



**GOVERNMENT OF MALAWI**

**MINISTRY OF AGRICULTURE, IRRIGATION AND  
WATER DEVELOPMENT**

**SHIRE VALLEY IRRIGATION PROJECT**

**Environmental and Social Impact  
Assessment (ESIA) and Pest  
Management Plan (PMP) for the  
Shire Valley Irrigation Project (SVIP)**

**ESIA Executive Summary**

**June 2017**

**BRLi, Nîmes France**





**BRL ingénierie**

**1105 Av Pierre Mendès-France BP 94001  
30001 NIMES CEDEX 5**

<b>Date</b>	<b>June, 2017</b>
<b>Contacts</b>	<b>Eric Deneut, Gilles Pahin</b>

<b>Document title</b>	Environmental and Social Impact Assessment (ESIA) for the Shire Valley Irrigation Project (SVIP) Executive Summary
<b>Reference</b>	<b>800816</b>
<b>Version</b>	<b>V.2</b>

<b>Date</b>	<b>Version</b>	<b>Comments</b>	<b>Written by</b>	<b>Validated by</b>
March 2, 2016	V.1	Final version	Eric Deneut: Terrestrial Ecologist with contributions from :  Noemie Arazi: Cultural Heritage Specialist Arie Remmelzwaal: Soils Specialist Robert Matengula: Rural Sociologist specialist Alfred Maluwa: Aquatic ecology expert Pierre Gazin: Environmental Health Specialist Stephane Delichere: Hydrologist Dominique Olivier: Integrated Pest Management Specialist Eric Verlinden: Drainage and flood control specialist	Gilles Pahin, Team Leader / ESIA/ESMP Expert
June 12, 2017	V.2	Final version		

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT  
(ESIA)  
FOR THE SHIRE VALLEY IRRIGATION PROJECT (SVIP)  
EXECUTIVE SUMMARY

## Table of Contents

<b>1. INTRODUCTION .....</b>	<b>5</b>
<b>2. PROJECT DESCRIPTION .....</b>	<b>6</b>
<b>3. PROJECT AREA: PHYSICAL ENVIRONMENT .....</b>	<b>6</b>
<b>4. SOCIOECONOMIC BASELINE .....</b>	<b>8</b>
<b>5. CULTURAL HERITAGE.....</b>	<b>10</b>
<b>6. NATURAL HERITAGE.....</b>	<b>10</b>
<b>7. ECOLOGY.....</b>	<b>10</b>
<b>8. REGULATORY.....</b>	<b>12</b>
<b>9. PROJECT POSITIVE AND NEGATIVE IMPACTS .....</b>	<b>12</b>
9.1 Impacts during pre-construction phase	13
9.2 Impacts during construction phase	13
9.3 Impacts during operational phase	15

---

## List of Acronyms

ADD	Agricultural Development Division
Ca	Calcium
CC	Construction contractor
CBOs	Community Based Organizations
CMIP	Common Management Information Protocol
COB	Coyne and Bellier Study
DNPW	Department of National Parks and Wildlife
EC	Electrical Conductivity
EFR	Environmental Flow Requirement
EIA	Environmental Impact Assessment
Escom	Electricity Supply Commission of Malawi
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESP	Exchangeable Sodium Percentage
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Discussion Group
FS	Feasibility Study
GCM	Global Climate Model
GIEMS	Global Inundation Extent from Multi-Satellites
GoM	Government of Malawi
Ha	Hectares
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
JICA	Japan International Cooperation Agency
KRC	Korea Rural Corporation

---

LNP	Lengwe National Park
Masl	Meters above sea level
Mg	Magnesium
MWK	Malawian Kwacha (1\$ US equals +/-715 MWK)
MoAIWD	Ministry of Agriculture, Irrigation and Water Development
MWR	Majete Wildlife Reserve
N	Nitrogen
NWDP	National Water Development Project
P	Phosphorus
PAPs	project-affected people
PCCPLTRPF	Preparation and implementation of a Communications, Community Participation, Land Tenure and Resettlement Policy Framework
pH	Soil Reaction
PMP	Pest Management Plan
PPE	Protective Personal Equipment
PPP	Public Private Partnership
RoW	Right-of-Way
SRBMP	Shire River Basin Management Program
SVIP	Shire Valley Irrigation Project
SVTP	Shire Valley Transformation Project
TORs	Terms of Reference
UNESCO	United Nations Education Scientific and Cultural Organization
WASVIP	Water Availability for Shire Valley Irrigation Project
WESM	Wildlife and Environmental Society of Malawi
WRB	World Reference Base for Soil Resources

## 1. INTRODUCTION

This document is the executive summary of the Environmental and Social Impact Assessment report (ESIA) for the Shire Valley Irrigation Project (SVIP). The ESIA is presented in 3 volumes: Baseline report, Impact assessment report, Environmental and Social Management Plan (ESMP). A Pest Management Plan (PMP) was also produced. Volume 1 Baseline Report was prepared as technical background information, but it does not formally constitute a part of the package of documents for the World Bank's (and Government of Malawi's) environmental review of SVIP.

The client is the Ministry of Agriculture, Irrigation and Water Development of Malawi. Korea Rural Corporation (KRC) is the consultant in charge of the Feasibility Study (FS), and BRLi is the consultant in charge of the ESIA.

Measures developed under this assignment have informed the Client and technical studies about ways to mitigate impacts and enhance the positive effects of the Project. The ESIA is based on the FS description of the Project.

The project is an agricultural project aiming at irrigating about 43,370 ha of land in Chikwawa and Nsanje Districts, in order to increase their economic prospective and food security. It involves a water intake from inside Majete Wildlife Reserve (MWR) and three main canals of a total length of about 133 km.

SVIP is part of the Shire Valley Transformation Program –I (SVTP-I) which includes a sub-component called “Sub-component 2.2 Natural Resources Management” that will be supported largely with GEF-6 funding. It will promote an inter-sectoral approach to the management of the Lower Shire landscape by addressing biodiversity conservation, protecting and enhancing the role forests, woodlands, rangelands and wetlands play in mitigating climate change, and promoting sustainable approaches to forest management which protect forest resources and deliver benefits to local communities.

