NBA VBA WRCC CICOS OMVS

COORDINATION OF THE ACTIVITIES OF BASIN ORGANIZATIONS

GUIDE OF GOOD PRACTICES

Optimization of monitoring

International Office for Water

AGENCE FRANÇAISE DE DÉVELOPPEMENT

ANBO

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CONTENTS

Referring to the bibliography, the references given in the paper are codified as follows:

Basin Organization	**NBA**	**VBA**	**WRCC**	**CICOS**	**OMVS**	**other**
Reference code	MN	MV	MO	MC	MS	MA

1. INTRODUCTION

1.1 General

Transboundary Integrated Water Resources Management (IWRM), by appropriate governance and planned investments on the basin scale is the key to sustainable use and conservation of natural resources. Through fair sharing of resources and benefits involved, it helps to prevent conflicts between uses and between States, and thus contributes to sustainable development in the areas considered.

Transboundary basin organizations (a term that covers a wide variety of structures) are the preferred framework for water resources management beyond national borders. Such organizations were established decades ago in the Senegal and Niger River Basins, or more recently on the Mekong, Congo and Volta rivers. A water resources coordination unit (today the Water Resources Coordination Centre), whose main focus is to promote river basin management, was established within the Economic Community of West African States in 2004. French cooperation supports these institutions through various projects and the secondment of technical assistants specialized in IWRM.

The Niger Basin Authority (NBA), established in 1980 by the nine States sharing the Niger basin (Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria) led to a Shared Vision process marked in particular by the adoption in 2008 of a Sustainable Development Action Plan (SDAP), an Investment Programme and the ratification of a Water Charter for the basin. A major challenge for the NBA is to accelerate and support the construction, coordinated management of large hydraulic infrastructures in the Niger River Basin and create the conditions for sustainable development of regulated water. The NBA has, among other things, a rich experience in collaborative planning, monitoring and hydrological modelling.

The Volta Basin Authority (VBA) was established in 2007 by six African States (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Togo) with a mandate to:

1. Promote continuous dialogue;
2. Promote IWRM and equitable sharing of benefits;
3. Authorize the establishment of infrastructures and the implementation of projects likely to have significant impacts;
4. Develop and implement joint projects and common structures;
5. Contribute to poverty reduction, sustainable development and better socio-economic integration.

The Council of Ministers in charge of water resources in the six VBA member countries adopted in 2009 the Authority's Strategic Plan 2010 - 2014 and started drafting the Basin Water Charter.

The Organization for the Development of the Senegal River (OMVS) was established in 1972. It is an international institution duly registered with the United Nations, with a home office in Dakar (Senegal). It gathers Guinea Conakry, Mali, Mauritania and Senegal around common goals, including food self-sufficiency for the basin populations, economic development of Member States and conservation of the ecosystem balance in the region. OMVS has a Water Charter and is a globally rare case of relative sovereignty to large dams: any structure in the basin is the common and indivisible property of the Member States. It

also has a relevant internal funding mechanism. OMVS has developed a Master Plan for Water Development and Management ("SDAGE") through a participatory process.

For many years, West Africa has been involved in a regional IWRM process. Through one of its strategic areas of intervention for the 2007-2015 period focusing on governance of transboundary waters, the **Water Resources Coordination Centre** (WRCC) of the Economic Community of West African States (ECOWAS) is endeavouring to "provide support to transboundary basins and facilitate IWRM processes in the basins" and to "advance regional integration of the water sector". For this purpose, WRCC developed a regional framework and integration tools to enable countries and basins to move faster in a concerted manner towards practical implementation of IWRM. WRCC has adopted a benchmarking approach (Performance Indicators) and is conducting a dialogue on large water infrastructure projects in West Africa.

The International Commission of the Congo - Ubangi - Sangha Basin (CICOS), established in 1999, expanded its mission to IWRM in 2007, in addition to its original mandate focusing on the promotion of inland navigation. CICOS Member States (Cameroon, Central African Republic, Congo, Gabon, and Democratic Republic of Congo) cover 83% of the Congo River Basin, having a surface area of 3,822,000 km². CICOS has an original self-financing mechanism, the Community Integration Tax of the Economic and Monetary Community of Central Africa (CEMAC).

Each of these structures has experience with generic lessons learned that are potentially beneficial to other institutions within a process of capitalization and development. In addition, these structures actively participated in the "Key Performance Indicators" project jointly financed by France and the ACP-EU Water Facility and implemented by the African Network of Basin Organizations (ANBO) and IOWater, which gave very interesting results with appropriation of the developed indicators to measure the quality of IWRM implementation.

As a public institution, the "**Agence Française de Developpement"** (AFD) has for seventy years been fighting against poverty and promoting development. It implements the policy defined by the French Government. AFD finances and supports projects that improve the living conditions of the people, promote economic growth and protect the planet. Accompanied by the French Global Environment Facility (FFEM), AFD is especially supporting the six above-mentioned institutions in transboundary water management.

The African Network of Basin Organizations (ANBO) was established in 2002 and aims to strengthen the links between its members and with other basin organizations, to organize joint activities of national, regional and continental interest based on the IWRM principles, to foster the emergence and strengthening of basin management bodies in Africa. The ANBO permanent secretariat is provided by the OMVS and its sub-components of West and Central Africa are respectively chaired by the NBA and CICOS.

The International Network of Basin Organizations (INBO), which has several regional variations including ANBO, was established in 1994 to promote IWRM and the creation and strengthening of basin organizations over the world. The INBO permanent secretariat has been provided by the International Office for Water since its inception. We will also note the establishment in 2002 of the Network of International Commissions and Transboundary Basin Organizations (TINBO).

The International Office for Water (IOWater) has developed an international know-how on the capacity building of stakeholders in the water sector, either State or not. Various tools have been used to date:

- Training on IWRM in workshops and seminars, organizing specialized tours and training courses;
- Providing studies related to capacity building (audits and training plans);
- Design and installation of water training centres, the establishment and facilitation of the International Network of Water Training Centres;
- Organizational and technical support to the implementation, at national and transboundary basin level, of water information systems promoting the sharing of data and the production of useful information for decision making.

1.2 Objectives

The overall objective of the project is to improve, through experience sharing and capacity building, the operation and effectiveness of activities of the beneficiary institutions (NBA, VBA, WRCC, CICOS, OMVS) regarding basin IWRM and accompanying the technical assistance provided to them.

The specific objectives are the following:

- Appropriation of the relevant experiences of each by the other institutions and of best practices by all of them;
- Support and coordination of the technical assistants seconded to the institutions;
- Improvement of the strategic vision of their activities by the beneficiary institutions;
- Organization of benchmarking, especially on the following topics:
  a. governance;
  b. self and sustainable financing;
  c. strategic planning and implementation of actions;
  d. optimization of **monitoring** and capacity building for data management;
- Exchange of best practices at the regional and global levels, including through the ANBO, INBO and TINBO networks.

Guides are been written for each of these four topics ; this guide focuses on the monitoring topic. These documents allow the organizations to convey their experience and know-how, to formalize them and build on the successes of other organizations, but also, whenever necessary, to change their activities and integrate the lessons learned from action in the reporting to their decision-making bodies.

The guides can evolve and be regularly upgraded with new relevant experiences. The INBO-GWP Handbook for IWRM in basins of 2009, the methodological guide on joint management of transboundary aquifers (AFD-IOWater-Water Academy-BRGM-UNESCO, 2010) and the Handbook for IWRM in transboundary basins of rivers, lakes and aquifers (INBO-GWP-UNECE-UNESCO-GEF-AFD, 2012) provide theoretical bases to the guides, that aim at being definitely practical.

