

The Federal Environmental Protection Authority



Environmental impact assessment guidelines on irrigation

NOT FOR CITATION

This guidelines is still under development and shall be binding after consensus is reached between the Environmental Protection Authority and the Environmental Units of Competent Sectoral Agencies

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Table of Content

Page

Introduction.....	1
1. Major Types of Intervention in the Irrigation Sub-Sector.....	1
2. Specific Characteristics of an Irrigation Project.....	2
3. Major Issues Related to an Irrigation Project.....	3
4. Potential Impacts, Enhancement and Mitigation Measures.....	5
4.1 Economy.....	5
4.2 Environment.....	7
4.3 Population.....	9
4.4 Health Outcomes.....	11
4.5 Gender.....	13
4.6 Participation.....	15
5. External Factors.....	16
6. Hazard Management.....	17
7. Environmental Monitoring.....	17

Introduction

These guidelines cover all types of irrigation projects and consider the various steps of the water cycle, including water harvesting, storage, conveyance, on-farm distribution and drainage. However, they do not address issues related to dams and reservoirs although such infrastructures are sometimes required to supply irrigation water.

These guidelines aim to assist in developing irrigation projects that can address the issues of sustainable development. They highlight major issues and potential impacts that should be taken into account during the preparation and assessment phases. The appropriate enhancement and mitigation measures should be integrated as early as possible, preferably in the project design.

1. Major Types of Intervention in the Irrigation Sub-Sector

Any types of intervention in water supply shall be undertaken through an integrated water resources management approach. In the case of irrigation projects, water supply is undertaken for the purpose of improving agricultural production and extending the cropping period. There are a wide variety of irrigation projects depending upon the source of water and the technologies associated with water harvesting, storage, conveyance and distribution. In general, irrigation projects include the following types of interventions:

- use of surface, underground water and/or wastewater;
- provision of water supply through storage in reservoirs, pumping and/or gravitation;
- conveyance and distribution of irrigation water by open channels and/or pipelines;
- application systems of irrigation water by means of flooding, basins, border strips, rills, sprinkling, pivot, dripped irrigation and/or subsurface;
- irrigation schemes preparation;
- drainage by means of open and/or concealed systems.

Irrigation projects often include the following technical facilities and infrastructures:

- dams and reservoirs;
- diversion and intake facilities;
- wells, pumping stations, canals, ditches and pipelines for the conveyance of water;
- distribution systems for pivot, sprinkling or dripped irrigation;
- feeder roads.

2. Specific Characteristics of an Irrigation Project

The description and justification of an irrigation project shall cover the following specific elements:

- Source of water and hydrological changes implied by the project.
- Up-stream water quality and potential contamination sources.
- Water uses, demands and needs.
- Affected groups (directly or indirectly).
- Resettlement and/or migration requirements and proposed transition and compensation means.
- Socio-cultural factors or constraints, such as customs and beliefs.
- Criteria for selecting project beneficiaries among local people/migrants, women/men, poor people, and other vulnerable groups.
- Legal and contractual arrangements, including land tenure, land ownership and water rights.
- Natural and human resources needs.
- Type of technology proposed (water intake, storage, conveyance and distribution) and justification.
- Project layout characteristics:
 - location (including site location map) and area to irrigate;
 - water intake, water conveyance and distribution systems, drainage,

- infrastructures;
 - domestic water supply facilities;
 - diagram illustrating irrigation schemes;
 - drainage installations.
- Agricultural exploitation features:
 - target crops and justification;
 - cropping seasons (length and frequency);
 - proposed agricultural techniques;
 - inputs (fertilisers and pesticides);
 - maintenance practices and infrastructures;
 - water management;
 - expected outputs, profitability for producers and commercialisation means.
 - Existing and proposed location of human settlements and public services such as health centres and accident and emergency units.
 - Construction activities (land clearing, burning, excavation, extracting, filling, compacting, waterways crossing, use of heavy machinery, construction of facilities, etc.).
 - Anticipated liquid, solid (including waste) and gaseous emissions, and sources of nuisances (at construction and operation stages).
 - Construction schedules and costs.
 - Maintenance works, associated costs and financing.
 - Water conservation and management (users organisation, fees/tariffs, revenue allocation, etc.)
 - Complementary initiatives related to improvements in host and/or new communities, particularly domestic water supplies, sanitary facilities as well as traditional and modern medical services.
 - Consultation approaches and participation mechanisms.