The overall goal of SVIP is to benefit local communities, which is a major positive impact given the dry conditions that prevail in the area. Improving livelihoods will lead to other indirect positive impacts: improved access to education and health, new opportunities for agribusiness, etc. The Project also has challenges to overcome in order to ensure its environmental soundness. In order to overcome these challenges, substantial funds, involvement and commitments are necessary for the following infrastructures and activities:

- appropriate wording and inclusion of all applicable mitigation measures in the call for tender (and terms of references) and in the contract of the construction contractor including leverages such as non-payment clauses for non-compliances ;
- inclusion of all applicable mitigation measures in the bulk water operator's call for tender (and terms of reference) and contract;
- selection of a construction contractor with a good reputation and who is environmentally and socially proactive ;
- phasing and confining work in MWR to minimize impacts on tourism;
- suitable compensation for impacts on tourism in MWR (a compensation plan is included in the ESMP);
- installation of low maintenance and autonomous wildlife infrastructures in MWR and LNP such as a fish barrier to maintain the separation between the Lower Zambezi and the Upper Shire fish assemblage, wildlife overpass, wildlife underpass, watering points, noise barriers, and walls around canals;
- installation of sufficient troughs and cattle bridges along the main canals;
- measures to prevent drownings of people (safety ladders) and treatment against Bilharzia, as it is a common disease in irrigation schemes.

Although the Project leads to uncommon impacts, with commitments, funds and reliable mitigations, it could become an example for future irrigation schemes in sensitive areas.

## 2. PROJECT DESCRIPTION

The project is an agricultural project aiming at irrigating about 43,370 ha of land in Chikwawa and Nsanje Districts, in order to increase their economic prospects and food security. It involves a water intake from inside Majete Wildlife Reserve and three main canals of a total length of about 133 km. Construction for Phase I will commence in 2018, at a minimum cost of 519,250,000 USD, excluding the mitigation costs outlined in this document. The water intake will debut from within the Kapichira reservoir, via 12 sluice gates. Phase II is not currently scheduled, but is expected to begin after Phase I completion.

**Water Intake:** Water intake will happen at the highest point of the Kapichira Reservoir, on the right shore of the Shire River. It is expected that between 20 and 50 m<sup>3</sup>/s will be extracted, through the use of gravity. It is clear that dredging will take place in the reservoir. During operation, the 12 gates will be fully automated, and divided into two partitions (8 gates, and 2 gates). These will be opened based on the water demands of the system.

**Canals:** The irrigation system will be comprised of 3 main canals, namely: a feeder canal (Main 1), the Supini Canal (Main Canal 3, previously Illovo Canal), and Bangula Canal (Main Canal 2, Phase II of the Project). The rest of the irrigation system will be composed of branches, complemented with siphons and culverts. It is expected that half of the canal will be buried in Majete Wildlife Reserve (MWR) due to topographic constraints and to reduce risks of drowning of wildlife.

Currently, there are few details on the construction phase. However, in terms of operation, all canals are gravity canals, with water going from the Feeder canal into the Supini and Bangula Canal. Main canals will be supplied on a 24h basis, whilst branch canals will only be used on a 12h basis using night storages, following furrow irrigation requirements.

**Command Areas:** During Phase I, three zones of between 5,199ha and 11,250ha will be implemented. Phase II also consists of three zones, between 4,076 and 10,749ha. The main irrigation method expected to be used will be furrow irrigation, but farmer organisations will be able to develop sprinkler or drip irrigation if they so choose. All areas include irrigated land as well as other infrastructures, such as access roads. Each command area will include parcels (to cultivate), drainage channels and farm roads, with construction requiring impressive earthworks and land levelling. In terms of operational management, a field block will be composed of 6 parcels, with each farm lot receiving 2 field blocks.

## 3. PROJECT AREA: PHYSICAL ENVIRONMENT

**Climate:** The climate of the study area is tropical, marked by high temperatures and two distinct seasons; a rainy season from November to April, and a dry season from May to October. Temperatures range from a minimum average of 15°C in June and July to a maximum average of 35°C in October and November. Humidity ranges between 50% to 80% throughout the year, and average sunlight between 7 and 9 hours a day. There is an effective rainfall of 52%, and the region is qualified as semi-arid.

**Local topography:** The project is located in the Lower Shire Valley. The area starts with the ESCOM reservoir, upstream from Kapichira Falls at 144 masl. From there, the Shire River flows via the dam spillway and Kapichira Falls, down into the valley, which includes a large lowland wetland, Elephant Marsh. North of the study area, the Majete Wildlife Reserve is bordered by hills (780masl), and the Majete escarpment to the North-West, where the Mwanza River flows down. The left bank of the Shire is lined with the Thyolo escarpment (1500 masl) from where numerous tributaries flow.



**River Geomorphology:** The project area includes a portion of the lower Shire catchment from Kapichira reservoir, to the end of Elephant Marsh. There are two main sections to consider: a 20km section from Kapichira to Chikwawa where the river cuts through alluvial terraces; in this section, the river is fed by tributaries from the Majete and Thyolo Escarpments. The second section runs for about 100km through an alluvial plain, and receives a number of tributaries, including perennial rivers (e.g. Mwanza and Ruo Rivers), from Thambani Hills, Salambidwe Hill, the Marangwe Range, the Matundwe Range, Thyolo Escarpment and Mulanje Mountain.

The Lower Shire River is known for its high mobility throughout the alluvial plain, with its drainage area covers 11 470 km<sup>2</sup>; overall, 16 of the 27 tributaries are left-bank, and generally smaller than right-bank tributaries, except for Ruo River which is a large tributary. The Lower Shire itself has an average slope of 1‰, whilst its tributaries have a more marked slope (e.g. 7‰ for Mwanza River), which accelerates runoff.

**River Hydrology:** The Shire River is regulated by the levels in Lake Malawi, as well as by an upstream dam, Kamuzu Barrage, at Liwonde. In addition, levels are also influenced by an irrigation scheme at Mtengula and the drinking water supply for Blantyre Water Board. The average flow at Kapichira Dam is 395 m<sup>3</sup>/s; the hydrological year is marked by two peaks, one in January, one in May, with the latter being more pronounced in dry years. The Shire is responsible for a minimum of 75% for the hydrological behaviour of the Elephant Marsh, throughout the year.

The Lower Shire Valley, notably Chikwawa and Nsanje districts, are prone to floods due to the increased influx of both the Shire and Ruo River during the rainy season; at these times, the Ruo River forces the Shire back at their confluence, often causing breaching of the embankment. In addition, increased erosion upstream due to deforestation has led to higher sedimentation, which intensifies the flood threat.

