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**SUMMARY ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT**

**August 2008**

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## **LIST OF ABBREVIATIONS AND ACRONYMS**

<b>CES/DRS</b>	Soil Conservation, Protection and Restoration
<b>CLE</b>	Local Water Committee
<b>ESIA</b>	Environmental and Social Impact Assessment
<b>ESMP</b>	Environmental and Social Management Plan
<b>ICOLD</b>	International Commission on Large Dams
<b>IPPM</b>	Integrated Production and Pest Management
<b>IWRM</b>	Integrated Water Resources Management
<b>NBA</b>	Niger Basin Authority
<b>PAPIM</b>	Maninkoura Plain Development Project
<b>PDRI</b>	Djenné Integrated Rural Development Programme
<b>PMB</b>	Middle Bani Plain Development Project

## 1. Introduction

1.1 The objective of the Irrigation Development Programme (PDI) is to improve food security and contribute to poverty reduction in Mali. It seeks to intensify the farming of complete water control irrigation areas and increase flood control irrigation areas, while contributing to environmental protection. The programme covers three zones (Maninkoura, Middle Bani and Djenné) the first two of which are the consolidation areas of completed projects. The programme, which will span five years, comprises four components:

- A. Irrigation infrastructures
- B. Rural Development
- C. Support Actions
- D. Programme Management

1.2 Complete impact assessments with an ESMP and some supplementary studies have been carried out in the three zones. A document entitled “Environmental and Social Impact Assessment and ESMP of the Irrigation Development Programme”, written during the preparation of the programme, summarizes and updates the conclusions of all these documents. The programme is classified under environmental category 2 by the Bank.

1.3 After presenting the regulatory and institutional context of the programme, the summary describes the positive and negative impacts that were identified, assessed and presented. It also presents the mitigation and compensatory measures identified in the ESMP and incorporated into the project, notably in its “Support Actions” component. The programme used a participatory approach in its preparatory phase, and public participation will be ensured throughout the project period through the consultation structures established during the first phase. In addition to environmental surveillance which is part of the project monitoring mechanism, the programme will put in place an environmental monitoring mechanism to regularly monitor some parameters and adequately solve any problems.

## 2. Programme Description and Justification

### 2.1 Description of Programme Activities

The proposed programme activities are divided into the following four major components:

**2.1.1 Irrigation infrastructures:** This component comprises all development works to be carried out in the three zones.

2.1.1.1 The works envisaged in the Maninkoura zone are:

- Construction of a sill on the Kourouba site on River Sankarani; with its baseline studies including an environmental and social impact assessment and a resettlement plan, if necessary;
- Consolidation of existing feeder roads, and protection of dykes against erosion ;
- Construction of structures for the retention of water in drains;
- Backfilling of tertiary roads with laterite within the area (54km);
- Construction of crossing structures over secondary canals (36 bridges);

2.1.1.2 The proposed works in the Middle Bani zone are:

- Development of the Eastern plot of Tougan, 9 plots of San Ouest and 4 plots of San Est (1,0540ha);
- Development of 110 ha of fish tanks;
- Extension of the protection bank dyke with two 18 and 33 km sections ;
- Reinforcement of some protective structures at the sill and main water supply structure;
- Resizing of the main canal built during the first phase of the project, and its extension (70km);
- Unblocking of blocked-up passes of structures built during the first phase of the project.

2.1.1.3 The proposed works in the Djenné zone are:

- Construction of Djenné 271 m IGN sill;
- Construction of Pondori feeder canals;
- Construction of right and left bank access dykes;
- Construction of right and left bank protective dykes;
- Construction of dividing dykes in Pondori plain ;
- Construction of structures in-between the plots;
- Development of 14000 ha of flood control irrigation areas;
- Construction of Pondori outlet works;
- Cleaning of Pondori feeder canals (Soala and Kandara).

**2.1.2 Rural development:** This component comprises all irrigation area development activities. It covers mixed farming (rice, market garden produce), with rice as the main crop, as well as livestock and fish farming. The proposed major activities are:

2.1.2.1 The proposed activities in the Maninkoura zone are:

- Farming and maintenance of 1094 ha of complete water control irrigation area, comprising double cropping of rice on 915 ha (after construction of the sill), cultivation of banana on 115 ha, and market gardening on 64 ha ;
- Health coverage for livestock through support to agents;
- Fish farming (10 ha) ;

2.1.2.2 The proposed activities in the Middle Bani zone are:

- Development of 10,540 ha through rice growing;
- Regeneration of 1 820 ha of bourgou fields;
- Fish stocking and farming of tanks (110 ha) ;

- Development of market gardening areas (490 ha) ;
- Health coverage for livestock through support to agents.

2.1.2.3 The proposed activities in the Djenné zone are:

- Development of 14 000 ha of flood control irrigation areas for rice growing ;
- Regeneration of 5 000 ha of bourgou fields;
- Development of 50 ha for market gardening;
- Health coverage for livestock through support to agents;
- Development and fish stocking of 150 ha of water bodies for fish farming.

**2.1.3 Support actions:** This component includes all measures taken to ensure environmental management in line with the recommendations of the ESMP, the integration of women and youths, support for local development, and capacity building.

*2.1.3.1 Environmental management:* The project will ensure the environmental management of worksites, which will be monitored by the DNACPN. For the rational management of pastoral, forestry and fishery resources, five local agreements will be prepared, 500 ha will be reforested, CES/DRS works will be carried out to strengthen the banks, Koutoloma forest will be developed, support will be given for the preparation of land-use management plans of the 12 councils of Djenné, support will be provided for water management of Talo and Djenné sills, and technical support will be provided for water management on the three sites. An environmental monitoring system will be put in place, and supported by a Geographic Information System (GIS).

*2.1.3.2 Integration of women and youths:* The programme will help to form Five Economic Interest Groups (GIE) for the procurement of agricultural equipment, which will enable young people to generate incomes by renting agricultural equipment and carrying out custom works for farmers. A CFAF 210 million line of credit will also be managed by decentralized financial services for the income-generating activities (IGA) of women and youths. Women will receive some processing equipment for demonstration purposes (mini-dairy plants, mills, hulling machines, dryers). They will also benefit from technical support for their IGAs.

*2.1.3.3 Support for local development:* Funding will be provided to support the PDSECs of councils of the Djenné District, pastoral wells will be sunk and facilities will be provided for the resettlement of displaced people. Wells/boreholes and latrines will also be constructed near the facilities.

*2.1.3.4 Capacity building:* The programme provides for a series of technical training sessions to improve the skills of various stakeholders in the practice of their profession: agriculture with emphasis on Integrated Production and Pest Management (IPPM), livestock production, fisheries and fish farming, water management, income-generating activities and cooperative organization. Such training will be backed by a literacy education programme for 6 000 people. Another series of training sessions will aim at improving the environmental skills of the various stakeholders: environmental and social impact assessment, combating bushfires, improved fireplaces, environmental monitoring, sanitation, STD/AIDS, integrated water resources management, conflict management and aquatic weeds. Support will be provided to the Bani Watershed Committee to strengthen its role in the concerted management of water resources and conflict management.

**2.1.4 Programme management:** This component covers the following activities:

- Administrative and financial management by the National Coordination Unit and Local Management Units;
- Memoranda of understanding with local technical services for close supervision;
- Programme monitoring and environmental surveillance;
- Communication.

**2.2 Description of Study Area**

The study areas are those which will be covered by the first phase of the programme.

**2.2.1 The Maninkoura zone:** The activities to be carried out on this site are activities for the consolidation of the first phase of PAPIM (Maninkoura Irrigation Area Development Project). This project, which was classified in environmental category 2 by the ADB, has already been the subject of a complete environmental assessment (Environmental Balance Sheet, SNC Lavallin, 2004) with its ESMP (SNC Lavallin, December 2006), and most of the recommendations have been implemented. In the next phase, a sill will be constructed in Kourouba on the Sankarani River to control the inflow of water needed for irrigation. An environmental and social impact assessment is part of the feasibility studies to be conducted for the sill. The project area is located in Kangaba District, Maranambougou Council, with an estimated population of 6,323 inhabitants in 2002 and massive migratory movement. The area directly covers two villages and 21 hamlets, and indirectly about 10 other villages and hamlets. Geographically, the study area is located in the south-east of Mali in the upper valley of the Niger River near the confluence of the Sankarani-Niger Rivers in Kourouba. It covers about 850 km<sup>2</sup> and comprises the Maninkoura plain located on the left bank of River Sankarani 40 km downstream Sélingné dam (see map appended).