3. Major Issues Related to an Irrigation Project

The major issues that can potentially arise when constructing and/or implementing an irrigation project are outlined in the following table.

Crosscutting Theme	Major Issues	Relevant or not
Livelihood	<ul style="list-style-type: none"> • employment and incomes. • Compensation for losses. • Access to benefits, in particular to irrigated land, for adversely affected populations and the poor. • Skill and knowledge requirements. • Availability of and access to infrastructures and services. 	
Environment	<ul style="list-style-type: none"> • Watershed management. • Water quality. • Drainage and sedimentation. • Water use. • Soil characteristics. • Protection of vegetation, habitats and specific ecosystems. 	
Population	<ul style="list-style-type: none"> • Involuntary resettlement and migration. • Population characteristics and dynamics. • Land uses. • Water access and rights. • Natural resources management. • Agricultural practices and local customs. • Quality of life. 	
Health Outcomes	<ul style="list-style-type: none"> • Vector-borne and water borne diseases. • Sexually transmitted diseases. • Food supply and safe drinking water. • Accidents and injuries. • Sanitation and hygienic conditions. 	
Gender	<ul style="list-style-type: none"> • Women's workload. • Control over land and land proceeds. • Income-generating activities. • Access to facilities and services. • Women's involvement in decision-making processes. 	
Participation	<ul style="list-style-type: none"> • Participation of affected groups in consultations. • Organisation of irrigation water management. 	

4. Potential Impacts, Enhancement and Mitigation Measures

The potential impacts outlined below are presented by crosscutting theme (one table per theme) to clearly identify the potential interactions between an irrigation project and a specific issue.

4.1 Economy

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Poverty	<ul style="list-style-type: none"> • Increase in agricultural yields and production, generating additional revenues. • Increase in local development and employment. • Increase in revenues for the local population due to induced development and complementary activities (such as fishing in major rice irrigation projects). • Perturbation of existing activities, particularly traditional agriculture. • Loss of revenues or productive means, primarily productive land. • Exclusion of specific groups from accessing irrigated land. 	<ul style="list-style-type: none"> • Give preference to local employment (men and women) and local inputs (food, basic material) to the extent possible. • Ensure that revenues generated by crop production activities are sufficient to cover the cost of irrigation infrastructures construction and maintenance. • Base profitability projections on conservative revenue assumptions. • Whenever possible, give priority access to irrigated schemes to men and women who are losing productive means (owners and people cultivating the land). • Ensure that compensations cover all revenue and asset losses by adversely affected men and women, either if they are landowners or land users. • Identify why specific groups are not benefiting from the project and adopt corrective measures as required, such as favouring excluded groups when irrigated schemes are reallocated or expanded.
Information, education and communication	<ul style="list-style-type: none"> • Development of water management skills. • Exclusion of specific groups from the irrigation scheme allocation process due to a lack of knowledge. • Lack of training of workers in charge of irrigation water system operations/exploitation. 	<ul style="list-style-type: none"> • Provide information and education to men and women on non-suitable uses of the irrigation water (e.g. using irrigation water for washing or drinking). • Assist groups of individuals (men and women) who may lack the capacity to apply for an irrigated scheme to prepare an application, if they want to. • Develop and implement a literacy program especially aimed at poor people and women. • Provide irrigation workers, men and women, with the training required to preserve water resources and to offer reliable water services. • Offer training to users, adapted to the specific needs of men and women, on irrigation techniques and sustainable water resource management.

