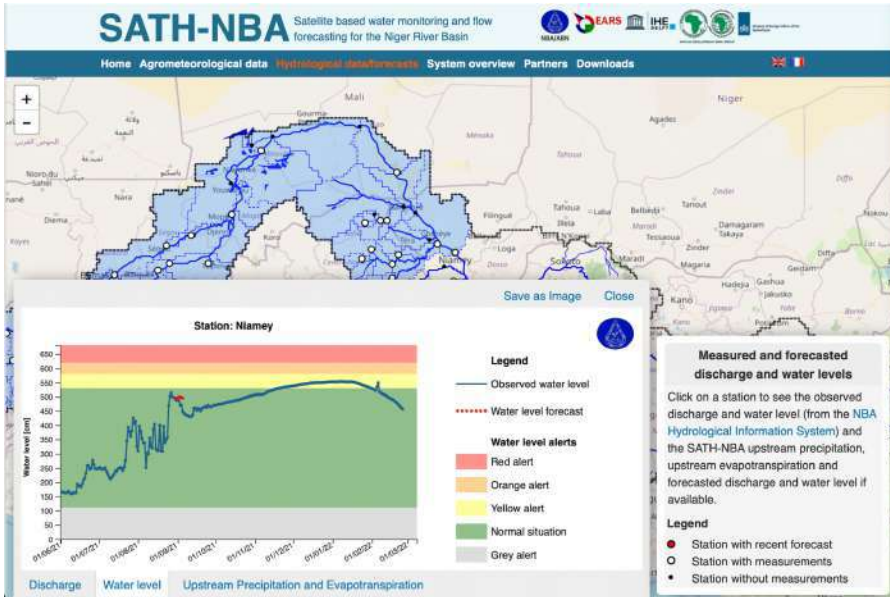


Figure 15-A: Hydrological data Niamey station on the Niger. Source: SATH-NBA website consulted on March 2nd, 2022.



Figure 15 -B: Hydrological data Niamey station on the Niger. Source: SATH-NBA website consulted on August 18th, 2022.

Upstream precipitation and evapotranspiration - data presented on website are one month old

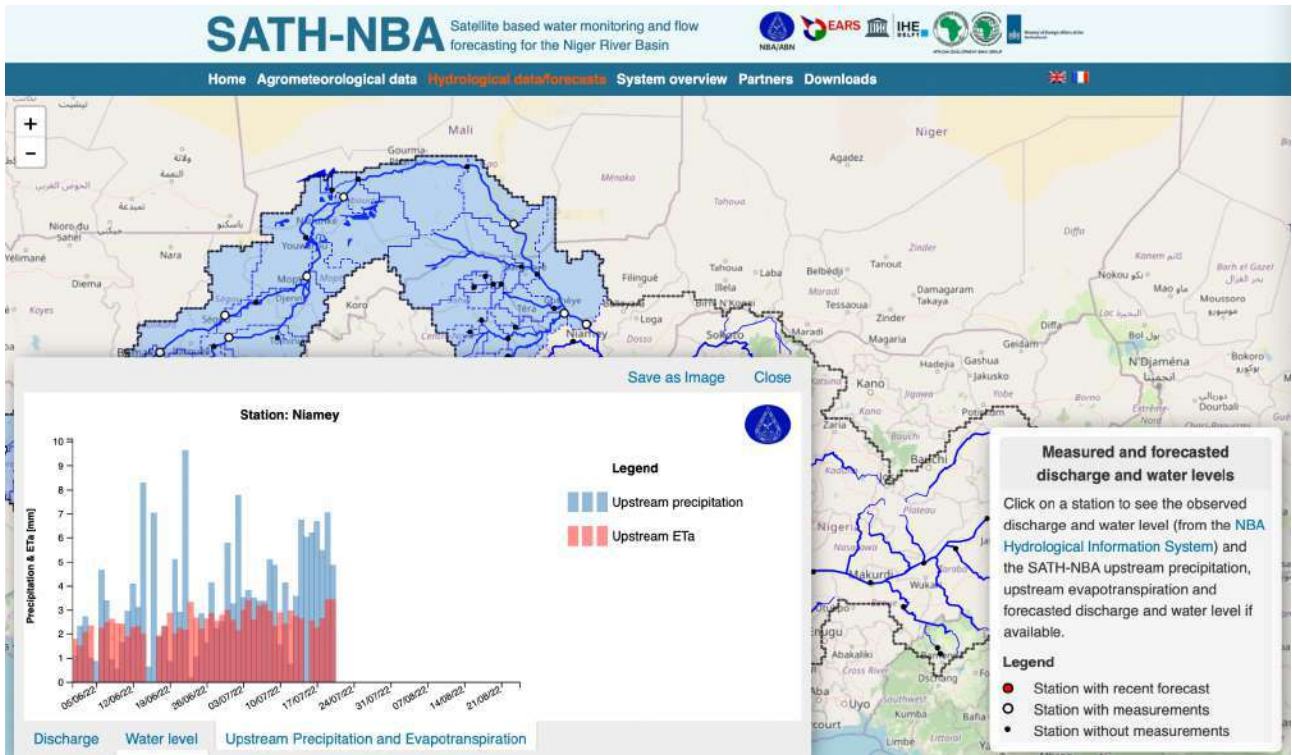


Figure 16: Upstream precipitation and evapotranspiration at Niamey station Source: SATH-NBA website consulted on August 18th, 2022.