1.3 Documents used

A web portal for sharing documents (COBAT: coordination of transboundary basins) was set up to allow partners to share working papers and summaries or any document to enrich thinking. Access to this portal has been so far restricted to project partners but will later be opened to the public through AWIS (African Water Information System), managed by ANBO.

The bibliography on monitoring available on the portal is provided in the appendix. Apart from general points, all practices (good or bad) presented in this guide are taken from these references.

Other references (bibliography, websites) are available on the website: www.sadieau.org.

1.4 Presentation of the river basins

The Niger River Basin

The Niger River, long of nearly 4,200 km (the third river in Africa and the 9th in the world), drains a catchment area of about 1,500,000 km^2, with significant natural resources hitherto little exploited but which are gradually diminishing. The Niger Basin is shared by nine countries: Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria. The basin population was estimated at 107 million inhabitants in 2000.

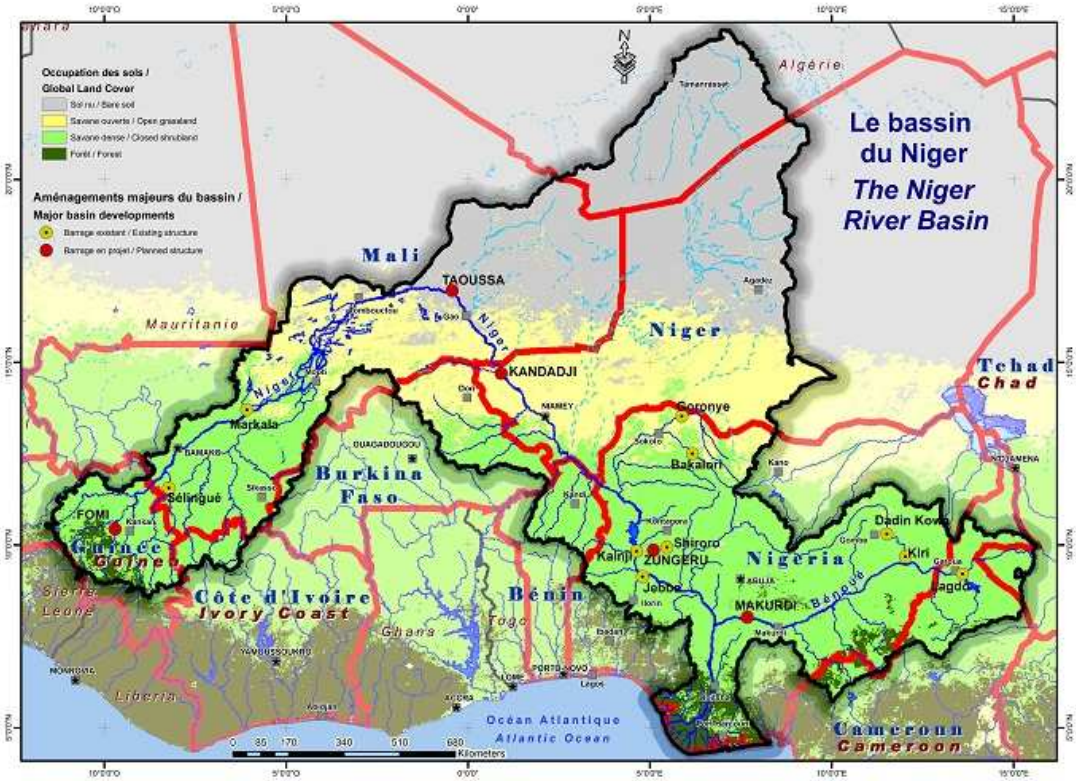

Figure 1: The Niger River Basin

The Volta River Basin

The Volta River is 1,850 km long with a basin surface area of 400,000 km^2, which covers six countries in West Africa: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali and Togo. 85% of the basin total area is shared between Ghana and Burkina Faso. With its reserves of over 60 billion m^3, the Akosombo Dam in Ghana is one of the major infrastructures. A population of over 18 million inhabitants lives in the river basin.

Figure 2: the Volta River Basin

The Economic Community of West African States (ECOWAS)

ECOWAS is composed of 15 States of the western region of Africa: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. A population of around 230 million people lives in the area which is estimated at more than five million km^2. The Niger, Senegal, Volta and Lake Chad (the latter also occupying part of Central Africa) are the major river or lake of the sub-region.

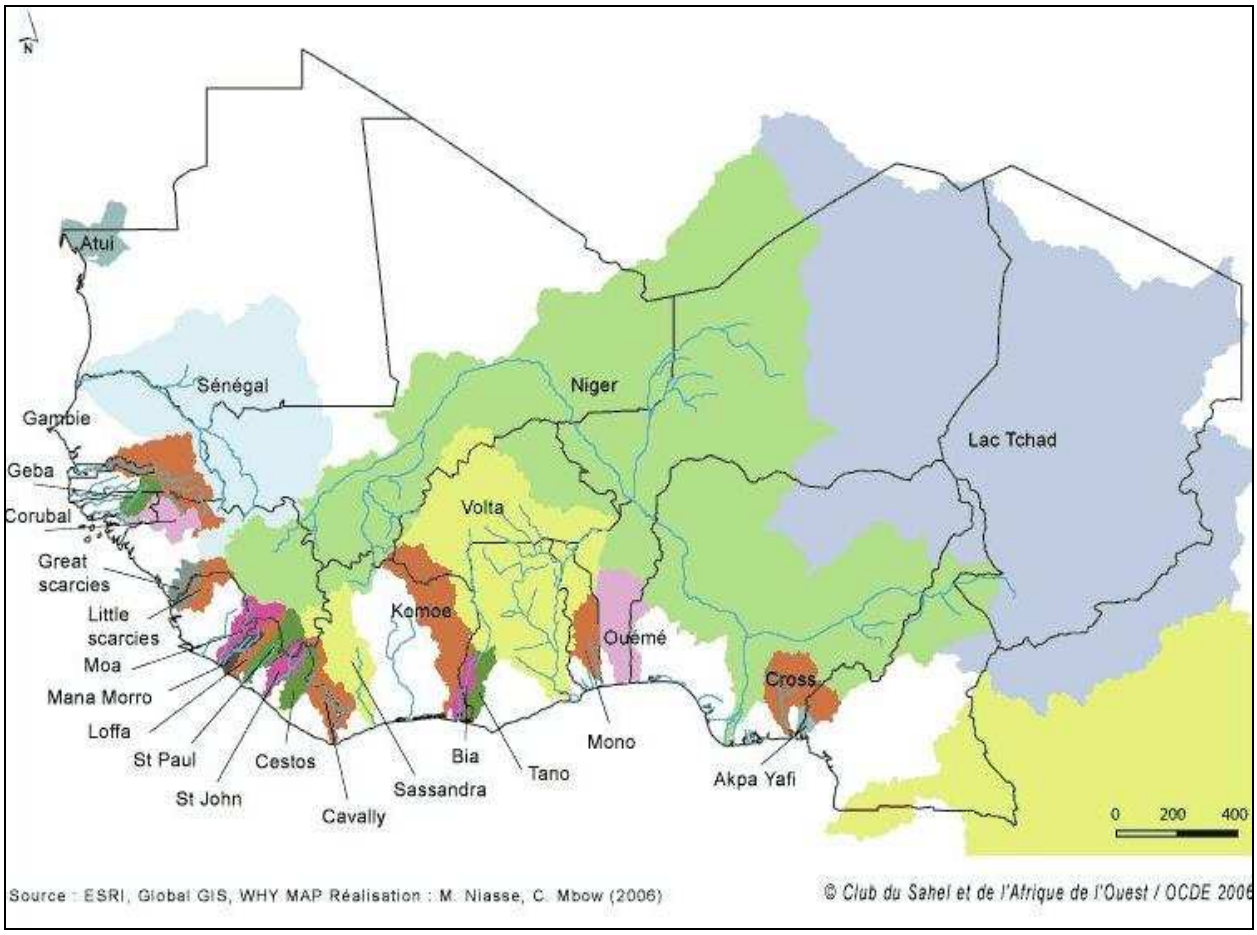

Figure 5: the Economic Community of West African States (ECOWAS) and its river basins

