

GEF

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May 21, 2003

Dear Council Member:

I am writing to notify you that we have today posted in the GEF's website at www.gefweb.org, a medium-sized project proposal from UNEP entitled ***Regional (Niger, Mali, Nigeria): Managing Hydrogeological Risk in the Iullemeden Aquifer System***. The GEF will contribute \$958,000 towards a total cost of \$1,738,000.

Within the goal of sustainable environmental protection and sub-regional and national development, the general objective of the project is to establish capacity under a sustainable cooperative framework for joint management of risk and uncertainty, to jointly identify, reduce and mitigate transboundary risk from changing land and water use and from climate change in the shared Iullemeden Aquifer System.

The project proposal is being posted for your information. We would welcome any comments you may wish to provide by **June 12, 2003**, in accordance with the procedures approved by the Council.

If you do not have access to the Web, you may request the local field office of the World Bank or UNDP to download the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such a request, please confirm for us your current mailing address.

Sincerely,

cc: Alternates, Implementing Agencies, STAP



United Nations Environment Programme

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PROGRAMME DES NATIONS UNIES POUR L'ENVIRONNEMENT • PROGRAMA DE LAS NACIONES UNIDAS PARA EL MEDIO AMBIENTE
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DIVISION OF GEF COORDINATION

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TELEFAX TRANSMISSION

To:

Mr. Kenneth King
Assistant Chief Executive Officer
GEF Secretariat
Washington, D.C. 20433, **USA**

Date: 7 April 2003

(1 202) 522 3240/3245

ATTN: GEF Programme Coordination

Mr. Lars O. Vidaeus
Executive Coordinator, The World Bank

Frank Pinto
Executive Coordinator
UNDP/GEF,

Ms. Julia Carabias
Chairman of STAP

From:

Mr. Ahmed Djoghlafe
Director
Division of GEF Coordination

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Subject **IW MSP OP#9 "Managing Hydrogeological Risk in the Iullemeden Aquifer"**

Please find attached a Medium Sized Project entitled "Managing Hydrogeological Risk in the Iullemeden Aquifer" for your review and comments.

Your comments will be appreciated by 25 April 2003.

Regards.

MANAGING HYDROGEOLOGICAL RISK IN THE IULLEMEDEN AQUIFER SYSTEM

GEF Medium Size Project

PROJECT BRIEF

March 2003

MANAGING HYDROGEOLOGICAL RISK IN THE IULLEMEDEN AQUIFER SYSTEM

ACRONYMS

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ACRONYMS

AMCOW	African Council of Ministers on Water
CDD	Convention to Combat Desertification and Drought
CILSS	<i>Comité Permanent Inter Etats de Lutte Contre la Sécheresse au Sahel, Ouagadougou</i>
DDC	Swiss Development Corporation
ECOWAS	Economic Community of West African States, Abuja
ETH-IAH	<i>Eidgenössische Technische Hochschule (Zürich)- Water Resources Institute</i>
FMWR	Federal Ministry of Water Resources (Nigeria)
FAO	Food and Agriculture Organization
IAEA	International Atomic Energy Agency
IAS	Iullemeden Aquifer System
IGRAC	International Groundwater Resources Assessment Centre
IRD	<i>Institut de Recherche en Développement, France</i>
ISARM	Internationally Shared Aquifer Resources Management, initiative
LADA	Dryland Land Degradation Assessment (GEF project)
MSP	Medium Size Project (GEF)
NBA	Niger Basin Authority; UNDP-GEF PDFG project
NEPAD	New Partnership for Africa's Development
NNJC	Niger-Nigeria Joint Commission for Cooperation
NNOCC	UNEP/UNDP-GEF: Management of Shared Catchments between Niger and Nigeria.
OSS	<i>Observatoire du Sahara et du Sahel, Tunis</i>
PPCMN	Mali-Niger Protocol, 12 July 1988
SAP	Strategic Program of Action (GEF)
SRAP	Sub-Regional Action Programme for West Africa (CCD)
TB	Transboundary
TDA	Transboundary Diagnostic Analysis
3WWF	3 rd World Water Forum, Kyoto, 2003
UMR	Hydro-Science, University of Montpellier
UNESCO	UN Educational, Scientific and Cultural Organization
WAWS	West African Water Sector, Ouagadougou
WWSD	World Summit on Sustainable Development, Johannesburg, 2002

MSP PROJECT BRIEF

PROJECT IDENTIFIERS	
1. Project name: MANAGING HYDROGEOLOGICAL RISK IN THE IULLEMEDEN AQUIFER SYSTEM	2. GEF Implementing Agency: UNEP
3. Country or countries in which the project is being implemented: Mali, Niger, Nigeria	4. Country eligibility: Mali, Niger, Nigeria are eligible for GEF funds.
5. GEF focal area(s): IW-International Waters	6. Operational program/Short-term measure: Operational Program # OP9 Integrated Land and Water. Relevant to OP#1 on Arid and Semi-arid Ecosystems.
<p>7. Project linkage to national priorities, action plans, and programs:</p> <p>Recently established national water resources strategies in the countries sharing the Iullemeden sedimentary groundwater basin recognize the strategic importance of integrated land and water resources management and conservation to reduce risk and uncertainty and sustain national and regional development. The national policies give high priority to the management of internationally shared water resources. In the Iullemeden basin area non-sustainable agricultural development, driven by demands for food and livelihood for growing populations, is expanding rapidly into marginal, low-rainfall areas. As a result land degradation from uncontrolled land use changes affects and upsets the balance in the recharge areas and humid zones in the aquifer basin. The resulting threats from adverse local and regional impacts on the aquifer resources represent a potential, and actual cause for international water conflict. National development-oriented country water resources policies have recently been complemented with water and land conservation strategies with due attention to management of the shared water resources. The countries have become aware of the ineffectiveness and growing transboundary risk of pursuing individual country approaches to land and water resource management in shared aquifer resources systems. In this situation, based on the recent adjustments in national land and water resources management policies, the three countries have confirmed the priority to collaborate and strengthen common research for development and implementation of social and decision-making policies for joint management and monitoring of transboundary risk to address the threats from land use change, inappropriate and uncontrolled water and land use and reduced precipitation and impacts of climatic change on the shared Iullemeden aquifer system.</p> <p>The domestic water resources sectors in the three countries sharing the Iullemeden aquifer resources have recently been decentralised to local level with the role of the central governments focused on regulation, monitoring and control. With adjusted national water resources policies supported in recent updated national water legislations (The 2002 Malian Water Act, the 1998 Nigerien Water Act and the 1993 Nigerian Federal Water Decree have been updated for enhanced inter-sectoral integration and decentralised water administrations and have been or are currently complemented with implementing regulations), the basic domestic legal, policy and institutional frameworks for implementation of joint risk management measures are largely in place.</p> <p>With the sub-regional importance of the Iullemeden groundwater resources and in view of the water scarcity and potential for water conflict in the sub-region, the water and land policies substantiated under a new sub-regional West African water sector established in 2001 and the recently developed West African Regional Action Plan on Integrated Water Resources Management under ECOWAS, give high priority to joint management of the transboundary surface and groundwater resources in the sub-region.</p> <p>Following a regional seminar on the Iullemeden aquifer system in 1999, the formulation of the GEF-MSP was initiated in July 2001 with working meetings in the water ministries in Bamako, Niamey and Abuja and discussions with ECOWAS in Abuja. The initiative for joint management of transboundary risks in the shared Iullemeden aquifer system with the priority focus on the recharge areas and humid zones and integrated land and water resources management was identified and endorsed in a sub-regional technical consultation in UNESCO, Paris, in February 2002. The meeting included the participation of senior water officials and national experts from Mali, Niger and Nigeria together with</p>	

international experts, including representatives of UNEP, OSS and ETH and the members of the scientific working group of the UNESCO/ISARM initiative.

A draft project brief for the MSP was presented in the International Workshop on “Managing Shared Aquifers Resources in Africa”, in June 2002. The international workshop, in its recommendations to NEPAD, AMCOW, WSSD and 3WWF, proposed the Iullemeden project as a first priority activity under an ISARM Strategic Action Plan for Africa.

8. GEF national operational focal point and date of country endorsement:

The letters of endorsement from the GEF Focal points in Mali, Niger and Nigeria are attached.

PROJECT OBJECTIVES AND ACTIVITIES

9. Project rationale and objectives:

The Iullemeden sedimentary groundwater basin is located in Mali, Niger and Nigeria with minor, non-connected sections in Algeria and Benin. The aquifer basin covers an area of 525 000 km² with 31 000 km² in Mali, 434 000 km² in Niger and 60 000 km² in Nigeria. The basin population of approximately 15 million, with 65 per cent in Niger, 34 per cent in Nigeria and 2 per cent in Mali, is projected to grow to 28 million in 2025.

The aquifer system receives substantial modern recharge along its basement fringes in the river valleys with runoff from the bordering highlands in Mali, Niger and Nigeria. The upper Iullemeden aquifer is largely unconfined and recharged locally from rainwater infiltration in permeable sections and concentrated to depressions and humid zones with seasonal or permanent standing water. Over the last 50 years the land use in the recharge areas has changed and affected the recharge to the upper aquifer. With agriculture expanding into marginal low-rainfall areas and resulting land use change in recharge areas and humid zones the environmental threats and transboundary risks in IAS are growing. The adverse impacts are expected to be amplified further from climate change with reduced precipitation and increasing evaporation losses and impacts from declining water levels on the vegetation cover in the humid zones. In addition the risks for degradation in water quality, with transboundary implications, from salinization, water pollution and inter-aquifer leakage and contaminant transport need to be identified and managed. Management of transboundary issues are subjected to and need to be handled with due recognition of the actual conditions of high scientific, policy and political uncertainty.

The principal environmental threats that are common to and will have to be shared between the countries in the IAS, are direct and indirect adverse impacts on the aquifer resources from land use change in recharge areas and humid zones and climatic change with reduced precipitation and increased evaporation. These emerging threats are expected to become aggravated with increased

General Indicators:

1. a risk-based approach for joint, basin-wide identification and management of transboundary risk under high scientific, policy and political uncertainty in the IAS, is introduced and operationalized.
2. transboundary risk identification is focused on uncertain and less visible impacts from extensive, long term land use change in recharge areas, climatic change and expanded extractions and growing risk of ground water pollution and water and land salinization.
3. risk and uncertainty issues are reviewed and addressed through joint policy for measures that include shared preparedness and transparent structures for sharing of risk and responsibilities.

<p>abstractions and environmental degradation of the aquifer resources and result in growing international pressures and water conflict.</p> <p>The following two categories of <u>environmental threats</u> in the IULLEMEDEN basin with transboundary risk and conflict have been identified:</p> <ol style="list-style-type: none"> 1. <u>Loss of strategic shared aquifer resources from:</u> (a) land use change in recharge areas and humid zones of the IAS, (b) climatic change, and (b) over-extraction and human-induced water pollution and water and land salinization, and 2. <u>Increased international water stress,</u> and transboundary risk, <p>These threats will be addressed by the project through the establishment of joint mechanism and cooperative frameworks for: (a) identification of transboundary risk and uncertainty issues, (b) formulation of joint risk mitigation and sharing policy; and (c) joint policy implementation through a joint IAS legal and institutional cooperative framework.</p> <p>The scope for management of transboundary risk and conflict in the IAS is constrained by the scientific uncertainty on the aquifer system and by the impacts of climatic change. Further causes for indecision relate to social and policy uncertainty and unawareness. To address these risk and uncertainty aspects the project will adopt a risk-based management approach. The emphasis can be expected to be on preparedness, responsibility, with monitoring and feedback to jointly address, mitigate and share risk and reduce uncertainty.</p>	
<ol style="list-style-type: none"> 11. Project Outcomes <ol style="list-style-type: none"> a. Joint mechanisms for identification of transboundary risk issues in the IAS, b. Joint mechanisms for policy formulation and implementation to address transboundary risk issues in the IAS, c. A joint development and conservation strategy for the IAS, d. A joint tripartite legal and institutional cooperative framework for the IAS. e. Joint programmes for awareness, participation and inter-government communication 	<p>Indicators:</p> <p><u>Process Indicators:</u></p> <ol style="list-style-type: none"> i. Existence of a jointly prepared and politically accepted Transboundary Diagnostic Analysis, based on country positions and perceptions, identifying transboundary concerns, risk and uncertainty in the IAS, ii. Existence of an inclusive and consistent joint basin-wide process of risk identification, policy formulation to address identified risk and implementation of identified policies, including <ul style="list-style-type: none"> - a common database with capacity for selected focused modelling of the IAS for identification of transboundary risk issues, - joint mechanisms at basin level for: (a) Identification of transboundary risk and uncertainty issues; (b) Development of policies to address identified risk issues, (c) A joint