Though climate models show little change to the Shire Basin flow and runoff due to climate change, the region is still at risk to a more extreme cycling between floods and droughts. In addition, the Shire River is more at risk to increased evaporation than most rivers in Malawi due to the large surface area of Lake Malawi.

**Elephant Marsh Hydrology:** It is estimated that a minimum of 20 km<sup>2</sup> during the dry season and 160 km<sup>2</sup> during the wet season of Elephant Marsh is inundated. The water contributions are shared between the Shire and Ruo Rivers.

**Shire River Water Quality:** There are few recent, reliable and precise data available for the project area on water quality. The most recent values suggest a mesotrophic environment, which present a risk of nuisance growth of aquatic plants. In addition, due to the high population density in the region, it is likely that the water does not reach domestic use standards for turbidity, faecal coliform and total coliform; as such, it is also unadvisable to rely on surface water for drinking.

**Soil, Erosion, Sediment Transport and Geology:** Erosion in the catchment is an important and well-documented issue. Material transported by the Shire River, mainly originating from the West and North-West hills, is deposited in the centre of the valley. Due to increased human activity, there is increased runoff and erosion. In the top part of the basin, the deposits are mainly stratified sandy and silty alluvium. Salinity and alkalinity is reported in depressions, clay-like soils, and around marshes. Vertisols dominate the centre of the study area, with some areas being characterised by heavy Vertisols. Finally, there is little information available for the lower reaches of the area, though it seems to be dominated by a mix of Luvisols, Cambisols and Fluvisols.

**Aquifer and groundwater:** Previous studies have noted that groundwater in the area qualifies as brackish (91%) or salty (5%), with salinity increasing as it flows towards the Shire. The Shire therefore does not significantly affect the water table, with water moving slowly from the river to the aquifer.

## 4. SOCIOECONOMIC BASELINE

The proposed project will affect up to 100,000 small holder farms from two districts, Chikwawa and Nsanje, who should benefit from the installation of gravity irrigation. Crops intended to be grown include maize, sorghum, cotton, rice, and high value crops like tomatoes, onions, beans and sweet potato. The socioeconomic baseline used primary data (e.g. focus discussion groups) as well as secondary sources (e.g. Government of Malawi and NGO reports).

**Public Consultations:** the Consultant has carried out several public consultations, onsite meetings and workshops:

- Inception mission (June 2015) with an inception Workshop in Lilongwe with the Task Force;
- Baseline mission (January 2016) : meeting with stakeholders;
- Public consultations (June 2016) : two meetings with stakeholders : one in Chikwawa and one in Nsanje to present key findings of the baseline report and presentation of a first set of mitigation measures;
- Mitigation workshops (November 2016): two meetings with stakeholders - one in Chikwawa and one in Nsanje to present key findings of the ESIA. An additional presentation on the mitigation measures to the Task Force, Lilongwe stakeholders and World Bank was held to discuss the technical and financial feasibility of the measures.

Public perception of the project is generally positive. However, there is some mistrust of local people about the fulfilment of the project, as discussions surrounding this project have never lead to its implementation. In addition, a number of concerns were raised, notably about the drowning hazards posed by the canal for people, wildlife and livestock, and the social fragmentation resulting from the canal building. Additional issues surrounded employment opportunity, gender and youth issues, and compensation.

**Social Indicators:** the 2008 Population Census estimated the population to be at 434,648 and 238,103 in Chikwawa and Nsanje districts, respectively. Survey results from the area put the average household size between 4.9 and 5.1. The 2008 census suggested a 52:48 female:male ratio, whilst a recent survey found that there were more men than women on average in the project area.

There are distinct gender inequalities in agricultural work. Women are found to be most active in the small scale farms, yet men continue to be in charge of the financial undertaking for both farm produce and livestock. In addition, men are more likely to be hired for casual labour in the surrounding Illovo estates, which provides more substantial income. This is thought to be one of the reasons why women make up a larger portion of those engaged in government and NGO sponsored projects in the area. During focus groups, orphans and elderly were identified by the communities as vulnerable group. Youths between 15 and 35 years of age are viewed as marginalised due to unemployment rates, whilst female headed households are also considered as marginalised due to the lack of property and land rights in their culture.

Within the project area, 2/3 of both males and females complete primary level schooling. However, only 10.6% of females attend secondary education, compared to 14.5% of males. The overall low attendance is mainly due to the tuition fees. Generally, school infrastructure is severely lacking, which could also account for some of the primary level dropouts, alongside underage marriage.

Settlements are concentrated around communal infrastructures such as markets, schools and water points, while communities are based around family groups, communal cultural beliefs and language. There are over 10 ethnic groups in the project area, with Sena and Mang'anja representing the largest two. Christianity is the most represented religion.

**Infrastructure:** Buildings are made of locally sourced materials, such as bricks (sundried and burnt), grass, poles, and clay. The most modern buildings include other materials such as cement and corrugated iron sheets. The area is served by one main asphalted road, three secondary roads, four district roads and a number of unclassified roads, which are often impassable during the rainy season. Transport is primarily limited to push bicycles, as well as motorcycles and ox-carts. Telecommunication is covered by two mobile network companies, but is unreliable away from the main road; phone ownership does not surpass 55%.

Boreholes are the most utilised water source, followed by public taps; in some areas, boreholes are saline or brackish, and communities draw water from unprotected wells in the river beds. While water sanitation seems to be important to communities, approximately 40% of people simply cover their water containers, while 50% use more efficient ways (e.g. boiling, chlorination, filtering). 81% of households have a toilet facility.

Both Chikwawa and Nsanje are home to District hospitals, and are supported by a network of dispensaries and clinics. Common diseases include malaria, diarrhoea, bilharzia and STIs. In addition, communities flagged up a number of health-related issues, from shortages of medication for common ailments, to shortages of staff and bed spaces.

Only urban and larger trading centres benefit from access to electricity, as the connection to the national grid is uncommon. Most households rely on candles, kerosene lamps and solar lanterns for lighting instead. Firewood remains the most important fuel for cooking, followed by charcoal; considering the slew of environmental issues resulting from deforestation, such reliance is of concern.

**Land:** There are four categories of land ownership in Malawi: customary, government, public and private. About two thirds of land being developed for this project is customary land, with the rest being divided between public land (e.g. national parks, towns) and private land. Land ownership is a contentious issue in the project area, as a result of land grabbing practices, lack of title deeds, and differing customs (i.e. matrilineal – vs – patrilineal).