The Congo River Basin

The Congo River Basin is the first in Africa and the second in the world in surface area (3.8 million km²) and flow rate (41,000 m^3/s in Kinshasa/Brazzaville). It spans over several countries of Central Africa, primarily Cameroon, the Central African Republic, Congo, Gabon and the Democratic Republic of Congo. The main tributaries of the Congo are the Ubangi, Sangha and Kasai. More than 120 million people live in the whole river basin.

Figure 4: the Congo River Basin

The Senegal River Basin

The Senegal River is 1,800 km long and its basin covers a surface area of about 300,000 km^2 shared by Guinea, Mali, Mauritania and Senegal. About 3.5 million people, approximately 85% located near watercourses, live in this basin. The Diama and Manantali dams allow meeting a portion of the electricity needs of the four riparian countries and significant agricultural production.

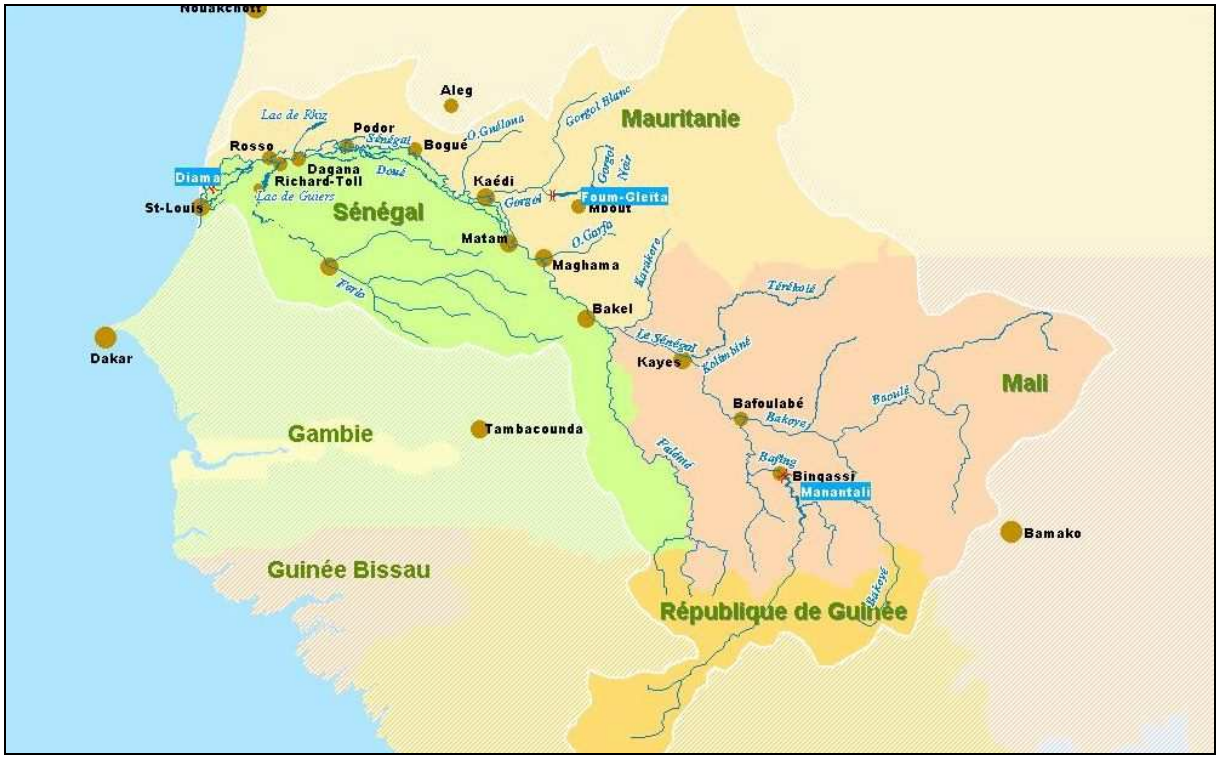

Figure 5: the Senegal River Basin

2. GENERAL

2.1 Background and challenges of transboundary data management

Transboundary water resources management requires using multiple kinds of information that are most often produced under national and local management policies. Thus, many stakeholders involved in various initiatives, programmes and/or projects, produce and/or use water-related data.

The main difficulty encountered to produce the expected information is that the basic data needed to produce this information are often dispersed, heterogeneous, incomplete and rarely comparable or adapted to the needs. In addition, national authorities may also be reluctant to provide information, considered to be strategic, to neighbouring countries. The transboundary basin organization provides the proper framework for basin-related data management, which is often one of the pillars of its mandate.

Water resources management in transboundary basins requires organizing **data production and information sharing** for the various planning, monitoring, assessment, warning activities, etc. In many cases, the production of the data required for natural resources management is insufficient, and the sharing of data and information related to a transboundary basin is often difficult for relational, structural and technical reasons.

Basin organizations are faced with two major challenges:

1- Sustainable capacity building for the production of the data required for water resources management, taking into account the production costs that can be high;
2- Developing procedures, tools and methods to enhance the value of the existing data to meet the information expectations of the public and decision-makers.

2.2 Overall methodology for developing transboundary information systems

a) Assessment of the situation – Analysis of the needs and of what already exists

The assessment phase allows for an inventory of existing data including analyzing information and their access conditions. The data and information needs expressed by the main partners according to their role and level of intervention (national, basin, regional) should be inventoried.

➢ **<u>Analysis of the legislative and institutional situation</u>**

Given the diversity of issues to be addressed to and the number of organizations producing data at regional, national and local levels, it is advisable to make a prior analysis of the legislative and institutional situation of data management and complete it by an inventory of the stakeholders – data producers, managers and users.

It will include highlighting:

- the roles and responsibilities of key stakeholders regarding data production and management at regional, national and local levels;
- on-going projects on data management and sharing;

- the existing procedures and obligations in terms of production, management and dissemination.

➢ **Joint inventory of the collection arrangements and existing data sources**

The inventory of collection arrangements and existing data sources is essential to:

- Identify existing datasets (datasets on paper or digital) and analyze their level of accessibility;
- Check that the quality of existing datasets meets the users' needs;
- Organize, whenever necessary, the additional information needs and rules for the data production, sharing and access to be developed.

This inventory of data sources is to be achieved through cooperation with data producers and managers. In order to respect the role of each partner, each producer and manager should be able to describe the datasets it produces or manages.

After organizing a framework for collaboration with the various partners, a catalogue of data sources (**metadata**) can be made available on the Web to facilitate this collaborative approach. These catalogues thus allow:

- The partners to directly integrate the data they manage;
- The users to identify and download data through user-friendly interfaces.