	<p>address identified risk issues, (c) A joint development and conservation strategy for the IAS, and (d) Implementation of agreed risk reduction policies.</p> <p>iii. Existence of a joint legal and institutional Iullemeden cooperative framework, including:</p> <ul style="list-style-type: none"> - recognition of opportunities for institutional sustainability and integration with parallel initiatives (NBA, NNOCC) for cross-border land and water management and conservation, - mechanisms for harmonization of national policies and legislation, - a basin organization structure approved and committed for continuing support by the countries and their development partners, and - existence of a transboundary aquifer monitoring system with basin - wide and national components.
<p>11. Project activities to achieve outcomes:</p> <p>Component 1: Identification of Transboundary Risk. The Component, at a total cost of US\$ 555 000 (GEF: US\$ 185 000, Co-financing/associated project: US\$ 370 000), includes (4) activities. Government in-kind contributions, US\$ 75 000.</p> <ol style="list-style-type: none"> 1. <u>Transboundary Diagnostic Analysis</u>: at a total cost of US\$ 90 000, (GEF: US\$90 000), 2. <u>Modelling Capacity Building</u>: at a total cost of US\$ 30 000, (GEF: US\$ 30 000), 3. <u>Field Studies of Aquifer Recharge</u>: at a total cost of US\$ 85 000, (GEF: US\$ 65 000, Co-financing: US\$ 20 000), 4. (a) <u>Establishment of a Common Risk Identification Data Base</u>; and (b) <u>Targeted Pilot Area Surveys</u>: at a total cost of US\$ 350 000 (Co-financing/associated project: US\$ 350 000). <p>Component 2: Policy and Institutional Mechanisms for Reducing Transboundary Risk (Management Framework), total cost US\$ 450 000 (GEF: US\$ 150 000, Co-financing/associated projects: US\$ 300 000), includes (3) activities. Government contributions US\$ 42 000.</p> <ol style="list-style-type: none"> 1. <u>Establishment of Mechanisms for Formulation of Risk Reduction Policies and a Joint Development and Conservation Strategy for the IAS</u>: The Component, at a total cost of US\$ 125 000 (GEF: US\$ 125 000), 2. <u>Development of a Joint Legal and Institutional IAS Cooperative Framework</u>: The Component, at a total cost of US\$ 300 000 (Co-financing/associated project: US\$ 300 000), 3. <u>Mechanisms for Transboundary Aquifer Monitoring</u> The Component, at a total cost of US\$ 25 000 (GEF: US\$ 25 000), 	<p><u>Stress Reduction Indicators</u>:</p> <ol style="list-style-type: none"> iv. transboundary risk and uncertainty issues from land use change, climatic change and extractions and pollution are jointly identified and addressed. v. development of common agreed policy and management measures for groundwater development and extraction, pollution and salinity control and land use management in the recharge areas and humid zones and outflow sections of the IAS, reflected in a joint development and conservation strategy for the IAS, vi. existence of a legal cooperative frameworks and institutional and communication mechanisms to address transboundary risk and water conflict, vii. existence of an inter-government communication programme for effective, timely contact and consultation between national water resources administrations <p><u>Environmental Status Indicators</u></p> <ol style="list-style-type: none"> viii. jointly adopted environmental goals and criteria identified in a joint Transboundary Diagnostic Analysis, including quantitative and qualitative indicators upon which priority actions can be identified and implemented, ix. land use change in recharge areas and humid zones with transboundary risk of adverse environmental impacts on the IAS, jointly monitored and managed, x. actual and planned groundwater abstractions and pollution pressures and salinization hazard are jointly monitored for transboundary risk and adverse environmental impacts on the IAS, xi. national governments and local communities

<p>Component 3. Awareness, Participation, Communication. total cost US\$ 133 000 (GEF: US\$ 133 000.), includes (2) activities. Government contributions US\$ 18 000.</p> <ol style="list-style-type: none"> 1. <u>Common Public Awareness Program</u>: at a total cost of US\$ 83 000, (GEF: US\$ 83 000), 2. <u>Inter-government Communication Tools</u>: at a total cost of US\$ 50 000, (GEF US\$ 50 000), <p>Component 4.: <u>Project Monitoring and Evaluation, Data Dissemination</u>: total cost US\$ 95 000 (GEF: US\$ 45 000, Co-financing: US\$ 50 000), includes (3) activities. Government contributions US\$ 16 500.</p> <ol style="list-style-type: none"> 1. <u>Project Monitoring and Evaluation</u>: at a total cost of US\$ 30 000, (GEF: US\$ 30 000), 2. <u>2a.Dissemination of ISARM Reference Information</u>: at a total cost of US\$ 20 000, (Co-financing: US\$ 20 000), and 2b <u>Strengthening aquifer knowledge community</u>, cost US\$ 10 000; (GEF: US\$ 10 000). 3. <u>3a.Inclusion of Project Data in the Global Groundwater Data Base</u>: at a total cost of US\$ 30 000, (Co-financing: US\$ 30 000), and 3b.<u>Data Standards, Inter-compatibility</u>, US\$ 5 000, (GEF, US\$ 5 000). <p>Component 5.: <u>Project Coordination, Management</u>. The Component, at a total cost of US\$ 445 000 (GEF: US\$ 445 000), includes (3) activities. Government contributions US\$ 18 000.</p> <ol style="list-style-type: none"> 1. <u>Project Steering Committee</u>: at a total cost of US\$ 111 000, 2. <u>Project Management</u>: at a total cost of US\$ 254 000, 3. <u>Scientific Supervision, Support and Coordination</u>: at a total cost of US\$ 80 000. 	<p>are involved in the management of transboundary risk and uncertainty related to the IAS</p> <p>xii. existence of a pilot project in the perspective of scaling up to a global aquifer focal area for information sharing across GEF- IW projects.</p>
<p>13. Estimated budget: PDF: - (other sources: UNESCO/IHP): US\$ 60 000 GEF: US\$ 958 000 Co-financing: US\$ 720 000 TOTAL: US\$ 1 738 000</p>	
<p>INFORMATION ON INSTITUTION SUBMITTING PROJECT BRIEF</p>	
<ol style="list-style-type: none"> 14. Information on project proposer: The project is proposed by the Governments of Mali, Niger and Nigeria, following a formulation process supported by UNESCO/IHP, together with the ISARM partners (IAH, FAO, UN-ECE), IAEA, OSS, ETH and IRD-UMR. At sub-regional level the project is supported by ECOWAS. 15. Information on proposed executing agency (if different from above): <u>Observatoire du Sahara et du Sahel (Sahara and Sahel Observatory - OSS)</u> was created in Paris in 1992. It serves to provide an international framework for partnership and consultation, and to contribute to the mastery and exchange of information of use in the combat against desertification and the attenuation of the effects of drought. 	

In March 2000 OSS became independent of UNESCO as an international organisation based in Tunis. Its headquarters agreement was signed in June 1999 with the Tunisian Government and ratified by law no. 2000/12 of 7 February 2000. The OSS statutory bodies are:

- the General Assembly, which meets every four years,
- the Executive Board, which meets once a year,
- the Scientific and Technical Council (STC), appointed by the Executive Board, which meets every two years. It deals with scientific and technical issues related to the OSS activities program.

OSS membership is composed of African and European countries, regional and international organisations, and representatives of the civil society.

OSS has been developing a program to facilitate technical and scientific cooperation between the basin-sharing countries. Through its "Aquifers of the Major Basins" Program, OSS is providing a framework for scientific and technical dialogue designed to favour the updating and harmonisation of knowledge needed in the preparation of efficient management strategies. OSS has recently successfully concluded the execution of the first phase of the North-Western Sahara Aquifer project common to Algeria, Libya and Tunisia

16. Date of initial submission of project concept: October 2001

INFORMATION TO BE COMPLETED BY IMPLEMENTING AGENCY:

17. Project identification number: tbd

18. Implementing Agency contact person: Ahmed Djoghlaif, Executive Coordinator, UNEP GEF Co-ordination Office; Sheila Aggarwal-Khan, Medium sized projects, UNEP GEF Co-ordination Office.

18. Project linkage to Implementing Agency program(s): The project is linked to and will coordinate and exchange information with on the first hand the UNEP-UNDP GEF NOCC and the UNDP GEF PDF NBA projects and with the UNDP/World Bank Lake Chad Basin Land Degradation project, the Global GEF/FAO LADA project and with other GEF-IW initiatives in the sub-region including the UNDP/UNEP Volta River Basin and the UNDP/FAO Fouta Djallon projects. Through ISARM the project has linkages with the on-going World Bank Guarani Aquifer in Latin America. In this sense the project will provide a pilot framework for standardized reporting and monitoring land degradation and linkages with aquifer degradation and provide inputs into the proposed programme for a global and regional inventory of transboundary aquifer systems and represents a pilot activity for a proposed focal area for information management across GEF-sponsored aquifer projects. Similar to other IW projects in West Africa and to enhance inter-project coordination the project will be linked to the CDD, SRAP for West Africa

PROJECT DESCRIPTION

RATIONALE AND OBJECTIVES

Background

The Iullemeden Aquifer system (IAS)

The transboundary Iullemeden sedimentary basin extends for approximately 1000 km from 10°N to 19°N, and for about 980 km from 1°E to 10°E (Figure 4 Geology and Boundary Conditions). Smaller segments of the Iullemeden formation located in Algeria in the north and in Benin are not linked to the Iullemeden hydrogeological system. The project area covers the connected main basin of IAS with an area of approximately 500 000 km², with about 31 000 km² in Mali, 434 000 km² in Niger, 60 000 km² in Nigeria.

The current population in the project area (Figure 1.) is approximately 15 million, with 65 per cent in Niger, 34 percent in Nigeria and less than 2 percent in Mali and is projected to grow to 28 million in 2025.

The sedimentary Iullemeden basin is defined by the surrounding major mountain ranges with the Air in the north, the Adrar in the north west and the Jos Plateau in Nigeria in the south. In the east, along a line from the Jos Plateau to the Air massive, the basin is partly separated from the confined aquifers in the Chad Basin by the south-north Continental Dorsal. To the west, in Mali and Niger, the system is bounded by the Hamadien Sandstone and may be connected to the Tamesna extension basin to the west of the Adrar highlands through the Gao Trench. In the southwest the basin limit follows the basement range along the River Niger. The Iullemeden is a multi-aquifer system composed of inserted Cretaceous Continental Intercalaire sedimentary formations and with overlying final Tertiary Continental Terminal regroupings. In some parts the system is overlain by the Marine Cretaceous aquifers that extend along the northern fringes of the basin. In the southeast, in the North-West Nigeria Basin, the Iullemeden multi-aquifers are known as the Rima Group with the Cretaceous Gundumi-Ilo and Wurno and Sokoto Group and the Tertiary Gwandu aquifers and the Kalambina limestone formation.

Aquifer depths are generally large as evidenced from deep borehole and geophysical records to 1500 – 2000 m below BSL. The upper limits of the aquifers are located at between 100-400 m and reach beyond 1000 m near the Gao Trench. The water levels vary from 0-80 meters. In the north and middle section of the system, in Niger the aquifer is reached at 600 m with the static water level at 60 m and becomes artesian further south. The aquifer sections below 250 m BSL are not considered to take an active part in the modern hydrological cycle. The aquifers have medium to high permeability with a transmissivity, normally between 10⁻³ to 10⁻⁴ m²/sec locally reaching 10⁻² - 10⁻³ m²/sec in the central part of the basin.

Linkages between aquifer and land resources

The water and land linkages are important especially in the recharge areas and the humid zones with wetlands and water bodies and in the aquifer discharge and seepage areas (A detailed discussion is given in Annex 14: *Iullemeden Aquifer Resources: Integrated Management of Water and Land Resources. Inter-project Coordination with other GEF initiatives*).

Located in a semi-arid region with fragile dryland ecosystems the soil moisture is to a large extent supported from seepage and evaporation from shallow groundwater tables in aquifer outflow areas. Changing land-use and deforestation forms a main cause of land degradation and resulting loss of eco-systems, climate desiccation and dust production. Land use change in aquifer recharge areas and humid zones influences aquifer recharge, modern water balance and the water quality of the aquifer resources. The related risks of change in water levels, loss of water resources and water quality degradation and salinization are also aggravated from the risk and uncertainty of climatic change with reduced precipitation and increased evaporation. The consequence of a reverse trend with a raise in water levels on the other hand could lead to water logging and salinization with loss of land and water resources.

There are visible indications of groundwater depletion and water and land degradation, and the joint consequences of high water use, changing land use in the recharge areas and of climate change have started to appear at local level in the Iullemeden aquifer area. Monitoring of these impacts is complicated already at

domestic level where land and water resources are normally managed under different sectors and programs. In the shared sub-regional IAS the environmental impacts and threats have transboundary implications that require joint management of the water and the land resources.

The principal impacts and the linkages in aquifer resource and land degradation are sampled in Table 1.

Table 1: Aquifer resource and land degradation; linkages and trade offs

Impacts:	Aquifer resources		Land resources	
Threats: origin,	Local impacts	Global impacts	Local impacts	Global impacts
<u>Aquifer resources:</u> Water over-extraction with change in hydrodynamics and hydrochemistry: pressure loss, inter-aquifer contamination and contamination flows.	Declining water levels, loss of pressure, increased drilling and pumping costs. Change in flow patterns Inter-aquifer contamination, Raising water levels, waterlogging, salinization. Inter-aquifer contamination. Reduced suitability Local water stress	Increased stress in the international waters environment. Global/regional loss of strategic groundwater resources Increased energy demands	Declining seepage, soil moisture Loss of perennial vegetation, Land degradation Loss in humid zones waterlogging, salinization	Loss of dryland and humid zone eco-systems Climate desiccation Increased dust production Global/regional loss of productive land resources
<u>Land resources:</u> Deforestation overgrazing Encroachment of annual crop cultivation Manipulation of surface and shallow ground water resources in aquifer recharge areas	Changed, increased or reduced, recharge: High evaporation and runoff losses, Clogging, reduced infiltration Salinization Local water stress	Global/regional loss of strategic groundwater resources Increased stress in the international waters environment.	Land degradation: Loss of land and range productivity, (e.g. outside tsetse fly areas). Wind and water erosion and dune formation in farming and range lands Social impoverishment	Loss of dryland eco-systems Climate desiccation Increased dust production Global/regional loss of land resources

Land resources

The land area overlying the Iullemeden basin is characterized by a tropical arid and semi-arid climate with a long dry season and a short and irregular wet season. The basin area is prone to extended drought. There are trends of long-term reductions in the rainfall and the 200 mm isohyets had advanced about 200 km towards the south during the Sahel drought, 1970-1985. The topographic relief consists, and defines the range of different dryland eco-systems at risk that comprise: mountain plateaus, semi-arid grassland and savannah plains and local and major flood plains and covered by important dune systems.