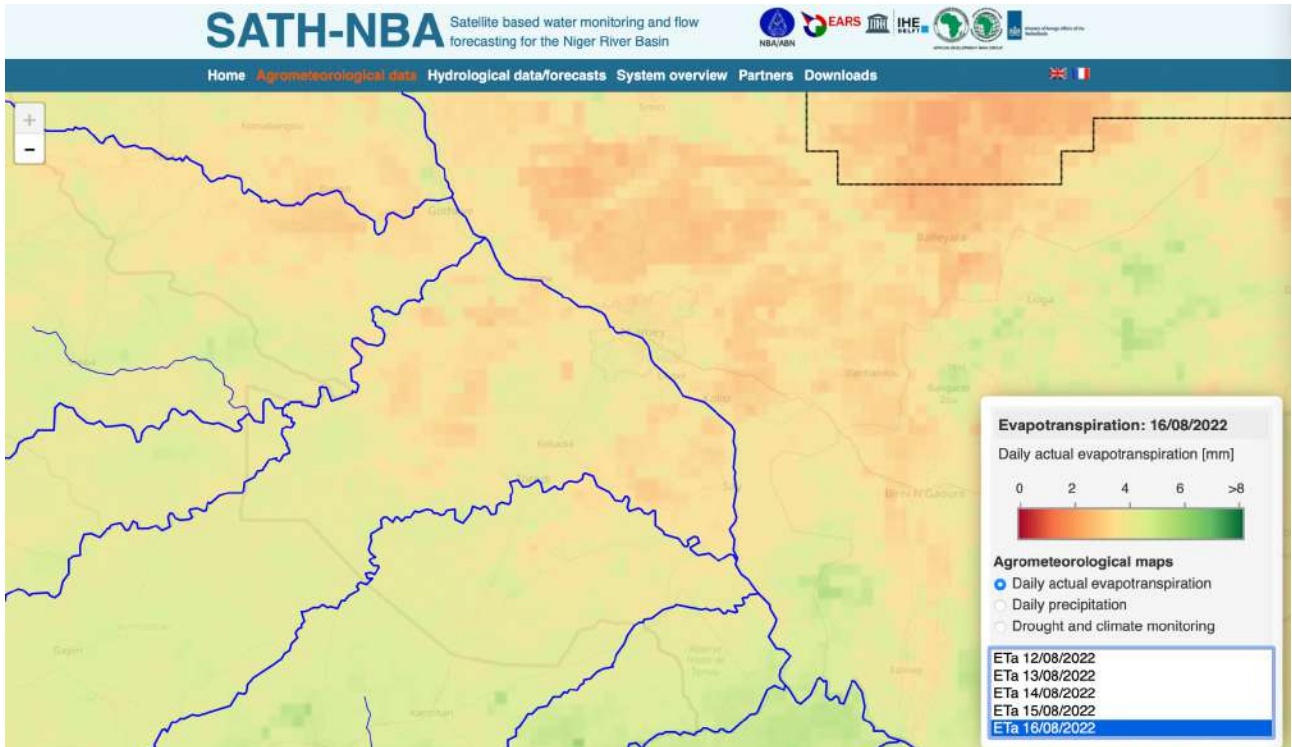


Figure 17: Evapotranspiration date 16/08 close to Niamey Source: SATH-NBA website consulted on August 18th, 2022.

