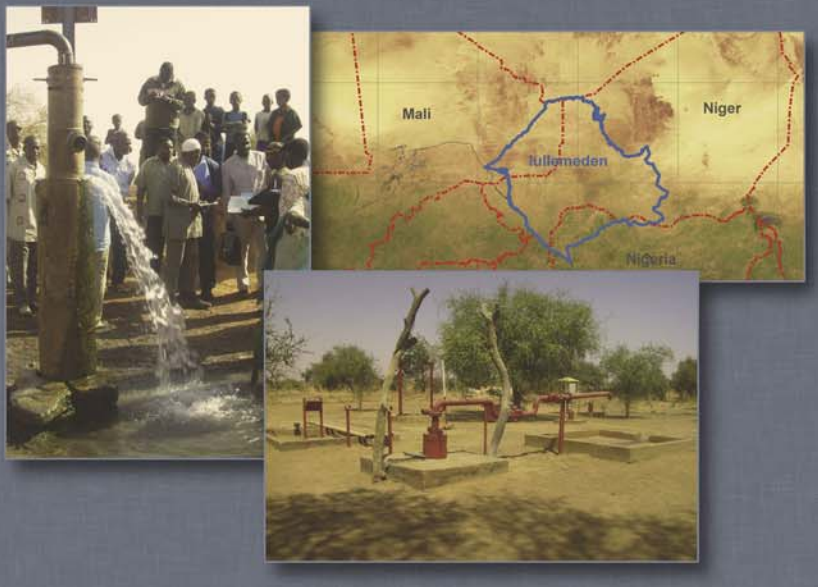
Synthesis Collection

No. 2

IULLEMEDEN AQUIFER SYSTEM

CONCERTED MANAGEMENT OF THE SHARED WATER RESOURCES OF A SAHELIAN TRANSBOUNDARY AQUIFER



OSS

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No. 2

THE IULLEMEDEN AQUIFER SYSTEM

(MALI, NIGER, NIGERIA)

Concerted management of the shared water resources of a Sahelian transboundary aquifer

Tunis, 2008

Synthesis Collection

No. 1 The North-Western Sahara Aquifer System (Algeria, Tunisia, Libya): joint management of a transborder water basin

No. 2 Iullemeden Aquifer System (Mali, Niger, Nigeria): concerted management of shared water resources of a sahelian transboundary aquifer

No. 3 Long-Term Environmental Monitoring in a Circum-Saharan Network: the Roselt/OSS experience

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CONTENT

INTRODUCTION

The Iullemeden Aquifer System, shared by Mali, Niger and Nigeria, designates a group of sedimentary deposits containing two major aquifers: the Intercalary Continental (IC) at the bottom and the Terminal Continental (TC) at the top. It covers an area of about 500,000 km² and represents the main perennial source of drinking water for the majority of this region's population.

The water resources of the Iullemeden Aquifer System (IAS) are considerable but their renewal is very limited. Part of the upper layer of the Terminal Continental is renewed through inputs from rainwater and the hydrographic network (ponds, temporary streams), whereas the deep waters of the Intercalary Continental, having little outcrop, are not easily renewed and are thus threatened to mining exploitation.

At present these water resources face the consequences of overexploitation such as decline of the piezometric level, degradation of water quality and the effects of climate change and variability.

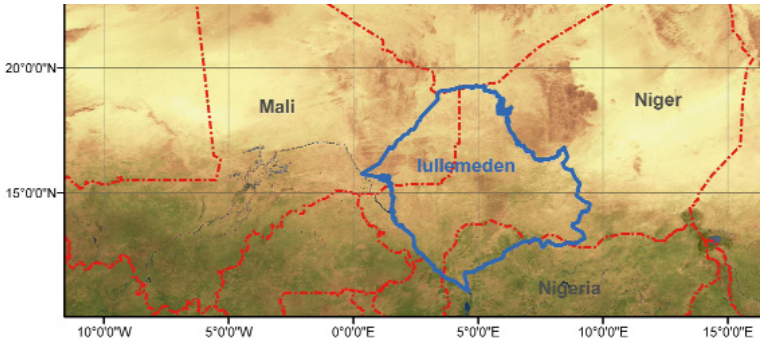
According to estimates made by the OSS project on "Management of hydrogeologic risks in the Iullemeden Aquifer System" annual withdrawals have increased from 50 million m³ in 1970 to 180 million m³ in 2004, mostly as a result of a high rate of demographic growth (about 6 million inhabitants in 1970 vs. 15 million in 2000 an probably double of that by 2025). The number of withdrawal points has gone from a few hundred points in the 1940-1950 period to some 17,200 points in 2007.

The first simulations run with the IAS mathematical model show with greater precision the zones at high risk of overexploitation. They also allowed to quantify the contribution of the ground-waters to the annual flows of the Niger river. The present document syntheses the main results produced by the "Managing

Hydrogeological risks in the Iullemeden Aquifer System" project. These outcomes offer Mali, Niger and Nigeria for the first time an opportunity to use appropriate decision-support tools for a sustainable development and a rational and concerted exploitation of their shared water resources.