**2.2.2 The Middle Bani Zone:** The activities to be carried out concern the consolidation of the first phase of the PMB (Middle Bani Plain Development Project). This project, which was classified in environmental category 1 by the ADB in 1997, was the subject of a complete environmental assessment in 1995 together with its ESMP in 1998. The ESMP was updated again in 2004 (AGRER, Haskoning 2004), and most of the recommendations have been implemented. The project area is located in Ségou Region, and covers Ségou, San and Bla districts, with an estimated population of 187 742 in 2003. The area comprises 189 villages, 65 of which are more directly covered by the project and divided between 21 councils, and covers a surface area of 3701 km<sup>2</sup>. Geographically, the project area comprises three (3) major types of spaces: (i) to the north, the inter-river space located between the Niger and Bani Rivers, with periodic floods during natural swellings of the River Bani ; (ii) between the Bani River and the paved road (RN6), mainly to the west of San, where the area is exposed to flooding by swellings of the Bani River, is formed by a succession of shallow basins and where, because of drought, floods are increasingly less frequent; (iii) more to the south of the road linking San to Bla, an area not exposed to floods and suitable for the cultivation of rain-fed crops (cotton) and has pastures for the transhumance of herds from the region of Mopti to the settlement areas of Koutiala and Sikasso.

**2.2.3 The Djenné zone:** The activities to be carried out in the Djenné zone were defined in the feasibility studies of the Djenné Integrated Rural Development Programme (PDRI) whose report was validated in September 2007. It is a new operation. The studies include the Environmental and Social Impact Assessment (BCEOM, BETICO, Coyne et Bellier, 2006) and its Environmental and Social Management Programme (BCEOM, BETICO, Coyne et Bellier, December 2007). The assessment covers the entire Djenné district, Mopti region, as well as the areas upstream and downstream (San, Bla and Mopti districts) of Rivers Niger and Bani, which include the entire project area. However, the priority actions will be located in a more restricted area around the facilities. The population of Djenné district was estimated at 171 003 in 2006, comprising 12 councils, 177 villages and 162 hamlets. The project area, which straddles River Niger and its main tributary the Bani River, is covered by five major geographical entities of a total surface area of 650 000 ha: on the left bank: the Sébara plain, the Yongari and Mangari plains, and the Pondori plain; on the right bank: from upstream to downstream the Bougoula, Sarantomo, Goubé and Sofara plains.

### **2.3 Programme Justification**

2.3.1 Within the current global economic context marked by a food crisis the scope of which have not yet been fully grasped, but which most analyses predict will continue to worsen in the years ahead, the Malian Government reacted by taking a number of measures. The measures include, in particular, the rapid increase of the country's rice production. This goal is expected to be attained mainly through intensification of agricultural production, increasingly using inputs (selected seeds, fertilizers, etc.) and mechanization. Emphasis will be laid on the intensification of rice production in the irrigation areas which have total or partial water control that can protect this crop from unstable rainfall.

2.3.2 The Irrigation Development Programme is fully consistent with the African Development Bank's 2005-2009 Strategy Paper and the strategic and sectoral context of development and promotion of irrigation in Mali, which is based on guidelines from the following basic texts and strategies: (i) the Economic Growth and Poverty Reduction Strategy Paper, 2<sup>nd</sup> generation 2007-2011 (EGPRSP II); (ii) the Agricultural Orientation Law (LOA); (iii) the Sector Consultation on Rural Development and Irrigated Agriculture (CSDRAI); and (iv) the National Irrigation Development Strategy. The strategic and sector guidelines stipulate that irrigated agriculture contributes explicitly to rural development as the main vector for combating poverty and food insecurity.

2.3.3 The Programme has become necessary for the following reasons: (i) the rural sector plays a predominant role in the socioeconomic development of Mali, generating incomes for 75% of the population. It accounted for 36% of GDP in 2003 and about 22% of exports in 2002; (ii) the food situation of the country is fragile because of its heavy dependence on climatic factors (about 75% of the agricultural production comes from rain-fed farming) and because of inadequate agricultural intensification and diversification; (iii) the consolidation of the two completed projects (PAPIM and PMB) will foster development of the facilities that could not be provided in the first phase and that will contribute to the achievement of the expected positive impacts in terms of food security and incomes; and (iv) the facilities to be constructed in Djenné are in response to the strong demand expressed by the populations during the Djenné Forum in 2003 and reiterated throughout the consultation phase of the preparatory studies.

### **3. Policy, Legal and Administrative Framework**

#### **3.1 Mali's Environmental Policy**

3.1.1 In Mali, environmental and social impact assessments are prepared in compliance with Decree No. 03-594/P-RM of 31 December 2003 on environmental impact assessments. The decree describes the procedure for obtaining the environmental permit of the project. A new decree issued on 26 June 2008 specifies the procedures and confirms that irrigation projects of more than 50 ha are classified in category A and require an environmental and social impact assessment. A provisional sector guide on impact assessments relating to irrigation schemes was prepared by the Ministry of the Environment and Sanitation in July 2007. Mali does not yet have a resettlement policy for populations who have to be displaced; the country draws on ADB directives in this area.

3.1.2 The projects must also take into consideration the following laws on the environment:

- Laws Nos. 95-031/AN-RM and 95-032/AN-RM of 20 March 1995 to lay down the conditions of management of wildlife and its habitats;
- Law No. 95-004/AN-RM of 18 January 1995 to lay down the conditions for management of forest resources and define the prerequisites for quarry or mine excavation;
- Law No. 01-020 of 30 May 2001 on pollution and nuisances, instituting the polluter pays principle;
- Law No. 92-013/AN-RM of 17 September 1991 instituting a national standardization and quality control system aimed at ensuring the preservation of health and protection of life; the security of men and property; improvement of the quality of goods and services ; environmental protection; and the elimination of technical obstacles to trade;
- Law No. 95-032 of 20 March 1995 on fisheries and fish farming;
- Law No. 95-034 of 12 April 1995 to institute the Regional and Local Authorities Code in Mali;
- Decree No. 99-320/P-RM of 4 October 1999 instituting the procedure for clearing forest lands;
- Decree No. 96-050/P-RM of 14 February 1996 to lay down the terms and conditions for classifying and downgrading wildlife reserves, sanctuaries and areas of cynergetic interest;
- Decree No. 00-022/ P-RM of 19 January 2000 to lay down the terms and conditions for classifying and downgrading forests, reforestation areas and protection areas in the forest estate of the State;
- Decree No. 01-394/P-RM of 6 September 2001 defining the purpose of solid waste management and the concepts of this form of pollution;

- Decree No. 01-397/P-RM of 6 September 2001 defining the purpose of air pollutants management and the concepts of this form of pollution;
- Decree No. 01-396/P-RM of 6 September 2001 defining the purpose of sound nuisances management and the concepts of this form of nuisance;
- Decree No. 90-355/P-RM of 8 August 1990 to determine the list of toxic wastes;
- Ordinance No. 00-027/P-RM of 22 March 2000 to institute the property and land code.

### **3.2 Bank Environmental and Social Policies**

The reference procedures are those governing the 2001 Environmental and Social Impact Assessment (ESIA) which was revised in 2004, particularly the guidelines concerning the irrigation sector, as well as the policy of involuntary displacement of the population (2003). In addition, the projects must take into consideration: (a) the Bank's population sector policies (2002) to which the programme contributes by building the economic capacities of women, improving access to health care, and reducing rural-urban migration; (b) gender (2001) which is addressed through women's participation and income-generating activities; (c) participation (1999) which is reflected in the participatory approach adopted by the programme; (d) poverty (2004); (e) health, education, agricultural production, integrated water resources management (2000) and water supply and sanitation.

### **3.3 Mali's Rural Sector Policies**

3.3.1 In addition to environmental laws and regulations, the programme is consistent with the following policies : (i) the National Livestock Policy; (ii) the Rural Sector Development Policy; (iii) the Fisheries and Fish Farming Policy; (v) the National Water Resources Policy, the Water Code and the National Integrated Water Resources Management Plan (PAGIRE); (vi) the National Territorial Development Policy; (vii) the National Irrigation Development Strategy; and (viii) the National Food Security Strategy.