Risk and Uncertainty

Assessment of the water resources and the hydrodynamics characteristics of the overall IAS including recharge and outflow areas, stored volumes and flow patterns will for a considerable future remain uncertain. The available information on the aquifer system is limited and comprised of uncoordinated and often contradicting country data. Similar to in other large sedimentary aquifers the high level of scientific and policy uncertainty and lack of precision in identification and assessment of related long term risk and its transboundary implications, form major constraints and challenges to effective, fact-based joint management of the IAS. The uncertainty is further enhanced from international pressures, differences in country perceptions and potential conflicts over the shared aquifer resources. The different aspects and accumulating levels of uncertainty need to be addressed with mechanisms for joint risk identification, definition of clear, pre-defined responsibilities and mechanisms for action and supported with active monitoring and feedback and targeted surveys focused on specific items of system-wide or local scientific and policy uncertainty.

Aquifer Recharge and Outflow

Modern aquifer recharge (Figure 3.) occurs principally as seasonal, punctual or sporadic infiltration in river valleys in connected aquifer outcrop zones with free water tables and along the peripherals of the basin at the basement mountain ranges of Adrar and Air and the Jos Plateau. In addition there is vertical recharge from overlying Cretaceous Marin and Tertiary aquifers into deeper aquifers. The recharge to the upper free aquifer is distributed over the basin and occurs mainly in depressions with flooded areas plains and wetlands connected to the aquifers. As mentioned in Annex 2 (IRD-UMR), extensive clearing of the permanent vegetation cover in only a few decades has changed the recharge to the upper free aquifer. In addition to

current extractions the outflows out of the aquifer system are dominated by evaporation from shallow phreatic water tables and humid zones and local seepage and evaporation in the middle and southern Sahel sections of the aquifer and include important seepage into the River Niger and its tributaries and a possible aquifer overflow into the Chad aquifer basin in the east.

IAS water balance

The total exploitable water reserves of IAS are estimated to about 2000 km³, corresponding to about 4000 mm over the entire basin area. IAS is an enormous strategic reserve of high sub-regional significance that equals 50 years of the flows in the River Niger. The storage ratio in the captive areas is generally high, 2-5000 m²/km² along the Mali-Niger border and 15 000 m²/km² in southern Niger and in Nigeria. The annual modern recharge is substantial, however that the total water resources comprise to a great extent large volumes of fossil water replenished under the earlier wetter climate conditions in the Pleistocene and Holocene. A similar relation of large storage reserves and still substantial modern recharge had been confirmed (Oteze, 1989) for the IAS in Nigeria¹. The conditions for planned, sustainable groundwater mining vary over the basin but form an important management option that will be addressed under project. The approximate annual water balance for IAS in Niger between the total inflow from recharge of 70 m³/sec and the outflows as: (a) evaporation losses, 50 m³/sec, (b) current water abstractions, 10 m³/sec^{3 below}, and (c) a drainage outflow, 10 m³/sec to the River Niger, of high importance for maintaining dry season and drought low flow in the River Niger and other surface water courses. The Iullemeden water balance reflects the importance of the modern recharge and the ecologically important evaporation and outflow losses in the humid zones.

Water extractions

The aquifers in the IAS are being exploited from wells from 40 to 100 m, with a few deep exploratory and production boreholes up to 600 m deep, at extractions rates that are generally between 20 and 100 m³/hour. Significant current expansion in extractions is taking place mainly in the southern part of the Mali section, in southern Niger and in the Sokoto basin in Nigeria. There are currently more than 23 000 recorded wells and boreholes in the project area including 400 active boreholes in Mali, 500 boreholes including 200 deep boreholes in Niger and more than 1200 registered boreholes in Nigeria². The extractions from Iullemeden, mainly for agriculture are assessed to 50 Mm³/yr in Niger³ and to the same order in Nigeria⁴.

Water quality and pollution

The water quality in IAS is generally good (Table 10: Iullemeden Aquifer System (Niger); Hydro-geological parameters). To the present time water quality problems have in general remained local and with limited transboundary impacts. There are however high risks of salinization and contamination from the surface and from lower, artesian aquifers. While water quality records are limited there are recorded water quality issues and incidents that include: (a) high ground water salinity rendering an irrigation development project infeasible, (b) high fluorine contents in water supply boreholes with severe public health impacts, (c) groundwater contamination in free aquifers from wetlands with salinized or polluted stagnant water - e.g. from solid waste dumps, (d) agricultural water pollution of free aquifers in the intensive agriculture areas, and (e) infiltration of toxic chemical and organic polluting waste from agro- industries.

The IAS area is subject to current mineral exploration licenses with mineral exploration drilling focused on strategic and precious metals and of possible potential threat to the aquifer resources. Reports in the mid-90s indicated the possibility of commercially viable petroleum findings in the Sahara section of the Niger Republic, outside of IAS. In this respect there are future potential threats of abusive interference with damage and contamination from deep drilling and leakage from future petroleum pipelines passing the basin area. It

¹ The estimated aquifer storage of 255 km³ in Nigeria corresponds to 3400 years of recharge at 15 mm/yr over the recharge area of 5000 km² (Oteze, 1989).

² With the recent rapid groundwater development there are indications that the current number of boreholes in the Nigerian part of the basin exceeds 3000.

³ The estimate differs with a factor of 6 from the above estimate of abstractions under the IAS – Niger water balance.

⁴ Recent isotope based studies in Sokoto Nigeria supported by IAEA have confirmed that surface water resources and shallow groundwater uses in recharge zones had no recordable impact on the recharge of the deeper aquifers.

will be important to jointly identify and monitor these risks and secure appropriate protection in national legislations and in commercial permits and concessions.

Threats

The principal cross-border environmental threats, common to the countries in the IAS, include direct and indirect adverse impacts on the aquifer resources from land use change in recharge areas and humid zones and from climatic change with reduced precipitation and increased evaporation. The threats can be expected to become aggravated with increased abstractions, surface based water pollution and other environmental degradation of the aquifer resources and develop into growing international pressures and water conflicts.

The following factors contribute to enhance transboundary risk and vulnerability:

(a) IAS is a large shared strategic groundwater reserve of global and sub-regional significance located in the water scarce semi-arid parts of the West African Sahel sub-region. The aquifer system is vulnerable to rapid land use change and climatic change, inappropriate use and water pollution that could result in transboundary implications.

(b) IAS covers a large basin area with important productive potentials needed to sustain the growing basin population. Rapid land use change in aquifer recharge areas and humid zones mainly through low productivity subsistence agriculture is resulting in changes in modern recharge and threatens to have adverse impacts on the shared aquifer system resources. The consequent losses of water and land resources include falling water tables and on the other hand water logging and water and land salinization with resulting losses in regional environmental values and production capacity

(c) The aquifer system supports rich dryland eco-systems, including humid and oasis zones. The dryland eco-systems depend on a fragile hydrological balance supported by groundwater seepage and evaporation from shallow water tables. The systems are vulnerable to change in water tables and horizontal and vertical flows with growing risks of drought or water-logging and salinization, with possible but not always visible and evident transboundary implications within and beyond the aquifer area, and

(d) As the impacts of land use change and groundwater use expand, present water and land resources management approaches that are country specific and development-oriented focused on production, growth and distribution, have become increasingly inappropriate to address common risk in the IAS in a joint and concerted way.

The IAS forms a representative example of a regionally shared underground water body that is not yet heavily degraded, but under threat from land use change in the recharge areas and humid zones and vulnerable to risk and uncertainty of climatic change. The risk is enhanced from the limited current knowledge level of the IAS that renders precise assessments highly uncertain and on the other hand from limitations in current country-based management approaches. With high risk and scientific and policy uncertainty in a transboundary context, the approaches to joint management of the IAS need to be risk-based focused on reduced vulnerabilities and transparent responsibilities for identification, mitigation and accommodation and sharing of risk and uncertainty.

The following three categories of risk in the IAS, and the underlying causes will be addressed under the project:

1. Loss of strategic sub-regional water resources. Lowering water tables, change in aquifer hydro-dynamics and quality degradation from: (a) over-extraction, human-induced and accidental inter-aquifer leakage water pollution; (b) land use change in recharge areas and humid zones, and (c) transformation of adverse impacts through e.g. drop in piezometric levels, reversed flows or transportation of contaminants. The transboundary risks are most evident in border areas subject to intensive and rapidly increasing extractions and land use changes,

2. Land degradation at a sub-regional scale with loss of land productivity and dryland and humid eco-systems caused by: (a) loss in soil moisture, from declining water levels and reduced seepage, and (b) water logging and salinization from raising water table and reversed flows.
3. Increased international water stress. Inappropriate uncoordinated domestic water resources, land use and development policies with risk of misperceptions and conflict as the consequence of uncertainty and related to aquifer recharge and abstractions especially in the border areas⁵.

Project objectives

Within the goal of sustainable environmental protection and sub-regional and national development, the general objective of the project is to establish capacity under a sustainable cooperative framework for joint management of risk and uncertainty, to jointly identify, reduce and mitigate transboundary risk from changing land and water use and from climate change in the shared Iullemeden Aquifer System.

The immediate objectives of the project are to:

- (1) establish joint mechanisms and capacity to identify risk and uncertainty issues in the IAS related to:
 - land use change in recharge areas and humid zones,
 - climate change with reduced net precipitation, and
 - inappropriate development, extraction and surface based water pollution and salinization.
- (2) establish mechanisms to formulate policies for management of identified risk and uncertainty issues, and
- (3) establish a legal and institutional IAS cooperative framework.

The project will support the participating countries, Mali, Niger and Nigeria in:

- a. preparing a Transboundary Diagnostic Analysis, to define threats and root causes⁶, jointly improving and coordinating the understanding and the knowledge for risk identification, establishing a selected common shared data base targeted for identification and documentation of risk in the basin,
- b. jointly identifying risk issues, guided by targeted modelling studies and field and pilot area surveys to address selected priority issues and areas, e.g.: recharge areas and humid zones, inter-aquifer flows, water pollution and contaminant transportation and critical sub-basins and border areas,
- c. establishing a joint development and conservation strategy for the IAS and implementing a common legal and institutional management framework for joint formulation and implementation and enforcement of risk mitigation policies, and
- d. development of a joint public awareness and stakeholder participation programme, and building of capacity for inter-government communication.

⁵ Risk for enhanced international water conflict over the IAS resources could add to the recent issues conflict and upset current cooperation on shared surface water courses in the sub-region, e.g. in the Niger basin and in the four shared surface water courses shared between Niger and Nigeria. These shared watersheds are currently studied under the UNDP GEF NBA and the UNEP/UNDP GEF NNOCC projects.

⁶ That are expected be addressed in a post-project strategic action program (SAP) on common active management of the IAS.

CURRENT SITUATION

1. Monitoring and Data

Current country actions on monitoring and data include national water resources assessments and inventories and establishment or updating of water resources data centres. While national monitoring, data collection and study networks established in the 1970s and 1980s have declined, the countries in the last few years have initiated programmes for data collection and assessment of the water and land resources, including the general modelling studies of the Iullemeden aquifer system (Annex 1). However data collection and modelling are constrained to country sections of the basin and data remain scattered and fragmented between the countries and in individual institutions. Earlier reference studies and current activities in the Iullemeden comprise:

Mali:

A nationwide study, Hydrogeological Synthesis of Mali, including the establishment of the digitised GIS based SIGMA data base completed in 1993 (under the UNDP assisted projects, DP/MLI/82/005 and DP/MLI/84/005), provided a comprehensive collection and analysis of (physical parameter, piezometric, hydrodynamics and hydrochemistry, water balance, utilization) hydro-geological information for the general sedimentary aquifers including the Malian section of the Iullemeden basin. The SIGMA data base is currently being updated. In the Iullemeden area water resources development under a joint program with Algeria in support of nomadic populations for deep water drilling and data collection has recently been initiated in north-eastern Mali.

Niger:

The SIGNER digitised and GIS based database established in the Ministry of Water Resources in the 1990s is currently being updated under project NER/99/001 "Water and Sustainable Development", supported by UNDP. The new national water sector strategy (2001) based on The Comprehensive National Water Resources Master Plan established in 1993 with support from UNDP, recognizes and supports the need for planning and research. The National Water Resources Action Plan includes programs for improved water resources monitoring, continued support of the water resources database, GIS and diagnostic studies, and establishment of efficient and participatory planning frameworks and management capacity at different levels. Recent studies and data collection including identification of recharge areas, land use and land degradation using remote sensing and ground surveys, and modelling studies of the Iullemeden in Niger include modelling studies by ETH and others and work by the water resources ministry and national universities (mentioned in Annex 1). Ongoing field surveys of water levels and groundwater recharge and sampling of chemical and isotope and tracer elements in the upper free aquifer in two pilot areas in the Niamey region are supported by IRD-UMR (Annex 2).