IULLEMEDEN AQUIFER SYSTEM WHAT IS THE ISSUE?

The Iullemeden Aquifer System (IAS) lies under the arid and semi-arid zone of West Africa (Fig. 1). It stretches between latitudes 10°30 and 19°40 North and longitudes 0°50 and 9°20 East and has a total area of more than 500,000 km² (Mali: 31,000 km², Niger: 434,000 km², 60,000 km²). It is crossed by the Niger River and some of its affluents, including the Rima River (or Goulbi de Maradi in Niger).

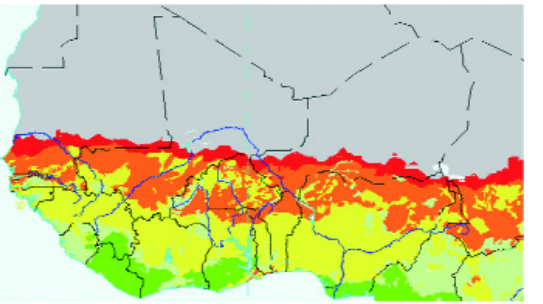


Source: ESA TIGER - AQUIFER Project, 2007

Figure 1: Geographic situation of the Iullemeden Aquifer System (IAS)

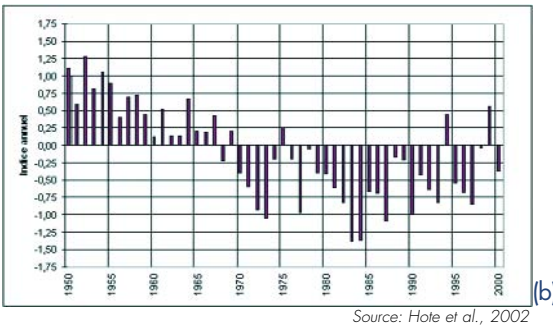
The Iullemeden Aquifer System is located in one of the earth's most vulnerable regions to climate change, desertification and drought, two phenomena that threaten, among other things, the recharge of aquifers (Fig. 2a). West Africa has been in the throes of a persistent drought since the 1970s (Fig. 2b) with a 20-30% drop in rainfall, leading to a 20 to 50% reduction in surface runoff as well as to sand bar and dune formation, particularly in the hydrographic network.

Figure 2a: Map of vulnerability to desertification (from US Department of agriculture, Washington D.C. 1998). Vulnerability level: Green = Low; Yellow = Moderate; Orange = High; Red = Very High)



(a)

Source: Department of agriculture, Washington D.C. 1998



(b)

Source: Hote et al., 2002

Figure 2b: Evolution of pluviometry in the Sahel (1950-2000).(from L'Hote et al., 2002)

As a result of a growing demand for water, withdrawals from the intercalary Continental (IC) and the Terminal Continental (TC) have spiraled in the last forty years. These water resources represent the only perennial source of water for the region's populations whose numbers have been increasing during that period. Agricultural use (particularly livestock breeding) and industrial use (especially mining) have also contributed to greater withdrawals from the IC and the TC. There has also been a degradation of water quality as a result of various forms of pollution. For example, the abstraction of deep and highly-mineralized groundwater has led to a surge in water-related diseases such as skeletal and dental fluorosis (more than 600 children affected are permanently crippled).

Riparian countries drill water points (boreholes, wells) and use the shared water resources of the basin without consulting each other. In fact, they are not aware of the dynamics of groundwater flows within the transboundary basin. Although there are organizations and authorities in charge of basins in this sub-region, such as the Niger Basin Authority (NBA) in charge of managing the transboundary

surface waters of the Niger River, there are no agreements or structures dedicated to the IAS that could give countries guidance and advice for defining and implementing a concerted strategy for managing this shared resource.

All of these factors made it imperative to undertake a comprehensive and joint study by the three riparian countries on shared water resources in IAS. OSS, in concordance with its Strategy 2010 and on the basis of its experience in the concerted management of transboundary aquifers in Africa – such as the North Western Sahara Aquifer System (NWSAS) shared by Algeria, Libya and Tunisia – instituted a partnership with the three riparian countries to engage in cooperation on issues related to IAS water resources.

The project, entitled "Managing Hydrogeological risks in the Iullemeden Aquifer System", was launched in January 2004, with funds provided by GEF, UNESCO, FAO, IAEA and ESA. Activities are undertaken by national teams that form National Coordination and Monitoring Committees (NCMC), with OSS serving as a facilitator for implementing the project. The main results, presented below, have increased considerably the knowledge that Mali, Niger and Nigeria have about these shared water resources.