3.3.2 At the international level, the Talo and Djenné irrigation schemes are part of actions included in the Development and Management Master Plan of the Niger Basin Sustainable Development Action Plan (July 2007) managed by the Niger Basin Authority (NBA). The schemes contribute to the achievement of the food security objective of this Action Plan.

### **3.4 Institutional Framework**

3.4.1 The environmental institutional framework comprises the following key institutions: (i) the Ministry of the Environment and Sanitation, supported by the Permanent Technical Secretariat of the Institutional Framework for Management of Environmental Issues (STP-CIGQE) and the National Directorate of Pollution and Nuisance Control (DNACPN); (ii) the deconcentrated services of the DNACPN at regional, district and council levels which support regional and local authorities at their level of operation; (iii) the National Directorate of Nature Conservation (DNCN) with the Nature Conservation Service (SCN) at local level.

3.4.2 The framework comprises the following key Ministries : the Ministry of Agriculture (MA) which is the programme promoter, and the Ministry of Livestock and Fisheries (MEP) which has the following national directorates: Agriculture (DNA), Rural Engineering (DNGR), Livestock (DNE), Fisheries (DN), and the Plant Protection Authority (OPV). These services are also deconcentrated at the level of the regions, districts and, sometimes, councils. Fisheries Stations are examples of such deconcentrated services.

**3.4.3 Local Authorities and other decentralized structures:** Law No. 95- 034 to institute the Regional and Local Authorities Code in the Republic of Mali empowered organs of Regional and Local Authorities in matters of environmental management, occupancy and development plans, property and land management, utility creation and management policy, organization of rural activities and agro-sylvo-pastoral production, and administrative police regulation, Fisheries Councils, etc. The law stipulates that regional and local authorities are responsible for the management, development, conservation and protection of the ecological balance of their areas. In this capacity, they are charged with the preparation of land-use development plans, which will define the forest, agricultural, pastoral, wildlife, fishery and mining area, as well as the housing areas. The regional (Regional Assembly) and local (Councils) levels have structures for the management of environmental issues, comprises Government institutions, regional and local authorities, as well as private structures.

**3.4.4 Civil society organizations:** Some NGOs are operating on the programme sites. They were consulted during the preparatory studies or hired as service providers. The key beneficiaries and stakeholders of the programme involved in all the stages are village associations, socio-professional organizations, women's organizations and local Chambers of Agriculture. The Bani Watershed Committee is the key institutional stakeholder, representing the civil society on the Middle Bani and Djenné sites. A functional local consultative committee which proved its worth during the first phase has been established on the Maninkoura site and represents all civil society opinions. At the national level, the Global Water Partnership, which seeks to ensure integrated water resources management, brings together the majority of the stakeholders involved in the programme.

### 3.5 International Conventions

The international agreements, conventions and treaties relevant to the PDI are:

- The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998);
- The Convention on Biological Diversity / Cartagena Protocol, adopted on 5 June 1992 and ratified by Mali on 29 September 1995. The protocol was ratified on 4 June 2002;
- The Convention on Climate Change, adopted on 9 May 1992, ratified by Mali on 28 December 1994; the Kyoto Protocol was ratified on 28 March 2002;
- The United Nations Convention to Combat Desertification, adopted on 17 June 1994 and ratified on 31 October 1995;
- The African Convention for the Conservation and Management of Wildlife, adopted in 1968;

- The Bonn Convention on the Conservation of Migratory Species of Wild Animals, adopted on 23 June 1979 and ratified on 1 October 1987;
- The Convention Concerning the Protection of the World Cultural and Natural Heritage, adopted on 16 November 1972 and ratified by Mali on 5 April 1977;
- The RAMSAR Convention on Wetlands of International Importance as Waterfowl Habitat, adopted on 2 February 1971 and ratified in September 1987;
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora, adopted on 3 March 1973 and ratified on 16 October 1994 by Mali;
- The Convention Concerning the World Cultural and Natural Heritage (1972);
- The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal (1989);
- The Convention for the Protection of the Ozone Layer and the Montreal Protocol (1987);
- The Plant Protection Convention, 1987

#### **4. Description of the environment of Programme Sites**

The description of the environmental components will be updated at the start of the programme using a study on the reference situation to be conducted in the three zones.

##### **4.1 In Maninkoura Zone**

The environmental report card (SNC Lavallin, 2004) and the ESMP (SNC Lavallin, 2006) contain a detailed description of all the components of this ecosystem.

4.1.1 Located in the Sudanian-Guinean zone with a rainfall of 850 mm to 1200 mm and average temperatures varying between 20° C and 35° C, the relief of the zone comprises a series of highlands and hardpan buttes (350 to 400 m) with flood-prone plains located near River Sankarani and River Niger, and several types of gravel and hardpan soils on buttes, sandy to clayey in depressions, some of which are prone to erosion.

4.1.2 Several erosion phenomena have been observed on the banks of Lake Sélingué and River Sankarani and its tributaries downstream of Lake Sélingué; sedimentation deposits could in the long run gradually fill the storage lake which supplies water to the irrigation areas. The water quality of River Sankarani downstream of the Lake Sélingué dam is monitored on a quarterly basis by the Department of Fisheries and the Environment at 4 sampling stations located in the study area. The monitoring is carried out on 11 irrigation areas and the results of the analysis show that the water quality is good.

4.1.3 The most common plant formations are open woodland forests (less than 50% of coverage); the flora is rich, varied and widely used by the people; only the *Khaya senegalensis* features on the red list of the International Union for the Conservation of Nature and Natural

Resources (IUCN) and other species are protected by Law No. 95-004. Forests are threatened by wood harvesting both for domestic use and for commercial activities (cabinetwork, sale, charcoal, etc.). Among the wildlife species identified, the Cobe de Buffon and Dama Gazella feature on the IUCN list. Most species are on the decline, thereby reducing the activity of hunters. There is no classified forest and no protected natural habitat in the zone, but some sensitive habitats such as gallery forests or riparian forests deserve special protection, as is the case with the bank strips of River Sankarani and River Niger and the gallery forests bordering the Koba stream threatened by agriculture.

4.1.4 Socioeconomic surveys conducted in villages in April 2006 confirm the high level of poverty (70%). The specific situation of women is detailed in a gender study; it reveals that women are active in agriculture, picking, small livestock farming and petty trade, against the backdrop of gender inequalities and socio-cultural taboos which limit their access to land. They obtained 0.7% of the PAPIM rice-growing plots; this same project enabled them to access micro credits for their income-generating activities. Many community organizations have been set up, mainly for infrastructure management, and PAPIM made it possible to professionalize a few of them, including women's organizations.

4.1.5 Access to health care was quite low in 2002, but has improved thanks to the interventions of the first phase of PAPIM which constructed and equipped a health centre, opened up the zone and carried out sensitization and prevention activities regarding STDs/AIDS and hygiene; the major diseases are malaria, diarrhoeal diseases, and schistosomiasis. The local AIDS prevalence rate has not been analyzed, but a few cases have been recorded. The school enrolment rate is low (estimated at 20% in 2005). That is why 15 new classrooms were constructed by PAPIM. Concerning drinking water supply, in 2007 PAPIM added 12 boreholes and 6 large-diameter wells to the 3 boreholes and 3 large-diameter wells existing in 2002, thus improving the coverage rate needed by the population and preparing for the arrival of new inhabitants.

4.1.6 Agriculture is the main economic activity in the zone with the cultivation of cereals (maize, sorghum, millet and rain-fed rice), cash crops (cotton and groundnuts), fruits (banana, mangoes and oranges) and market garden crops. Extensive farming is practised, except for the cultivation of cotton and banana which are grown more and more intensively with the following constraints: (i) insufficient and irregular rainfall; (ii) gradual soil degradation; (iii) insufficient equipment and farm inputs for certain families; (iv) difficult access to farm credit; (v) land-locked situation of the zone; (vi) low level of supervision of farmers; (vii) drop in cotton prices; and (viii) crop diseases and pests. Small amounts of fertilizers and pesticides are used for cotton and maize cultivation. Livestock farming (cattle, goat and poultry) is facing the following constraints: (i) inadequate health monitoring (barely once a year); (ii) absence of qualified veterinary workers; (iii) difficult access to veterinary products; (iii) overgrazing by animals on transhumance; (iv) difficult access to oilseed cake; (v) proliferation of cattle diseases (trypanosomiasis, cattle peripneumonia). Fishing is carried out along River Sankarani, between the Sélingué dam and its confluence with River Niger, with more than 1,000 fishermen whose catch varies between 400 and 1000 kg/day in peak season and 10 to 50 kg/day in low season (March to May). The difficulties they encounter are: (i) insufficient swelling of waters; (ii) difficulty in acquiring supplies of fishing gear at affordable cost; (iii) low fish counts in waters; (iv) reduction of fish spawning ground since the construction of the dam; and (v) land-locked situation of the zone.