Land holding size is predominately small, with over two thirds of surveyed farmers with 0.5 ha or less. About 80% of the workforce relies on rain-fed agriculture, with crops such as maize, rice and sorghum. The second main land use is irrigated agriculture, through larger schemes such as Nchalo Sugar Estate. A few smaller, government-funded or independent schemes (e.g. treadle pump) exist on either side of the river, with rice being the main crop, sometimes alternating with maize.

This area has one of the highest livestock populations of Malawi, with 12% of farms owning livestock. Animals are kept free-range on communal land, with little additional feeding; manure is rarely used as fertilizer. Keeping the animals on communal land gives rise to a number of conflicts, especially when harvest is near.

**Economics:** Most households rely on agriculture, primarily maize. Overreliance on agriculture causes economic distress from November through to February, as food reserves grow low, and crops are not yet ready for harvesting. The two main cash crops are cotton, grown by smallholder, and sugar cane, grown in Illovo sugar estates. Other key economic activities include livestock farming, which mainly happens near trading centres, and fishing. Fishing is mainly carried out by riverine households, and helps to complement income in bad crop years.

Additionally, the main employer of the area is Illovo and is a large income contributor to many households. More than half of the population indicated an annual income of less than \$150 per year, with about 85% living on less than one dollar a day. However, through the development of Majete Wildlife Reserve, and its inclusive management style, the surrounding communities have benefited from growing tourism as well as from trainings, income generating activities, and community infrastructure.

**Health issues:** The leading health issues of Malawi are present in the region: malaria, schistosomiasis, soil-transmitted helminthiasis, onchocerciasis, cholera, and leptospirosis. In addition, the HIV infection is high; in the Chikwawa district alone, up to 11.4% of pregnant women were affected.

## 5. CULTURAL HERITAGE

While known for its cultural richness, there is little documentation available on the Lower Shire Valley. Nevertheless, the area is rich in pottery and stone tools thought to date from the Iron Age. Later, the area was known as the Lundu Kingdom, and as such, contains a number of spiritual and religious sites, such as Mbewe ya Mitengo, Mawira and Mangalanga. More recent sites of cultural significance include the Livingstone Baobab inside the Majete Wildlife Reserve.

The ESIA preparation included a systematic survey of the Main Canal right-of-way and other planned civil works sites, checking for archaeological relics, fossils, human graves, shrines, sacred trees or groves, and other physical cultural resources. Based on this survey, the ESMP specifies nine sites of archaeological interest where pre-construction salvage of pottery fragments and other items should take place, led by Malawi's Department of Antiquities.

## 6. NATURAL HERITAGE

**Majete Wildlife Reserve:** This reserve covers 689 km<sup>2</sup>, and was established as a game reserve in 1955. Since 2003, its management has been taken over by African Parks, and is the main touristic attraction of the Lower Shire Valley. The number of tourists is continuously increasing from 6000 in 2012 to around 8000 in 2015. The park can be divided into five sections, notably the Mkulumadzi Concession Zone, the high Intensity Tourism Zone, the Low Intensity Tourism Zone, the Resource Use Zone, and the Utility Zone. The first two are the main areas for game viewing. Management objectives and goals are outlined in a five year business plan (2015-2019), which at the time of production of this report was only available as a draft.

**Lengwe National Park:** Established as a game reserve in 1928, the area was later declared a National Park and extended in 1970 and 1975, respectively. Currently covering an area of 887 km<sup>2</sup>, it receives less than 600 visitors a year. Tourism is restricted to the eastern section of the park. Like Majete, the park is subdivided into zones, namely the Wilderness Unit, the Semi-Wilderness Area, the Resource Use Zones and the Utility Area. The most recent management plan was produced by the Shire Basin Management Program, and outlines new objectives, notably to rehabilitate LNP for wildlife, communities and tourism.

**Mwabvi Wildlife Reserve:** this 104 km<sup>2</sup> area was gazetted in 1951 and is managed by the same staff as LNP. The reserve is crossed by the seasonal Thangadzi River, and punctuated by a number of small hills. It is outside of the Project Right of Way.

## 7. ECOLOGY

**Land cover:** Both districts that will benefit from the project are broadly divided into similar land use zones. Natural or semi-natural terrestrial vegetation cover the largest portion in both districts, 55.2% and 43.5% in Chikwawa and Nsanje, respectively (thanks to the presence of two parks); cultivated or managed land is the second largest, with 38.8% and 37.4%. Natural or semi-natural aquatic vegetation, mainly found in Elephant Marsh and Bangula lagoon, further represent an additional 3.4 and 11.1% in either district. Finally, urban areas represent 3.6% of land cover in Chikwawa, 4.7% in Nsanje.

**Anthropogenic modifications:** The study area is subject to huge anthropogenic pressure, notably logging and land transformation, unsustainable fishing practice, encroachment in Lengwe National Park (LNP), and incursion into wetlands by subsistence farmers (dimba agriculture). With much of the land around the national parks being inhabited, most of the current modifications are occurring close to the park and reserve, as well as Elephant Marsh.

**Terrestrial habitats:** Natural habitats in the area is mainly found in the parks and reserve, with some woodland remaining around, but too small to support large fauna. Majete Wildlife Reserve has successfully decreased human wildlife conflict through the erection of an electrical fence, though still faces demands by surrounding communities to utilise the resources within the park. Within the project area, the plant community in Majete Wildlife Reserve is defined into two main plant communities: riverine and alluvial associations, and low-altitude, mixed, tall, deciduous woodland. With the animals unable to move outside the reserve, their movements are limited in the park, and mainly dictated by water availability.

On the other hand, in LNP, the problem of illegal logging, grazing and poaching is severe. In addition, as fencing does not cover the whole area of the park, there are movements of animals, notably buffalo, in surrounding fields. Plant community is dominated by *Acacia* and *Combretum* in thicket communities, as well as well-preserved riparian forest. Due to fencing and high human density around the parks, there is no movement between LNP, MWR and Mvawbi.

**Wetland habitat:** Downstream from Kapichira falls, past the Mwanza junction, the Shire River floodplain expands – the first section is known as Elephant Marsh, and past the Ruo River, known as Bangula Lagoon – covering an area of 1,100 km<sup>2</sup>. The system is fed by both the Shire and its tributaries. The plant community is dominated by grasses, with few ligneous plants. A preliminary study noted the presence of 130 plant species, 62 species of butterfly, and a number of wetland birds, as well as larger wetland fauna (e.g. crocodiles and hippos).