It should be emphasized that this does not focus on collecting data but only makes an inventory (a photograph at time t) describing data characteristics: who produces these data, in what form they are (format, geographic projection, scale, etc..), the conditions under which data are produced or made available (including confidentiality rules), the existing information fixed by the producers, etc.

➢ **Analysis of existing data flows between the partners**

Diagrams can be developed to describe the flows of information existing between the various partners at national and regional level, on the main IWRM topics, including the following data:

- meteorological (rainfall, temperature);
- hydrological;
- quality of surface waters and sources of pollution;
- environmental (ecosystems, wetlands);
- groundwater;
- water uses and abstractions;
- sociological and sanitary;
- the administrative and economic situation.

Here too, it is advisable to organize the flow analysis through a collaborative approach with partners, for example by organizing national and regional workshops.

➢ **Enquiries to assess the information needs**

Information needs usually include:

- status of water resources in quantity and quality, including meteorological information;

- uses and demand (drinking water supply and sanitation, irrigation, hydropower, fishing, recreational activities, etc.), associated developments and their impacts on water resources and ecosystem functions;
- problems (floods, sedimentation, salinization, pollution, drought, etc.);
- measures taken to solve the problems and improve the use or functioning of the watercourse.

It also means analyzing the partner needs in terms of:

- production of (raw and processed) data;
- hardware and software for data collection, transfer, storage and processing;
- service for hosting/ processing data and disseminating information;
- training for technical capacity building.

b) Definition of the action plan related to water data

Based on the results of the assessment, a comprehensive multi-year action plan can be defined and discussed with the regional and national authorities to meet the identified major needs. The action plan summarizes the current situation, the priority targets and lists recommended actions, both organizational and technical, to improve data production and management while defining priorities to achieve the national and basin objectives.

The action plan for data monitoring and management, itself part of the overall action plan of the basin organization (see guide for planning) allows establishing synergies with actions otherwise financed, thus avoiding duplication of work.

c) Implementation of the action plan

Information systems are tools used to facilitate the production and sharing of the information expected by country partners. Given the stakes, their development requires, on the one hand, to work on institutional, organizational and governance issues (see corresponding guide) and, on the other, on technical issues.

A **step-by-step approach** is recommended to make the best use of available resources and knowledge. It can begin with informal cooperation between countries at the operational level, which can evolve into more formal agreements, starting with modest goals to more ambitious ones. Step-by-step approaches can also help to assess cost-effectiveness and make a careful analysis of the needs and to combine monitoring and modelling.

Regarding transboundary waters, raw data are usually acquired at the national level rather than by systems especially created and operated by the transboundary basin organization. The data are transmitted to it; each country can of course also manage its own national information system.

The platform of the information system of the transboundary basin organization (servers, software) shall, as far as possible, be constructed from existing infrastructure of each national partner. This platform should be able to manage all kinds of information: geographical, alphanumeric, texts and multimedia. Its main components are usually:

- a database and a Geographic Information System (GIS);
- tools for online management of metadata catalogues;
- a web portal for the sharing and dissemination of the information;

- modelling and decision-making supporting tools (see guide for planning).

For information purposes, activities related to the development of the information system may include:

➢ Development of common rules for data sharing

Any exchange of data presupposes defining common rules for sharing (general principles on the rights of access and use, compliance with the rules of confidentiality defined with the producers, etc.), and, on a case-by-case basis, exchange scenarios (who exchanges what with whom, for what purpose, how often, what format, etc.).

It usually leads to the signing of memoranda of understanding between the key organizations concerned to formalize these rules and organize data collection.

➢ Development of semantic interoperability

Any sharing of data and information is only useful if the data are comparable and homogeneous. It is therefore required to check the comparability of data and possibly clarify the concepts, definitions, coding systems, units and common calculation methods to be used when exchanging information.

In the case of non-homogeneous data sources, the definition of a common language may require:

- a detailed analysis of the concepts, definitions, codes and calculation methods used by each partner;
- the adoption of a common reference frame for the exchanges with the definition of a common model (conceptual diagram, common definitions and codifications).

➢ Development of technical interoperability

Further to semantic homogeneity, it is required to make sure that the information systems that manage the data made available by the partners can communicate with minimal human intervention, while respecting the exchange scenarios which have been adopted. Strengthening this technical interoperability of information systems first implies defining an architecture for networking services, or for centralizing information. This reinforcement is done by relying as much as possible on the existing information systems of the various partners.

➢ Human resources development

A basin's information system requires qualified personnel to operate it. A capacity building programme can thus include:

- general training on the administration of environmental data;
- general technical training;
- training on methods and tools specific to the administration of water data at national and regional levels.

2.3 World Hydrological Cycle Observing System (WHYCOS)

WHYCOS is a WMO programme which aims to improve observations, strengthen international cooperation and promote free exchange of data on **hydrology**. The programme is implemented through various HYCOS components, particularly in transboundary basins.

WHYCOS promotes a bottom-up approach, starting from the needs at the national, basin or regional level to reach global level. WHYCOS and its components are primarily targeted at technical and institutional capacity building of the **National Hydrological Services** (NHS) and at improving their cooperation in managing shared resources.

The main objectives of WHYCOS are:

1- technical, human and institutional capacity building of the NHS's of the Member States;
2- promoting regional and international cooperation in the sharing of hydrological data and in the management of shared water resources;
3- facilitating adaptation to the impacts of climate variability and climate change.

2.4 Climate change and risks

Fighting against water-related risks is even more relevant in the context of **climate change** that may increase the frequency of extreme phenomena. It is important for countries to share information, especially hydro-meteorological, necessary for this fight, as well as progress in sectoral plans: fighting against the impacts of climate change, management plans for droughts and floods.

Flood risk is identified through hazard and vulnerability crossing maps. Specific rules for construction in these areas should be developed and the definition of protection measures should be promoted. It is also important to develop a **forecasting system** that can anticipate and warn people when a weather episode can lead to flooding. The specificity of transboundary basins lies in the complexity of the system to be developed.

The system must be closely operated with Member States and specialized national agencies. Fed by meteorological and hydrological data, it can calculate the evolution of flows in the basin and therefore the water levels in rivers. Signals relative to forecasts should be addressed to the governments that are responsible for protecting people and property.

Every phenomenon must **be assessed** in order to learn lessons and modify procedures whenever necessary. This is particularly important in the case of extreme phenomena, which occur only after a long interval (about a century), but whose frequency can be increased due to climate change.

3. PRACTICES USED IN BASIN ORGANIZATIONS

3.1 Niger Basin Authority

<u>Niger HYCOS and observatory</u>

We distinguish hydrological monitoring, which is the focus of the NBA Niger HYCOS project, from the monitoring of the other parameters. The Niger Basin Observatory, directly supervised by the NBA Executive Secretary, is responsible for monitoring the evolution of the basin regarding its hydrological, environmental and socio-economic aspects.

The **Niger HYCOS** project started in April 2005 with the support of the AFD and follows the HYDRONIGER programme which had been underway since 1980. Niger HYCOS is

implemented by the NBA and the National Hydrological Services of the nine member countries. The number of observation stations is 105 hydrometric stations, including 45 automatic data collection units.

According to the bibliographic MA2 reference, the main concerns are related to the operation and maintenance of the stations. It should be noted that the countries sometimes wrongly perceived them as the property of the NBA.