## 4.2 In Middle Bani Zone

In addition to the 2004 ESMP, several studies conducted by the PMB provide details on the characteristics of the Middle Bani site.

4.2.1 The Middle Bani zone is located on the so-called Precambrian sandstone platform of Koutiala made up of alluvial deposits. It has a Sudanian-Sahelian climate. The average temperature is 28°C, with the highest temperature in the month of May (32°C) and the lowest in January (23°C). The average annual rainfall is 750 mm. The water table level is currently at a depth of 15 to 20 m and tends to drop, which can be explained by the drastic reduction of flooded areas in the last decades. Underground water quality is satisfactory. The same is true of the waters of River Bani. However, analyses carried out by the PMB in 2002 show that the water of the large-diameter wells and surface waters are contaminated; only boreholes provide drinking water.

4.2.2 A pedological survey conducted in 2004 gives details of the main soil types: high ridges with bank strips (immature alluvium soils with low organic matter content, well drained, with coarse texture); average ridges which are ancient bank strips (averagely drained vertisols); and low plains (poorly drained clayey soils with high organic matter content). Wildlife is limited to a few ground game, and a few carnivores like jackals and small rodents. The bird fauna is represented by grain-eating and water birds: queleas, common guinea fowls, francolins, garganeys, Canada geese, grey herons, etc. whose numbers have dropped significantly as a result of drought, deforestation and hunting. Big ground and bird game have disappeared from the zone. Only francolins, columbidae and sparrows abound, especially during cereal planting periods. About one hundred different kinds of fish have been identified, and colonies of manatees are found upstream and downstream of the Talo sill.

4.2.3 The main economic activities in the zone are agriculture (maize, sorghum, rice, cotton, and groundnut) and livestock farming. In October 2002, there were 0.8 UBT per inhabitant, which corresponds to one cattle per person. There is no transhumance concentration zone in this area, but one of the constraints encountered is the illegal occupation of space, which gives rise to conflicts. Several animal pathologies were identified in the zone by the epidemiological investigation carried out in the zone in 2004; that is why the PDI provides for measures to strengthen veterinary structures. Women practise agriculture, but are not very present in organizations that concern livestock farming; the PMB reinforced their economic involvement through the cooperative organization, access to credit and support for their processing activities. A PMB epidemiological investigation highlighted the major diseases in the zone; health centres were constructed and equipped, and local health stations set up; these stations will be reinforced by the PDI especially for the prevention of AIDS and water-borne diseases.

## 4.3 In Djenné Zone

PDRI feasibility studies, including the social and environmental impact assessments, provide a detailed description of the Djenné zone (BCEOM, Betico, 2006).

4.3.1 The lower part of River Bani covers a total area of 20 000 km<sup>2</sup>, including 4 560 km<sup>2</sup> for the Djenné district with a rather flat relief dominated by the presence of large basins or flood plains cyclically prone to the floods of River Bani and River Niger. Lands suitable for rice cultivation using the River Bani are estimated at more than 105 000 ha. The climate of the

zone is the south Sahelian type (Sahel to Sudanian-Sahelian zone). The tree cover is dominated by a few gallery forests in the rare flooded zones and herbaceous vegetation in the large flood basins. A few wildlife species are present in the zone: hyenas, jackals, rabbits, seabirds, jacanas, herons, egrets, Gambian geese, white-headed stilts, crows, black kites, monitor lizards, blacksmith lapwings, guinea fowls, partridges, turtle doves, monkeys, porcupines, etc. The various types of fish have not been identified, but about one hundred species are known. The zone also plays host to manatees. The hydrology of the zone is influenced by River Niger and River Bani whose floods constitute a key factor for farming activities. The analysis of hydrological data on the Bani stations highlighted a significant drop in the flow coefficient of the river. As such, annual flows, which were between 600 and 800 m<sup>3</sup>/s before 1973, have since dropped to between 200 and 300 m<sup>3</sup>/s.

4.3.2 Trade and transport are expanding relatively, although there are still major difficulties due essentially to the overall land-locked nature of the district and to the rather high incidence of poverty in the area, which is considered as one of the poorest of the country. The primary sector employs more than 80% of the population of the district who engage in agriculture, livestock farming and fishing. Tourism is developed in the historic town of Djenné. Swamp rice cultivation employs the majority of farmers of the zone. The practice of transhumance livestock farming is considered as vital to this sector of activity where vast flooded expanses (of bourgou fields) are liberated to allow herds access when the level of water drops. Fishing, which is an age-old activity, is practised in rivers (Bani and Niger) and ponds during low water periods. All these activities are faced with constraints relating to the scarcity of natural water resources, inadequate collective and individual infrastructure and equipment and the low technical capacity of players, resulting in widespread impoverishment of the rural populations, especially women whose specific status has been examined in a study.

## **5. Project Alternatives**

The planned alternatives are:

### **5.1 In Maninkoura Zone**

The main alternative envisaged is not to construct the Kourouba sill, in which case it would be necessary to reinforce the current structures and replace the pumps in place, which will entail costs. The advantage of constructing the sill is the possibility of irrigating additional 5000 ha, growing off-season crops and thus creating jobs and curbing rural-urban migration. This will serve as basis for the construction of a bridge, which will open up the entire zone and make it possible to build a mini electric power plant. That is why the populations insisted on the construction of this sill.

### **5.2 In Middle Bani Zone**

The only alternative would have been not to carry out the planned developments. Without such additional developments, it will not be possible to maximize returns on the heavy initial investments (the Talo sill and the construction of canals) and produce most of the expected positive impacts relating to food security and incomes expected by the populations through irrigated rice cultivation.

### **5.3 In Djenné Zone**

5.3.1 The International Commission on Large Dams considers that dams should bring about human development that is economically viable, socially equitable and sustainable from the environmental standpoint, and that the selection of the dams should take into account the options available at the political, institutional and technical levels. The construction of the Djenné sill falls under the implementation of the Djenné District Integrated Rural Development Plan, designed after broad-based consultation of the various stakeholders, well documented and validated by the Djenné Forum in 2003. It also falls within the implementation of the National Irrigation Development Strategy (SNDI, 1999). Several alternatives have been analyzed since the 1980s for the regulation of the flow of River Bani: (i) absence of sills; (ii) Kouï sill; (iii) Talo and Djenné sills; (iv) both sills with the construction of two retaining reservoirs upstream. The decision was made to construct the two sills for a start, and later on construct the retaining reservoirs upstream. The construction of the sill will contribute to the achievement of many development objectives such as incomes, food security, restoration of pre-drought ecosystems, opening up of the zone and energy production, which can not be achieved by mere policy and strategy adjustments.

5.3.2 As regards construction of the structure, the fixed and mobile sill options were analyzed; the mobile sill option was selected because it is less costly and limits the number of embankments. After analyzing six technical variants for the gates, the Aubert shutter was selected as the most reliable. The design of the structure may also allow for the addition of a mini hydroelectric power plant, whose economic and ecological profitability in comparison with the use of fossil energy will be easier to demonstrate in the current context.

## **6. Potential Impacts and Mitigation and Compensatory Measures**

This section describes the major impacts specific to each of the zones. An appended overall table summarizes the major impacts with their scale, duration and intensity. Mitigation measures are presented globally.

### **6.1 In Maninkoura Zone**

6.1.1 During the construction phase, the major possible negative impacts may stem from poor management and rehabilitation of borrow pits, risks of water and soil pollution by worksite wastes (washing, waste oils and lubricants), and an increased risk of STDs and AIDS within the worksites. The embankments of structures of the first phase showed several signs of erosion and their vegetal invasion should be envisaged, and the bank strips between River Sankarani and the facilities should be completely protected. During the operations phase, problems of soil and water contamination may arise from a poor use of pesticides and fertilizers, and a poor management of water may encourage the increase of water-borne diseases (malaria, river blindness, and schistosomiasis) and soil degradation. The arrival of new populations attracted by the possibilities of earning an income will generate additional drinking water and sanitation needs. The planned impact assessment for the construction of the Kourouba sill will determine whether it will be necessary to displace populations.