Nigeria:

A detailed nation-wide compilation of available water resources data, drawing from the data base established under the long term National Borehole Program was established under the National Water Resources Policy Study in 1993. The National Water resources policy, built on the earlier FAO-supported National Water Resources Master Plan in 1985, was adopted in 1999. The Federal Ministry of Water Resources is carrying out a three years National Hydro-geological Map project to update and establish a GIS based database. A recent study of groundwater recharge in the Nigerian parts of the Iullemeden basin was recently (2000) completed with IAEA support using isotope technology. Earlier hydrogeological studies of the Iullemeden aquifers in Nigeria in the 1970s and 80s by the Geological Survey of Nigeria and USAID represent important reference data from deep exploratory drilling.

Basin data and studies are available with national universities active in groundwater research, including ENI in Mali, the Abdou Moumouni University in Niamey (Annex 1) and the Universities of Benin and Maduguri in Nigeria. The national universities have participated actively and provided background data for the project formulation and can be expected to assist and secure data and scientific input under the project.

Externally assisted activities

GEF is supporting a number of projects in the West African sub-region focused on integrated land and water management and arid and semi-arid ecosystems and primarily in the surface water resources systems (Details, see Annex 14: *Iullemeden Aquifer Resources: Integrated Management of Water and Land Resources. Inter-project Coordination with other GEF initiatives*). The UNDP-GEF, NBA, Niger River Basin PDFB and the UNEP/UNDP GEF “Management of Shared Catchments between Niger and Nigeria (NNOCC) PDFB are focused on basin management and land and water conservation and are partly located within the Iullemeden project area. The projects have been informed of the Iullemeden initiative. The project will exchange information and experience with these projects in particular on water resources balance, change of land use and climatic change and joint management of related transboundary issues. In particular, the project will ensure effective co-ordination with the NBA UNDP-GEF project through attendance at respective technical meetings, formal transmissions of interim draft and final reports together with day-to-day communication and information exchange. The cooperation with the NBA GEF project would add synergy to the two projects, supporting risk management in the IAS under the MSP project and facilitate inclusion of the results of the MSP project in the framework of the foreseen Niger Basin TDA and SAP to be produced under a full Niger Basin project. The project will also cooperate with the LADA (Dryland land degradation assessment) project to develop linkages and synergies to assess the extent of land degradation in a standardized way, within the Iullemeden aquifer area.

The national water resources and environmental management sectors in Mali, Niger and Nigeria continue to be supported by UNDP. UNESCO is executing a program on groundwater recharge and infiltration in the sandy zones in Sahara- Sahel. UNESCO and FAO have earlier undertaken modelling studies of the Iullemeden area. UNESCO have recently supported technical seminars and programming consultations in Mali, Niger and Nigeria on the proposed Iullemeden project in 1999 and 2001. The proposed project activities coincide with the 6th phase of the UNESCO International Hydrological Program (IHP), in 2002-2007⁷, where UNESCO is proposing Iullemeden, and the proposed GEF project, as a priority activity under the Inter-agency initiative on International Shared Aquifer Resource Management Systems (ISARM) with participation of UNESCO, IAH, FAO and UN-ECE. Based on the priority need to create an international network to improve scientific knowledge on Transboundary Aquifer Resources Management in Africa a regional ISARM Strategy for Africa was recently launched in the International Workshop on Management of Transboundary Aquifer, held in Tripoli in June 2002. During the period 2002-2007, the UNESCO-IHP 6th programme will concentrate its activities on water systems at risk and associated social challenges through the five themes (global changes, watershed dynamics, regional perspectives, water and society and knowledge transfer). The ISARM initiative has been presented in a Framework Document and the ISARM members launched an initiative on Internationally Shared Aquifer Resources Management in the International Conference on Fresh Water, held in Bonn, December 2001. The initiative is followed up through regional ISARM programmes with the African Program preceded by a Latin American ISARM programme that was recently (2002) initiated in Mar del Plata, Argentina.

Over the last decades IAEA, a main project partner, has supported technical cooperation programmes on application of isotope techniques to address national water management issues. In particular IAEA has assisted in the identification of recharge areas mechanisms within the Iullemeden area in the three countries, including Dallol Bosso, Dallol Mauri, Talhaoa-Tillabery-Dosso, Eastern Niger Basin, Arlit-Agadez, Bilma region and the right bank of the River Niger in Niger and the Rima Basin in Nigeria (see Annex 3).

Ongoing externally assisted national projects and programs together with the national programs are expected to contribute data and information and specialist advice to the project. The project is built on partnerships, with defined roles and contributions from project partners that are already active in the Iullemeden region. It can be expected that the IAS cooperative framework will take on an important coordinating and monitoring role to secure consistent approaches with substantial benefits and leverage to the national programmes. The project is expected to be complementary to, and to provide experience and also benefit from other GEF projects on shared aquifer systems and notably the recently started sub-regional project on the Guarani

⁷ 14th Session of the UNESCO Intergovernmental Council of the IHP, June 2000, Resolution XIV-12 “International Initiative on Transboundary Aquifer Resources Management (TARM)”.

Aquifer in Latin America⁸, implemented by the World Bank. Liaison and exchange with the Guarani and other shared aquifer system projects is provided for as a project activity undertaken by ISARM as the common partner to projects related to shared aquifer resources.

Policy, legislation and institutions

The three countries have recently established national water resources strategies, environmental action plans and natural resources conservation policies and promulgated new or updated existing national water legislations. The countries are currently implementing structural changes in the water resources sectors, including establishment of decentralised and participatory water resources management and development in Mali and Niger, and with central federal management of all groundwater resources in Nigeria. The national policies, while focused on need-based water supplies and agricultural development include important explicit components for data collection and information systems, updating of water resources assessments and hydrogeological mapping, water and land resources monitoring and with important investments in soil conservation and afforestation. To mitigate and address common risk, national legislations and country data and management approaches need to be coordinated and harmonised at the level of the shared Iullemeden basin.

Mali:

The national water sector is being restructured, replacing the centralised inter-ministerial committee for sector coordination and allocation with the new National Rural Water Supply Strategy (2000) focused on decentralisation and privatisation in particular for urban and rural water supplies. A national strategy has been finalised (2001) and includes revision of the national 1990 Water Act. The new legislation will maintain water in the public domain but reduce state development and operational responsibilities and transfer management functions to privatised water agencies, regional groups and direct users. In the captive areas of Iullemeden, in the Gao and Kidal regions, identified minimum demands include 150 operational and rehabilitated boreholes, of which about 400 productive boreholes, to supply about 800 villages. The development, supported from central fund and annual costs is delegated to municipalities and users' associations handled by private operators. The costs are recovered with a block tariff system with monthly and unit rates and free supplies to local rural uses. Irrigation groundwater use, constrained by high operation costs, will remain limited. National groundwater monitoring networks are operated by the regional water administrations. Of importance to the Iullemeden and the issues in aquifer recharge areas in Mali, the national strategy recognizes explicitly the ecological effects from extended drought and linkages between water, land and other natural resources and anthropogenic causes and impacts from population pressures with over-exploitation, deforestation and land degradation.

Niger:

The National Hydraulic Program was adopted in 2001 as an integrated part of the National Environmental Plan with the Economic Recovery Program. The program has been based on the Water Resources Master Plan in 1999 and includes four priority areas: (a) an improved water resources knowledge base; (b) improved community water supplies, and protection against erosion, floods and droughts and pollution; (c) support to production sectors (including livestock, rainfed crop production and irrigation); and (d) adjustment of institutional and legal framework, with establishment of uniform, hydrological and hydrogeological (basin) units, implementation of the national water legislation and gradual transfer of management and development responsibilities to local administrations and the private sector.

The national policy recognizes that the low productivity rainfed-farming sector that contributes 96 percent of the domestic food crops is also the main cause of accelerated land degradation and loss in land productivity. With a widening national cereal and food gap the national strategy comprises an important program for erosion control and improved crop yields, expansion of irrigated area based on surface and shallow groundwater resources to spare marginal lands and improved and reclaimed degraded fodder potentials and watering capacities in the pastoral sub-sector.

⁸ Project for the Environmental Protection and Sustainable Development of the Guarani Aquifer System; (Argentina, Brazil and Paraguay).

The policies are implemented through an amendment of the national water legislation, established in 1998 with assistance from FAO, to provide for including institutional development for decentralised and participatory management.

The National Hydraulic program supports capacity building and stakeholder awareness through institutional and legal measures, interventional planning, monitoring, evaluation and management and established community consultation mechanisms. During a first 5 year phase the program with important technical assistance and capital investment components of close to 1 billion US\$ will be focused on expanded supplies from boreholes and support of the production sectors mainly in agriculture. As a result the pressures on the Iullemeden water resources and recharge areas are expected to increase with possible transboundary consequences. The government therefore gives high priority to sustainable development through protection of the aquifer resources and management of international issues.

Nigeria:

The national water resources policy, adopted in 1999 is implemented through the 1993 Federal Water Resources Decree, 101/23 August 1993, developed with legal assistance from FAO, together with Rules and Regulations for Administration and Enforcement of the Provisions of the Water Resources Decree, September 1997. The decree provides for centralized federal groundwater management and control, through decentralized federal units in the states and federal management of international and interstate aquifers based on planning, monitoring and evaluation and regular reporting to FMWR. FMWR is the lead agency and collaborates on international water relations with the Federal Ministries of Finance and Foreign Affairs. Other key water resources legislations are the River Basin Development Authorities Decree no 35/1987, the Federal Environmental Protection Decree, 1988 and the Environmental Impact Assessment Decree, 86/1992. Local water management is based on bylaws of the State Water Boards and water permits issued by FMWR. Land management with agricultural land use planning is centralized under the Federal Land Agency, MoE and MoA. The Iullemeden basin in Nigeria extends over the Sokoto and the Kebbi States and is within the constituency of the Sokoto-Rima River Basin. The national policy is to restrict the use of deep groundwater to drinking water supplies and to supply irrigation from surface waters and shallow groundwater.

West African sub-region

International water issues over shared water resources and large-scale land degradation are given high priority in the West African sub-region. The sub-region has a tradition of sub-regional cooperation and there are existing cooperative frameworks at sub-regional and bi-lateral level that relate to the shared Iullemeden system.

- The Economic Community of West African States, ECOWAS, with the secretariat in Abuja is currently (2001) establishing an independent Sub-Regional West African Water Sector (WAWS) as a sub-regional forum also for international issues and sub-regional monitoring of the management of transboundary water courses. The project can be expected to complement and benefit from priority initiatives and coordination towards improved regional water security under ECOWAS. The West African Regional Action Plan on Integrated Water Resources Management has recently been developed and agreed upon. It can be expected that the Iullemeden aquifer cooperative framework developed under the project will provide reference information as input to the development of a regional water resources protocol that represents one of the priority activities under the Action Plan.

- The existing bi-lateral protocols and cooperative institutions on shared water resources include the NNJC⁹, between Niger and Nigeria, and PCCMN¹⁰, between Mali and Niger. The frameworks are focused on bi-lateral issues that were raised during the extended Sahelian drought.

- Mali and Niger, together with 6 other riparian countries (but not Nigeria) are members of the Fouta Djallon Regional Integrated Development Programme created by OAU and UNEP in 1981 and UNEP

⁹ Niger-Nigeria Joint Commission for Cooperation; Protocol, 18 July 1990, between Niger and Nigeria. on "Equitable sharing for development, conservation and utilization of the common water resources".

¹⁰ Protocol, Mali and Niger, 12 July 1988, on Cooperation for the utilization of the Niger River, including promotion of exchange of data and studies, under a Permanent Technical Committee of the Ministers responsible for Water Resources.

together with FAO is currently implementing a PDF B to develop a GEF project for the programme covering the source of the River Niger.

- The Sahel is the highest priority area under the Convention to Combat Desertification and Drought (CDD) and the project represents an important activity linked to and in support of the CDD, Sub-regional Action Programme (SRAP) for West Africa, coordinated by ECOWAS and CILSS with the focus area on management of shared water resources. Also to secure enhanced coordination with the other IW projects in the sub-region, the IAS project, similar to all the other IW projects in West Africa will be linked to SRAP. It can be expected that the project will add leverage to these current and earlier initiatives and frameworks and activate the use and application of the bi-lateral protocols and institutions. A trilateral Iullemeden basin protocol can be expected to recognize the established consensus and already tested mechanisms for bi-lateral issues provided in the NNJC and PCCMN protocols. NNJC and PCCMN will participate as observing partners in relation to bi-lateral issues under the Transboundary Diagnostic (TDA) and analysis and the formulation of a joint management framework. The future roles of NNJC and PCCMN need to be critically reviewed and decided at sub-regional and national levels giving due considerations to the level of political support together with the mandate, the financial sustainability and the cost for a Iullemeden cooperative framework and a basin institution.

Socio-economic Development;

The Iullemeden aquifer resources are shared between the smaller agricultural (agriculture represents 45 percent of GNP) economies of Mali and Niger (GNPs 2,6 and 2.0 billion US\$) and the much larger (GNP 40 billion US\$) and more diversified (agriculture represents 30 percent of GNP) economy of Nigeria. About 80% of the production and employment in the Iullemeden is based on low productivity subsistence sector agriculture. In addition to agriculture the economies depend on the mining sector in Niger – mainly for uranium, and the globally important petroleum and gas production in Nigeria. Per capita GNPs vary between 190\$ in Niger to 260 US\$ in Nigeria.