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Access to infrastructure s and services	<ul style="list-style-type: none"> • Development of new infrastructures or improvement to existing ones. • Increased agricultural productivity due to a reliable water resource access. • Increased pressures on existing social services due to migration. • Increased prices of social services (water, electricity, etc.). 	<ul style="list-style-type: none"> • During project preparation, consult concerned ministries to verify the adequacy of current and proposed social infrastructures. • Involve users, men and women, in the maintenance and management of new infrastructures to ensure their sustainability. • Ensure appropriate social services are available to address the basic needs of the host and migrant populations. • Assist social service administrations in coordinating their efforts to offer additional services and improve service delivery, if required. • Implement consumption fees on irrigation water to finance infrastructure construction and maintenance. • Promote safety net measures to protect the poor and other vulnerable groups against price increases in social services.

4.2 Environment

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Air	<ul style="list-style-type: none"> • Degradation of air quality and ambient noise due to construction works. 	<ul style="list-style-type: none"> • Near residential areas, avoid noisy works after regular working hours. • Maintain vehicles and machinery in good condition in order to minimise gas emissions and noise. • Use appropriate means such as vegetation hedges to avoid dust dispersion during construction.
Water	<ul style="list-style-type: none"> • Improved water supply. • Contamination of surface and underground water during construction. • Water flow reduction downstream of the irrigation site, causing adverse effects on fish habitat, drinking water intake and pollution dilution. • Degradation of groundwater and surface water quality downstream of the irrigation site due to high concentrations of nutrients and pesticides. • Obstruction and clogging of canals by weeds and sedimentation increasing standing waters and vector breeding sites. • Saline intrusion in coastal area, in particular when groundwater is pumped. • Rise in water table. • Over-pumping of groundwater. • Overuse and misuse of irrigation water. 	<ul style="list-style-type: none"> • Maintain vehicles, machinery and equipment in good condition in order to avoid leaks and spill of hazardous materials. • Take all precautions during the refuelling of vehicles, machinery and pumps, and forbid the refuelling near water bodies. • Ensure a safe management of hazardous materials. • Avoid crossing permanent waterways; if necessary, locate the crossing where the banks are stable and the narrowest. • Do not hamper drainage of surface water and plan for restoration measures after construction. • Plan works in areas prone to flooding outside the rainy season. • Install appropriate sanitary facilities in workers' camps. • Adopt a watershed management approach while designing the project. • Minimise the loss of water caused by leaks, evaporation and infiltration through canals and reservoirs (e.g. maintain vegetation along water canals). • Develop compensation measures for affected downstream water users. • Ensure that drainage water complies with discharge standards, treat wastewater accordingly and ensure safe re-use of wastewater. • Design water canals for reducing sedimentation and facilitating drainage and maintenance. • Control access to irrigation water for other purposes than irrigation (safety measures and rules). • Remove aquatic vegetation from margins of water canals and reservoirs. • Adjust the annual pumped water volumes in accordance with the aquifer annual refill.

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
		<ul style="list-style-type: none"> • Ensure proper water management and irrigation system maintenance by establishing fees for water users.
Soil	<ul style="list-style-type: none"> • Soil compaction due to repetitive mechanical works. • Soil erosion resulting in sedimentation problems. • Soils contamination from spilling of hazardous materials. • Water logging due to excessive irrigation. • Increased percolation rate. • Change in soil chemical properties : pH, salinity, fertility, etc. 	<ul style="list-style-type: none"> • Minimise the use of heavy machinery and limit their circulation to minimal areas. • At the end of construction works, level off the soils and facilitate vegetation regeneration. • Use existing borrow pits rather than creating new ones; after the works, restore borrow pits by stabilizing slopes and facilitating vegetation regeneration. • Avoid to clear vegetation along water bodies. • Minimise and clearly define the land clearing areas. • Avoid steep slope and level the land (terrace on slopes) as much as possible. • Maintain vegetation hedges in order to reduce wind erosion. • Design irrigation perimeters in order to minimise pluvial erosion. • Manage safely hazardous materials. — In order to avoid water saturation, regulate adequately the irrigation (avoid excessive irrigation), maintain the drainage network and select an irrigation system that is low demanding in water and appropriate for crops.
Ecosystems	<ul style="list-style-type: none"> • Encroachment in ecologically sensitive areas. • Reduction of biodiversity. 	<ul style="list-style-type: none"> • Minimise the length of works in sensitive areas. • Forbid any encroachment in ecologically sensitive or protected areas. • Establish a perimeter of protection around sensitive ecosystems such as wetlands and unique habitats sheltering endangered species. • Minimise sedimentation in spawning grounds downstream of the site. • Take into account reproductive habitats, wetlands, spawning grounds and protected ecological areas.
Flora	<ul style="list-style-type: none"> • Development of vegetation in irrigated areas. • Potential use of wastewater from irrigated productions to grow trees, orchards, woodlots or forests. • Damages to trees (during infrastructure construction). 	<ul style="list-style-type: none"> • Clearly mark the land clearing areas and optimize the structures location in order to minimize deforestation. • Protect trees from machinery. • Plan for recuperating timber and fuel wood extracted from land clearing and identify mechanisms to distribute the products to the local population. • Immediately after the works, facilitate vegetation regeneration with adapted