6.1.2 The expected positive impacts are linked to an increase in the people's incomes and enhanced food security as a result of the farming of the developed areas. The envisaged reforestation on the sites will also provide firewood, and contribute to protecting forest resources. The environmental monitoring system will shed light on the problems, and serve as a tool for sensitizing the populations.

## **6.2 In Middle Bani Zone**

6.2.1 During the construction phase, the major possible negative impacts are also related to borrow pits, which should be managed with care. Negative impacts are also possible on living areas, due to poor management of waste oils and lubricants, dust and speed on worksites, and increased risk of STDs and AIDS. During the operations phase, the same negative impacts relating to the use of pesticides or poor management of water may occur. Management of new grazing lands requires measures to avoid the degradation of sites and conflicts; training/sensitization measures and enforcement of the pastoral agreement prepared in the first phase are envisaged. The arrival of new populations attracted by possibilities of earning incomes will generate additional drinking water and sanitation needs. Measures for the preservation of the fishery resources of the Talo sill impoundment lake, which are already attracting fishermen from the entire country, should be enhanced by setting up Fishery Councils.

6.2.2 Positive impacts are expected from the exploitation of new rice-growing areas, fish ponds and grazing lands (bourgou fields), as well as from support measures for women and the youths: farm credit, processing equipment, various training sessions, and formation of socio-professional organizations. Reforestation and the implementation of the Doukoloma Forest Management Plan will secure sources of firewood and protect one of the last wildlife habitats.

## **6.3 In Djenné Zone**

6.3.1 During the construction phase, all potentially negative impacts relating to worksites are likely to occur, if the recommended measures are not implemented. The construction of the structure will entail the displacement of about twenty households of a population estimated at 86 in the village of Kouin Bozo, mostly Bozo fishermen who will be resettled in more secure sites as they may desire. Terms of reference have been prepared for the resettlement plan, which will be implemented with the resources of a PPF. Measures have already been taken to avoid the isolation of certain villages, and a resettlement plan will specify the terms and conditions of the displacement of these villages.

6.3.2 The major impact of the irrigation schemes is the control of the flood levels of River Bani to the right and downstream of the Djenné sill, in harmony with the impacts of the Talo sill located about 200 km upstream. Modifications of the sub-critical flow upstream will be significant, particularly during the dry season. Disruptions of the hydrological systems involving the two sills, which, however, may be temporary, concern only River Bani. However, despite water catchments for the operation of the two sills, a greater part of the contribution of River Bani to the flow of River Niger will be maintained. The coordinated management of the two sills, depending on the demands of the beneficiaries, will require the establishment of a technically well-informed (forecasting of floods) and sufficiently participatory system. The Bani Watershed Management Committee will have an important role to play in communication and conflict resolution.

6.3.3 During the operations phase, the programme will help to secure and intensify agricultural production in the zone over an area of 14 000 ha for rice cultivation and 5000 ha for fodder, which will produce a minimum of 35 000 tonnes of paddy rice each year. It will also offer the possibility of carrying out off-season market gardening on the banks of River Bani. This will create jobs, reduce rural-urban migration, and improve the socio-professional organization of producers. In addition, the support measures will provide better access to education and health, and some villages will be opened up.

6.3.4 The protection of infrastructure (dykes, roads, villages, etc.), water bodies and banks against natural hazards (winds, erosion, evapo-transpiration, etc.) will lead to the development of many hectares of plantations in the form of windbreaks, groves and ribbon plantations. Such plantations will provide firewood in a region which badly needs it. The protection of banks, water erosion control, and restoration of quarries and borrow pits is expected to bring about the development and restoration of many hectares of natural formations in flooded, as well as dewatered zones.

6.3.5 The creation of a water body could have a negative impact on fishing, especially if the impounding lake is not drained off each year. In order to allow for the passage of fish, a fish way has been envisaged at the level of the sill. The mobile part of the structure may also enable the migration of manatees which abound in River Bani in times of flood. The development of protection areas (sanctuaries) for manatees and the increase of flood control areas upstream, especially in the adjacent plains (Pondori, Yangari, etc.) where the species already find shelter in certain deeper pockets in times of low water, may mitigate this negative impact.

6.3.6 The negative impact of the use of fertilizers, pesticides, weed killers and other farm inputs in agriculture will be mitigated by the construction of enough drinking water supply points near the sites and continuous information, sensitization and education campaigns on drinking water and pesticides. There may also be inequalities in the distribution of plots.

6.3.7 The presence of standing water on large areas and in the impounding lake, and the permanent contact of the populations (rice growers, fishermen, children, housewives, etc.) with water poses problems of sanitation, hygiene and public health with the risk of development of water-borne diseases (malaria, river blindness, schistosomiasis, etc.) which will be mitigated by sensitization campaigns and sanitation infrastructure.

6.3.8 All the historical, archaeological and cultural sites met have been identified and geo-referenced. They are not expected to be affected by the construction works, except for a site which will undergo salvage excavation. Furthermore, the sill and its bridge/dam will help to open up the town of Djenné, thus saving tourists the long hours of waiting to cross by ferry and increasing access to services for an entire population currently cut off on one side of River Bani.

6.3.9 The increase in agricultural production resulting from the facilities put in place is expected to translate into a rise in livestock production. Additional fodder production raises fears of cases of overload and stray animals, in both dewatered and flooded grazing lands, thus leading to damage on farms and irrigation infrastructures, fishing grounds and fishing gear, with the consequences being possible conflicts among producers, as is currently the case in the project area, although studies show that it is rather the scarcity of resources that provokes conflicts most. Therefore, in the case of Djenné, many measures, ranging from support to the Council Area Development Plan to the preparation of several types of local agreements covering natural resource management, have been envisaged.

## **6.4 Mitigation and Compensatory Measures**

Mitigation and compensatory measures are included in the programme, mainly in its “Support Actions” component. They apply to the three sites, and are detailed in the consolidated ESMP of the PDI. These measures are:

### **During the construction phase**

6.4.1 Ensure that clearly-written environmental clauses are included in Bidding Documents and contractors' contracts with enough financial packages for their implementation. The DNACPN will conduct the environmental monitoring. Furthermore: (i) insist that contractors and consulting firms that monitor them should have the environmental expertise; (ii) specify the security and hygiene measures; (iii) provide additional training in environmental measures on worksites; (iv) regularly inform and involve the populations and councils in monitoring; (v) avoid burning stumps; (vi) train programme officials and technicians in environmental assessment to ensure better monitoring of operations; (vii) carry out a sensitization campaign against STDs and AIDS before establishment of the worksites and provide post-worksite monitoring; (viii) construct the fish ladder provided for the Djenné sill; (ix) restore excavation sites at the end of works; (x) obtain approval for quarry locations and other layouts likely to modify the tree cover, soils and water bodies through a reasoned decision of the Nature Conservation Service and health services; (xi) compensate vegetation losses due to construction work by planting tree and shrub screens along the dykes and canals and by compensatory tree-planting; and (xii) provide for the planting of grass on the embankments in sensitive areas.

6.4.2 Implement the plan for the resettlement of displaced populations on the Djenné site and implement the plan to protect the archaeological site developed during the preparatory phase. Build sanitation facilities (boreholes and latrines) on the developed areas, and set up their management committee.

### **During the operations phase**

6.4.3 In order to reduce the risks inherent in the use of pesticides, train farmers on the rational use of pesticides. Train supervision staff in Integrated Production and Pest Management. Provide adequate training in irrigation water management including environmental aspects, with training in integrated water resources management. Establish a flood forecast system which will provide better knowledge of water catchments.

6.4.4 In order to mitigate the negative impacts relating to loss of grazing lands and cattle pressure on dewatered lands: (i) support livestock farming services for dissemination of the method of treating straw with urea and other intensification techniques; (ii) provide cattle health coverage through support to agents, in order to limit the degradation of structures (plots and dykes); (iii) implement pastoral agreements, which will clearly specify the rights and obligations of shepherds and farmers and lay down rules of herd management so as to secure the developed areas, cultivated plots, grazing lands and bush growth.