It is estimated that the wetland covers 498 km<sup>2</sup>, approximately half of the Lower Shire River floodplain, and almost half is impacted by agricultural activities (dimba agriculture also called recession agriculture). In addition to this encroachment, this area is also at threat due to its lack of official status, invasive plants, silt deposition from upstream erosion, and human-wildlife conflict. Elephant Marsh remains one of the most productive ecosystems in Malawi.

**Wildlife:** Most of the wildlife encountered reside in the parks and reserve. Overall, 73 species of mammal can be encountered in this area, though MWR was restocked in a number of larger mammals. Additionally, while LNP was created to protect the rare Nyala, their numbers is dropping due to poaching. On the other hand, bird life is thriving in the area with approximately 340 resident species, 250 regular migrant species, and an additional 50-60 species as vagrants; the valley is an important wintering ground for a number of Palaearctic migrants.

**IUCN and Local Vulnerability:** At least 23 species present in the area are listed on the IUCN Red List: 11 near threatened, 5 vulnerable, 5 endangered, and 2 critically endangered. In addition, this area is a biogeographical limit for thicket of the South-East African region, associated bird species are at risk. Finally, within both LNP and MWR, locally rare plants have been identified.

**Aquatic Ecology:** Malawi is known for its numerous waterbodies, which includes the fish biodiversity hotspot that is Lake Malawi. The Shire, which flows from Lake Malawi is divided into three main sections: Upper, Middle and Lower Shire. The project area is within this last stretch, which has similar fish fauna to the Zambezi River as they are connected. The Lower Shire is indeed physically separated from the upper stretches of the River due to Kapichira Falls, an impassable obstacle that keeps fishes from migrating upstream. As such, fish assemblage is different in the Lower Shire from the rest of the river.

The main fish species include African Catfish (*Clarias gariepinus*) and Tilapia (*Oreochromis mossambicus*), which alone account for 90% of the local fisheries. There are about 49 species present in the system. The ten species of highest economic importance are: Tilapia; African Catfish; Straightfin Barb; *Synodontis njassae*; Tiger fish; Lake Salmon; Redeye labeo; *Barbus eurystomus*; and *Barbus johnstonii*.

Fisheries in the Lower Shire account for about 4.2% of total fish landings in Malawi; as they are poorly regulated, such fisheries are a major threat to the aquatic ecosystem, alongside habitat loss, and water hyacinth blooms.

## 8. REGULATORY

The current project is subject to the national policy framework in support of agriculture, irrigation and sustainable natural resources management. This includes the National Constitution of the Republic, the National Road Map Malawi Vision 2020, the Umbrella National Development Planning instrument, the National Growth and Development Strategy (MGDS), various sectorial policies in agriculture, land, forestry, irrigation, environment; the various strategies to implement international conventions on biodiversity, sustainable development, climate change, desertification etc. Most of the policies have recently been reviewed, revised or/ and harmonized.

As the current project is partially funded by World Bank and African Development Bank, safeguard policies from these institutions will have to be respected. These policies include environmental themes, including pest management and protection of natural habitats, and social themes, including resettlement, cultural heritage and stakeholder engagement.

According to the Environment Management Act, 1996 the Project qualifies for an Impact Assessment under several criteria (List A: List of projects for which an EIA is mandatory: A1 Agriculture/aquaculture projects, A13 Projects in proximity to or which have the potential to affect: National parks, game reserves and protected areas) and also as it will affect national parks.

As the project involves work in national parks, it falls under the Malawi National Parks and Wildlife Act (1992). According to this Act, any person who has a good and sufficient reason to believe that any proposed or existing government process or activity of the government or any other organization or person may have an adverse effect on any wildlife species or community such person may request that a “wildlife impact assessment” be conducted by a board made of representatives of several ministries and stakeholders (fishery, antiquities, DNPW, Wildlife society, etc.). The Act provides the typical content of such impact assessment:

- A statement of the existing or anticipated impacts upon wildlife, including an account of the species, communities, and habitats affected and the extent to which they are or may be threatened;
- A statement of whether rare, endangered or endemic species are or may be affected;
- A list of alternative actions, including inaction, which might be taken to remove or lessen adverse impacts; and
- Its recommendations for subsequent government action.

## 9. PROJECT POSITIVE AND NEGATIVE IMPACTS

Impacts arising from the Project have been assessed using four criteria, namely, the affected component's value; impact intensity; impact extent; and impact duration. Simultaneously, the probability of impact has been assessed. Altogether, impacts identified with ‘major impacts’ require mitigation, offsets or compensation (followed by monitoring), whilst ‘minor impacts’ seldom necessitate more than mitigation.

## 9.1 IMPACTS DURING PRE-CONSTRUCTION PHASE

The overall impacts during the pre-construction phase are concentrated in community organisation and the natural heritage front. These include community reorganisation and resettlement, which will be addressed in the Resettlement Action Plan. In addition, the final decisions on canal design and alignment was influenced by the type of long-term consequences on the National Parks. Finally, the use of a tendering process for construction will need to be inclusive and closely monitored in order to ensure the adherence to the environmental mitigation recommendations determined in the ESIA and its ESMP. On the other hand, there will be no impacts on the physical environment or ecology during the pre-construction phase.

## 9.2 IMPACTS DURING CONSTRUCTION PHASE

The following is a summary of impacts during construction phase. The ESMP provide further details on the role of the each actors in the implementation of mitigation measures and monitoring of impacts.

**Impacts from the tender process for a construction contractor:** The selection of a construction contractor and the inclusion of appropriate mitigation measures in call for tender and contract is a crucial step as many contractors are not environmentally and/or socially proactive and most have no experience in working in sensitive areas.

Mitigation:

- The selection of the construction contractor will require a conscious decision by project proponent and financing agencies prior to tendering. The bidding document and contract shall reflect the new requirements of the World Bank as highlighted in the document "Summary of Environmental, Social, Health and Safety (ESHS) Enhancements Standard Procurement Documents (SPDs) & Standard Bidding Documents (SBDs)";
- African Parks and the DNPW should have a right to review the Design for the upcoming Phase I and to propose improvements, as Phase I will soon start. African Parks and the DNPW shall also be involved in the pre-qualification selection of the construction contractor as advisors;
- In addition, many measures proposed in the ESIA and ESMP involve costs for the construction contractor, call for tender shall be clear on the requirement to quantify measures in the Bills of Quantities;
- It is highly recommended to require that the contractor has experience working in wildlife parks but most importantly, its reputation must be assessed by a Tender panel.