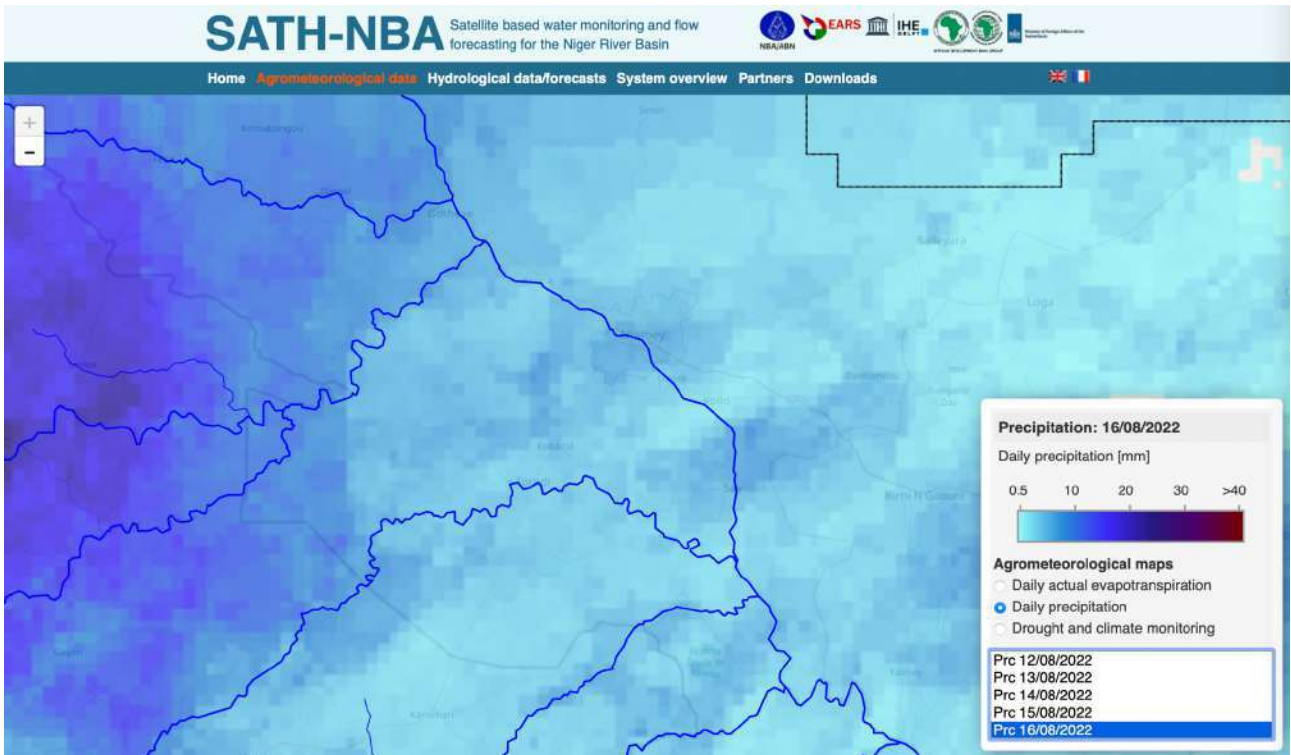


Figure 18: Precipitation date 16/08 close to Niamey Source: SATH-NBA website consulted on August 18th, 2022.

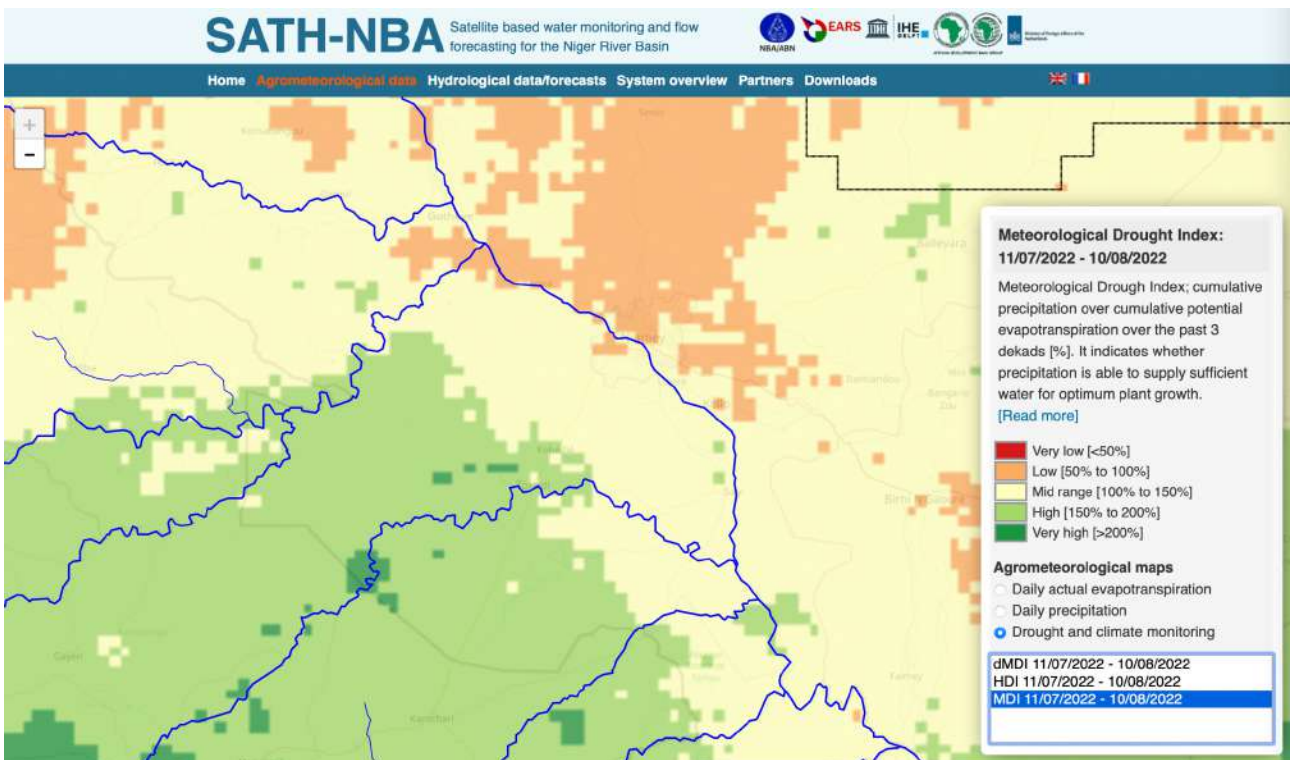


Figure 19: Drought index period 11/7-10/8 close to Niamey Source: SATH-NBA website consulted on August 18th, 2022.

## Annex 6: NBA Presentation

In the 1960s, the independent countries of the Niger Basin decided to coordinate their efforts in order to exploit the natural resources of the basin, among which water is the first. The Niamey Act related to Navigation and economic Cooperation between the countries of the Niger Basin was signed on October 26, 1963 and was replaced by Niamey Agreement related to the River Niger Commission and to Navigation and transportation on the Niger River which was signed on November 25, 1964. The Commission of the Niger River was renamed the Niger Basin Authority (NBA) on November 21, 1980. The member Countries are: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria and Chad.

The NBA is an intergovernmental organization responsible for promoting cooperation amongst Member states and contributing to improve the living conditions of the basin populations through sustainable management of water resources and associated ecosystems.