OBTAINED SCIENTIFIC RESULTS

The IAS project led to a greatly improved knowledge of the functioning of IAS and generated common tools which the riparian countries could later organize and use to manage jointly these shared resources. This section will present the structure of the Iullemeden Aquifer System, the common Database and the Geographic Information System that have been set up to gather all collected data and use them for diagnosing the resource dynamics with a hydrodynamic model into which they are fed.

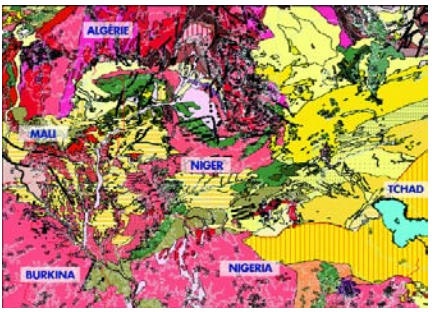
1- Common cartographic base

A detailed description of the geological structure of the zone allows to understand better the Iullemeden Aquifer System. On the basis of a topographical reference map and a digital geological map (Fig. 3a), the natural limits of the system have been identified on the basis of rock outcrops (Fig. 3b).

Using litho-stratigraphic sections and drilling logs, a geological analysis was carried out that provided a greater understanding of the area's geology. In order to preserve the hydraulic continuity between the various parts of the basin when moving from one country to another within the IAS, the simplified global image that has been chosen represents the system as two main aquifers: the intercalary Continental (IC) and the Terminal Continental (TC). The Terminal Continental incorporates the series of Tertiary aquifers and water tables assembled in Quaternary alluviums; it represents the first generalized aquifer level and covers an area of about 203,000 km^2. The second aquifer level, on which the TC lies and which covers an area of about 486,000 km^2, corresponds to the intercalary Continental and assembles locally the upper level of the Lower Cretaceous. These two main aquifers are separated by an aquitard constituted mainly of Paleocene and Eocene formations and incorporating locally (e.g. in Mali) part of the Upper Cretaceous.

Figure 3: Digital geological map (a) limits of the main IAS aquifers (b)

(a)



Source: OSS, oct. 2007

(b)

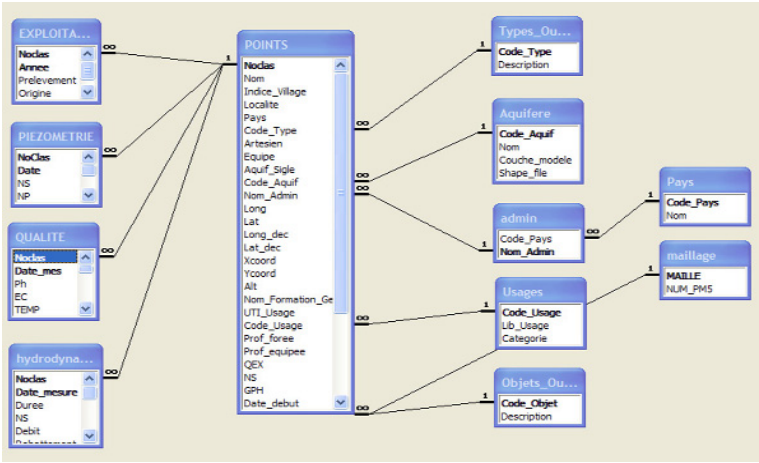
Source: OSS, déc. 2007

Thus, the Iullemeden Aquifer System will be considered, in the first phase of its conceptualization, as a "bi-layer" of a regional extension having a basin structure showing a thickening of its layers in the center and a reduced thickness towards the edges. It will further be noted that the western flank of the IAS shows a large regional fault running in a parallel direction with the Niger River.

2- Database and Geographic Information System

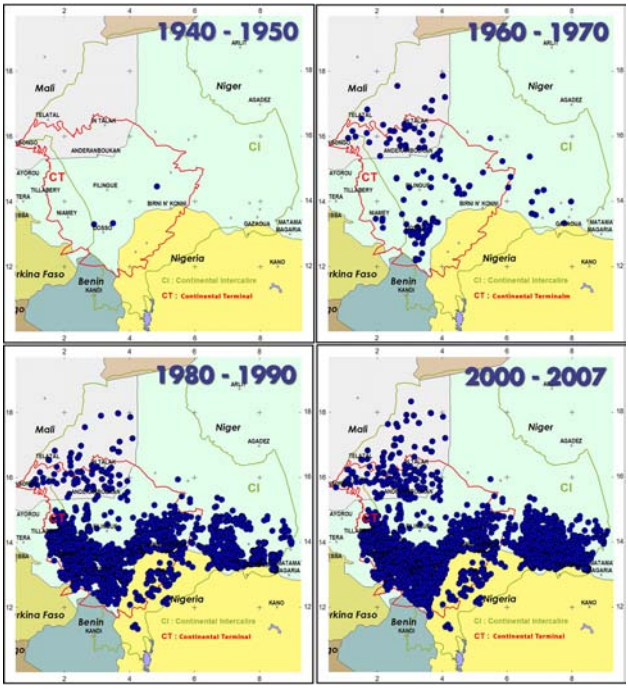
The IAS common database contains data collected by the three riparian countries. The data relate to the IAS climatology, hydrology, geology and hydrogeology. Hydrogeological data pertain to some 17,200 inventoried water points: 740 in Mali (4%), 16,170 in Niger (94%) and 300 in Nigeria (2%). The data have been collated, organized and stocked in a relational database (Fig. 4a) which is common to the three riparian countries so that they can use it with greater ease.