The **Niger Basin Observatory's** assignment is to follow up the evolution of the basin, to produce and disseminate information periodically. It has been operational since 2006 and has recently been audited by the FFEM (French Global Environment Facility). The main lessons learned are:

- the good operation of the Centre's activities is closely linked to the NBA National Focal Structures, whose role is to be consolidated;
- the constraints and main difficulties encountered concern the procedures for data acquisition, the low reactivity of the national data producers and insufficient internal funds to sustain activities.

The main achievements of the observatory are:

- Baseline Study for operationalization ;
- List of 28 indicators and their specifications;
- GIS platform and baseline of some indicators;
- Development Plan for the Observatory, which however requires a high level of external financing, i.e. 90% of 12 million Euros over 15 years.

Computerized Forecasting Information System (FIS)

The NBA computerized Forecasting Information System operationalized in 2011 is made up of a set of models for predicting flows in 38 stations of the Niger Basin (part of the 105 Niger HYCOS stations). The report on MN4 reference concludes:

- In the case of floods, a deficit in basic data (or in the quality of those available) on the Lower Niger does not allow providing forecasts on all the stake sites. Forecasting water releases downstream from the dam would improve the forecasting model. Forecasting on the Benoue River is biased by error due to the lack of information on intermediate inputs. Another problem lies with the weak forecast horizons on the upper part of the Niger;
- Trends in low water levels can be forecasted but uncertainties on low water flows influence results. If influenced by dams, corrections are sometimes possible when data are available (case of the Koulikoro Dam);
- Trend models provide valuable information for the management of water resources, especially for the Kandadji, Kainji and Jebba dams;
- Globally, the need for reviewing raw information was highlighted. There are many other gaps in the datasets including in some synoptic stations.

To implement the FIS in a sustainable manner, an occasional use of services provided by external consultants is considered to support the team of the NBA Executive Secretariat.

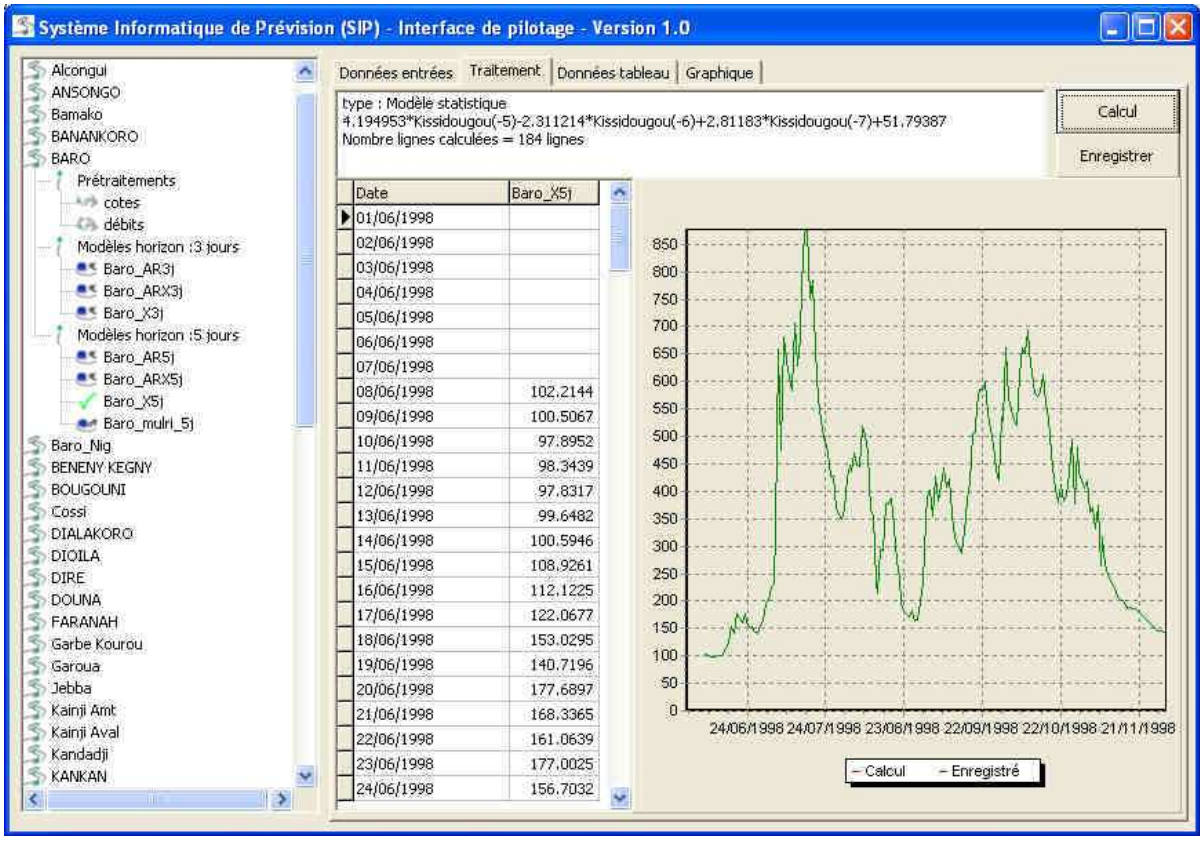

Figure 6: NBA's FIS driving interface

Other projects

Projects on the reversal of trends in land and water degradation in the Niger River Basin (GEF funding), on the protection against water-related erosion and on silting control in the Niger River Basin (ADB financing) have both managed a large number of data until 2011. The data bases and GIS of these two projects were given to the observatory. The latter also manages the planning, monitoring and assessment software of the programme for the development of water resources and the sustainable management of ecosystems in the Niger River Basin (World Bank funding).

The NigerWet project inventories and defends the promotion of wetlands (RAMSAR sites) in the Niger River Basin.

Climate risk on the Niger River Basin

The largest decreases (from 30 to 50%) in the flows of the Niger River and more generally of West African watercourses since the 1970s are attributed to climate change. We may also fear an increase in the frequency of extreme phenomena in the future.

The NBA Heads of State raised questions in 2008 on the additional risks associated with climate change for the implementation of the Action Plan for the Niger River Basin Sustainable Development. With support from the World Bank, the simulation scenarios of the IPCC (Intergovernmental Panel on Climate Change) were implemented in collaboration with the AGRHYMET regional centre of the Interstate Committee for Drought Control in the Sahel (CILSS). According to the MN5 reference:

- The results of simulated rainfall by global models are very divergent (from -20% to +15%). Calculations must be completed;
- The implementation of the NBA Sustainable Development Action Plan is in itself a good response to the possible negative impacts of climate change, which makes its implementation even more urgent;
- It is important to remind the regulating role of the Fomi dam and the need to accelerate the search for its funding, including considering changes in project management;
- A major effort must be made on adaptation to climate change in rainfed agriculture, which depends on sub-regional organizations other than the NBA.

3.2 Volta Basin Authority

Observatory for water resources and associated environments

According to the VBA mandates, the project related to the observatory focuses on:

1. Supporting VBA by providing an operational multisectoral tool;
2. Allowing the VBA to make an assessment of water needs and resources as well as of the environmental situation in the basin; developing an information and communication tool;
3. Contributing to decision-making to define priorities and options for sustainable basin management and to anticipate the negative impacts of water management.

In this perspective, the project has three components:

- Component 1 - Assessment of the basin's environmental situation;
- Component 2 - Development of the observatory;
- Component 3 - Involvement of stakeholders in water and environmental management.