The NBA has the ambition to be recognized as an and transparent , appreciated for its capacities to reinforce the solidarity between the Member States and to generate some benefits that affect the populations.

### The legal framework:

The legal framework is constituted by some statutory texts among which the main ones are :

- The revised Convention on the creation of the Niger Basin Authority on October 29, 1987;
- The Agreement of Headquarters between the Government of the Republic of Niger and the Niger Basin Authority on September 1982 to facilitate the execution of the missions assigned to the NBA and set the privileges and immunities granted to the Authority and to its staff;
- The Improved Status of the Personnel;
- The Internal Regulations and the Code of Ethics;
- Books of Account and Financial Procedures;
- The Financial Settlement;
- The rules for signing contracts ;
- The Water Charter of the Niger Basin;
- Annexes of the Water Charter..

### The Institutional Framework:

Is composed of the statutory organs of the Niger Basin Authority which are:

- The Summit of the Heads of State and Government;
- The Council of Ministers supported by the Technical Committee of Experts;
- The Executive Secretariat ;
- The National Focal Structure.

The competencies and the modalities of the functioning of each of these organs are set by the Revised Convention on the creation of NBA.

### Specific objectives:

- harmonize and coordinate development of national policies on development of water resources in the basin;
- participate in development planning by establishing and implementing a basin-wide integrated development plan;
- promote and participate in the design and implementation of joint works and projects;
- ensure the control and regulation of all forms of navigation on the river, its tributaries and sub-tributaries;
- participate in the formulation of requests for assistance and mobilization of resources for studies and works necessary for basin development.

While the Satellite Based Water Monitoring and Flow forecasting System in the Niger Basin is based at NBA headquarters in Niamey (Niger), information is shared amongst all of the member countries (Benin, Burkina Faso, Cameroon, Ivory Coast, Guinea, Mali, Niger, Nigeria and Chad). More details about data and information flows are given in the description of the SATH model hereafter.

The water charter (*Charte De L'Eau*, 2020): The purpose of the water Charter is to encourage cooperation based on solidarity and reciprocity for a sustainable, equitable and coordinated use of the Niger Basin hydrographic catchment area. In this perspective, a specific goal is to promote research and technological development, information exchange, reinforcement of capacities, in particular as regards the IWRM and the use of adequate technologies for the management of the Niger Basin hydrographic catchment area. The SATH model is such a technological development.

The Niger Basin Observatory was created within NBA in order to ensure the systematic monitoring of the main components of the Environment and to provide stakeholders and political decision-makers with information designed to inform their decision-making. It reports directly to the Executive Secretary. It is an operational structure that complements the Technical Directorate and ensures the implementation and monitoring of projects at NBA. The Niger Basin Observatory contributes to strengthening the coordination role of NBA and to improving the concerted and coordinated management of natural resources at the basin level.

The Observatory is an online information system that provides access to available data and information on Integrated Water Resources Management (IWRM) and related themes as climate change and precipitation data, water management, environment and natural resources. The Observatory aims to contribute to more informed decisions on the management of the Upper Niger River

The tasks of the NBO are:

**Mission 1: Monitor the evolution of the Basin in its different components**

The Observatory aims to monitor the basin in its hydrological and environmental (natural as well as human environment) and also socio-economic aspects. To fulfill this mission, this structure will have to collect, format, process and store data on these aspects. Some of this data will be directly produced by other structures of the NBA and the projects that have all as goal - in the area that is their raison d'être - to collect, process and produce technical information. The Niger HYCOS even has its own website for the dissemination of hydrological data that it has helped to collect and process. Same should be the case for the ADB project on silting and other upcoming projects. The Observatory will therefore have "in house" specific data made reliable and processed, so that it will be possible to "rework" so as to integrate them into a broader context.

**Mission 2: Produce regular information on the development of the basin**

This structure cannot aim to observe for the sole purpose of accumulating and storing data. That is why the Observatory should further develop the skills needed to analyze the data collected and implement a system to disseminate useful information to both policy makers and economic operators and development stakeholders. This information must relate to different aspects of hydrology and environment in a sustainable socio-economic development viewpoint.

## Annex 7: Understanding of the SATH Model

### Description of the SATH Model

Description of the two combined models that provide spatially distributed data.

#### Energy and Water Balance Monitoring System (EWBMS)

The EWBMS is a model developed by EARS (currently Eleaf), that uses quarter hourly satellite imagery from the Meteosat Second Generation satellites. The full satellite images are used to prepare composites that represent local noon and local midnight visible light (VIS) and thermal infrared (TIR) values. These values are combined with the original input images to represent cloudiness, rainfall and temperature cycles on a pixel level throughout the day. The energy balance algorithm is then fed with the cloudiness, rainfall and temperature data to generate quantitative spatially distributed maps of rainfall, radiation, sensible heat flux, temperature, and evapotranspiration on a daily basis. Beside the satellite imagery, ground measured precipitation data is used, referred as WMO-GTS. The stations are distributed around the basin and their location is given in figure 20.