**Impacts on river geomorphology and water quality:** The construction of the irrigation system will require extensive construction work around existing rivers, and as such will affect the geomorphology of rivers, as well as the water quality.

Mitigation:

- In order to minimise impacts, the mobile nature of the rivers shall be taken into account;
- Crossing of tributaries shall be done in straight lines;
- A buffer zone will be maintained around river so that irrigated fields are not too close to river banks;
- Infrastructure to solidify banks shall be installed (e.g. gabions).

**Soil excavation and land levelling:** the project will require extensive excavation work for canals, as well as rock blasting.

Mitigation:

- All reusable excavated soil shall be either provided free of charge to surrounding communities, or flattened and revegetated;
- Burrow pits from blasting should be repurposed whenever possible and in consultation with communities (e.g. creation of wetland, filled with unusable soil, etc.).

**Impacts on workforce:** The construction site will offer a number of job opportunities for the local populace, both skilled and unskilled.

Enhancement and mitigation measures:

- There will be a need to prioritise local workers in order to revitalise the local economy, and actions will be necessary to minimize the negative impacts which could result from the influx of foreign workers (e.g. increased human pressure on natural resources, gender based violence, etc.);
- These actions are the enforcement of a workers code of conduct, the development of a grievance redress mechanism encompassing the construction phase to allow community to communicate with the construction contractor about their concerns and grievances (and behaviour of workers), and the fight against encroachment in Lengwe National Park and Mwabvi Wildlife Reserve;
- To minimize the risk of sexual harassment and gender based violence due to the influx of male workers in the Project area, it will be important to mobilize and reinforce the presence of the local law enforcement in the area.

**Impacts on infrastructure agriculture and cultural heritage:** The project will have manifold impacts on the human infrastructure, natural and cultural heritage throughout its construction.

Mitigation:

- Chance Finds Procedures for the civil works contractors to follow during irrigation canal construction, along with pre-construction training and awareness for contractor personnel are to be incorporated within all relevant bidding documents and contracts;
- The canal alignment is being selected with a view toward minimising interference with physical cultural resources. No graveyards or shrines are expected to be affected by the project;
- Items of cultural interest will be systematically catalogued and stored or displayed, in accordance with guidance to be provided by the Department of Antiquities;
- In addition, new infrastructure accompanying the construction (e.g. bridges) should be developed simultaneously in order to limit disruptions, health and safety risks, and facilitate reprise of activities by local communities. The ESMP has recommended that one cattle/pedestrian bridge be built every km of main canal.

**Impacts wildlife parks and reserves:** Considering the passage of canals through Majete Natural Reserve (during Phase I) and Lengwe National Park (during Phase II), the impacts during construction in these areas are non-negligible. Infrastructure and fences will be impacted during construction, as well as tourism due to the noise, earth work and machine and truck traffic.

Mitigation:

- In order to minimise the impacts, it is crucial that park/reserve managers work hand in hand with construction and that all parties agree and respect schedules and mitigation measures (e.g. fencing off areas, road diversion, right of way, etc.);
- In order to mitigation impact, it is absolutely necessary to include appropriate wording and all applicable mitigation measures in the call for tender (and terms of references) and in the contract of the construction contractor including leverages such as non-payment for non-compliance and on-site audit by a Supervising engineer;
- Certified noise barriers will have to be installed in MWR as work will take place very close to all important building and touristic sites;



- There will be a need to phase and confine the work into distinct areas inside MWR, in order to minimize disruptions. The scheduling of these should be made clear within the construction tender. The ESMP has describe three phases for construction which distinguishes the area along the Shire inside MWR, Ng'ona lodge private property and the Southern tip of MWR;
- For inevitable impacts such as loss of revenue and infrastructure destruction, a compensation schedule shall be drawn up based on the ESMP.

**Impacts on terrestrial biome:** there are two major considerations to investigate, notably the rapid change in land cover and the disruption to wildlife and vegetation. The construction will inevitably modify the current vegetative landscape, though much land area is already converted agricultural lands.

Mitigation:

- A reforestation scheme in LNP and MWR: in MWR, 25 ha of forest will have to be compensated and in LNP 60 ha of forest and thicket;
- Setting aside lands for protection concern, i.e. Open woodland (including riparian forest), Marshes and flood prone area, Heavy Vertisols area, Grazing area, Rivers and their banks, wetland and buffer zones around LNP. This will require that the Design study fine tunes the irrigated areas to create set-aside lands and access for cattle to grazing sites along the Elephant marsh;
- Carefully designed and implemented safeguarding plans for protected trees and avoiding communal forests.

**Impacts on aquatic habitats:** Construction will lead to work on temporary rivers, which a number of fish use to migrate to spawning sites.

Mitigation:

- In order to limit unforeseen damage to these channels, temporary earth dikes and other structures that can modify the channel or destabilise earth banks should be avoided;
- The ESIA recommends that channelization of some rivers be avoided or done in consultation with stakeholders to minimize impacts (for example: Nkombedzi Wa Fodya River which crosses LNP) ;
- In addition, appropriately placed and sized culverts should be provided in order to ensure that there are no floods (super-sized culverts with natural bottoms), and work prohibited on these channels during fish spawning season.

### 9.3 IMPACTS DURING OPERATIONAL PHASE

The following is a summary of impact during operation phase. The ESMP provide further details on the role of the each actors, mainly the Bulk Water Operator, in the implementation of mitigation measures and monitoring of impacts.

**Hydrological impacts:** This project represents a consumptive demand on the Shire system at the level of the Kapichira reservoir, which will not be – for the main part – reintegrated into the system. Increased demand on the reservoir will have compounded effects downstream, notably a significant decrease in flow at the Kapichira Falls. The main mitigation effort proposed would be to increase the debit of upstream barrages (i.e. Kamuzu Barrage); however, in the current situation, this is not an option.

**Hydraulic transparency:** Due to the dynamic nature of this riverine landscape, poorly designed culverts and other infrastructure could lead to damming of tributary rivers and flooding of villages upstream. Any floods inside main canals could also lead to colonisation of Lower Shire fish species upstream of Kapichira falls.

Mitigation:

- In order to avoid such occurrences, the culverts sizes should adhere strictly to the designs that are informed by highest flow data (super-sized culverts).