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
	<ul style="list-style-type: none"> • Loss of vegetation due to land clearing. • Loss of forest products (fuel wood, timber, non timber forest products, medicinal plants). • Proliferation of aquatic vegetation in canals due to excessive use of fertilisers. 	<p>species to the project area.</p> <ul style="list-style-type: none"> • Minimize vegetation destruction along water bodies. • Promote implementing agro forestry techniques adapted to the site. • Ensure the plantation of indigenous species. • Promote the development of community tree nurseries, preferably operated by women. • Promote the use of improved fuelwood stoves and other biomass saving devices. • Preserve wild food and medicinal plant supplies.
Fauna	<ul style="list-style-type: none"> • Benefits to wildlife from water retention, increased access and permanent waterways. • Fragmentation and degradation of wildlife and fish habitats. • Creation of habitats for animal disease reservoirs and vectors. • Increase in poaching due to migration and non-resident workers. 	<ul style="list-style-type: none"> • Do not carry out works in wildlife reproduction areas during reproduction periods. • Preserve migration corridors for wild and domestic animals. • Avoid selecting any site sheltering endangered species. • Control vectors and hosts using bio-environmental management techniques. • Control illegal hunting and fishing in the project area, particularly by non-resident workers.
Natural and cultural heritage	<ul style="list-style-type: none"> • Loss of cultural, religious and historical heritage as well as aesthetic resources. • Breach in agreements with traditional authorities concerning cultural, religious, historical and aesthetic sites and resources. 	<ul style="list-style-type: none"> • Early in the project planning process, carry out an archaeological search in the areas containing artefacts and preserve discovered artefacts. • During construction, ensure an archaeological surveillance in the potential areas containing artefacts and in case of a discovery, advise the concerned authorities. • Negotiate with and involve traditional authorities in the preservation and monitoring of important cultural, religious, historical and aesthetic sites and resources during planning and construction activities, as well as in the arrangements for potential compensation for the communities.

4.3 Population

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Demographic trends	<ul style="list-style-type: none"> • Population growth encouraged by irrigation scheme allocation criteria favouring large families. • Increase in the population due to migrants attracted by new economic opportunities. • Increased population density, which can generate health problems and social conflicts (disobedience). • Increased ethnic diversity after migration. • Temporary imbalance between men and women due to male workers and migrants, which can lead to an increase in sexually transmitted diseases. 	<ul style="list-style-type: none"> • Establish allocation criteria for irrigation schemes that are not based on family size. • Plan human settlements in order to prevent promiscuity among new settlers and between migrants and the local population. • Work closely with host communities to facilitate the integration and acceptance of migrants. • Establish labour camps at a reasonable distance from villages. • Whenever possible, employ women or married men with nearby families. • Assist non-resident workers and migrants in order to encourage their families to rapidly join them.
Migration and resettlement	<ul style="list-style-type: none"> • Migrants living in better conditions and with equivalent or increased incomes. • Decreased standard of living for involuntarily displaced people. • Inappropriate living conditions for non-resident workers and their families. • Constraints in adjusting to resettlement and changes in productive activities. • Population pressure due to the arrival of migrants attracted by new economic opportunities. • Unplanned human settlements. 	<ul style="list-style-type: none"> • Provide equivalent or better housing and accompanying facilities to involuntarily displaced people in accordance with consultation results, prior to taking possession of their land. • Provide adequate settlement areas with appropriate housing and services (water and sanitation) to non-resident workers and their family. • Provide temporary food supply to migrants and involuntary displaced people (men and women). • Provide complementary training /support to men and women to facilitate adjustment during the transition period. • In accordance with the priorities of displaced men and women, ensure appropriate funding for resettlement and productive land compensations to owners and those occupying/cultivating the land. —Plan adequate settlement areas with appropriate housing and services (water and sanitation) for migrants (fishermen, traders, seasonal workers, etc.). —Establish controls in order to avoid unorganized settlements.
Natural	<ul style="list-style-type: none"> • Increased access to productive land for 	<ul style="list-style-type: none"> • Take into account the various land uses while designing irrigation