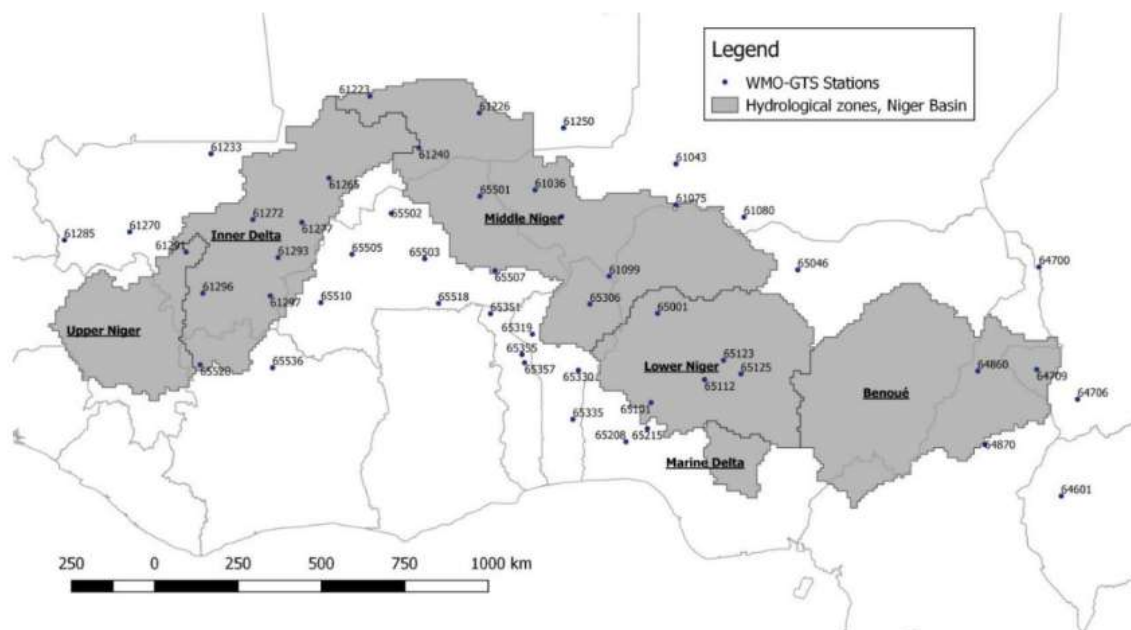


Figure 20: Overview of WMO-GTS stations (source: SATH Scientific Report, July 2021)

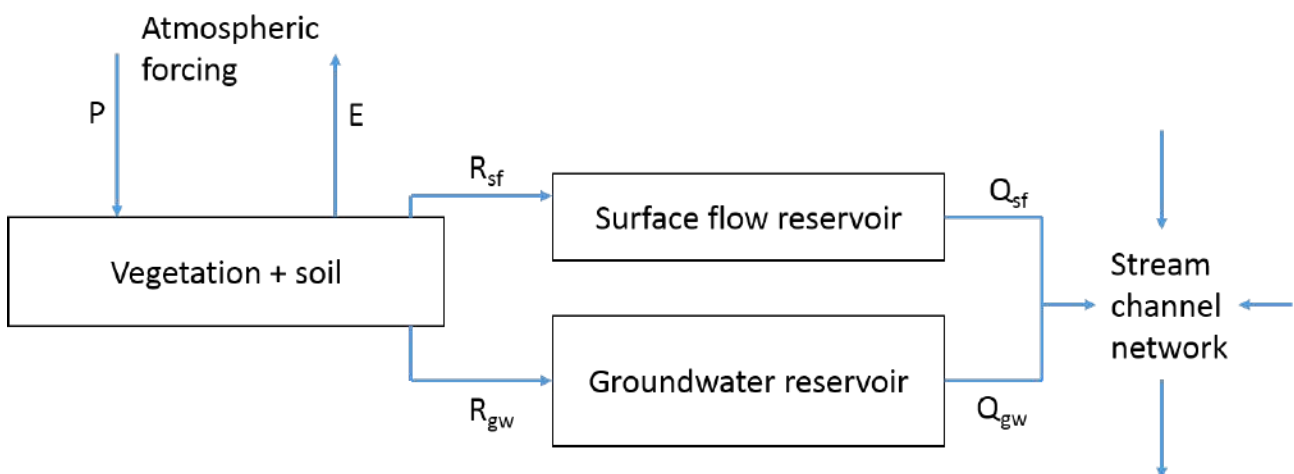
The energy related outputs of the EWBMS were validated against the measured data of the meteorological station over the period of 2005 to 2008. There are two meteorological stations present in the area of the Niger basin, namely: Djougou and Agoufou. For the validation of the derived precipitation data, the same ground station of WMO-GTS was used as for the derivation (see figure XX). The validation was done with the JackKnife method, a leave-one-out strategy. With this method the precipitation data of a station is left out when calculating the precipitation for that station. This is done for all stations of WMO-GTS. The validation of both the energy and precipitation simulations was done for each component by calculating four different statistical indicators. The validation has shown that the information derived has very high accuracy.

The EWBMS system provides spatially-distributed daily-data of Temperature, Radiation, Actual Evapotranspiration and Actual Precipitation.

### Large Scale Hydrological Model (LSHM)

The LSHM is a rainfall-runoff model developed by IHE to derive river discharges and water levels across the Niger River. This model uses some outputs of the EWBMS: actual evapotranspiration, rainfall and temperature. The model operates daily and is structured on a geographical grid of approximately 9.5 km. Each grid cell encloses 3 x 3 EWBMS cells which are structured on a grid of approximately 3 km. The information for every cell is spatially specific related to physical model parameters, such as soil type, land cover, elevation data (DEM) and channel data. The calculations effectively collect the water at all grid cells in the drainage basin and route the resulting discharge downstream towards the outlet. All grid cells are linked via the stream channel network that is connected according to the elevation differences between adjacent cells.