Figure 7: Homepage of the descriptive application of VBA hydro-meteorological networks

Component 2 has not yet been completed. Regarding component 1, a meta-database of the hydro-meteorological networks and an atlas of thematic maps on the Volta basin were put online. The study on the environmental and socio-economic situation is underway. MV1 underlines the following points:

A. As concerns the inventory and characterization of existing hydro-meteorological networks
The study has enabled a first descriptive inventory of existing hydro-meteorological networks in the Member States. A second phase is recommended to consolidate the inventory, especially with regard to national networks.

B. Regarding the inventory of reservoirs, non-controlled floodplains and wetlands
The inventory of reservoirs was discussed but further inventory is recommended. The inventory of floodplains and wetlands has not been dealt with.

C. Regarding data enhancement, interpretation of results, and presentation of the status of the resource
The kinds of data processing carried out at the national level must be identified, as well as the methods used for the interpretation of results and their presentation.

The VBA Activity Report 2010-2011 makes the following recommendations:
i. Continuing the process of recruiting additional staff for the Observatory;
ii. Resubmitting the protocols for data sharing to the Member States;
iii. Initiating the establishment of National Focal Structures in each Member State.

Volta HYCOS

We noted the following points in the development of the Volta HYCOS project:

- In December 2009, transfer of the Volta HYCOS server of the IRD (Research and Development Institute) centre in Ouagadougou to the VBA premises;
- Rehabilitation and installation of stations in the Member States;
- Equipment purchasing process;
- Development of hydrological products using spatial modelling and analysis in collaboration with 2iE (International Institute of Water and Environment Engineering);
- Development of hydrological bulletins in January 2010;
- Purchase of HYDROMET software;
- Drafting of a protocol for the exchange of hydrological data with Member States (signing of Togo and Benin).

Others

A hydrological model has been achieved as part of the **Project for Improvement of Water Governance in the Volta Basin** (PAGEV - Burkina Faso and Ghana alone). MV2 recommends:

- The databases and methods used in both countries should be harmonized;
- The model should be refined by breaking down the requirements for irrigation and livestock;
- Information on water quality is insufficient;

- The groundwater assessment project in Ghana provides data and a similar assessment should be carried out in Burkina Faso;
- The data on reservoir characteristics must be used.

The Study on the establishment of a regional system for exchange of information and data related to the Volta basin (MV3) funded by the GEF provides the following recommendations:

- Support to the organization by identified national structures is needed;
- The observatory will serve as a focal point for international programmes regarding data and information on the basin;
- The observatory could rely on thematic committees or working groups that will study the procedures, norms, standards for collecting and processing environmental data;
- The harmonization of the tools used for the collection, processing and dissemination of information at the basin level is highly recommended.

As part of another project (**GLOWA**), the geoportal and the collected data were transferred to the VBA in November 2010. A workshop on forecasting the start of the rainy season was held under this project.

3.3 Water Resources Coordination Centre

An essential element of the WRCC Strategic Plan 2007-2015 is the establishment of a **Regional Water Observatory**. It aims to strengthen water information systems in the countries, promote the compatibility of the information obtained at the national level, summarize information at the regional level and make it available to interested partners:

- Making comparative analyses on how IWRM general principles are adapted and applied in the countries and river basins;
- Supplying a base of summarized information on the experience gained at the regional level to allow the partners to have access to best practices and identify benchmarking lines;
- Feeding a regional management chart with the progress made in IWRM implementation.

As part of the regional water observatory, information sources and elements that will allow defining the specifications of a Regional Water Atlas of ECOWAS were identified in 2006 in MO1. The **Atlas of regional water resources in West Africa** (MO2) was completed in 2010.

3.4 International Commission of the Congo - Ubangi - Sangha Basin

The Information System of the Congo Basin (**SIBCO**) was established in CICOS in 2007, with funding from GIZ (GETRACO project). The SIBCO includes in particular:

- A computerized register of the boat fleet and of statistics related to river ports;
- A **Hydrological Information System** (HIS), being developed.

The African Monitoring of the Environment for Sustainable Development Programme (**AMESD**) developed from 2007 to 2012 with European funding includes the management of data coming from satellite imagery. This project works in particular with the research sector (IRD).

The **Congo-HYCOS** project is being started. The activities planned in 2012-2013 with FFEM funding are as follows:

- Establishment of the institutional framework - Agreements with the countries and institutions, that are data owners, for the provision and use of these data;
- Selection and recruitment of the regional coordinator of the project;
- Detailed assessment of the condition of the existing hydrological network - Standards, requirements for rehabilitation and maintenance of the existing stations, specifications for the revision of the stations and the acquisition of new equipment;
- Definition of a detailed activity plan and budget estimate.

Training related to the Congo-HYCOS project started in 2012 with funding from the ACP-EU Water Facility.

Finally, projects are being prepared linking water management in the Congo Basin and the management of tropical **rainforests** in the context of climate change impacts, both in terms of adaptation and mitigation.