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
resources and land management	<p>beneficiaries of irrigated schemes.</p> <ul style="list-style-type: none"> • Satisfaction of water needs for agriculture. • Increased opportunities for high value crop productions with access to irrigated water. • Change in land and natural resources uses. • Perturbation of traditional agriculture, including flood recession agriculture. • Increase in land values and price due to irrigation water. • Restriction for livestock grazing. • Conflicts on water access and rights. • Pressure on natural resources due to migration. 	<p>schemes.</p> <ul style="list-style-type: none"> • Coordinate project work with other land users (men and women). • Provide access to productive land to men and women losing productive means (owners and people cultivating the land) and make arrangement to prevent food insecurity. • Offer alternative income opportunities to men and women deprived from land to practice traditional agriculture. • Plan corridors for migrating livestock. • Develop alternative grazing areas to compensate for those lost. • Plan to maintain annual floods to continue flood recession agriculture, while preventing flood damages (warnings and barriers). • Integrate irrigation schemes and traditional agricultural land into local development plans. • Create a water user organisation, involving men and women, to effectively manage water resources and ensure an equitable access among users (men and women).
Quality of life	<ul style="list-style-type: none"> • Improvement in quality of life due to new economic opportunities and adequate compensations for losses. • Degradation of the quality of life due to nuisances such as noise, dust and traffic related to construction works. • Degradation of the landscape by land clearing, construction works, new infrastructures, etc. • Social conflicts due to the venue of non-resident workers and migrants (divorces, ethnic tension, etc.). 	<ul style="list-style-type: none"> • Establish a formal consultation mechanism with local authorities to discuss issues disturbing inhabitants and to find solutions satisfying all stakeholders. • Train users (men and women) in the field of environmental protection. • Inform in advance men and women on project activities, potential nuisances and means to reduce perturbations. • Implement a communication plan to inform the local populations on work to come and opportunities for them. • Involve local authorities in monitoring implementation activities and compensation agreements, ensuring a good representation of men and women.