The most critical spatial element of the LSHM is therefore the Digital Elevation Model (DEM). This information defines the geometric structure of the model which refers to the extent of the basin, flow direction, topographic slopes and accumulated drainage. The DEM used in the LSHM was derived from the open-access SRTM data (The Shuttle Radar Topography Mission). The calculations effectively collect the water at all grid cells in the drainage basin and route the resulting discharge downstream towards the outlet. All grid cells are linked via the stream channel network that is connected according to the elevation differences between adjacent cells.



Other parameters related to the flow dynamics are derived by calibrating and validating the output of the model simulations against observed flow data of the HYDROMET stations that are implemented in the model. Firstly, the calibration used 37 stations with daily-mean discharge data of the years 2010-2013. This resulted in calibration performance coefficients. Secondly, validation was carried out by comparing the

model output of the LSHM for the same 37 stations but with measured discharge data for a different period, from 2014 to 2016.



Figure 21: Overview of the Hydromet stations with observed discharge along the basin.

The information collected from the HydroMet stations are crucial for the system results. The gauging stations are used for updating the curves of calibration, which are the curves used to convert a water level reading into flow rate measurement of the river.

The data is collected and shared via excel files, specifying the location, the catchment and the country of the station. The information collected from the Hydromet stations is shared on a monthly basis by the country-members through hydrology services. In case of need, NBA requests the information with more frequency than once per month. Some stations' information is also collected directly by the NBA.

The model runs a forecast component whenever the water level exceeds a determined threshold level. This component is an autoregressive component that can forecast the discharge and water levels in the river up to six days ahead. The thresholds are location specific as they correspond to the station characteristics. Ultimately, the LHMS provides daily-data of the river discharge and water levels over the entire river and its tributaries. Figure 21 summarizes the LSHM data-structure and information flow.

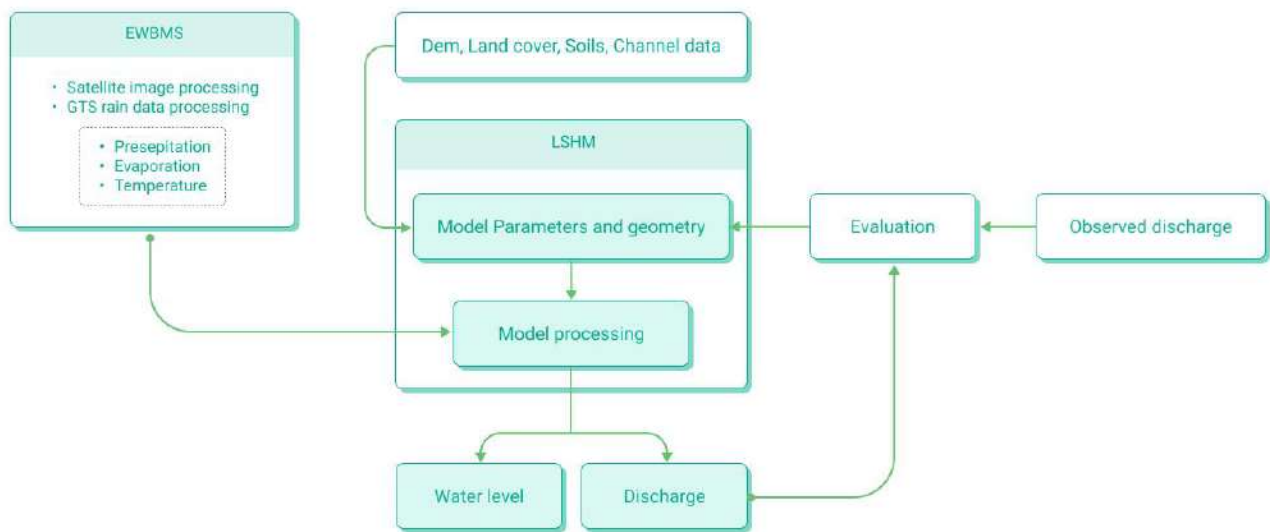
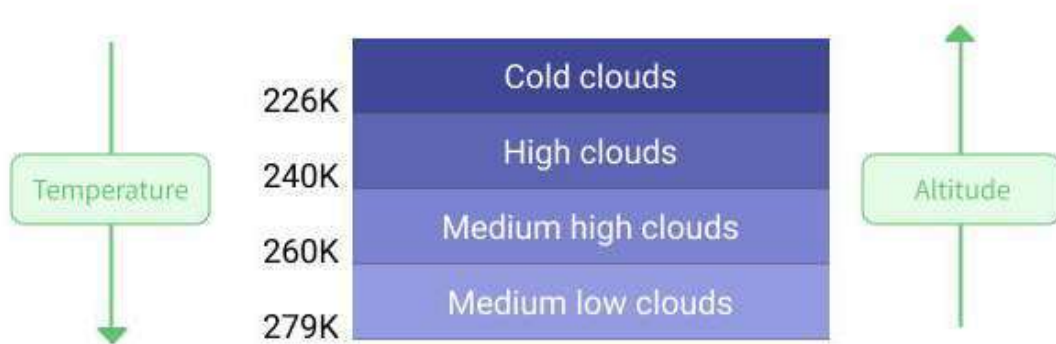


Figure 22: Large-Scale Hydrological Model (LSHM) data structure and information flow