With lower population density and limited socio-economic development in the captive areas the pressure on the Iullemeden aquifer resources and the recharge areas is lower in Mali and relatively higher in Niger and Nigeria. The situation can be expected to be changing as Mali is planning further groundwater development and has recently initiated important well drilling programs in the Iullemeden sections in north-western Mali. As a consequence the pressures on the aquifer system are growing in all the three countries with related threats and transboundary risks.

The socio-economic development that will decide environmental risk and the water and land use patterns in the Iullemeden aquifer area can be expected to focus on the following aspects:

- Protection of the agricultural production potential of the land,
- Water resources and soil conservation for improved productivity in the low productivity subsistence farming sector to address rural poverty and food security, and the risk of land degradation,
- Accelerated well drilling, especially in vulnerable artesian aquifers but also deep multi-aquifer wells for water supplies and irrigation,
- Introduction and investment in demand management activities,
- Intensive irrigated agriculture with groundwater over-extraction and contamination threats, and
- Intensified mineral exploration drilling and development and operation of petroleum pipelines with potential adverse impacts and contamination threats in the IAS area.

EXPECTED PROJECT OUTCOMES

The principal alternative approaches and increments to the baseline under the project for: (a) global/regional environmental benefits, and (b) domestic benefits from the project, are summarized in Table 2.

Table 2. Baseline and Alternative/Increment

<u>Global/ regional Environmental Benefits</u>	Baseline Action (prior to the GEF-MSP project)	Incremental Action (the GEF-MSP project)
Management of transboundary risk and uncertainty in the IAS sub-regional aquifer resources system. Assessment and management of risk, vulnerability and uncertainty from: a. inappropriate water resource use, b. water pollution, salinization, c. land use change in recharge area, humid zones, and d. climatic change.	Recharge assessment studies: hydro-geological and isotope studies in Mali, Niger, Nigeria, (IAEA, IRD, national universities, others); Basin and sub-basin modelling of IAS, (DDC/ETH, national universities, others) Country databases.	- Identification of risk/ vulnerability and uncertainty issues: a. joint Transboundary Diagnostic Analysis b. establishment of a common selected basin-wide IAS data base, c. targeted, theme and sub-basin, aquifer modelling, d. targeted field studies (recharge areas, isotope studies) - Development of mechanisms for development of joint social and decision-making policies to address risk/ vulnerability and uncertainty issues
Reduced stress in the international water environment	Existing bi-lateral protocols/ cooperative frameworks, Updated national water resources strategies, legislation and institutions, (FAO) Country water resources awareness and participation programmes	- Development of mechanisms for joint implementation of identified policies: a. joint identification of transboundary risk issues with formulation of a joint development and conservation strategy for the IAS, b. development of a joint legal and institutional cooperative framework for the IAS, c. joint transboundary aquifer monitoring programme, d. coordinated basin-wide public awareness programme, and e. inter-government communication programme

Domestic Benefits	Baseline actions	Alternative/ incremental actions
Country water security, for food security and environmental ecological uses,	Country data bases and water and land resource assessment, Updated country level water resources and land use management frameworks.	Joint review with development of a agreed joint policy on land and water use. Harmonization of national land use and water demand with agreed common basin-wide risk reduction policies . Review of domestic and sub-regional water and food security plans
National Socio-economic development	National sectoral development strategies, programs and incentives	Basin-wide assessment of national sectoral development policies and plans for transboundary risk and uncertainty

The table shows the alternative course under the project, with related baseline and increments for area-wide identification and management of transboundary risk and uncertainty in the IAS. The flow-chart for the alternative course of action are presented in Table 3.

Transboundary risk and uncertainty issues have been mentioned in the earlier sections on Threats and on Project Objectives. Risk is referred to the probability the vulnerability as social, economic and environmental costs. In the IAS there is a high level of scientific uncertainty in the assessment of transboundary risk. As unexpected adverse transboundary impacts need to be considered and managed especially in relation to risk of extensive irreversible long-term impacts of transboundary scale the mechanisms established under the project will be focused on pre-arrangements and definition of clear responsibilities, at basin and country levels, for risk reduction, preparedness and reduced vulnerability for accommodation and sharing of risk. Risk management will progress as multi-level interventions and include hazard avoidance and reduction through bans, command and control for safety provision at regional and country level and risk polling and soft risk reduction at country and local level together with vulnerability reduction and harm alleviation at community and individual level.

The options for risk reduction policy include socio-economic, conservation and technical strategies, such as:

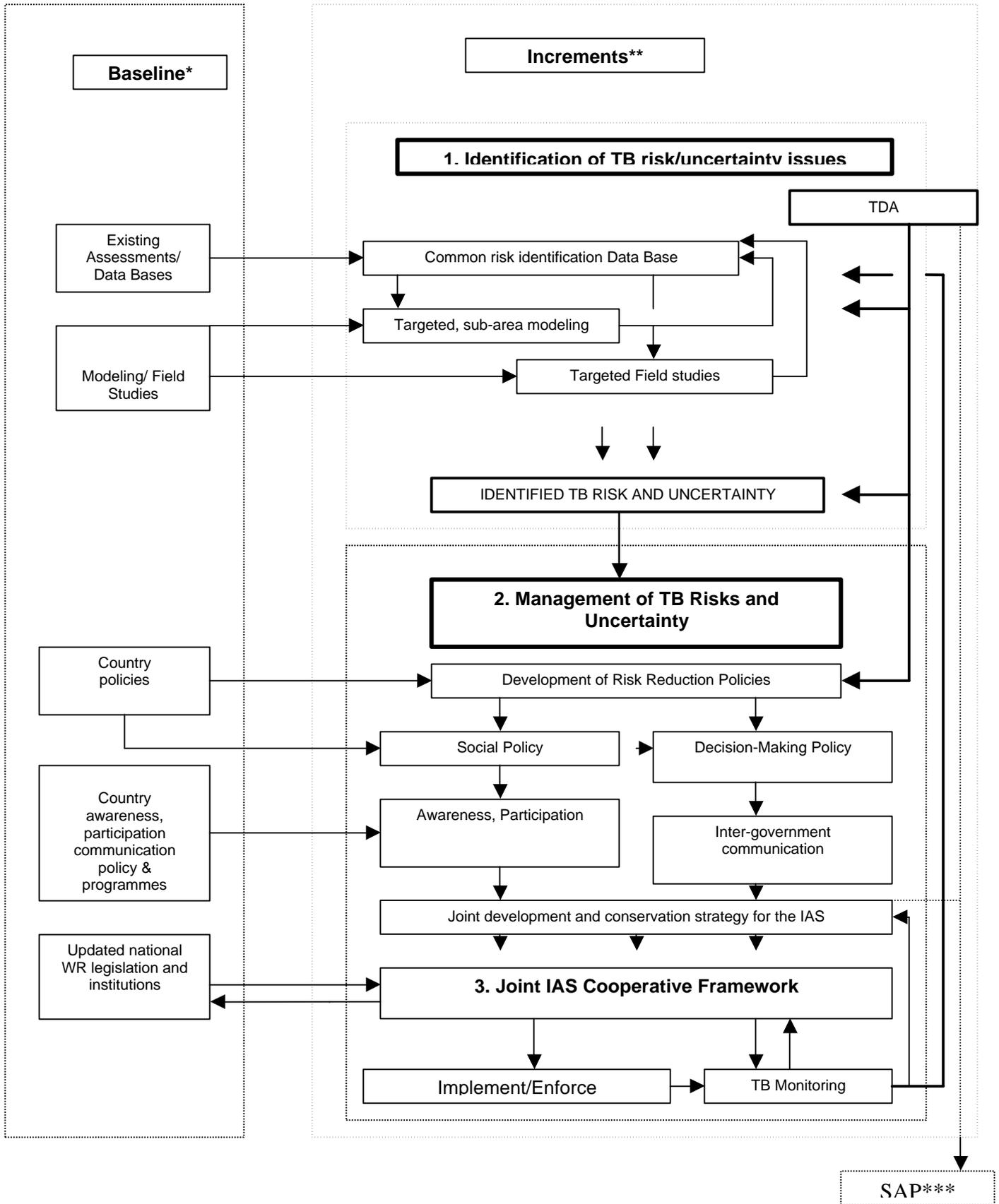
- Targeted programmes for poverty alleviation, enhancement of the involvement and responsibilities of local water and land users and
- Incentives and demand management for appropriate and efficient water and land use.
- Water and land tenure policy with water pricing and land value and land markets,
- Agricultural policy for land use, cropping patterns and produce pricing and intensification in recharge areas. ,
- Regulation and monitoring of borehole development
- Conjunctive surface-groundwater use,
- Nature protection and protected area strategies,
- Harmonized responsibility policies for prevention, emergencies and long-term environmental protection, and Macro-economic policy on risk reduction and environmental and social sustainability versus growth and income.

The mechanisms for policy implementation of risk-reducing policies at regional, national and local level are normally focused on soft law approaches and cooperation that include.

- Consultative groups and meetings
- Establishment of water user groups
- Participatory sub-area/ sub-aquifer planning and monitoring
- Water use rights mechanisms
- Drilling regulations
- Monitoring and inspection

Table 3. Flows for the Alternative (GEF) Course of Action

*: pre-MSP project; **: MSP project; ***: post-MSP project



ACTIVITIES AND FINANCIAL INPUTS

The following activities will be implemented under the project. Project progress will be monitored and evaluated based on performance indicators on: (a) process, (b) stress reduction, and (c) environmental status identified below:

The project activities are building on specific capacities and contributions from the project partners as international agencies, regional organizations and international and national universities and donor organizations funding the activities. The GEF project will mobilize and direct the investigations, studies and training programs under the project towards achievement of the project objectives.

The following activities, organized under five components, with total costs (Annex 9) and time frames (Annex 11) will be implemented under the project:

Component 1: Identification of Transboundary Risk. The Component, at a total cost of US\$ 555 000 (GEF: US\$ 185 000, Co-financing/associated projects: US\$ 370 000), will be carried out in project months 2 to 36 and includes (5) activities. Government in-kind contributions are US\$ 75 000.

1. Transboundary Diagnostic Analysis: at a total cost of US\$ 90 000, (GEF: US\$90 000), will be carried out in project months 5 to 11,
2. Modelling Capacity Building: at a total cost of US\$ 30 000, (GEF: US\$ 30 000,), will be carried out in project months 2 to 36,
3. Field Studies of Aquifer Recharge: at a total cost of US\$ 85 000, (GEF: US\$ 65 000, Co-financing: US\$ 20 000), will be carried out in project months 2 to 20,
4. (a) Establishment of a Common Risk Identification Data Base; and (b) Targeted Pilot Area Surveys: at a total cost of US\$ 350 000 (Co-financing/associated project: US\$ 350 000), will be carried out in project months 3 to 21 and project months 7-36 respectively.

Component 2: Policy and Institutional Mechanisms for Reducing Transboundary Risk (Management Framework). The Component, at a total cost of US\$ 450 000 (GEF: US\$ 150 000, Co-financing/associated project: US\$ 300 000), will be carried out in project months 10 to 27 and includes (3) activities. Government in-kind contributions are US\$ 42 000.

1. Establishment of Mechanisms for Formulation of Risk Reduction Policies and a Joint Development and Conservation Strategy for the IAS: The Component, at a total cost of US\$ 125 000 (GEF: US\$ 125 000), will be carried out in project months 18 to 26,
2. Development of a Joint Legal and Institutional IAS Cooperative Framework: The Component, at a total cost of US\$ 300 000 (Co-financing/associated project: US\$ 300 000), will be carried out in project months 10 to 27,
3. Mechanisms for Transboundary Aquifer Monitoring The Component, at a total cost of US\$ 25 000 (GEF: US\$ 25 000), will be carried out in project months 18 to 30

Component 3. Awareness, Participation, Communication. The Component, at a total cost of US\$ 133 000 (GEF: US\$ 133 000), will be carried out in project months 16 to 34 and includes (2) activities. Government in-kind contributions are US\$ 18 000.

1. Common Public Awareness Program: at a total cost of US\$ 78 000, (GEF: US\$ 78 000), will be carried out in project months 16 to 34, together with 1b Introduction of Experience/References from other GEF projects: at a total cost of US\$5 000 (Co-financing US\$5 000), will be carried out starting in project month 18,
2. Inter-government Communication Tools : at a total cost of US\$ 50 000, (GEF: US\$ 50 000), will be carried out in project months 22 to 28.

Component 4.: Project Monitoring and Evaluation, and Dissemination of Data: The Component, at a total cost of US\$ 95 000 (GEF: US\$ 30 000, Co-financing: US\$ 65 000), will be carried out over the full project duration, project months 1 to 36, and include (3) activities. Government in-kind contributions are US\$ 16 500.