6.4.5 Introduce environmental monitoring, backed by a GIS, with an epidemiological monitoring of human and animal health, water and soil quality and the state of the natural environment and wildlife, with the collaboration of beneficiaries, technical services and specialized service providers (Nature Conservation Service, INRSP, IER, NGOs, etc.). The mechanism will facilitate close monitoring of water flows and water catchments, which are data essential for proper resource management at the level of the River Niger watershed. Ensure that the system can be monitored on a sustainable basis after project completion, by the technical services and regional and local authorities, and that the data are distributed to users. The GIS should be able to use certain satellite image analyses to illustrate changes in the ecosystem and facilitate identification of priority intervention areas.

6.4.6 In order to protect the tree cover, carry out compensatory tree-planting to protect infrastructures (dykes, roads, villages, etc.), water bodies and banks against natural hazards (winds, erosion, evapo-transpiration, etc.) with the creation of many hectares of plantations in the form of windbreaks, groves, ribbon plantations and deferred grazing (in flooded and dewatered zones). Such measures will be supplemented by natural formation protection measures and the implementation of the Doukoloma Forest Management Plan, which is a wildlife habitat reserve.

6.4.7 Strengthen the Bani Watershed Management Committee in its role of manager of water, information, communication among stakeholders, and conflict resolution. Envisage support for communication and training of committee members.

6.4.8 Sensitize stakeholders on the protection of banks through the use of GIS tools developed by the project, by identifying priority zones for reforestation, site protection and anti-erosion activities in consultation with local Water Committees.

6.4.9 Implement the support activities programme, which will help to improve access to health care and education, and build the capacities of the various stakeholders (infrastructure construction, sensitization/training on several topics, income-generating activities for women, and cooperatives for youths). Encourage and monitor the involvement of women and youths.

## **7. Environmental Hazard Management**

7.1 There is no major environmental hazard in the three sites studied. Only the risk of flood may be considered, and it is not necessarily linked to the existence of the proposed structures. The technical design of the proposed structures takes into account the risk of one-in-one hundred year floods; the mobile sills of Talo and Djenné may be carried away to allow floods to pass.

7.2 There is a flood forecast system for River Sankarani, managed by ODRS. For River Bani, the project will enhance the implementation of a flood forecast system, which will make it possible to pre-empt floods from information collected on rivers and streams upstream. The system will be linked to the water management system provided for the Talo and Djenné structures. This activity will reinforce the Inter-Ministerial Committee for the Prevention of Crises due to Floods set up by the Government in 2007. The secretarial services of the Committee are provided by the Ministry of the Interior. The Committee carries out sensitization on flood risks, and dissuades the populations from settling in the risk-prone zones and from clogging strategic water channels. In the event of a flood, it quickly mobilizes emergency operations for the affected populations.

## **8. Monitoring Programme**

8.1 Environmental surveillance is a responsibility shared between the Programme's National Coordination Unit and the competent Government services. At the level of the Programme's National Coordination Unit, there are provisions for positions of environmental specialist and gender specialist who will monitor environmental and social measures. Statistics will be disaggregated by gender. On each site, a light team headed by these specialists, in collaboration with the technical services, will ensure environmental monitoring. Memoranda of understanding will be signed with the National Directorate of Sanitation and Pollution and Nuisance Control and its regional and local branches, to ensure regular monitoring of the programme, particularly during the construction phase.

8.2 An environmental monitoring system will be established to collect information on the environment so as to understand and mitigate, as appropriate, the negative impacts that may occur. Baseline studies are available for certain parameters (water, soil, vegetation, wildlife, human and animal health) for the Middle Bani site, with their indicators. For the Maninkoura site, the ESMP proposes a complete monitoring system with indicators, parameters to be followed, the role and responsibility of the various stakeholders, as well as a budget. The programme will therefore harmonize the two systems, make them compatible with the national systems for environmental monitoring, and select the most relevant indicators which could be monitored with minimum recurrent costs. The proposed system will involve local communities, technical services and private service providers for certain monitoring exercises. The findings of observations by both systems will be widely disseminated among stakeholders by the project.

## **9. Public Consultations and Information Dissemination**

9.1 Several consultations were organized on the programme during the feasibility studies of the three sub-projects. More recently, meetings organized in the three zones under programme preparation and a national programme formulation workshop held in Bamako on 2 July 2008 allowed for broad-based consultation among stakeholders, as documented in the summary environmental and social impact assessment (ESIA).

9.2 Consultations and validation workshops were also organized on impact assessments and the various ESMPs during their preparation, and the list of persons met is included in these reference documents. The three documents were also disseminated in the Ministry of the Environment and Sanitation. Public information and sensitization campaigns were organized around the Talo and Djenné sills, with the support of a Good Offices Committee set up to facilitate dialogue between the populations and the Government. In the same vein, a River Bani Watershed Committee has been set up, comprising the water users: government services, elected officials, and the civil society. The Committee will be the dialogue, communication and conflict prevention instrument of the Middle Bani and Djenné sites.

9.3 The various consultations made it possible to take into account the concerns of the populations and to add activities like the construction of a sill in Kourouba for the Maninkoura site, support for processing activities for women in Bla and San, the protection of banks for Maninkoura, Djenné and Middle Bani, support for income-generating activities for women and the youths, the opening-up of certain villages, and the protection of archaeological sites in Djenné with the transformation of the living area into tourist camps.

## **10. Additional Initiatives**

10.1 The risk mitigation programme and compensatory measures are quite comprehensive and totally integrated into the design of the programme; the measures are summarized in a document updated during the project preparation phase. The document is supplemented by the resettlement plan, which provides details on the measures to be taken for persons who may be displaced, identification of resettlement sites and structures to be built, as well as other compensatory measures. The programme has already taken into account the opening-up of 7 villages, which could have been isolated by water as a result of constructing secondary connecting dykes. A detailed study on the impacts of the Talo sill will be conducted during the preparation phase to maintain dialogue with the various stakeholders, including those who opposed the construction of the sill.

10.2 On the other hand, in order to harmonize best practices in matters of irrigation in Mali, a strategic impact assessment will be conducted covering the entire irrigation sector in Mali. Furthermore, in order to broaden the scope of measures envisaged for the protection of the banks of River Bani and strengthen the Bani Watershed Committee, a request will be submitted to the International Waters window of the Global Environment Facility.

## **11. Conclusion**

11.1 In conclusion, the Mali Irrigation Development Programme will have both positive and negative impacts on the environment, but the positive impacts are by far more significant. The project will have beneficial impacts on the economic and social development of the two regions, which are today very much affected by drought. It would lead to better use and development of natural resources to increase food security and reduce poverty. With the measures implemented on water management, the programme will contribute to the development of the integrated water resource management approach in Mali.

11.2 For the Djenné site, a summary population resettlement plan will be prepared during the programme appraisal phase.

11.3 The programme is the result of a broad-based participatory process, and meets the aspirations of the populations. It significantly contributes to financial poverty reduction through increased incomes and access to basic services, the organization of farmers and the opening-up of agricultural, silvicultural, pastoral and tourism production zones.

11.4 From an environmental standpoint, the principal negative impacts of the construction phase could be reduced by the implementation of the measures included in the contracts of contractors, training of all the stakeholder and proper monitoring by the programme, the Ministry of the Environment and Sanitation and the beneficiaries themselves. During the operations phase, the negative impacts will be mitigated by the various measures put in place by the programme, including training sessions, organization of space management, rational management of water and inputs, sanitation facilities and reforestation. The total cost of the measures is CFAF 2 545 million incorporated into the programme costs and itemized in the consolidated ESMP.