4.4 Health Outcomes

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Communicable diseases	<p>Changes in exposure to:</p> <p>Water borne diseases e.g.: diarrhoea and cholera associated with poor sanitary conditions and misuse of irrigation water for domestic purposes, leptospirosis associated with rodent urine.</p> <p>Water related diseases e.g.: malaria, onchocerciasis, filariasis associated with increases in vector breeding and contact.</p> <p>Water contact diseases e.g.: schistosomiasis and swimmer's itch associated with domestic and occupational behaviour.</p> <p>Water washed diseases e.g.: scabies and skin infections associated with poor sanitary and hygienic conditions.</p> <p>Sexually transmitted infections: e.g. HIV/AIDS associated with migration, construction, economic change.</p> <p>Zoonoses associated with project location e.g.: trypanosomiasis.</p> <p>Respiratory infections e.g.: TB associated with crowding.</p>	<p>Appropriate domestic water supply to address additional needs.</p> <p>Facilitate the implementation of appropriate latrines and other sanitation facilities.</p> <p>Information, education and communication about safe uses of irrigation water and occupational safety.</p> <p>Environmental management for vector control; contact avoidance via settlement location and design and use of bednets and repellents; focal insecticide and molluscicide application.</p> <p>Strengthen medical services to ensure rapid diagnosis and treatment.</p> <p>Ensure safe food storage and handling.</p> <p>Support implementation of HIV/AIDS prophylaxis for men and women through appropriate health promotion as well as wide distribution and use of condoms; employment opportunities for project-affected women; provision of family accommodation for construction workers.</p> <p>Project settlement housing designed to avoid crowding, and provide ventilated kitchens and efficient stoves.</p> <p>Refer to measures proposed under Environment and Poverty crosscutting themes as they address many health determinants of communicable diseases.</p>
Non-communicable diseases	<p>Poisoning associated with excessive mineralization of irrigation water.</p>	<p>Strengthen medical services to ensure rapid diagnosis and treatment.</p> <p>Monitor water quality to detect excessive mineralization.</p>
Malnutrition	<p>Increased and diversified food supply all year long fulfilling basic local needs.</p> <p>Deterioration in nutritional status due to reduction in the production of subsistence crops.</p>	<p>Ensure that part of the crop production (from irrigated and traditional agricultural land) is directed to local markets to maintain or increase food supply.</p> <p>Plan for complementary food supply during the transition period when subsistence food supply may decrease.</p>

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
		Strengthen medical services to ensure suitable support and advices on healthy and balanced nutritional practices.
Injuries	<p>Increased risk of injuries for the local population due to working sites and increased traffic.</p> <p>Appearance of or increase in domestic and communal violence, for example resulting from water disputes.</p> <p>Increased risk of drowning.</p> <p>Occupational injuries due to a lack of attention to safety at work.</p>	<p>Develop, communicate and implement safety and preventive measures for the population (such as traffic calming devices).</p> <p>Control access to working sites.</p> <p>Install and maintain appropriate signs.</p> <p>Plan stabilisation and evacuation of injured.</p> <p>Prevent communal and domestic violence through awareness and through resolution of water disputes.</p> <p>Plan lifesaving equipment and measures.</p> <p>Develop, communicate and implement safety and preventive measures for construction workers and irrigation system workers (men and women).</p> <p>Plan equipment for moving heavy loads such as donkey carts and ergonomic equipment for men and women.</p>
Psychosocial disorders and well-being	<p>Well-being associated with improved income, stability, work opportunities, settlements, health, empowerment, education and training.</p> <p>Stress and anxiety associated with involuntary resettlement, rapid social change, loss of traditional authority, loss of spiritual assets, uncertainty and locus of control, severance, exclusion, and marginalisation, gender related problems and domestic disputes leading to suicide, physical and mental abuse, child marriage, labour and sale, and communal violence.</p>	Refer to measures proposed under other crosscutting themes as those address many causes of psychosocial disorders and factors contributing to well-being.

4.5 Gender

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Division of labour (paid or unpaid work)	<ul style="list-style-type: none"> • Reduction in time allocated to crop production water supply. • Increased time allocated to drinking water supply by women and children, when irrigation water demand reduces total water supply. • Increase in women's workload, as her reproductive work is not reduced. 	<ul style="list-style-type: none"> • Promote women and children with means to reduce the efforts required for water transportation (donkey, cart, etc.). • Plan for the expansion of drinking water supply sources and for their location close to human settlements while planning an irrigation project. • Plan support initiatives to reduce women's reproductive workload.
Income-generating activities (money or kind)	<ul style="list-style-type: none"> • Local jobs obtained by women during construction or operation phases. • Opportunities to increase income and diversify revenue sources through induced development. • Women not compensated for the loss of land used for traditional cropping. • Limited participation of women in project benefits due to cultural barriers. 	<ul style="list-style-type: none"> • Ensure that women are directly paid for their work, avoiding intermediaries. • Ensure that not only land owners but also women and men occupying / cultivating the land are compensated for the losses related to the project. • Ensure that project promoters do not reinforce cultural barriers affecting negatively women • Consider targeting women beneficiaries when inequities exist and persist.
Access to and control over productive factors	<ul style="list-style-type: none"> • Increased control of women over irrigation water management. • Limited access of women to irrigation schemes. • Water supply options do not respond to women priority needs. 	<ul style="list-style-type: none"> • Establish, and change if required, the allocation criteria to ensure women's access and control over irrigation schemes. • Ensure that project promoters consult women, in particular for planning water supply.
Involvement in societal organisation	<ul style="list-style-type: none"> • Involvement of women in decision making related to irrigation water and irrigation systems management. • Women get organised to obtain training and/ or support in irrigation systems and water management adapted to their specific needs. 	<ul style="list-style-type: none"> • Ensure that women and their organisations get involved and participate in the various phases of the project planning process. • Facilitate the creation of women groups when women express an interest in being better organised and represented. • Ensure that women are involved in irrigation user organisations as members and producers on irrigation schemes. If cultural barriers do not allow mixed structures, develop independent structures for women.