1. Project Monitoring and Evaluation: at a total cost of US\$ 30 000, (GEF: US\$ 30 000), will be carried out over the full duration of the project,
2. 2a. Dissemination of ISARM Reference Information: at a total cost of US\$ 20 000, (Co-financing: US\$ 20 000), will be carried out throughout the project with dissemination of project experience and data in project months 34 to 36, and 2b Strengthening aquifer knowledge community, at a total cost of US\$ 10 000 (GEF: US\$ 10 000),
3. 3a. Inclusion of Project Data in the Global Groundwater Data Base: at a total cost of US\$ 30 000, (Co-financing: US\$ 30 000), will be carried out in project months 26 to 32, and 3b Introduction of Data standards and Inter-compatibility: at a total cost of US\$ 5 000 (GEF: US\$ 5 000)

Component 5.: Project Coordination and Management. The Component, at a total cost of US\$ 445 000 (GEF: US\$ 445 000), will be carried out over the project duration, project months 1 to 36, and includes (3) activities. Government in-kind contributions are US\$ 18 000.

4. Support to the Project Steering Committee: at a total cost of US\$ 111 000,
5. Project Management (Annex 13): at a total cost of US\$ 254 000,
6. Scientific Supervision, Support and Coordination (Annex 13): in project months 1 to 36, total cost US\$ 80 000.

Indicators:

Process Indicators:

- i. existence of a jointly prepared Transboundary Diagnostic Analysis, identifying and separating transboundary concerns, risk and uncertainty in the IAS, linked to land use change and climatic change,
- ii. existence of an inclusive and consistent joint basin-wide process of risk identification, policy formulation to address identified risk and implementation of identified policies, including: (a) Identification of transboundary risk and uncertainty issues; (b) Development of policies to address identified risk issues, concluded and adopted in a joint development and conservation strategy for the IAS, and (c) Implementation of identified risk reduction policies.
- iii. existence of a joint legal and institutional Iullemeden cooperative framework, including:
 - mechanisms for harmonization of national policies and legislation,
 - a basin organization structure approved and committed for support by the countries and their development partners, and
 - existence of a transboundary aquifer monitoring system with its common and national components.

Stress Reduction Indicators:

- iv. transboundary risk and uncertainty issues from land use change in recharge areas and humid zones and from climatic change are identified and addressed jointly.
- v. development of common agreed policy and management measures for groundwater development and extraction in captive areas and land use change in the recharge areas and humid zones seepage zones of the IAS,
- vi. existence of a legal cooperative frameworks and institutional and communication mechanisms to address transboundary water conflict and related issues,
- vii. existence of inter-government communication programme for direct and timely contact and consultation between national water resources administrations.

Environmental Status Indicators

- viii. existence of agreed goals and criteria identified in a joint Transboundary Diagnostic Analysis, including quantitative and qualitative indicators upon which priority actions can be identified and implemented,
- ix. land use change in recharge areas and humid zones with transboundary risk of adverse environmental impacts on the IAS, are jointly monitored and managed,
- x. groundwater abstractions and pollution transboundary with transboundary risk of adverse environmental impacts on the IAS, are jointly monitored and controlled,
- xi. national governments and local communities are involved in the management of transboundary risk and uncertainty related to the IAS and
- xii. a pilot project is executed in the perspective of scaling up to a global aquifer focal area for communication and information sharing across GEF- IW projects.

Descriptions of Activities.

Component 1: Identification of Transboundary Risk.

The component supports establishment of common, basin wide mechanisms with human skill and institutional capacity to identify and keep updated records of risk and uncertainty issues. The activities include joint formulation of a Transboundary Diagnostic Analysis, targeted modelling studies, field recharge studies and isotope studies and establishment of a common risk identification database and targeted pilot risk area isotope surveys.

1. Transboundary Diagnostic Analysis

The activity (see Annex 6), includes:

- inter-ministerial TDA committees/task forces in Mali, Niger and Nigeria will collect factual country information on the country-sections of the IAS,
- joint review, analysis and reconciliation of country information to identify and determine the significance and priority with the root causes of transboundary risks and separate them from issue of national concern,
- preparation and reconciliation of the joint TDA draft report specifying risks elements from land use change and climate change for critical geographic location, economic activities and sectors and other social and economic influences to be addressed under the project,
- review and acceptance at political decision-making level of the draft TDA in a regional workshop.

The TDA represents the first step under the GEF TDA-SAP process for the formulation of a future, post-project Strategic Program of Action to address environmental and development concerns and their root causes.

2. Modelling Capacity Building:

The activity, under collaborative agreement with ETH in cooperation with national universities, building on the baseline modelling studies (Annex 1) is focused on post-graduate training of one modelling specialist in each country on specific targeted modelling for assessment of identified transboundary risk issues, at local, sub-basin or aquifer level or of specific themes including recharge and discharge mechanisms, hydro-dynamic impacts on aquifer, contaminant transport etc. The following steps are envisaged:

- nomination of three national post-graduate specialist
- identification of modelling needs/scope in response to risk issue identification,
- development and calibration of (3 different) specific models,
- reporting of modelling results, and
- certification of the three national specialists

3. Field Studies of Aquifer Recharge

The activity, under sub-contract with IRD-UMR provides for application of methodology and baseline field surveys by IRD-UMR (Annex 3), with expansion to other representative recharge areas and humid zones with identified transboundary risks or impacts on the IAS. The following steps are included:

- identification of the needs/scope and locations within IAS for targeted field surveys in response to risk issue identification,
- field surveys of hydrodynamic and geochemical characteristics,
- development of institutional modalities and in-service training to sustain targeted field surveys in support of risk identification,

4. (a) Establishment of a Common Risk Identification Data Base., (b) Targeted Pilot Risk Area Surveys

The activity is technically supported and executed as an associated IAEA TC project based on government experts and support, includes the following steps (see Annex 3):

- (a)
- joint review of potential issues within IAS for transboundary risk and conflict from land use change and climatic change,
 - selection, collection, verification, organization and data entry into a joint digitised data base of relevant available data (at country and international level),
 - initial trials for identification and reporting of risk issues based on the data base,
 - joint review and reconciliation of data base and identified risk issues,
 - institutional modalities and in-service training, to sustain the data base.

- (b)
- establishment a common isotope data base and monitoring network – in conjunction with Activity 1..1 Establishment of a Common, Selected and Targeted, IAS Data Base,
 - assessments for improved global hydrogeological understanding of the IAS,
 - hydrogeological studies in three pilot areas, representative for transboundary risks: (a) at the Mali-Niger border, (b) at the Niger-Nigeria border area, and (c) at a selected site with significant inter-aquifer exchange and related water quality impacts,
 - development of institutional modalities, in-service training, regional courses and fellowships.

Component 2: Policy Mechanisms for Management of Transboundary Risk (Management Framework).

The component provides support for establishment of mechanisms, at the common basin level to address transboundary risk issues identified under Component 1., through a process of policy formulation, policy implementation and enforcement, and transboundary monitoring of the activities.

1. Establishment of Mechanisms for Development of Risk Reduction Policies

The activity includes the following steps:

- review and joint assessment by an established tripartite IAS policy development Committee¹¹ of transboundary risk issues identified under Component 1, with options for practical and acceptable policy and implementing strategies, ,
- national level development of draft policy options and policy implementation mechanisms by national policy development committees in Mali, Niger and Nigeria,
 - joint review and reconciliation of proposed draft policy options and policy implementation mechanisms for sustainability and defined responsibilities, and
 - formulation and adoption of joint development and conservation strategy for the IAS. The strategy will focus on water and land use and include post-project activities and investment opportunities for supply and demand management and identification of alternative funding sources (e.g. GEF and others).

2. Development of a Joint Legal and Institutional IAS Cooperative Framework

The activity, as an associated FAO-TCP project (Annex 4) in close collaboration with the countries and the project executing agency, and includes the following steps:

Phase 1:

¹¹ Two members from each of the participating countries

Review and analysis of: (a) relevant national water and land resources legislation and institutions, (b) relevant existing bi-or tripartite cooperative frameworks and agreements, and (c) proposed policy options

Assessment report on recommended actions

Planning Workshop on action to be taken.

Phase II:

Development of options for an IAS cooperative framework,

Drafting of an agreement with schedules for a sustainable IAS basin organization,

National review, in three national workshops,

Tripartite review and coordination in a tripartite regional workshop,

Final drafting of a basin agreement and schedules for a basin organization,

A final report on the results under the activity.

In-service training of country legal and other staff .

3. Mechanisms for Transboundary Aquifer Monitoring

The activity (based on the UN-ECE methodology and references, Annex 5) includes the following steps:

- consultation and assessment study of the base for transboundary monitoring: (a) data and legal and institutional frameworks; (b) modalities for interactions with the legal framework and with the common targeted data base; (c) proposal for scope of operational monitoring in the IAS – including of transboundary risk and uncertainty, and impacts; risk mitigation policy measures; and (d) proposal for sustainable monitoring mechanisms, cooperation, structures, organization and financing.
- pilot monitoring activity in the pilot areas addressed under Activity 1.5.
- review of proposed monitoring mechanisms including progress reporting from the pilot area monitoring, in a tripartite regional workshop.

Component 3. Awareness, Participation, Communication.

The Component provides support for establishment of policy implementation through enhanced involvement, participation and communication between the countries and IAS stakeholders, focusing on local communities as water and land users and the water managers and officials of the national government.

1. Awareness and Participation Programmes

The activity includes two interlinked sub-activities focused on the implementation of policies to address the risk issues identified under the project: (a) development of a Joint IAS Awareness-raising Programme, and (b) assessment, pilot scheme trials and formulation of a coordinated basin wide programme on participatory water and land use management, and also introduction of experience and references from other GEF projects

a. Joint IAS Awareness Programme.

Define and initiate an operational communication program at sub-regional, country and local level in the three countries. Participatory design and initiation of a joint social communication program on management of risk in the IAS.

Establish a continuing common stakeholder consultation and community awareness and participation programme in selected high-risk locations of the basin (e.g. in border areas with potential transboundary water conflicts, recharge areas and humid zones subject to land use change and sub-areas vulnerable to climatic change. The pilot area consultations will include stakeholder consultations in local workshops and a joint regional workshop, in the three countries to review and accommodate needs and concerns of the local communities and water and land users.

b. Participatory Water and Land Use Management:

The activity includes an initial assessment study identifying potentials and constraints for involvement of the different stakeholder groups (exemplified in Table 4) for participatory management to address risk issues and implement policies identified under components 1 and 2 of the project. The study will specify, draw from the experience and assess the scope for collaboration with current and planned natural resources or agricultural

awareness and participation programmes in the participating countries. The preliminary stakeholder analysis will be expanded and developed into a detailed joint assessment of needs, practical forms and effectiveness for awareness and participation programmes of local communities and other water users and stakeholders also addressing rights and responsibilities of the local users. The study will develop the curricula and initiate pilot schemes in two selected locations/countries representative for local management of high risk and vulnerability to land-use change and to climatic change respectively for a concerted participatory and awareness programme in the basin to address identified risk issues and implement risk reduction policies at local level. Drawing from the experience of the pilot schemes and the capacity for local management of the aquifer resources a long term participation and awareness programme will be formulated. The study material with the experience from the pilot schemes and the proposal for a long term basin wide participatory management programme will be reviewed by the PSC for implementation at basin and national level.

2. Inter-government Communication Tools

The activity is partly built on the experience of communication systems under other GEF- IW projects. The activity will train key water and land resources managers to establish and secure effective communication between the water ministries in Mali, Niger and Nigeria and to maintain contact and exchange with the sub-regional WAWS in Ouagadougou. The needs for communication in the IAS, between: (a) national water ministries; (b) national water ministries and the West African Water Sector and,; (c) national water ministries and in-country stakeholders will be identified and government and sub-regional officials trained in communication methodology. The activity will comprise joint training sessions and country level in-service training .

Component 4.: Project Monitoring and Evaluation, and Dissemination of Data.

The Components provides for standard project monitoring procedures, exchange within the ISARM initiative of international experience on management of transboundary aquifer systems, collection, entry and global dissemination of project data under the Global Groundwater Data base managed by IGRAC.

1. Project Monitoring and Evaluation

The activity includes, in addition to the preparation of the project monitoring and evaluation plan by the project management, under Component 2, two independent project review (at a total cost of \$ 30 000) provided from the GEF contribution.

2. Dissemination of ISARM Reference Information

The activity, under sub-contract with UNESCO/ISARM will secure active exchange of experience, data and information, including provisions for translation of project-produced documents, from/to other ISARM projects with project information reported, recognized and followed up under global and regional strategies, meetings initiatives under the ISARM programme. The activity will secure and through ISARM/IAH, provide for access to available alternative technical methodology and approaches for surveys and modelling for application for project activities and outputs. The activity will include strengthening of the aquifer knowledge community.

3. Incorporation of Project Data in the Global Groundwater Data Base

The activity, under sub-contract with IGRAC, covers selection, certification, data entry for global dissemination of project data and information, into the Global Groundwater Data Base. The activity will develop and introduce data standards for inter-compatibility.

Component 5.: Project Coordination and Management.

The Component provides for project coordination and the operational support of the PSC, including meetings and reports to the Project Steering Committee, and for project management through the executing agency (OSS) at its home office (in Tunis).

1. Project Steering Committee

Preparation, implementation and reporting from 3 PSC meetings.

2. Project Management

Project management for project delivery, liaison and coordination with national and regional institutions and project donor and technical partners, activities, outputs and inputs and detailed budget planning and management and progress and final reporting (The activity is described in Annex 13).

3. Scientific Supervision, Support and Coordination

Scientific and technical review, supervision and coordination, including selection of expertise and inputs and evaluation of activities, inputs and outputs to ensure relevance, effectiveness and quality, and exchange with parallel relevant projects and programmes (The activity is described in Annex 13).