**Changes in soil properties:** Irrigated agriculture sometimes trigger a series of changes in soil properties; salinization, sodicity, waterlogging.

Mitigation:

- Monitoring of soil properties is highly recommended. Soil water levels and salinity will require very close monitoring to provide early warning of problems;
- In addition, due to the presence of poorly drained Vertisols in two of the three canal zones (B and C), alternative crops such as rice should be considered.

**Rapid social change and hinterland effect:** The installation of a modern irrigation scheme will necessitate the social acceptance and behaviour modifications from local communities in order to truly be successful. Furthermore, increased economic and demographic growth in the area could increase pressure on natural resources, including on water, wood and fish. The community level communication is currently addressed in the communication strategy, while the latter is to be addressed by other stakeholders as the project evolves.

**Lack of proper maintenance of infrastructure:** This ESIA requires that a number of mitigation infrastructure be installed (e.g. bridges, wildlife passes, walls) which will need to be adequately maintained in order to ensure their efficacy.

Mitigation:

- Responsibility of maintenance shall be assigned for all infrastructure. It is recommended that the Bulk Water Operator be responsible for maintenance of infrastructures proposed in the ESMP:
  - Bridges (cattle, pedestrian, and vehicle)
  - Safety stairs and ladders for villagers to bathe and wash and to exit in case of falls
  - Invasive fish barriers
  - Water intake trash rack (to hold back debris, crocodiles and floating Water Hyacinth)
  - Walls around the open canal section in MWR;
- In order to prepare for long term risks and to ensure that stakeholders interests and mainly those of parks are not affected by others, clear chain of responsibilities have to be defined taking into account all possible situations and “worst case scenarios”;
- Training should be given to users of the canal system to ensure proper use of the irrigation canals (e.g. avoid waste-dumping);
- In addition, due to the presence of water hyacinth in the Kapichira Reservoir, regular eradication plans should be continued and extended to the canal as needed.

**Changes and delays in agricultural development:** Whilst the project is designed to allow further agricultural development past subsistence agriculture, delays to the start of operation and or of behavioural shift could potentially postpone benefits, especially at a household (e.g. food security) and community level (e.g. access to improved health and education facilities). In addition, the successful rolling out of the project could also lead to an over-supply in crops, which would decrease the market value of these.

Mitigation:

- Adaptive research and development;
- Creation of best practices based on the lessons from Phase I (before starting Phase II);
- Increased market-linkages;
- Emphasis on the export industry and the food transformation industry.

**Livestock rearing:** Livestock rearing practices will need to be adapted to the new conditions, as canals and command areas will represent obstacles to movement of cattle and grazing lands and water points will be reduced.

Mitigation:

- In order to avoid conflicts, infrastructure will be put into place along main canals, including drinking troughs at every village and cattle bridges at each kilometre of main canal;
- In addition, conflict management structures between cattle herders and irrigation farmers shall be instated, alongside access to unfarmed land for grazing and new business opportunities (e.g. organic manure).

**Decline in fisheries:** Fisheries, which are already in decline, may further be affected by the decrease in flows in the Elephant Marsh.

Mitigation:

- In order to decrease the extent of this impact, fish farms are proposed, in line with the Agricultural Development Planning Strategy;
- A wetland management plan under the Shire River Basin Management Program (SRBMP) also aims at sustainable development.

**Health and Safety:** The intricacy of the canal system will increase the risk of drowning and injuries, specifically for children, as they are at risk even in the shallowest channels.

Mitigation:

- Sensitisation campaigns to be implemented, notably in schools, but also the addition of safety features such as ladders at every 500 meters in main canals (Feeder, Bangula and Supini). Large safety stairs shall be built at every villages along main canals;
- As schistosomiasis is expected to rise but not malaria (malaria prevalence is not linked with the presence of canals), farmers and canal workers will be expected to wear suitable protective clothing. In addition, sensitisation campaigns will be put in place as well as preventative treatment campaigns (e.g. praziquantel for Schistosomiasis), and construction of pit latrines.
- The ESMP also recommends to provide funds for capacity building for local health specialists to use up-to-date detection method for both urinal and intestinal schistosomiasis.

**Impact on gender and vulnerable groups:** The project has both the potential to benefit women through improving their access to water, as well as impacting them by increasing their workload in agricultural yield. Furthermore, as financial services often remain unattainable to women and youth, they may not have access to the same opportunities as men arising from the operation of the irrigation system. Likewise, landless people may be disadvantaged by the project.

Mitigation:

- Mitigation efforts on this aspect are fully described in the Gender and Youth Strategy Study, and are to be implemented from the preparatory phase through to operation;
- Additional mitigation will be included in the upcoming Resettlement Action Plan.

**Kapichira falls attractiveness:** The present project will decrease the environmental flow released by the sluice gates, known as Kapichira Falls. Currently, the flow is under 10m<sup>3</sup>/s less than one month a year, but this could rise to over 6 months a year, decreasing the touristic value of this site. It is crucial that the falls should remain visible during the rainy season, when irrigation needs are less important.

**Impacts in wildlife parks:** The passage of the project through two wildlife parks will inevitably cause long-term changes in the park through the creation of new infrastructure, the introduction of new stakeholders (such as the bulk water operator) as well as new chains of responsibility (especially regarding maintenance of infrastructure). These changes have the potential to greatly encumber the reserves and their management's mission, and present a number of unknown risk factors, from changes in animal behaviour and drownings, to increase in encroachment and poaching. The latter are of particular concern in Lengwe National Park, which already suffers from imposing human pressures.

Mitigation:

- In order to mitigate these impacts, it is necessary that a Memorandum of Understanding be signed between African Parks/Department of National Parks and Wildlife (DNPW) and the bulk water operator for MWR, and DNPW and the bulk water operator in LNP;
- The canals shall remain part of the MWR and the right-of-way of the canal not be alienated from MWR. Access to the intake and canals for maintenance will be managed in accordance with African Parks' access restrictions (and inspection to avoid poaching);
- The presence of a canal in LNP, if designed to avoid animal drowning, could be a positive impact because this park suffers from water shortages. This might well produce a net gain from a conservation standpoint for LNP. An artificial wetland with water pumped from the main canal shall be installed in both MWR and LNP to create a drinking spot for wildlife;
- Most illegal wood cutting activities and illegal grazing originate from communities in Zone A and B; however, as they gain to benefit from the SVIP, their inclusion in the scheme shall be conditional upon a signed agreement to comply with the rules prohibiting wood cutting, grazing, or other unauthorized activities within Lengwe National Park (this also applies to MWR and surrounding communities). Village headmen shall sign a contractual agreement or some form of formal engagement to respect this rule prior to their inclusion in the scheme. The SVIP should be used as an opportunity to request some environmental engagement in exchanges of irrigation;
- Dredging will extract more than 500,000 m<sup>3</sup> of fine sediment from the reservoir. Transport of these sediments through MWR should be avoided (as transport will require about 1 truck per every 2 minutes through MWR). Discussion shall be engaged at Government level about ways to dispose of this large amount of sediment and about the need to avoid storing them within MWR;
- Ng'ona lodge, a private property beside MWR, will be affected by the Feeder canal RoW and work. Compensation, which should be developed within the Resettlement Action plan, shall be paid to the owner.