The database has been linked to a Geographic Information System (GIS) to generate thematic maps that facilitate information processing and allow users to visualize the data, becoming as a result useful decision-support tools (Fig. 4b). These are maps representing the evolution of the number of water points at ten-year intervals, piezometric maps, transmissivity maps, and geological and hydrogeological correlation maps. The maps give a clear visual rendering of the high increase in the number of withdrawal points in the Iullemeden Aquifer System during the last 40 years, and in particular the transition from the decade 1960-1970 to the decade 1980-1990, the latter having been proclaimed by the United Nations General Assembly as the International Drinking Water Supply and Sanitation Decade (IDWSSD). States made a commitment to improve during the decade the standards and the quality of water supply and sanitation and to increase the number of water points to provide access to potable water.



(a)

Source: OSS, oct. 2007



(b)

Source: OSS, oct. 2007

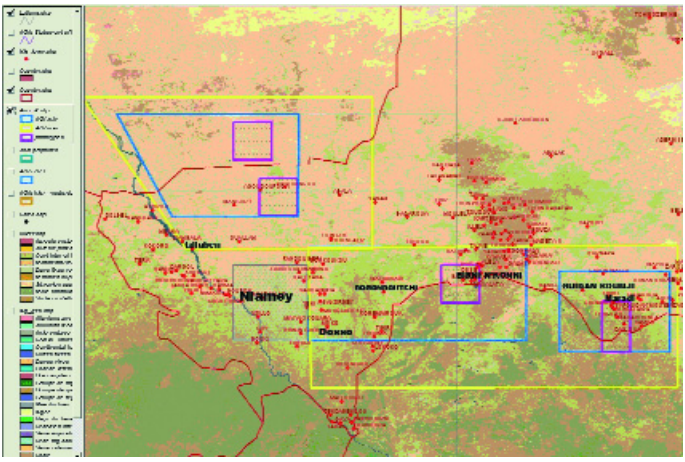
Figure 4: IAS Relational Database Structure (a), and maps showing distribution of water points in IAS at ten-year intervals (b)

3- Contribution of remote sensing to an improved knowledge of shared aquifers

Aside from data collected by the three countries, those generated by images taken from Earth Observation satellites provided additional information; this activity is undertaken in the framework of the AQUIFER project with the support of the European Space Agency and the active participation of the three riparian countries and the regional AGRHYMET center based in Niamey. Pilot zones have been selected within IAS (Fig. 5) for which the following products have been generated:

- Land cover maps for Banibangou pilot area in Niger, Birni N'Konni and Maradi on the Niger-Nigeria border, with images from Landsat and Alsat;
- a map of surface water dynamics for Banibangou pilot area, Birni n'Konni and Maradi with radar pictures from ERS/SAR and ENVISAT/ASAR;
- Digital elevation Models for the Banibangou pilot area first, then for the entire IAS basin, from radar images ERS/SAR;
- map of IAS groundwater balance (aquifer recharge) generated on the basis of an annual evapotranspiration map and a map of annual precipitation in 2005.

All of these results provided valuable information for a better understanding of the system in the pilot zones. More importantly, this pilote project made it possible to evaluate accurately the potential use of remote sensing in studying the behavior of an aquifer system such as IAS. As part of the project, training sessions have been organized for the various departments in charge of water management in the three countries so as to allow experts to acquire skills in using remote sensing tools and principles in monitoring water resources, particularly through an analysis of land cover. Eventually, an extension of the use of remote sensing to the entire IAS will help improve estimations of water demand for agricultural use.



Source: ESA TIGER - AQUIFER Project, 2007

Figure 5: Representation of intervention zones in IAS space

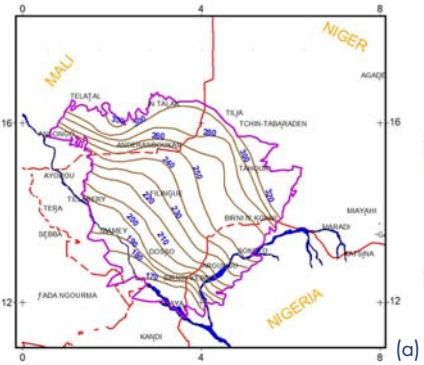
4- Groundwater water dynamics flow in IAS

Activities undertaken in the framework of the IAS project have really improved knowledge of the hydrodynamic flow in the entire basin. Using existing work and newly acquired data, piezometric maps of the initial condition (1970 being the base year) of the IC and TC have been generated. Initial condition refers to the steady state of the aquifer system undisturbed by withdrawals.