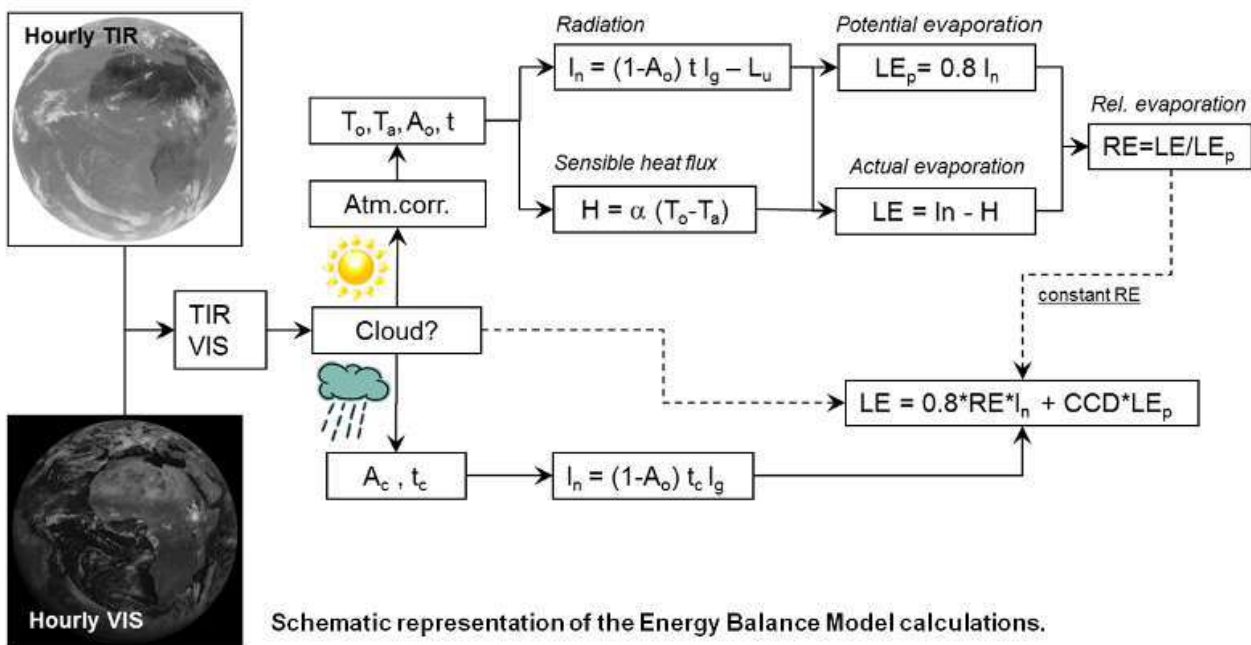
Example is for the precipitation calculation :



Precipitation is estimated using a combination of ground measured precipitation data and Meteosat satellite imagery. Using quarter hourly thermal infrared images, cloud levels are classified on the basis of their cloud top temperatures. This top temperature is related to the altitude of the cloud. Their presence is counted providing the cloud duration for different cloud height classes during each day. Ground measurements are obtained on a six-hourly basis through the WMO-GTS. These ground measurements are used to estimate rainfall from the cloud durations by means of 'local' multiple regression. The regression coefficients and the residual are determined for each rainfall station and its 11 nearest stations, which are then interpolated for each pixel. Hereafter, rainfall for each pixel is estimated with the regression equation, using the interpolated coefficients and residual.

Actual evapotranspiration is derived through the earth surface energy balance. Quarter hourly thermal infrared and visual Meteosat data are pre-processed to noon and midnight composites. By means of calibration procedures the data are subsequently converted to planetary temperature and albedo. Atmospheric correction procedures are used to derive actual surface temperature and albedo. In addition the boundary layer air temperature ( $T_a$ ) is determined from the noon and midnight surface temperature using an analytic model of the daily temperature cycle.

The surface albedo, surface and air temperature are input to the calculation of the net radiation ( $I_n$ ) and the sensible heat flux ( $H$ ) at the earth's surface. Once these are known, the latent energy flux (heat used for evaporating water) can easily be calculated and converted to actual evapotranspiration. When a pixel is cloudy, transmissivity is derived from its albedo and its long wave radiative fluxes are assumed to cancel. To estimate the distribution of net radiation between sensible and latent heat flux, the relative evapotranspiration of the last cloud free day is used. When cold clouds are observed this is corrected upwards on the basis of the cold cloud duration (CCD).



## Annex 8: Potential SATH-generated services and users

The SATH-system data output is foremostly meant to support the different governments of the country members and for NBA as an overarching institution. The generated information supports the water resources management activities, including planning, managing resources and reducing the impacts of extremes. In order to broaden the application possibilities of the SATH output, we made an analysis of who can use the information and which information. We focus on the river users, as they are in the direct focus of the NBA. Currently the information provides high quality products and data related to “warning” of extreme hydrological conditions: flood and drought. Based on our findings we believe that the services can be expanded to services related to “normal” conditions. Such “normal” conditions services would support the mandates of the different member countries and authorities such as providing and having access to a transparent water allocation information service in the basin and optimization of available resources for other sectors such as hydropower and the agricultural sector.

Below shows the potential application of the SATH model. At every intersection field an example is provided on the potential “information-services” based on the SATH-model. The services to be developed should aim to provide an interpretation of the output data and information provided by SATH-system. This was indicated as an opportunity during the workshop at NBA and later during the discussions with the developers of the system.