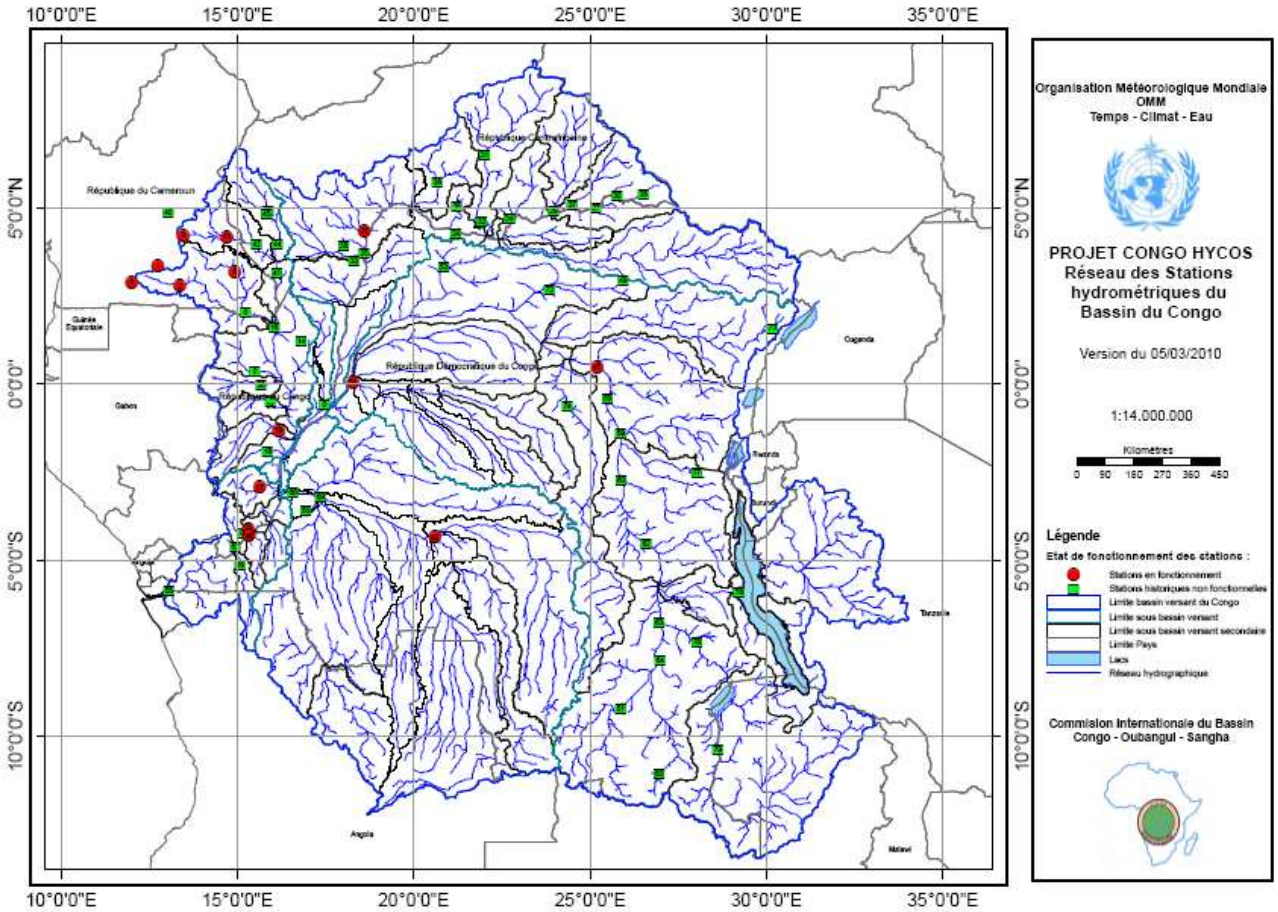

Figure 8: hydrometric stations in the Congo basin

3.5 Organization for the Development of the Senegal River

In 2000, OMVS started a process for the establishment of an **Environmental Observatory** with FFEM support. The reference MS1 report collects the Technical Notes of the

Observatory on the monitoring and assessment of the status of the environment in the basin. The computerized tool allows, for each thematic network, managing the stakeholders, the handled information, the information flows between the stakeholders and the processing of this information leading to actions.

The system is operational and can generate, among other things, thematic maps of the assessment in time and in space. A report on the status of the environment in the Senegal River Basin was published in 2011, thanks to the analysis of the data collected in the States.

Once directly supervised by the High Commissioner, the observatory was integrated into the Department of the Environment and Sustainable Development during the institutional reform of the OMVS in 2010.

In addition to the observatory, OMVS established a **health monitoring** system in 2010 with the support of the World Health Organization, the World Bank and AFD. The MS2 report examines the detailed arrangements of this establishment, a Handbook of Procedures was drafted (MS3) and the first Annual Report was produced.

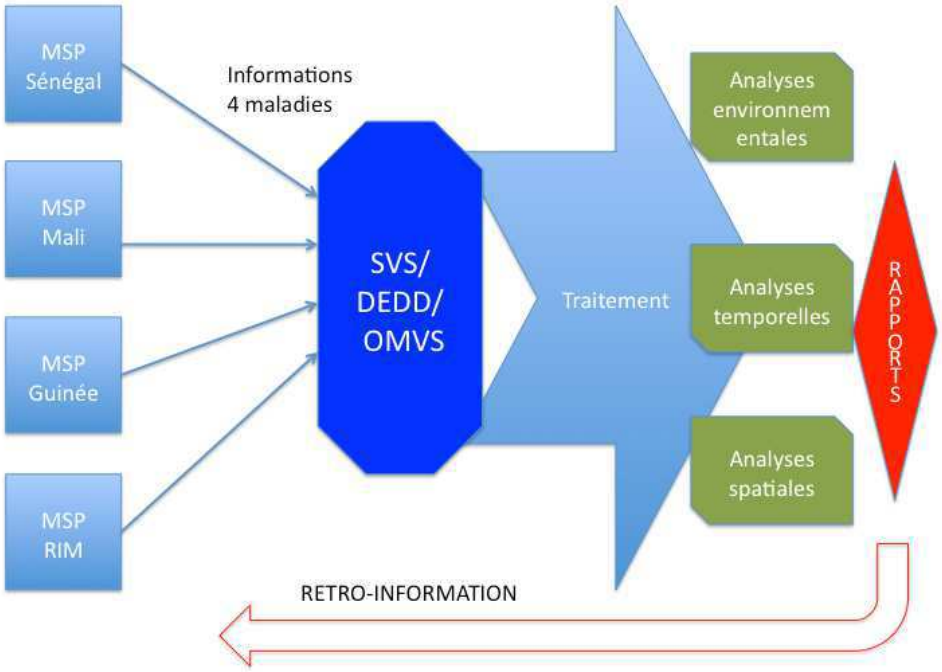

Figure 9: OMVS health monitoring system

OMVS also established a water needs / resources **Management tool**.

Finally, we noted that a **Senegal HYCOS** project is under preparation in collaboration with WMO.

3.6 Other experiences

The Mekong River Commission (MRC) has been developing since 2006 the **Mekong-HYCOS** project supported by AFD (French Development Agency) and FFEM. In April

2012, the MRC conducted a final assessment of the project, whose main conclusions are outlined below:

- Priority should be given to the management of data on discharges and not on water levels. The historical and real-time data bases (automatic transmission by GSM network) can be integrated to produce a unique dataset. A sole software could be used by both MRC and the countries;
- The network of stations can progressively be optimized, conventional hydrometric stations (without real-time transmission) can be integrated in addition to the automatic stations;
- "On demand" technical assistance may be provided. The MRC key project personnel could be recruited permanently;
- Links between national hydrological services and data users can be strengthened.

4. SYNTHESIS AND RECOMMENDATIONS

General

General recommendations are as follows:

- Monitoring, together with planning, is one of the **primary functions** of the basin organization. Hydrological monitoring (we can only manage what we know) is particularly crucial;
- The **institutional framework** for coordination of data management activities must be established and approved by the parties involved;
- Information systems may be gradually developed **in stages**. A first version of the system can be quickly developed, even if it only concerns, in a first step, a limited number of parameters: this means not getting involved in too burdensome bureaucracy, keeping in mind the necessary operability of the system;
- The Information System should be managed by a **permanent** and competent **staff** within the organization;
- Even if externally funded projects are supporting the Information System for some time (creation, start-up), sustainability requires a precise timetable, developed in consultation with all partners and leading to **autonomous operation**. There should be only a single information system in the basin organization (and also in the countries in relation to a particular topic, e.g. hydrology); each project cannot manage parallel and redundant systems;
- To ensure the sustainability of monitoring, internal financing of the basin organization should not only concern the staff managing the Information System, but also the collection and **operating costs** of the system itself and its hardware, which may be important.

Data acquisition and management

Recommendations on data are as follows:

- Knowledge of data related to water **consumption and use** (current and future) is necessary, including major developments and existing and future infrastructure. With regard to these developments, other data are fundamental such as those relating to ecosystems (green infrastructure), to displaced populations or to health even (water-borne diseases);

- The "added value" brought by the basin organization, using the data provided by the countries and integrated into the Information System must be clearly established and proven. It can especially involve **applications** derived from data, such as decision-making support regarding major infrastructure (see guide for planning) or flood warning. The **provision of data** will thus be facilitated ("win-win" process), as well as the contribution from the countries to the operation of the system (or of that of the basin organization itself, see guide on funding);
- The good operation of the monitoring activities of the transboundary basin organization is closely linked to that of the **national structures** representing it; those are playing the fundamental role of relay with national data producers;
- Beyond the first informal exchanges with the countries, procedures for **data exchange** and their use by the basin organization and by-products should be clearly described in protocols on bilateral and multilateral exchange.

Practices specific to HYCOS projects

The figure below gives the functions of a hydrological information system (WMO).