4.6 Participation

Component	Potential Beneficial and Adverse Impacts	Enhancement and Mitigation Measures
Consultations	<ul style="list-style-type: none"> • Integration of men's and women's concerns into the project design. • Increased support for the project among affected populations. • Exclusion of specific groups from consultations, particularly women. • Irrigation water fees determined without consultations. 	<ul style="list-style-type: none"> • Consult affected men and women at all phases of the project, including for determining irrigation water user fees. • Provide the opportunity to all affected groups, men and women, to participate in consultations by offering adapted consultation mechanisms. • Use consultations to identify traditional patterns of right and responsibilities concerning the water management and to determine ways to increase the involvement of excluded groups (men and women). • Inform consulted men and women on how their concerns were taken into account.
Civil society strengthening	<ul style="list-style-type: none"> • Creation of new user groups and organisations to manage irrigation water. • Participation of the community, men and women, in the development of irrigation schemes. • Loss of power for traditional leaders. • Lack of collaboration between new and existing organisations working on water conservation issues. 	<ul style="list-style-type: none"> • Ensure that men and women have the opportunity to organise themselves in groups representing their interests. • Establish a consultation mechanism with traditional authorities to ensure that their views are considered during the planning and implementation phases. • Transfer to user organisations the maintenance of irrigation systems, including user fees collection and allocation. • Facilitate the participation of existing CSOs in the project taking into account their respective intervention priorities and strengths.

5. External Factors

The most important external factors that may jeopardise the outcomes of an irrigation project are:

- **Pollution from industrial, domestic and animal sources**

Industrial and domestic effluents, as well as pollution from animal production, can lead to the degradation of irrigation water quality. To minimise the risks of water pollution, it is recommended to adopt an integrated water resources management approach, taking into account the location of potential contamination sources while planning the irrigation project.

- **Flooding**

Although irrigation schemes are planned to control water inflow, flooding can still occur (e.g. exceptionally abundant rainfalls). Flooding damages irrigation systems and can cause injuries and drowning. To minimise the risk of flooding, the project shall plan and maintain adequate drainage and comply with recognised safety measures. Moreover, the establishment of an alert mechanism and emergency procedures permit to reduce damages when flooding occurs.

- **Social instability**

The emergence of community violence, vandalism, civil war, border raids and boundary disputes are phenomena that generate social instability, which can lead to migration, disruption of the food chain, injury, epidemics and mortality as well as environmental damages in areas where displaced people have settled. Poverty alleviation policies are means to prevent social instability.

- **Instability in the agricultural sector**

The profitability of irrigation schemes can be affected by agricultural prices

and markets instability. In fact, a fall in agricultural prices, a decrease in market demand or a failure in input procurement markets involves reduced agricultural revenues and consequently, a lack of interest in valorising irrigation schemes. To minimize this risk, crop production and market diversification as well as product transformation generating added value shall be encouraged.

6. Hazard Management

The main hazard associated with an irrigation project is the following:

- **Hazardous materials spills**, resulting in water and soil contamination, aquatic wildlife poisoning, health and water supply problems.