These piezometric maps, which are also available on the GIS, provide a visual representation of the directions of the aquifer's groundwater flows. Thus, the piezometric map of the Terminal Continental (TC) (Fig. 6a) shows the main drainage axes of the TC water table, oriented northwest- southeast and northeast-southwest. Recharge zones are in the northeast (in Niger) and northwest (in the Taoudeni basin in Mali) ridges, as well as in the south with input from the Rima River (or Goulbi de Maradi). Groundwater flows mainly from the northwest, north and northeast towards the south. Drainage zones are mainly the Niger River and the Rima River, one of its affluents.

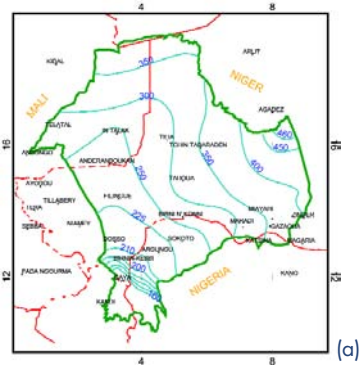
As for the piezometric map of the intercalary Continental (Fig. 6b), it shows that the main recharge areas are the Hoggar mountains in the north and the Rima River in the south. Groundwater flows from the north, northwest and northeast towards the south. The main outlet of the intercalary Continental aquifer is the Niger River.

Figure 6: Piezometric map of the IC and TC in 1970



(a)

Source: OSS, déc. 2007



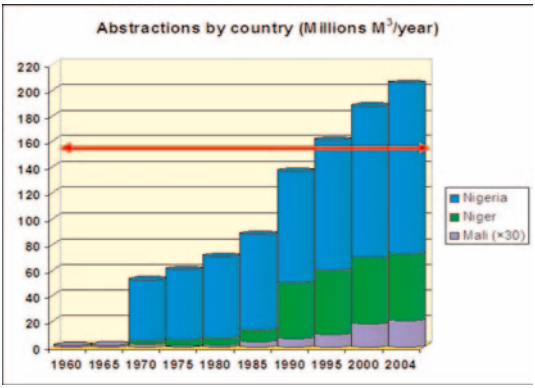
(a)

Source: OSS, déc. 2007

5- IAS mathematical model

With the data that have been collected and gathered, and an improved understanding of the system, it was possible to represent IAS in a mathematical model, and to simulate the dynamics of its water resources. The IAS hydrodynamic model which has been elaborated makes it possible to run simulations and to make forecasts. The system's behavior has been simulated first for the period starting with the initial state in 1970 up to 2004 (for which data are available); this allowed the model to be calibrated. The model yielded the first results on the dynamics of groundwater flows, estimates of levels of water resources abstraction, and the evolution of piezometric decline in the two aquifers. The results are as follows:

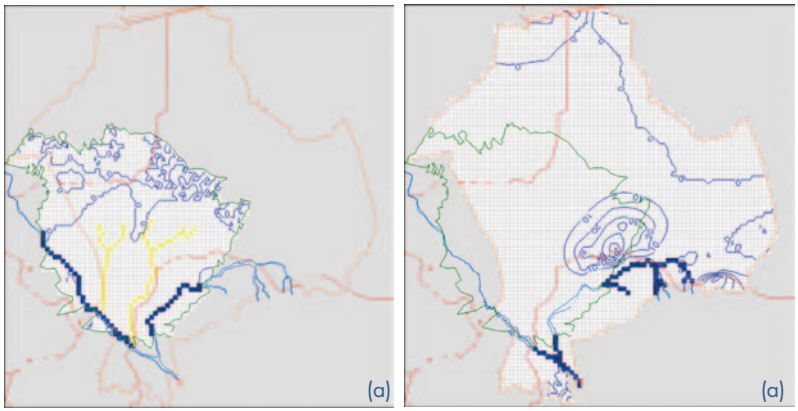
- Precising the water balance of Iullemeden Aquifer System at the initial state taken in 1970;
- Highlighting and measuring the two-way exchanges of water between the river Niger and the aquifer. The Niger River gets about **46 million m³/year** from the IC and **79 million m³/year** from the TC, for an annual total of **125 million m³**. Its tributary Rima River provides about 20 million m³/year to the IC and receives about **12 million m³/year** from the TC before joining the Niger river.
- Highlighting the overexploitation whose critical breakpoint was reached in 1995: that year withdrawals – estimated at **152 million m³/year** – began to exceed recharge which is estimated at **150 million m³/year** (red line on Fig. 7).