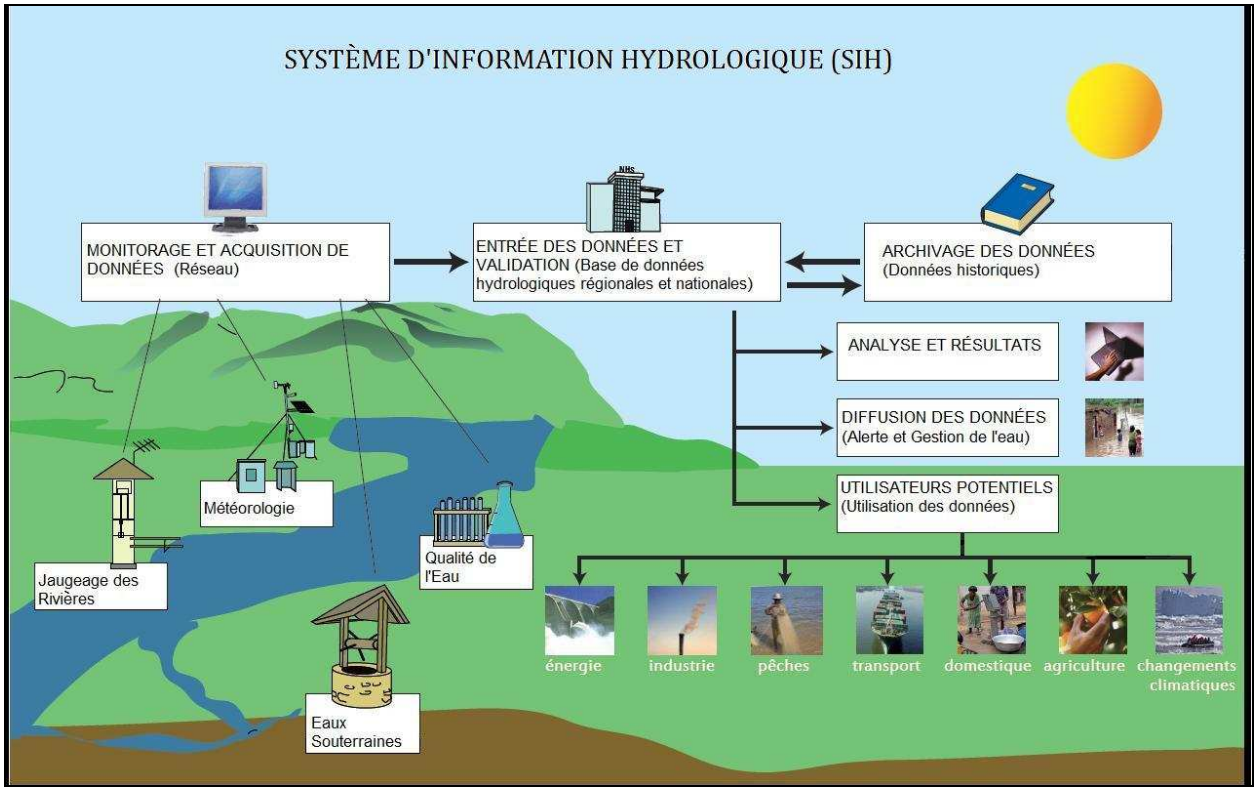

Figure 10: functionalities of a hydrological information system

We noted the following points regarding projects of the WHYCOS programme:

- The WMO Resolutions 40 (CG-XII) and 25 (CG-XIII) propose rules for **exchanging** hydrological **data** and products (applications) with the countries;
- **Automatic transmission** of data in "real time" can advantageously be carried out by GSM telephone network (where coverage exists, which is often the case), at lower cost compared to satellite transmission;

- It means ensuring proper **appropriation** of hardware for the acquisition of data, which belong to the countries;
- Monitoring should first consider the **quantitative aspects** of water resources and then their qualitative aspects. Regarding sedimentology, collaboration with scientific partners is essential;
- The data production and validation process of a **hydrological information system** consists of five steps (WMO): data acquisition (historical data, measurements) – processing and validation of data on water levels - development of a calibration curve - calculation of discharge and validation, including metadata (gauging, etc.) - quality control. Data management must be made using specific software meeting these steps. When developing or choosing the system, working together with hydrologists and computer experts is highly recommended;
- Monitoring of surface water by basin organizations should be expanded as soon as possible to **aquifer systems**, often less well known. Collaboration with the organizations, when they exist, responsible for their management (OSS : Sahara and Sahel Observatory) is required;
- **Rainfall monitoring** requires a denser and more representative network (the entire river basin) than that with hydrometric stations.

Derived tools

Regarding applications, we noted the following points:

- For the development of forecasting (floods, droughts) or simulation **models** (allocation, prospect), a major effort towards data review is often necessary;
- In addition to the internal competences of the basin organization, additional highly specialized skills may be occasionally mobilized in the fields of metrology, data processing, data bases, information systems, whether for a specific **technical expert appraisal**, or for training or software development. A service providing contract and "on demand" technical assistance can be considered;
- The use and processing of **satellite imagery** can be very useful, especially for data badly investigated or measured;
- Collaboration with the **research** sector is advisable, for example in the field of climate change.

Climate change

Monitoring is essential with regard to the impacts of climate change on water resources:

- A fundamental aspect of adaptation is the knowledge and prediction of phenomena. Despite their large uncertainties that must become under control, it is necessary to use basin **models** developed by downscaling global models of the Intergovernmental Panel on Climate Change (IPCC);
- The links between **water, energy and food security** are fundamental (e.g. through large hydraulic infrastructure) as well as the links between water and forests;
- The transboundary basin organization helps to **raise the awareness** of decision-makers on the impacts of climate change on water resources and hence the need for monitoring.

5. APPENDIX – BIBLIOGRAPHY ON MONITORING

Code	Title	Project owner	Author	Date
MN1	Niger-HYCOS project. Project document - AFD & European Water Facility	NBA	NBA - WMO	July 2006
MN2	Basic study for the operationalization of the Niger Basin Observatory. Development Plan	NBA	SOFRECO / GEO-HYD	November 2010
MN3	Basic study for the operationalization of the Niger Basin Observatory. Definition of the Indicators	NBA	SOFRECO / GEO-HYD	November 2010
MN4	Establishment of a Computer Information System for forecasting the flows of the Niger river. Development of the forecasting models	NBA	ISL	July 2010
MN5	Regional workshop for dialogue on the assessment of the climate risk in the Niger river basin. Report	NBA	NBA	May 2010
MV1	Assessment of the hydro-meteorological situation in the Volta river basin. Assessment of the existing monitoring systems	VBA	SHER	January 2011
MV2	Project for improving Water governance in the Volta Basin (PAGEV). Water audit of the Volta basin	IUCN	Nii Consult	August 2007
MV3	Study on the establishment of a regional system for exchange of data and information on the Volta river basin	GEF-Volta	UNEP-GEF-UNOPS	December 2008
MO1	Regional Water Atlas of ECOWAS. Identification of data sources	WRCC	Emmanuel BALLOFFET	January 2007
MO2	Regional atlas of water resources in West Africa	WRCC	WRCC	2010
MC1	Congo-HYCOS. Preliminary project document	CICOS	WMO	April 2010
MS1	Technical Notes of the Observatory on the monitoring-assessment of the Status of the Environment in the Senegal River Basin	OMVS	OMVS	June 2005
MS2	Establishment of a health monitoring system in OMVS	OMVS	AEDES	July 2010
MS3	Handbook of procedures for health monitoring by OMVS – Version 1	OMVS	OMVS	March 2011
MA1	WHYCOS Directives	WMO	WMO	October 2005
MA2	9th WIAG meeting. Geneva, Switzerland. Draft Report	WMO	WMO	8-9 December 2011