## 12. References and Contacts

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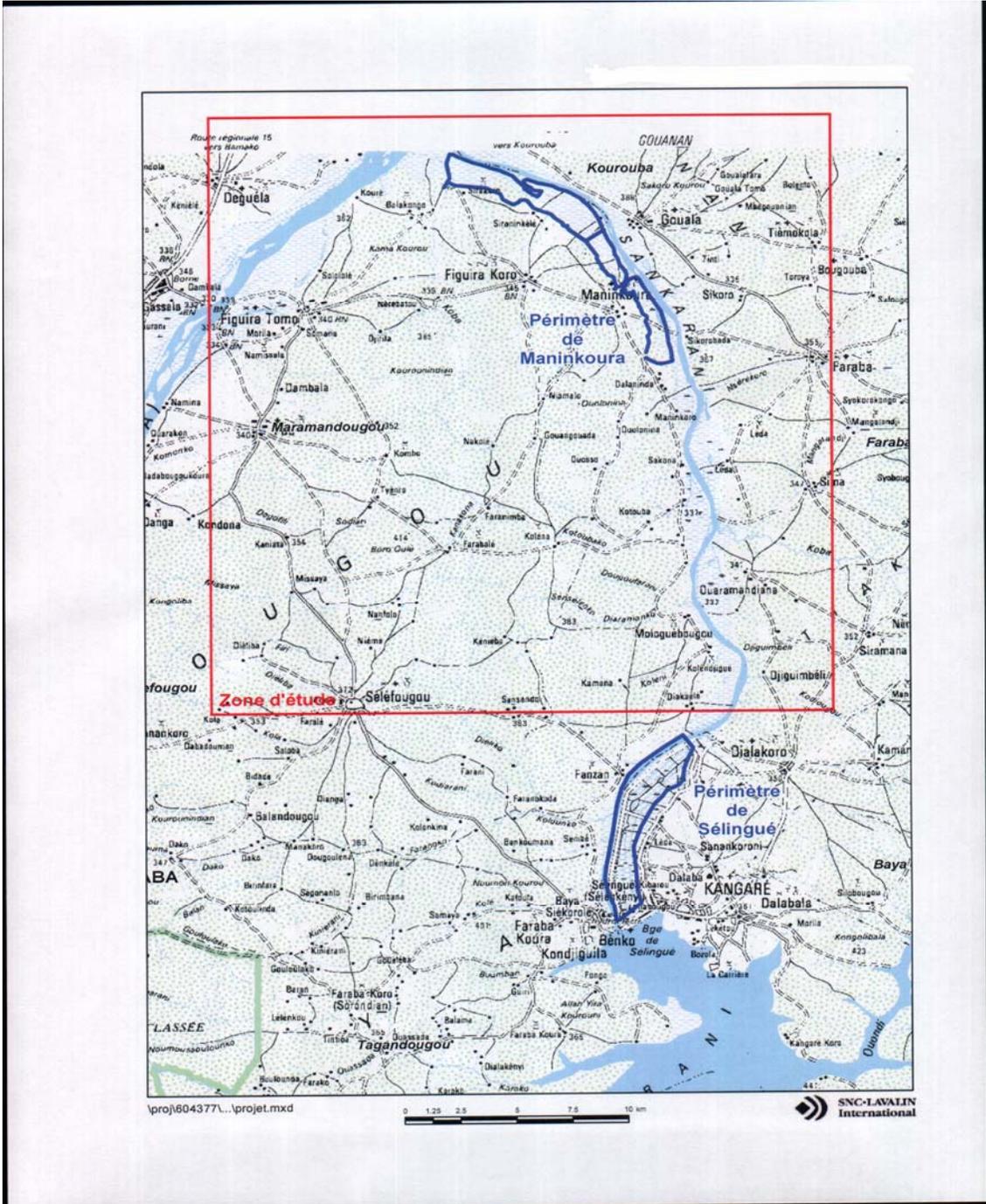
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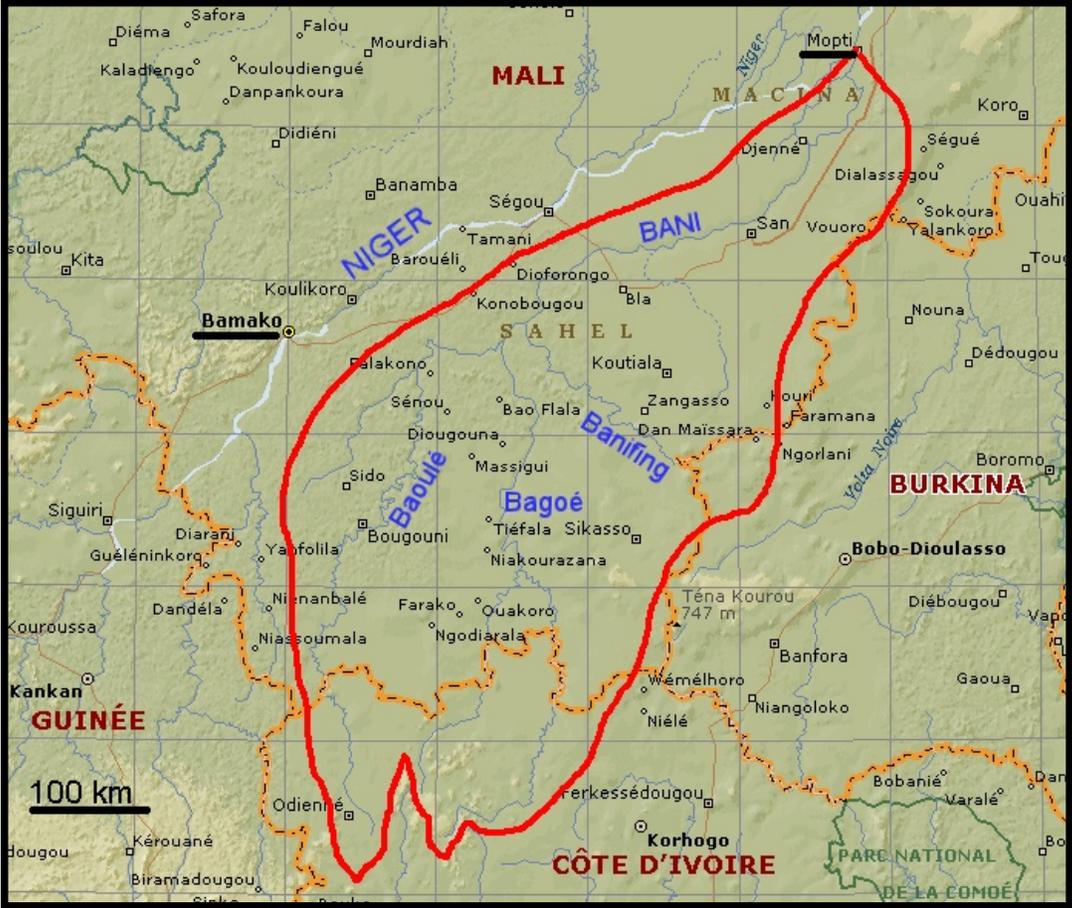
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Figure 5.1 PAPIM Study Area



2. Map of Middle Bani and Djenné Projects Impact Area



### Impact Rating Tables

#### Major environmental and social impacts of the construction phase

Type of activity	Environment and impact	Significance (quality, intensity, duration)
Movement on worksites	<u>Air</u> : dust pollution <u>Human</u> : accidents/deaths/respiratory diseases due to dust <u>Human</u> : accidents/deaths due to speed <u>Human</u> : sound nuisance	Negative, high and temporary Negative, high and temporary Negative, high and temporary Negative, high and temporary
Waste oil and lubricant spill	<u>Soil</u> : contamination <u>Surface and underground water</u> : contamination	Negative, low and temporary
Domestic site refuse	<u>Soil</u> : contamination <u>Surface and underground water</u> : contamination <u>Human</u> : diseases	Negative, low and temporary Negative, low and temporary Negative, low and temporary
Borrow sites	<u>Soil</u> : degradation of structure and disturbance of profile <u>Vegetation</u> : destruction of trees and grass <u>Landscapes</u> : <u>Economy</u> : income from quarry taxes for councils	Negative, average, isolated and permanent Negative, high, and permanent Negative, low and permanent Positive, low and temporary
Casual workers on worksites	<u>Human</u> : diseases (STDs/AIDS) <u>Economy</u> : income for the local populations	Negative, high, and permanent Positive, average, temporary
Work on rivers and streams	<u>Surface and underground water</u> : modification of the hydrological regime; temporary dewatering downstream	Negative, high, and temporary
Installation of structures	<u>Human</u> : damage on archaeological sites <u>Human</u> : immigration, displacement and resettlement of populations	Negative, average and permanent Negative and positive, high and permanent
Land clearing	<u>Vegetation</u> : destruction of trees and shrubs, loss of timber resources <u>Wildlife</u> : loss of habitats <u>Air</u> : pollution in the event of burning of stumps <u>Wildlife</u> : destruction of habitats and wildlife <u>Economy</u> : income from land clearing and harvested timber taxes	Negative, low and temporary Negative, low and permanent Negative, low and temporary Negative, low and temporary Positive, low and temporary