**Habitat fragmentation:** The building of canals will invariably fragment usable habitat, which will be of most relevance in MWR and LNP.

Mitigation:

- The construction of buried canal sections in MWR would reduce this issue; currently, about half of the Feeder canal will be buried in MWR;
- In LNP, there are also options of creating wildlife over- or underpasses at same locations as vehicle bridges.

**Wildlife drowning hazards:** Due to the nature of this project, there will be an inevitable risk of drowning for the numerous animal species in LNP and MWR due to the slippery nature of the concrete lined canals and the steep slope (1 Horizontal/3 Vertical) and the attractiveness of the canal as a drinking spot (especially in the dry season).

Mitigation:

- The ESIA has highlighted the need to erect a concrete and brick wall along the canal in MWR in section where the canal will be open (about half of the canal length will be buried in MWR);
- The ESIA has highlighted the need to provide gripping material in the canal in LNP or the need to design an earth canal in LNP (earth canals offer good grip so animals can exist the canal);
- All options will represent a higher financial cost, but currently low maintenance concrete and rock walls are recommended for MWR, and a flexible matrix of cellular concrete blocks in the channel lining in LNP or an earth canal in LNP.

**Changes in wetland plant communities:** With a decrease in flow due to abstraction at the most critical period of the year (the dry season), there will be a decrease in suitable habitat for some wetland vegetation and a potential increase in human encroachment and dimba agriculture (recession agriculture), reducing the plant community diversity.

Mitigation:

- Under the Natural Resources Management Component 2.2, the SVTP-I Project will also enhance the conservation of the Elephant Marsh through support for its designation as a Ramsar Wetland of International Importance, and with the establishment of Malawi's first Community Wetland Conservation Area under the administration of the Department of National Parks and Wildlife (DNPW). Therefore, future agricultural encroachment within Elephant Marsh is likely to be limited;
- In addition, the 2015 flooding altered the course of the Ruo River, which now joins the Elephant Marsh directly. The ESIA recommends that this new channel be maintained to mitigate effects from the Project, though human resettlement from around the banks of the Ruo River would be advised to limit flooding risks.

**Increased wildlife-human conflict:** Human-wildlife conflict will be exacerbated, notably with crocodiles and hippopotamus because they will be impacted by changes in Elephant marsh.

Mitigation:

- While there are a number of mitigation efforts that can be considered based on the species being dealt with (e.g. non-food crops close to canals to avoid hippo raiding), sensitisation programs will be the main action to avoid risky behaviour;
- The Natural Resources Management Component includes investments intended to reduce human-wildlife conflicts in the Elephant Marsh

**Invasion of Lower Shire fishes:** Kapichira Falls constitutes a barrier between the Lower Shire to the Middle and Upper Shire. Currently, the Tiger Fish and other Zambezi River fishes are present only in the Lower Shire; the gentle slopes of the envisaged main canals could allow downstream fishes (including the Tiger fish) to by-pass Kapichira Falls. The Tiger fish has the potentiality of creating ecological havoc if it were present in the rest of the Shire basin; most notably, due to its piscivorous and aggressive nature, it has the potential to significantly alter the mainly endemic cichlid populations of Lake Malawi.

Mitigation:

- An effective fish barrier shall be put into place. Self-reliance and low maintenance are the two principles that should govern the fish barrier choice and installation. The Technical Feasibility Study recommends a high fish weir consisting of a 3.5 meter drop structure topped off with a 1 meter crest. This will result in a vertical free fall of at least 2 meters when the canal is conveying the maximum amount of water (50 m<sup>3</sup>/s) and a higher free fall with any lower water flow. This fish weir will be incorporated within the Main Canal Detailed Design, with the incremental cost included as part of the total canal construction cost. This high weir is intended to effectively prevent any entry of Tiger fish- or any other non-native fish species to Lake Malawi - into the upper Shire River above Kapichira Falls through the Main Canal. To minimise the risks from human interference (including the accidental or deliberate release of non-native fish into the canal, above the barrier), the fish weir will be located within the Majete Wildlife Reserve, where human access is carefully controlled. Also, this area is farther upstream and outside of flood prone area.
- Maintenance of the fish barriers will be the Bulk Water Operator's responsibility (this shall be highlighted in the call for tender).

**Reduction of aquatic habitat quality:** With a reduction of flow, Elephant Marsh will be impacted; as such, there will be a decrease of suitable habitat for fish as well as a possible decline in quality.

Mitigation:

- Much of the management and mitigation efforts for Elephant Marsh fall under the mandate of the Shire River Basin Management Programme. In addition, Natural Resources Management Component of SVTP-I includes investments in community fisheries management, intended to make fisheries in the Elephant Marsh more sustainable.

**Pesticides uses:** As presented in the Pest Management Plan, development of the SVIP will lead to increase use of pesticides. Pesticides can impact water quality, biodiversity and human health. The risks of such impacts are heightened with improper pesticide use and disposal. The PMP has described an Integrated Pest Management (IPM) aiming at:

- Sustainable control of pests in sugarcane plantation ;
- Sustainable control of weeds in sugarcane plantation;
- Sustainable control of diseases in sugarcane plantation;
- Management of post-harvest pests of cereal crops;
- Sustainable control of pest for other crops;

The measures developed in the IPM fall in the following categories:

- Pesticide application and disposal of pesticide containers (including incinerator, registration of pesticides, etc.);
- A list of recommended selective pesticides;
- Safety management principle and best practices for environmental and human safety;
- IPM capacity building for farmers (workshops, training session, etc.);
- IPM monitoring;
- Development of an IPM implementation team.