Source: OSS, déc. 2007

Figure 7: Critical breakpoint of over-exploitation was reached in 1995

Simulation results show that drawdown is negligible in the Terminal Continental (TC) with a maximum of 5 meters in 34 years (1970-2004) in the Goulbi de Maradi sector (Fig. 8a), whereas drawdown is highest in the eastern part of the basin around the village of Birni N'Konni, where it reaches 62 meters for the same period (Fig. 8b). These results show that the aquifer system is complex and that prevailing ideas that the groundwater resource is underexploited should be revised.



Source: OSS, déc. 2007

Figure 8: Drawdown in the TC (a) and the IC (b) en 2004

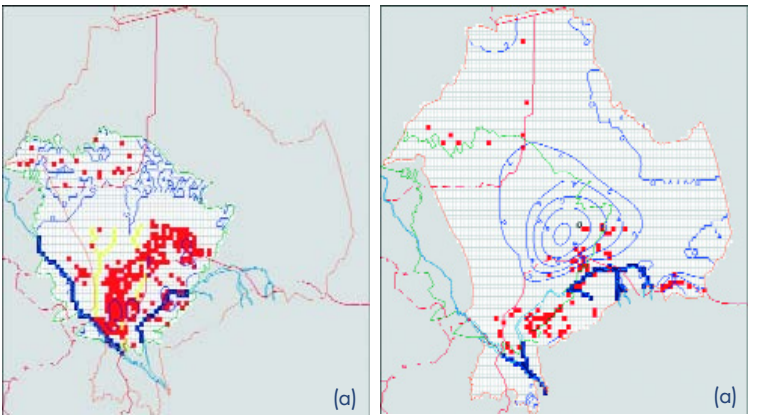
Exploratory simulations

These results have been used to simulate the behavior of the system for the period 2004-2025 using the zero (null) hypothesis, this approach being required for estimating the impact of future additional withdrawals. It consists in hypothesizing

that withdrawals remain constant over the years at their 2004 level (180 million m^3/year) and then simulating their impact on water resources by the year 2025.

The results of this forecast simulation show that there would be an additional two-meter drawdown for the IC (Fig. 9a) by 2025. This relatively small decline is due to the annual recharge of this water table through direct infiltration coming from precipitation and by Niger River discharges.

However, for the intercalary Continental which is quasi confined, there would be a drawdown of 10 meters by 2025 (Fig. 9b). Since the IC water resources renewal is limited, this aquifer runs the risk of an ever-increasing depletion for the medium to long term.



Figures 9: Additional drawdown in the TC (a) and the IC (b) by 2025

Source: OSS, déc. 2007

Furthermore, forecast simulations for 2025 pinpointed the **zones most vulnerable** to high water table depletion as a result of **additional withdrawals** (Fig. 9). In Niger they are located in the **Birni N'Konni** region (Malbaza factory), in Nigeria in the **Sokoto** region, and in Mali in an area located in the north part of the village of **Menaka**. In other words, additional withdrawals should be made away from these sites.

CONSULTATIVE MECHANISM BETWEEN THE THREE COUNTRIES

In addition to the joint technical activities that have been undertaken, the three riparian countries (Mali, Niger, Nigeria) need to establish close cooperation to achieve a joint management of this shared resources. To that end, the Transboundary Diagnostic Analysis (TDA) process – developed by GEF – has been compiled. TDA will be described below. At the same time, the three countries have started thinking about setting up a joint consultative mechanism.

1- Transboundary Diagnostic Analysis (TDA)

1.1- TDA methodology

Transboundary risks that may affect IC and TC groundwater resources have been analyzed applying the TDA/SAP (Transboundary Diagnostic Analysis/Strategic Action Program) developed by GEF for International Waters and adapted to the transboundary groundwaters of the Iullemeden Aquifer System. The Transboundary Diagnostic Analysis is a tool that studies scientific and technical facts to determine the quantity of water resources and the nature and impact of transboundary threats that confront these resources. In other words, TDA uses available and verified technical and scientific information to examine the state of the environment and the deep causes of its degradation. The analysis is trans-sectoral and focuses on transboundary problems, although it does not ignore national concerns and priorities. As for the Strategic Action Program (SAP), it is a negotiated policy document that identifies political, legal and institutional reforms that need to be undertaken and required investments in order to resolve priority transboundary problems. SAP set clear priorities for actions aimed at resolving transboundary priority problems identified in the

TDA. GEF encourages a participatory approach for TDA/SAP that involves all stakeholders concerned with the transboundary problems to be analyzed.

The Transboundary Diagnostic Analysis (TDA) was carried out by the project's National Coordination and Monitoring Committees (NCMC) and national consultancies, on the basis of existing and available data and information. The NCMC set up in each country is multidisciplinary: it includes governmental institutions (Ministries of hydraulic, environment, agriculture, livestock, foreign affairs for transboundary legal issues, Water institutions) and also non governmental organizations (NGO) dealing with water issues. During their periodic meetings, the committees discuss risks incurred by IAS water resources and evaluate investigations carried out by national consultants.