**Major impacts of the operations phase**

Type of activity	Environment and impact	Significance (quality, intensity, duration)
Priming of channels	<p><u>Air</u>: increased humidity, temperature drop</p> <p><u>Underground water</u>: rise in water table level</p> <p><u>Surface water</u>: modification of flows, reduction of water discharge downstream</p> <p><u>Economy</u>: security of agricultural and pastoral production</p>	<p>Positive, local, average, permanent</p> <p>Positive, high, permanent</p> <p>Negative, low, permanent</p> <p>Positive, high, permanent</p>
Construction of dykes/roads	<p><u>Economy</u>: opening-up of villages</p> <p>Facilitation of tourism (Djenné)</p> <p><u>Human</u>: protection against floods</p>	<p>Positive, high and permanent</p> <p>Positive, average and permanent</p> <p>Positive, average and permanent</p>
Sill	<p><u>Surface water</u>: reduction of naturally flooded areas</p> <p><u>Wildlife</u>: migration difficulty for manatees (Djenné)</p> <p><u>Human</u>: conflicts in land use</p> <p><u>Economy</u>: improved livestock farming through increase in grazing lands and number of water points</p>	<p>Negative, low and permanent</p> <p>Negative, low and permanent</p> <p>Negative, average and permanent</p> <p>Positive, high and permanent</p>
Control of dry-weather flows: continued flow of wastewater	<p><u>Surface water</u>: risk of drying-up</p> <p><u>Biodiversity</u>: continued existence of water point</p> <p><u>Economy</u>: continuation of agricultural, pastoral and fishing activities</p>	<p>Negative, low and temporary</p> <p>Positive, average and permanent</p> <p>Positive, high and permanent</p>
Planting	<p><u>Surface water</u>: pollution by inputs and pesticides</p> <p><u>Soil</u>: pollution by inputs and pesticides, risk of salinization and alkalization, settlement</p> <p>Improved fertility by manure</p> <p><u>Wildlife and stockbreeding</u>: risk of pollution by inputs</p> <p><u>Health</u>: risk of contamination by inputs</p> <p><u>Economy</u>: Incomes and food security for the populations</p> <p>Securization of yields; increase of agricultural production</p> <p>Development of trade and services</p> <p><u>Human</u>: Reduction of rural-urban migration</p> <p>Securization of land</p> <p>New arrivals</p> <p>Loss of traditional systems in favour of intensive production systems</p> <p>Improved organization of farmers</p> <p>Risk of poisoning by pesticides</p> <p><u>Health</u>: increase in water-borne diseases</p>	<p>Negative, average, permanent</p> <p>Negative, low, permanent</p> <p>Positive, average, temporary</p> <p>Negative, low, permanent</p> <p>Negative, high, permanent</p> <p>Positive, high and permanent</p> <p>Positive, high and permanent</p> <p>Positive, high and permanent</p> <p>Positive and negative, average and permanent</p> <p>Positive and negative, average and permanent</p> <p>Positive, high and permanent</p> <p>Negative, low and permanent</p> <p>Negative, low and permanent</p>
Maintenance and rehabilitation of structures	<p><u>Human</u>: better organization of the area</p> <p><u>Economy</u>: risk of negligence if not economically profitable</p> <p><u>Vegetation</u>: proliferation of weeds</p> <p><u>Wildlife</u>: risk of toxicity for fish and domestic animals</p>	<p>Positive, low, permanent</p> <p>Negative, average, temporary</p> <p>Negative, low, temporary</p> <p>Negative, high, temporary</p>
Forage crops (bourgou)	<p><u>Human</u>: risk of conflict in distribution of resources</p> <p>Better organization of stockbreeders</p> <p><u>Vegetation</u>: risk of overgrazing and degradation of grazing lands</p> <p><u>Economy</u>: income for stockbreeders, intensification of stockbreeding, increased productivity</p>	<p>Negative, low and permanent</p> <p>Positive, high and permanent</p> <p>Negative, average, permanent</p> <p>Positive, high and permanent</p>
Creation of water bodies	<p><u>Surface water</u>: evaporation and losses through catchments</p> <p><u>Underground water</u>: recharge of the water table</p> <p><u>Wildlife</u>: loss of land habitats and increase in fish habitat</p> <p><u>Economy</u>: increased fishing productivity</p> <p><u>Health</u>: increase in cases of malaria and other water-borne diseases</p> <p><u>Vegetation</u>: replacement of land vegetation by aquatic vegetation</p>	<p>Negative, low, permanent</p> <p>Positive, high and permanent</p> <p>Positive high and negative low, permanent</p> <p>Positive, high and permanent</p>

	<p>Risk of appearance of weedy water plants</p> <p><u>Human</u>: modification of traditional fishing systems Better organization of fishermen</p>	<p>Negative, high and permanent</p> <p>Positive and negative, average and permanent</p> <p>Negative, average and permanent</p> <p>Positive and negative, low and permanent</p> <p>Positive, high and permanent</p>
Management of irrigation and drainage water	<p><u>Human</u>: conflicts among users</p> <p><u>Water and soil</u>: risk of pollution</p>	<p>Negative, average and temporary</p> <p>Negative, average and temporary</p>
Irrigation and drainage facilities (canals)	<p><u>Soil</u>: erosion of slopes, sedimentation on river and stream beds and canals</p> <p><u>Health</u>: risk of proliferation of molluscs and insects which cause diseases</p> <p><u>Economy</u>: risk of water and productivity loss through vegetal invasion of canals</p>	<p>Negative, average and permanent</p> <p>Negative, average and permanent</p> <p>Negative, average and permanent</p> <p>Negative, average and permanent</p>
Borrow sites	<p><u>Health</u>: risk of accidents and proliferation of mosquitoes and other parasites</p> <p><u>Soil and vegetation</u>: degradation of the banks of ponds</p> <p><u>Wildlife</u>: drinking water spots of domestic animals and birds</p> <p><u>Economy</u>: fish farming and stock breeding opportunity</p>	<p>Negative, average and permanent</p> <p>Negative, local and permanent</p> <p>Positive, average and permanent</p> <p>Positive, average and permanent</p>
Health and educational infrastructure	<p><u>Health</u>: increased access to health care and education</p>	<p>Positive, high and permanent</p>
Drinking water and sanitation infrastructure	<p><u>Health</u>: increased access to drinking water; reduction of diseases caused by unwholesomeness</p>	<p>Positive, high and permanent</p>
Income-generating activities	<p><u>Economy</u>: increased incomes for women and the youth</p>	<p>Positive, high and permanent</p>
Rural credit	<p><u>Economy</u>: improved incomes</p> <p>Risks of indebtedness</p>	<p>Positive, high and permanent</p> <p>Negative, high, temporary</p>
Multi-purpose shops	<p><u>Economy</u>: increased incomes</p>	<p>Positive, high and permanent</p>
Livestock farming Infrastructure	<p><u>Economy</u>: Intensification of livestock farming</p>	<p>Positive, high and permanent</p>
GIS and environmental monitoring	<p><u>Human</u>: improvement in the quality of the environment and involvement of the people</p> <p>Prevention of negative impacts</p>	<p>Positive, high and permanent</p>
Technical training (agriculture, stock breeding, fishing, water management, bushfire, improved fireplaces, space management and development, environmental impact, soil conservation, ...)	<p><u>Human</u>: reduction of conflicts</p> <p><u>Economy</u>: higher output of activities</p> <p><u>Vegetation</u>: improvement of the vegetation cover</p>	<p>Positive, high and permanent</p> <p>Positive, high and permanent</p> <p>Positive, high and permanent</p>
Compensatory planting in villages and sites, national landmarks, protection of banks, windbreaks	<p><u>Vegetation</u>: increase of timber resources, protection of the vegetation cover</p> <p><u>Economy</u>: income from timber resources</p>	<p>Positive, high and permanent</p> <p>Positive, high and permanent</p>
Strengthening of the River Bani Watershed Management Committee and the Local Consultative Committee of the Maninkoura site	<p><u>Human</u>: reduction of conflicts, improved communication, sensitization and involvement of the people</p>	<p>Positive, high and permanent</p>