SUSTAINABILITY ANALYSIS AND RISK ASSESSMENT

Sustainability of the project activities and its achievements will be made possible by identifying and actively involving the stakeholders in the project activities from the start. The demand for the project has originated in the countries and the project design is based on the contributions from the Iullemeden stakeholders at the national, sub-regional and local levels. The project responds to these priority needs and demands for specific project outputs that have originated in the countries and been further defined by the countries during the project formulation.

A main project risk is related to the time-consuming and complex process for the development of an international cooperative legal framework. The establishment of a permanent forum or basin institution for management of the aquifer system requires long-term financial commitments from the countries and continuous strong political support. With the focus on mitigation of social and environmental risk the project is expected to attract high political priority and attention both at central and local levels, which is a necessary condition to secure that collaborative framework built up by the project will enjoy strong political support to be sustainable and continue to function after the end of the project. The common risk of sector barriers to integrated land and water resources management are minimized in risk-focused management approach with the focus on risk, uncertainty and vulnerabilities. The recurrent costs of the project, such as provision of manpower and institutions for maintaining the monitoring and information systems and administrate and operate a joint cooperative framework will be borne by the Iullemeden area countries also after the project is completed. Institutional and financial sustainability, broad participation and involvement and commitment at the decision-making level in the countries will form necessary conditions for identification, design and establishment of the joint aquifer cooperative framework.

The project will facilitate and build the network for continuous communication and dialogue to maintain the cooperative environment, build human and institutional capacities and sensitize stakeholders to support and maintain consistent management approaches at regional, national and the local level also after the completion of the project.

The countries will be involved in the formulation and reconciliation of an agreed TDA document. The TDA is prepared early (months 5-11) in the project to form evidence of country commitment to the project at political and technical level and to build country commitments to the post-project phase formulation and implementation of an Iullemeden Strategic Action Plan. The project outputs, such as the TDA, joint risk reduction policies, and a joint IAS development and conservation strategy include planning for a second implementation phase that can be expected to imply and commit the countries to investments in protection of recharge areas and humid zones and mitigation of risks from inappropriate drilling and abstractions and point-source and diffuse water pollution

Project risks that could influence the project results are identified in Table 4. As mentioned above, these risks reflect uncertainties related mainly to creating and implementing a joint management framework for the Iullemeden Aquifer System by the three countries.

Table 4: Risks and mitigation measures: Iullemeden Aquifer System Project Activities

Project Risk	Risk level; /mitigation of project risk
Countries discontinue to assess, create and share data about the aquifer; relevant data and information is not made available or shared	Low Risk: Compilation and sharing of a common risk identification data base formed an original rational and major justification by the countries, for Project Component 1. A strong collaborative environment established during project preparation and will be maintained through frequent and transparent communication assisted by common data standards and communication mechanisms.
Institutional arrangements (protocols, methodologies, processes and organizations) are not agreed or do not function;	Medium Risk: see above
Country contributions late or not available	Medium Risk: Resolve in Steering Committee
Capacity building results uneven and do not produce good quality contributions from all countries	Medium Risk: Monitor inputs from all countries; strengthen where needed
Agreement on administrative structure for aquifer management not reached	Medium Risk: Discussions need to start early
Local stakeholders, communities and NGOs, not properly involved	Medium Risk: Information Dissemination; redesign of institutional arrangements
Institutional roles not clarified or supported at sub-national government levels	Medium Risk: Frequent and transparent communication
Coordination with parallel projects and initiatives weakens	Medium Risk: Resolve in and between project Steering Committee(s)
Collaboration between project partners weakens	Medium Risk: Continued interaction, monitoring of joint project results
Project activities are not carried out timely	Medium Risk: Monitor input, strengthen where needed
Aquifer management system is not agreed or established	Medium Risk: Collaboration through frequent and transparent communication

STAKEHOLDER INVOLVEMENT AND SOCIAL ASSESSMENT

The main stakeholders as the senior water resource and environmental officials and experts have supported and participated in the project formulation. The scientific impetus with data and information on the IAS originated to a large extent through national water ministries and in the universities in the three countries involved in aquifer research. National water resources and environmental officials and experts from Mali, Niger and Nigeria in a technical UNESCO consultation on the aquifer system in Niamey in 1999, initially identified the project objectives and scope. The related government agencies and country experts were further consulted and contributed and supported the project formulation during an UNESCO mission to Mali, Niger and Nigeria in 2001. The draft MSP project brief was discussed and improved in a Technical Working Group Workshop with participation of the responsible senior officials from Mali, Niger and Nigeria, with representatives of UNEP and other project partners and contributing agencies held in UNESCO Paris in February 2002. An updated draft of the MSP brief was reviewed and accepted for a priority study under An African ISARM Strategy in the International Workshop on Transboundary Aquifers in Africa in Tripoli, June 2002.

The sub-region and The West African Community is taking on an important role and the sub-region is becoming an important stakeholder in the water and natural resource sector. The Economic Community of West African States, ECOWAS has confirmed the regional support (for coordination and to accommodate the project management unit) of the project similar to and as an key complement activity to the parallel GEF supported sub-regional surface water basin conservation projects (e.g. the Niger River Basin) and to the establishment of a sub-regional water sector¹². The Niger Basin Authority has been consulted during the formulation and confirmed the significance of an IAS management initiative and emphasized the benefits from close coordination and cooperation with the NBA.

The direct stakeholders and participants in the project include: (a) national officials in water, land and environmental administrations; in the water and land use sub-sectors; and in the National Security agencies at central and local levels of the country governments (b) local communities and the direct water and land users and beneficiaries, and (c) the sub-regional and bi-lateral bodies, including the land and water sectors under ECOWAS. The issues and needs of the different groups of stakeholders, with expectations, potentials and drawbacks, and the consequences for the projects are summarized in Table 4.

¹² The establishment of an independent WAWS under ECOWAS with intermediate secretariat in Ouagadougou was adopted in December 2001.

Table 5: Analysis of Stakeholders and Project Participants

Stakeholder Groups	Problems/needs	Expectations	Drawbacks	Potentials	Consequences for the project
National Governments officials National experts	Limited public resources focused on immediate social necessities. Limited local initiative and participation. Top-down donor-driven programs	Integrated management Improved information, computer, survey and exploration technology	Sectoral positions and barriers. Limited incentives and motivation Food security and Development priorities	Devoted high human capacity groups of national professionals. National universities: human resources, studies and data	Involvement, enabling and support of national officials and expertise. Introduction of modern information methodology/technology
Water, land users-farmers	Accelerated human-induced land and water degradation, loss of perennial vegetation, desertification, desiccation and drought Inadequate water supplies. Government induced development programs. Subsistence farmers outside the formal economy	Drought secure agriculture. Improved yields. Cash-cropping with enhanced farming and off-farm income. Safe drinking and livestock water supplies	Rural poverty. Population pressures. Land scarcity. No access to non-marginal land. Capital scarcity, limited access to technology. Lack of alternative off-farming income. Common open access, no land ownership and tenure structure. Lack of information and knowledge of environmental threats	High but rapidly declining biodiversity for traditional subsistence; traditional knowledge of land use, water management and use of local resources. High motivation to change to conserve common resources change. Rural women and land and water conservation.	Focus on: Rural poverty alleviation. Local awareness, participation and organization of farmers. Alternative strategies to food security. An outlet from project activities to subsistence farming groups . Mobilize rural women for conservation.
Sub-regional representatives	Limited socio-economic cooperation and trade. Lack of sub-regional authority. Limited financial sustainability of sub-regional institution. Country differences, backgrounds and languages	Establishment of an independent water sector. Sub-regional cooperation on integrated land and water resources.	Sectoral structure and barriers to integrated approaches. Lack of authority, and jurisdictions and established basin focused management frameworks.	Building on the tradition of West African regional cooperation. ECOWAS and up-dated existing sub-regional and bi-lateral frameworks (NBA, NNJC, PPNMC) Sub-regional scientific water and land resources and agricultural research centres in the basin.	The project PMU accommodated in the premises of ECOWAS, Abuja. ECOWAS is the Coordinating agency of the project. Existing mechanisms and institutions are reconsidered in the cooperative framework.

The project will be mobilized in a Project Launching Seminar – supported by UNESCO – with representatives for the stakeholders and the donor community as a separate meeting held prior to but in connection with the first meeting of the Project Steering Committee. The seminar will provide the opportunity for presentation of optional and supplementary activities and inputs for consideration and possible support by donors and collaborating partners.

INCREMENTAL COST ASSESSMENT

Baseline Situation

The base-line activities, summarized in Table 2, are at one hand represented by recent scientific work on hydrogeological data collection, assessment and modelling for enhanced general knowledge of the groundwater resources of the IAS mainly at the country level. The baseline also includes the completed or on-going putting in place of updated national water resources management frameworks in the participating countries with legislation and adjusted and decentralised water resources institutions defining the responsibilities in the national water resources sectors. While the outputs from these and other baseline activities including data gathered under other programmes have mainly domestic impacts, the data will be available and used in selective parts in the project. The information will be important for the preparation of joint development and conservation strategy for the IAS under the MSP, and for a full, future SAP established and implemented after the MSP.

The baseline activities have been less focused on the entire basin and not on identification and management of transboundary issues and risk. In particular, these activities, have not, with some exceptions, addressed the linkages between the impacts from land use and climatic change and risk in the IAS. The current knowledge base, when referred to the size and the complexity of the IAS, is limited and uncertain and not organised to

address transboundary issues at basin-wide level. As a consequence assessment and management of transboundary risk will proceed in a setting of high uncertainty. This data and assessment uncertainty is further enhanced from limited information on the extent and the hydrological impacts of land use change in the recharge areas and the humid zones, and the inherited uncertainty of the scope and time frame for climatic change. In this situation the approach to joint management will be risk-based based on defined responsibilities, preparedness, participation and communication and with uncertainty addressed through active monitoring and frequent feedback. In view of the significance of threats and potential transboundary risk in the IAS addressed under the project and with the insufficiency of the current development-oriented and country based management approaches, the increment activities for management of risk and uncertainty under the alternative GEF course of action can therefore be expected to have high payoffs.

Global Benefits

The global benefit arising from the GEF MSP project and the management mechanisms to reduce, mitigate and also accommodate and share transboundary hydrogeological risks in the IAS from land use change in recharge areas and humid zones of the IAS and from climatic change can be expected to be significant. An immediate benefit is reduced risk for hydrogeological disasters and irreversible loss of water resources and land productivity in the basin areas together with prevention of long term degradation of strategic sub-regional water resources. This can be expected to reduce pressures in the international and regional waters environments, prevent harmful long-term impacts on the global and regional climate and protect the significant dryland and humid zones and wetlands and freshwater eco-systems. An estimated total cost of the baseline activities attributed to the alternative course of action under the project is US\$ 800 000. The alternative project cost is US\$ 2 555 000. The GEF incremental funding is US\$ 1 720 000.

The global and baseline benefits with the alternative and incremental costs, identified by project component, are estimated in the Incremental Cost Matrix in Table 6.

Component 1. Identification of Transboundary Risk.

The baseline activities include hydro-geological and isotope surveys and assessment, data base and modelling of the aquifer systems and initial expert meeting at basin level.

The increment activities comprise joint preparation of a TDA, targeted modelling studies, establishment of a selected common risk identification data base targeted on the identification of transboundary risk issues and field hydrogeological and targeted isotope studies in selected critical high risk pilot areas.

The alternative project cost is US\$ 955 000. GEF incremental funding is US\$ 555 000.

Component 2. Policy and Institutional Mechanisms for Reducing Transboundary Risk.

The baseline activities include experience established from current cooperation under existing bi-lateral water resources frameworks, and national implementation mechanisms as a result of updated water resources legislation and institutions at country level

The increment activities comprise establishment of mechanisms for review of transboundary risk issue with formulation of policy and implementing strategies to address the issues, development of a legal and institutional cooperative framework including a basin institution and programmes for joint programmes awareness, participation and inter-country communication.

The alternative project cost is US\$ 750 000. GEF incremental funding is US\$ 450 000.

Component 3. Awareness, Participation, Communication.

The baseline activities include current program structures to be utilized for participation and awareness on basin and transboundary issues.

The increment activities comprise common basin-wide awareness programme and training on inter-country communication.

The alternative project cost is US\$ 233 000. GEF incremental funding is US\$ 133 000.

Component 4. Project Monitoring and Evaluation, and Dissemination of Data.

There are no baseline activities under this component.

The increment activities comprise international exchange with parallel activities on transboundary aquifer systems and global dissemination of project data and information.

The alternative project cost is US\$ 95 000. GEF incremental funding is US\$ 95 000.

Component 5. Project Coordination and Management.

There are no baseline activities under this component.

The increment activities comprise the support of a coordinating project steering committee and supplementary activities for project management, administration and delivery of the project.

The alternative project cost is US\$ 445 000. GEF incremental funding is US\$ 445 000.