<b>Information River Users</b>	<b>Water Resource Management</b>	<b>Risk Management</b>	<b>Resilience Climate Management</b>
<b>Governments</b>	Water allocation	Main current usage	Water allocation
<b>Hydropower</b>	Potential locations	Operational management of stations	Optimisation
<b>Navigation</b>	Navigable water levels	Low water level warnings	Planning calendars
<b>Fishery</b>	-	-	Suitable farming location
<b>Agricultural</b>	Crop water requirements	Flood & Drought risk for farming	Adjusting cropping calendars

For every economic sector we identify the following possibilities:

- Governments: Regulation and policy making entities

The allocation of the resources in the basin can be a beneficial service for this sector and dedicated services can be developed based on the SATH-information system. Additionally, timely information of large-scale droughts in the basin can support facilitation activities to develop emergency plans for water allocation and risk management reduction activities and resources deployment.

- Hydropower sector

An appropriate assessment of the information regarding water flows and timing can support the development of extra hydropower stations. Hydropower generation refers not only to the building of large reservoirs, but also to the possibilities of run-of-river installations. Services that aim to support the

hydropower sector using SATH information can aim to identify potential station-locations based on normal average conditions. The extreme hydrological information would be useful in services related to the optimization of hydropower stations and to guarantee minimum (ecological) flows. More importantly, services in the climate resilience theme can support the optimization of hydropower generation and the development of alternative plans for energy generation: indeed the forecast of the flow/level of the water helps in forecasting the production of energy.

- Navigability sector

The water level information is of prime importance for the navigation sector. Services can apply the information on water levels and discharges to elaborate navigation calendars based on the normal conditions. The Risk theme for this sector could be focused on providing an alarm system in case of (forecasting) low water flows. This information could support planning or re-directing the allocation of water depending on the importance of the vessels.

- Fishing sector

Next to the agricultural sector, the fishing sector is important in the basin. Services targeting the sector can elaborate on potential areas (flood plains) and timing to increase fishing practices.

## Annex 9: Alternative funding

- Germany

Germany is a digital pioneer in international cooperation. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH supports and implements cross-sector projects worldwide that promote innovative solutions and use data-empowered technologies. Particularly in developing countries, digital transformation can break down barriers due to networking, improved communication possibilities and access to knowledge – from allowing fair access to education, reducing poverty or building resilient health systems. Result 4 of the scoping study will explore if and how the German financial instrumentarium could support the commercialisation of the SATH generated data.

- The Netherlands

The Dutch government released in June 2022 a strategic policy document (“Doing what the Netherlands are good at”) presenting the priorities of the Dutch government. This document stresses how important digitalisation is and that it will be promoted in the various development cooperation priority themes (Water, Food security, Climate, private sector development, etc) . This document also presents the priority countries. The Dutch Embassies (in particulier in Niger, Burkina Faso and Mali) are preparing their multi-annual strategic plan for the period 2023-2026. Result 4 of the scoping study will explore if and how the Dutch financial instrumentarium could support the commercialisation of the SATH generated data.

- European Union

Nevertheless it is important to note that more and more donors, such as the European Union and/or The Netherlands decided to align their contributions and to be coherent with countries’ ambitions. This is reflected in the Multiannual Indicative Programs (MIP) agreed between the European Union and the countries, and the multi annual strategic programs from the donors (bilateral and multilateral funds), that may be regional and/or country related. As an example the MIP (EU-Niger)<sup>38</sup> focuses on an approach to development and modernization of the economy with respect for the environment and gender to restore hope to young people. The interventions will concern the business environment, general, technical and vocational education, access to finance, standards, green infrastructures (electricity, water, sanitation, digital), and the emergence of buoyant economic activity, in particular the sustainable agro-sylvo-pastoral and fisheries sectors. Result 4 of the scoping study will explore if and how the EU financial instrumentarium could support the commercialisation of the SATH generated data.

- African Union

---

<sup>38</sup> [https://international-partnerships.ec.europa.eu/system/files/2022-01/mip-2021-c2021-9242-niger-annex\\_fr.pdf](https://international-partnerships.ec.europa.eu/system/files/2022-01/mip-2021-c2021-9242-niger-annex_fr.pdf)

The African Union released recently THE DIGITAL TRANSFORMATION STRATEGY FOR AFRICA (2020-2030)<sup>39</sup>. This document presents priorities and strategic choices, in particular supporting regional cooperation and development of human competences.

- African development Bank

The African Development Bank has prepared as digital action plan (Williams & Edosio, 2022)<sup>40</sup>. It should be further explored how the support of commercialization of the SATH generated data could be part of this plan and supported by ADB. AfDB is looking for partnerships with the big TECHs. Nevertheless this approach could be a limitation when working with data for the common good.

Even if the interest of these donors for digitalisation is important, it will be important to explore other sources of funding in the next phase of this scoping study (resultat 4). Additional information from the NBA will be needed to know what is already done or in process when looking for additional funding based on the NAB conceptual note (dated 2020).

---

<sup>39</sup> <https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf>

<sup>40</sup> [https://www.afdb.org/sites/default/files/2022/04/04/africa\\_digital\\_action\\_plan\\_brochure\\_04042022\\_final\\_1.pdf](https://www.afdb.org/sites/default/files/2022/04/04/africa_digital_action_plan_brochure_04042022_final_1.pdf)