In order to prevent or minimise this hazard, appropriate risk management measures shall be designed and implemented.

7. Environmental Monitoring

The following table presents potential indicators that could be used to monitor the implementation of an irrigation project. The appropriate indicators for a specific project shall be selected according to the project context, major anticipated impacts and the cost of data collection and processing.

Component	Indicators
Environment	
Livelihood	<ul style="list-style-type: none"> Number of jobs created (directly and indirectly) and occupied by men and women. Level of satisfaction of adversely affected men and women toward compensations and offered alternatives (survey).
Information, education and communication	<ul style="list-style-type: none"> Acquired irrigation systems management skills by trained men and women.
Access to infrastructures and services	<ul style="list-style-type: none"> Volume of sedimentation in irrigation canals to evaluate soil degradation. Maintenance expenses on irrigation canals. Number of breakdowns of the irrigation systems. Number of water points as a function of the population. Number of domestic water supply breakdowns.
Environment	
Water	<ul style="list-style-type: none"> Groundwater static level and refilling capacity. Parameters of <i>WHO Guidelines for Drinking-water Quality</i> for evaluating the physico-chemical characteristics of underground and surface water quality (upstream, on the site and downstream). Coliforms and viable intestinal nematode eggs per litre for evaluating wastewater quality for irrigation purposes (<i>WHO Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture</i>). Quantity of water used compared to initial estimates.
Soils	<ul style="list-style-type: none"> Volume of sedimentation downstream of irrigated area. Changes in soil physical and chemical parameters (e.g.: pH, salinity, water retention, etc.).
Ecosystems	<ul style="list-style-type: none"> Surface of sensitive areas affected by the irrigation project.
Flora	<ul style="list-style-type: none"> Area covered by aquatic plants in canals. Biomass per inhabitant nearby the project area.
Natural and cultural heritage	<ul style="list-style-type: none"> Natural and cultural sites affected by the project.
Population	
Demographic trends	<ul style="list-style-type: none"> Population growth and ethnic composition.
Migration and resettlement	<ul style="list-style-type: none"> Type of house and accessible services to displaced men and women before and after project implementation. Integration level of migrants in host communities (survey). Number of informal settlements built by migrants.
Natural resources and land management	<ul style="list-style-type: none"> Subsistence production in calories per inhabitant. Presence of a water user organisation, including men and women. Revenues from irrigation water fee collection and allocation.
Quality of life	<ul style="list-style-type: none"> Level of satisfaction of displaced men and women (survey).
Health Outcomes	
Communicable diseases	<ul style="list-style-type: none"> Prevalence rates of diseases such as malaria, schistosomiasis, diarrhoea and HIV. Number of vector breeding sites and vector density.

Component	Indicators
	<ul style="list-style-type: none"> • Availability of condoms, impregnated bednets, mosquito repellents. • Outpatient attendance records. • Quantities of drug supplied and used from health services and local shops.
Non-communicable diseases	<ul style="list-style-type: none"> • Inventory of exposure sites including wastewater drainage. • Water quality analysis results.
Malnutrition	<ul style="list-style-type: none"> • Number of people affected by seasonal hunger (evolution over time). • Height/weight monitoring of children.
Injuries	<ul style="list-style-type: none"> • Number of violent events reported by the police and social services. • Construction site occupational health and safety records.
Gender	
Division of labour	<ul style="list-style-type: none"> • Time allocation of women before and after the irrigation project. • School attendance of girls and boys before and after the irrigation project. • Number of children working on a regular basis in irrigated schemes.
Income-generating activities	<ul style="list-style-type: none"> • Proportion of family income received and managed by men and women before and after the project.
Access to and control over productive factors	<ul style="list-style-type: none"> • Proportion of men and women being owners or tenants of irrigated schemes. • Level of satisfaction of women toward project investment decisions and management methods (survey).
Involvement in societal organisations	<ul style="list-style-type: none"> • Number of women and men involved in user organisations.
Participation	
Civil society strengthening	<ul style="list-style-type: none"> • Level of participation of user organisations in the water management decision-making processes.