Table 6. Incremental Cost Matrix (US\$)

Component	Category	Amount	Domestic Benefits	Global Benefits
Component 1. Identification of Transboundary Risk.	Baseline	400 000	In-country assessment of national groundwater resources	Basic hydrogeological data; initial definition and assessment and data, of the IAS resources.
	Alternative	955 000	Assessment for shared use of transboundary IAS resources	Identification of transboundary risk issues from abstractions, land use change, climatic change.
	Increment	555 000		
Component 2. Policy and Institutional Mechanisms	Baseline	300 000	National level water resources administration.	Established experience and frameworks for international water resources cooperation in the IAS sub-region. National institutional frameworks for country level policy development and implementation to address transboundary risk issues.
	Alternative	750 000	Enhanced preparedness for transboundary risk in the IAS.	Positive impacts of coordinated groundwater management, and development of methodologies able to be applied to other international basins. Reduced international pressures
	Increment	450 000		
Component 3. Awareness, Participation, Communication.	Baseline	100 000	Public awareness of water resources development, public health and conservation issues	Partly established local, country level capacity for awareness, participation on common basin issues.
	Alternative	233 000	Country preparedness through: Mobilization of local populations for local management of risk issues. Communication with partner governments and institutions in the basin.	Awareness, and capacity for mobilization and defined responsibilities of local populations for management of transboundary water and land resources issues
	Increment	133 000		
Component 4. Project Monitoring, Evaluation, Dissemination of Data.	Baseline			
	Alternative	95 000	Country involvement in international exchange and access to data and experience on international practice for management of transboundary aquifer resources.	Global access to data and experience on management of transboundary risk in shared aquifer resource system, for the benefit of this and other, future projects on transboundary aquifer resources.
	Increment	95 000		
Component 5. Project Coordination and Management.	Baseline			
	Alternative	445 000	Country experience and enhanced contact for sub-regional cooperation and coordination on water and natural resource issues.	Capacity to jointly manage and implement sub-regional programmes for mitigation and sharing of common natural resources and environmental transboundary risks.
	Increment	445 000		
PDF		60 000		

TOTAL	Baseline	800 000		
	Alternative	2 538 000		
Total Increment		1 738 000		

*including PDF

BUDGET

The project inputs and costs under the activities are estimated in Annex 8.

The total project costs, broken down for financing/contributing sources, are presented in Annex 9.

Detailed annual Project Budgets (UNEP format), are presented in Annex 10 a. Combined Budget and in Annex 10 b. GEF Budget.

The summary budget distributed for budget categories and financing sources is presented in Table 7.

TABLE 7: SUMMARY BUDGET (US\$)

Component	GEF	Other sources	Project Total
PDF:		60 000	60 000
MSP: Project Costs			
10 Personnel	134 000		134 000
20 Sub-Contr. /co-projects	439 000	720 000	1 159 000
30 Training	340 000		340 000
40 Equipment	30 000		30 000
50 Miscellaneous	15 000		15 000
99 Total (PDF + Project)	958 000	780 000	1 738 000

The current status of financing of the project is summarized in Table 8.

TABLE 8. STATUS OF PROJECT FINANCING¹³.

GEF	958 000	Requested
FAO	300 000	Regional FAO-TCP project assistance, associated to Iullemeden MSP, by the Governments of Mali, Niger and Nigeria under formulation and approval by FAO,
IAEA	350 000	Approved regional IAEA TC project assistance, associated to Iullemeden MSP, to Mali, Niger and Nigeria. Activity scheduled for start in May 2003
IGRAC (UNESCO/ISARM)	30 000	Accepted: IGRAC is under process of establishment; UNESCO/ISARM will assume intermediate funding responsibility
IRD-UMR	20 000	Accepted
UNESCO/IHP	60 000	Accepted
UNESCO/ISARM	20 000	Accepted
Total	1 738 000	

¹³ Reflects status 10 March 2003

IMPLEMENTATION PLAN FOR THE PROJECT PHASE

The Project Implementation Plan is presented in Annex 11.

PUBLIC INVOLVEMENT PLAN

The chart, in Annex 7, defines the Institutional Arrangements for Project Execution, with the structure for project steering and execution, the participating countries and national, sub-regional and international agencies and linkages and coordination with parallel land and water resources GEF projects and with other related initiatives, regional policy and institutional frameworks and strategic action programmes, including the CDD/SRAP coordinated by ECOWAS and CILSS.

At Sub-regional level:

The project is managed by a Project Steering Committee (PSC) with participation from the three participating countries, UNEP as the GEF-IA and the Donors and Cooperating Agencies, representatives of WAWS/ECOWAS as Regional Coordinating Agency for the project and UNESCO/ISARM as principal scientific coordinator and the contact point on Transboundary Aquifer System Management. The establishment and the first meeting of the PSC represent the formal commencement of the project. The PSC shall meet at least annually at locations within the Iullemeden basin.

The existing bi-lateral commissions, (NNJC) and (PCCMN), when called by two members, will participate as observers on specific bi-lateral issues in the PSC. For the purpose of inter-project coordination and information sharing, representatives of parallel GEF projects, including the NBA (Niger Basin) and the NNOCC projects, will be invited to participate in the PSC meetings and on the other hand OSS will participate in Steering Committee Meetings of these projects. The project will also widen the contacts within and along the margins of the IAS in the sub-region and cooperate with the LADA project and the PDF B on the Fouta Djallon Regional Integrated Development Program. The project will be referred under the CDD/STRAP for West Africa coordinated by ECOWAS and CILSS and liase under the CILSS thematic area of shared water resources.

National level:

National Project Committees (NPCs), in Mali, Niger and Nigeria, chaired by the national focal points, normally the national Directors or deputy Director of Hydrology. The NPCs members comprise technical specialist and representatives of the participating national line ministries/sectors, including Water Resources, Environment and Natural Resources and Agriculture and Land Management and Conservation, and national universities and specialised institutes. Multi-stakeholders committees will be established and be represented in the NPCs. The three NPCs will assign inter-sectoral representatives to work in a TDA-preparation Team responsible for the joint TDA document. The project will consider and draw from the national action programmes including the national CDD programmes in Mali, Niger and Nigeria.

The Executing Agency, OSS is responsible for the execution of the project activities and acts as the secretariat for the PSC. OSS will participate and represent the IAS project on related steering activities and steering committee meetings under the parallel NBA and NNOC GEF-IW projects. The project is supervised and coordinated scientifically by UNESCO together with ISARM. The executing agency, with scientific support from UNESCO/ISARM is responsible for the administration of the work of national technical teams and experts, sub-contracted institutions and NGOs, and consultants and the organization of the project meetings and training activities.

Project beneficiaries

The direct beneficiaries of the project are the national water ministries and decentralised water agencies and national natural resources agencies responsible for land conservation together with the regional level units including the West African water and natural resources sectors. The ultimate beneficiaries are the populations and local communities mainly in rural areas, who are under long term threat of land degradation, water scarcity and loss of water source and biodiversity. These groups will benefit from reduces exposure to transboundary risk in support of water and food security and improved health and reduced vulnerability to drought.

MONITORING AND EVALUATION PLAN

A monitoring and evaluation plan will be implemented to ensure monitoring and evaluation of project progress and results based on the project objectives and indicators. The M&E plan would be used on a continuing basis during and after project implementation and as a basis for dissemination of project results to other countries/regions. Key indicators to be monitored would be (a) improved knowledge and command of transboundary risk in the IAS; (b) establishment and active application of a joint Iullemeden Aquifer Cooperative Framework, (c) increased awareness by decision makers and civil society regarding the value and importance of the Aquifer, (d) strengthened institutions at all levels of society in the countries for aquifer management, and (e) risk of unexpected adverse social and environmental impacts and conflict as a result of the project activities.

The monitoring and evaluation activities will be consistent with the project management practices of the implementing agency, and comprise:

- Regular (half-yearly) progress reporting
- Project review meetings (UNEP, OSS, UNESCO/ISARM and others), in conjunction with the Project Steering committee meetings
- Establishment and regular update of project execution plans and project budgets
- One independent external project evaluation, and
- A substantive independent midterm project review.

The results of the project would be disseminated to other countries, regions and institutions. Replication elsewhere would be supported by production of written material as well as participation in international workshops and task forces.

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PROJECT CHECKLIST

PROJECT ACTIVITY CATEGORIES			
Biodiversity	Climate Change	International Waters	Ozone Depletion
Prot. area zoning/mgmt.:	Efficient prod. & distrib.:	Water body: x	Monitoring:
Buffer zone development:	Efficient consumption:	Integrated land and water: x	Country program:
Inventory/monitoring:	Solar:	Contaminant:	ODS phaseout:
Ecotourism:	Biomass:	Other: desertification control (complementary): x	Production:
Agro-biodiversity:	Wind:		Other:
Trust fund(s):	Hydro:		
Benefit-sharing:	Geothermal:		
Other:	Fuel cells:		
	Other:		
TECHNICAL CATEGORIES			
Institution building: x			
Investments:			
Policy advice: x			
Targeted research: x			
Technical/management advice: x			
Technology transfer:			
Awareness/information/training: x			
Other:			

Table 9: Importance of the Iullemeden Aquifer System in Mali, Niger, and Nigeria.

	Mali	Niger	Nigeria	Total Aquifer
Surface aquifer [% of aquifer]	31 000 km ² [5,9%]	434 000 km ² [82,6%]	60 000 km ² [11,5%]	525 000 km ² 1°E - 10°E (~980 km), 10°N - 19°N (~1 000 km)
Popul. (2000) [% basin popul.]	180 000 [1,3%]	9 370 000 [64,8%]	4 900 000 [33,9%]	14,45 million (projected to 28 million in 2025)
Characteristics	Mainly recharge area: limited, recharge from surface runoff off the Adrar crystalline massive. Free aquifer, water level at > 40 in NW, captive to artesian in the lower SW, pressured from the cretaceous aquifer. in the south. Depth > 300m falling to > 1000 in the Gao Trench.	Recharge and supply area. Recharged at the borders with the Air and the Hoggar massives. Piezometric levels between 0-80 m; Captive, and artesian, areas include Agadez, Dosso, Maradi and Tahoua	Recharge and active supply area	Aquifers: Continental Intercalaire (Hamadien); Continental Terminal (1,2,3). Nigeria: Sokoto GW Basin: local aquifers: Tertiary: Gwandu, Kalambina Cretaceous: Wurno, Taloka, Gundumi-Illou
Extent of exploitation	Limited exploitation date back to 1980s and earlier with recent programs for development and expanded extractions .	> 19 000 wells and boreholes in the project area ¹⁴ . < 500 boreholes, including in the artesian zones and < 200 deep boreholes; uses include irrigation, livestock, urban and rural and industrial supply and mining exploration	> 4 000 boreholes in the Sokoto Basin Aquifers. Use is for domestic urban and rural water supplies	
Environment-al issues and threats	over-exploitation and risks related to supply security in confined sections in desert areas without alternative supplies; resource degradation from over-abstraction, inappropriate water resources and other development e.g. exploration and long term contamination ; related risks of supply failure with depopulation and accelerated and irreversible desertification	Indications of environmental and public health risks: High fluor content in the Continental Hamadien resulted in physical deformation of children; High salinity rendering irrigation development non productive Groundwater Pollution from contaminated wetlands/ marshes.	High uses of shallow aquifers result in reduced aquifer recharge	Drastic recent increase in recharge to the upper free aquifer due to clearing of vegetation cover. Over- or inadequate exploitation: loss of pressure and Inversion of flows Vertical inter-aquifer pollution Climate change, persistent drought and desertification Pollution, infiltration from marshes with contaminated or salinized water Continued unmanaged, ad hoc demand driven exploration resulting in: environmental risk and loss of important strategic water resources reserves; and less than optimal benefits over-use in zones with shallow free aquifers affecting vegetation cover
Level of information	Information in the project area dates back to 1980s and earlier; inadequate current monitoring - data collection..	Considerable information available ; monitoring networks (piezometric and quality) are limited and represent a national development priority	Limited borehole and aquifer monitoring.	National contexts of piezometric water levels and flow directions in border sections differ between countries

Table 10: Iullemeden Aquifers - Hydrogeological parameters (Niger) .

Aquifer Parameters	Continental Intercalaire/Hamadien	Cretaceous Marin	Continental Terminal (see note)
Total Surface (km ²)	343075	not known	1. 103000 2. 52000 3. 76000
Free surface aquifer (km ²)	161675	(44465)	1. 103000 2. not known 3. not known
Depth – Wells (meters)	100-1000 m	40-150 m	1. 10 – 80 2. 70-170 3. 100 – 300
Piezometric level (meters)	0 – 80	20 – 150	10-70 20-80 0-40
Exploitable Yield (m ³ /h)	> 100	0 – 20	10-60 20-70 10-80 m ³ /h
Water quality	good	medium-poor	1. medium-good 2. good 3. excellent
Storage Ratio: Reserve per m drawdown	15 000 m ³ /km ²	100 (?)	1. 5000 2. 52 3. 8
<i>S Strategic Reserve (economically accessible)</i>	2 30 km ³ (for a drawdown of 30 m)	0,03 Km ³ for a drawdown of 10m	1. 28 km ³ (50m) 2. 0,13km ³ (50m) 3. 0,025 km ³ (50m)
Renewable, annual m ³ /km ²	38	10 (?)	1. 700 2. ? (limited) 3. ~ zero
<i>S Annual Renewal</i>	20 Mm ³	0,4 Mm ³	1. 72 Mm ³
Renewal Ratio (% of)	quasi-fossil	< 0,1 %	1. 0,5 % 2. very limited 3. very limited
Vulnerability to Pollution	Low to zero	middle	1. high 2. low 3. low
Notes	Artesian sections	Irregular exploitation, large drawdowns	1. – 2. – 3. artesian

Note: 1.Phreatic aquifer; 2. Middle Aquifer; 3.Lower Aquifer.
Source: Ministry of Water Resources, Niamey