1.2- Identified risks

Transboundary risks that threaten groundwater resources have been identified on the basis of analyses made by NCMC and the national consultants and investigations carried out by the OSS team. They relate to the effects of climate change, particularly extreme events such as droughts and floods, deforestation, overexploitation of water resources, decreasing artesian pressure, water pollution, high soil salinity, inadequacy of the aquifer monitoring network and the non concerted use of water resources. A finer analysis of those risks was then made in order to identify priorities. The objective was to verify:

- the transboundary character of the risk;
- how serious is the risk in relation to national priorities and regional and international conventions as well as various global initiatives;
- the impact that the risk may have on the economy, the environment and public health;
- the expected benefits of dealing with the risk.

The analysis showed, among other things, that some risks may be either the cause or the consequence of observed problems. Thus, lower artesian pressure or a decline of the piezometric level of water tables are a consequence of the excessive withdrawals combined with the impact of climate change and variability. Deforestation is among the causes of climate change and contributes to global warming. Aquifer pollution is a major risk. Use of water resources reduces available quantities. A non concerted use of the common resource is linked to water-use governance defined in each country's legislative and institutional

mechanisms. Other transboundary risks relate particularly to surface waters. This detailed prioritization of transboundary risks was established by the countries and the OSS team working on the project. This second analysis indicates that there are three types of transboundary risks that represent major concerns shared by the three riparian countries and for which sustainable solutions cannot be find through the efforts of a single country; the three types of risks are given below.

Priority transboundary risks identified by the Transboundary Diagnostic Analysis of the Iullemeden Aquifer

1. **decrease of water resources**: it is due to the combined effects of growing withdrawals, and reduced recharge of the aquifers as a result of decreasing rainfall;
2. **degradation of water quality**: it is caused by groundwater by the disposal of wasted waters that do not meet quality standards, and the abstraction of highly-mineralized groundwaters (fluorides);
3. **impacts of climate variability/change**: this major risk, often called "climate change/variability", has the special feature of being simultaneously the cause and the consequence of certain conditions.

2- Consultative mechanism between the three countries

Having become aware of these major transboundary risks that threaten their common water resources, the riparian countries that share the IAS recognized the need to work together to eliminate or, at least, to mitigate them. A comprehensive survey of legal and institutional texts, bilateral and multilateral agreements, and sub-regional institutions and organizations (NBA, LCBC, ALG) was undertaken. The three riparian countries confirmed that **there is no agreement or structure aimed specifically at the IAS, either bilateral or trilateral, that could provide guidance or assistance for defining and implementing a strategy for a joint management of transboundary aquifers**. At best, existing inter-state agreements and institutions deal with IAS water resources in a marginal and indirect way.

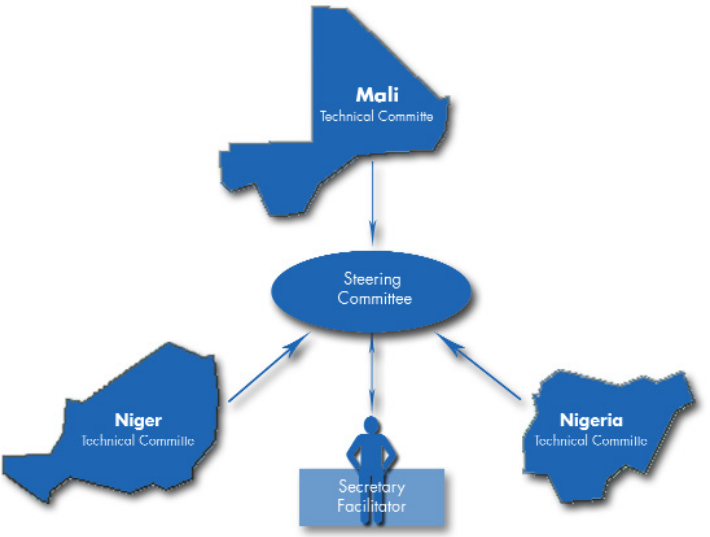
As project activities progressed and common results and products were obtained, national teams showed a growing appetence for joint management of the basin.

Scientific and technical consultations between the countries encouraged the exchange of data and information to improve knowledge about the IAS. At national and regional workshops countries recognized the need to start the process of defining and instituting a consultative mechanism for an efficient management of groundwater resources of the Iullemeden Aquifer System. The mission and structure of such a mechanism have to be defined in such a way that it would coordinate the joint management of the IAS resources before they fall in a situation of water stress. Consequently, at a regional workshop held at FAO headquarters in Rome on 19-20 Oct. 2006, the three countries unanimously agreed to create a consultative mechanism.

During a transitional period the consultative mechanism will rely on existing national organizations and will be housed in an existing sub-regional institution. The consultative mechanism structure (Fig. 10) includes:

- at the policy level, a **tripartite steering committee**;
- a **scientific/technical committee** in each country to be chaired by the head of the department in charge of water resources;
- a secretary appointed by the countries, to act as a "facilitator".

Figures 10: IAS transitional mechanism



Source: Nanni, 2005

The mechanism's main attributions are to:

- improve and update the common knowledge base. To that end it shall (i) define an initial monitoring-evaluation program related to water in the IAS (quantitative and qualitative aspects), land uses and land degradation within the aquifer's recharge zones, (ii) oversee the harmonization of procedures and methodologies for monitoring and for data collection, and (iii) define guidelines for the maintenance of the common database.
- Define methodologies for identifying risks to which IAS water resources and associated natural resources may be exposed;
- Identify and map IAS vulnerable zones;
- Prepare a setting conducive to the creation, at the end of the transitional period, of a permanent consultative mechanism.

CONCLUSION

Water resources in the Iullemeden Aquifer System are subjected to increasing withdrawals. They are exposed to a lowering of piezometric levels, degradation of the water quality, and the negative effects of climate variability and change.

The main results and products generated by this study offer Mali, Niger and Nigeria an opportunity to acquire for the same time appropriate decision-support tools. These are mainly basin-wide digital topographic and geological maps, a common database, a common Geographic Information System, and a common mathematical model.

Thanks to these tools it has been possible to:

- improve knowledge of the groundwater flow dynamics,
- define the system's water balance,
- confirm and measure the contribution to the Niger River discharge from the TC and IC water tables, and
- identify zones that could be negatively affected by additional withdrawals.

While activities were underway for this first phase of the project, national teams came to share a feeling of technical and scientific cooperation, and they recognized the need to start a process for defining and setting up a consultative mechanism for an efficient management of their common resource. It is a fact that so far there is no structure capable of guiding and advising them for defining and implementing a strategy for a concerted management of transboundary aquifers.

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ACRONYMS

ALG	*Autorité de développement intégré du Liptako-Gourma* [Liptako-Gourma Integrated Development Authority]
AGRHYMET	*Agronomie hydrologie météorologie*
ASAR	Advanced Synthetic Aperture Radar
CBLT	*Commission du bassin du lac Tchad* [Commission for the Lake Chad basin]
CT	*Continental Terminal*
ENVISAT	Environment Satellite
ERS	European Remote Sensing Satellite
ESA	European Space Agency
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
IAEA	International Atomic Energy Agency
IAS	Iullemeden Aquifer System
IC	Intercalary Continental
IDWSSD	International Drinking Water Supply & Sanitation Decade
NBA	Niger Basin Authority
NCMC	National Coordination & Monitoring Committees
NWSAS	North Western Sahara Aquifer System
OSS	*Observatoire du Sahara et du Sahel*
SAR	Synthetic Aperture Radar
TDA/SAP	Transboundary Diagnostic Analysis/Strategic Action Program
UNESCO	United Nations Education Science and Culture Organisation

IAS PARTNERS

National partners

Direction de l'hydraulique, ministère des Mines, de l'Énergie et de l'Eau (Mali)

Direction des ressources en eau, ministère de l'Hydraulique, de l'Environnement et de la Lutte contre la Désertification (Niger)

Direction of Hydrology and Hydrogeology, Federal Ministry of Water Resources (Nigeria)

Financial and Scientific partners

AIEA

ESA

FAO

GEF

UNESCO

UNEP

IULLEMEDEN AQUIFER SYSTEM

The Iullemeden Aquifer System, shared by Mali, Niger and Nigeria, designates in the framework of this study a group of sedimentary deposits containing two major aquifers: the Intercalary Continental (IC) at the bottom and the Terminal Continental (TC) at the top.

IAS water resources are considerable but their renewal is limited. In the last 30 years withdrawals have increased from 50 million m^3 in 1970 to 180 million m^3 in 2004, mostly as a result of a high rate of demographic growth. The number of water points (boreholes, wells) has gone from a few hundreds in the 1940-1950 period to some 17,200 in 2007.

At present, these water resources are threatened by overexploitation, quality degradation, and the effects of climate variability and change. The first simulations run with the IAS mathematical model identified the zones exposed to the risk of overexploitation. They also allowed the quantification of the contribution of groundwaters to the annual flow of the Niger River.

The riparian countries recognized that there is no structure dedicated to the IAS that could give them guidance and assistance to define and monitor the implementation of a strategy for a concerted management of transboundary aquifers. Convinced that no country could single handedly mitigate or eliminate the consequences of those transboundary risks, the countries agreed to create and set up the structure of a consultative mechanism to allow a better coordination of the concerted management of the IAS resources.

Acting to encourage and facilitate member activities in the framework of transboundary projects, and using its approach and its dynamic and multidisciplinary method for the concerted management of transboundary aquifer, OSS initiated the IAS and is overseeing its implementation.

IAS PARTNERS

Mali
Niger
Nigeria

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