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Guidelines on irrigation investment projects

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CONTENTS

FOREWORD

Significant and responsible public and private investments in irrigation are vital for delivering on the 2030 Agenda – from reducing poverty, improving food and nutrition security and boosting agricultural production, to strengthening rural livelihoods and managing land and water resources sustainably. Development of the irrigation sector faces multiple challenges, including water scarcity and degradation, competition over shared resources, agricultural transformation and the impact of climate change. Business as usual is not an option. Investments in irrigation innovations that promote productive, equitable and sustainable water use are urgently needed in order to provide more reliable, flexible and diversified water services for agriculture and rural development.

The Food and Agriculture Organization of the United Nations (FAO) is the custodian agency of 21 of the Sustainable Development Goal (SDG) indicators under the Agenda. FAO's Strategic Programme to make agriculture, forestry and fisheries more productive and sustainable underscores the importance of an integrated approach for efficient use of natural resources, including water resources. The Organization's Land and Water Division promotes innovative approaches and best practices for managing water for agriculture, while FAO regional offices in the Near East and North Africa and Asia and the Pacific are leading initiatives that address water scarcity. FAO's Investment Centre continues to support countries to make more and better investments in food security, nutrition, agriculture and rural development to improve rural livelihoods, raise incomes and safeguard the natural environment. These are just some of the ways FAO has aligned its work to contribute to achieving the SDGs.

These *Guidelines* are the product of a collaborative, multidisciplinary team, with contributions from various FAO technical units and decentralized offices as well as external partners, including the International Fund for Agricultural Development, the European Investment Bank, the International Commission on Irrigation and Drainage and the World Bank. They complement the existing FAO *Guidelines for planning irrigation and drainage investment projects*, published in 1996, by providing updated technical references and guidance on how to apply the innovative approaches and practices at each stage of the irrigation investment project cycle. It is our sincere hope that these *Guidelines*, which add to a growing body of knowledge on irrigation investment support, provide a useful reference to national and international professionals involved in irrigation investment operations.

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ACRONYMS AND ABBREVIATIONS

AAA	Analytical and Advisory Assistance
ADB	Asian Development Bank
AfDB	African Development Bank
AWM	agricultural water management
BDA	bilateral development agency
BoQ	bill of quantity
CBA	cost-benefit analysis
CDD	community-driven development
CFS	Committee on World Food Security
CRisTAL	Community-based Risk Screening Tool – Adaptation and Livelihoods
DA	development agency
EFA	economic and financial analysis
EIB	European Investment Bank
EIRR	economic internal rate of return
ET	evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
GEO	global environment objective
GHG	greenhouse gas
GIS	geographic information system
GWP	Global Water Partnership
IBRD	International Bank for Reconstruction and Development
ICID	International Commission on Irrigation and Drainage
ICR	implementation completion and results
ICT	information and communication technology
IDA	International Development Association
IFAD	International Fund for Agricultural Development
IFI	international financing institution
ISR	implementation status and results
IWMI	International Water Management Institute
IWRM	integrated water resources management
M&E	monitoring and evaluation
MASSCOTE	Mapping System and Services for Canal Operation Techniques
MIS	management information system
O&M	operation and maintenance
ORCHID	Opportunities and Risks of Climate Change and Disasters
PAD	project appraisal document
PCN	project concept note
PDO	project development objective
PDR	project design report

PES	payment for environment service
PIM	participatory irrigation management
PLD	project legal document
PMU	project management unit
PPP	public-private partnership
PROCA	Participatory Rapid Opportunity and Constraint Analysis
PTR	project termination report
RAI	Principles for Responsible Investment in Agriculture and Food Systems
RAP	Rapid Appraisal Procedure
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goal
SHARP	Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists
SOM	service-oriented management
SWOT	strengths, weaknesses, opportunities and threats
TCI	Investment Centre Division, FAO
TCP	Technical Cooperation Programme
TTL	task team leader
UNEP	United Nations Environmental Programme
UNSD	United Nations Statistic Division
VGGT	Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fishery and Forests in the Context of National Food Security
WAA	water accounting and auditing
WAc	water accounting
WAu	water auditing
WHO	World Health Organization
WSA	water spread area
WSI	water-saving irrigation
WUA	water users' association
WUO	water users' organization

INTRODUCTION

I. Background and purpose

Irrigation has been much appreciated for its significant contribution to global agricultural production and food security over the past 50 years. Currently, more than 40 percent of global agricultural products are produced on irrigated land, which constitutes close to 20 percent of the total global arable land. However, irrigation has also been criticized for inefficient water use, poor system performance and some negative externalities, including irrigation-induced soil salinization, groundwater depletion, water-borne diseases and water pollution. To meet the requirements of the world population, which is projected to be more than 9 billion by 2050, food production needs to be increased by 70 percent globally and by 100 percent in developing countries, and irrigation is expected to be a major contributor (FAO, 2012a).

Further development and improvement of global irrigation will involve multiple challenges and emerging needs, including: (i) increasing water scarcity and competition, which calls for more efficient and productive water use; (ii) rapid agriculture restructuring and transformation, which requires more reliable, flexible and diversified agriculture water services; (iii) adoption of agribusiness and value chain approaches, which implies a shift from single-headed irrigation to integrated agricultural water management (AWM); (iv) the shift from the first generation "green revolution" to sustainable agriculture intensification, which highlights social and environmental sustainability; and (v) increasing pressure to meet growing demand for meat and dairy products linked to a combination of population growth, rising incomes and urbanization. In addition to all these, climate change has brought and will bring more impacts, requiring adoption of a climate-smart approach.

In view of the above, irrigation, as the biggest water user – accounting for 70 percent of global freshwater withdrawal – cannot repeat old modes of development. Innovations are needed to promote productive, equitable and sustainable water management while improving water services to agriculture and rural development. Numerous approaches and tools have been developed and practiced by various partners in recent years to improve irrigation practices, which could be further disseminated in future irrigation investments. Useful experiences and lessons have also been learned from irrigation investment operations in recent years, especially those of FAO Investment Centre Division (TCI) staff and consultants. These could also be summarized and documented to provide a reference for future irrigation investment operations.

The *Guidelines for Planning Irrigation and Drainage Investment Projects,* published by FAO TCI in 1996, have provided good guidance to TCI staff and consultants as well as other practitioners in irrigation investment planning for the past 20 years. However, they mainly cover the project identification and preparation phases and need to be extended to cover all phases of the project cycle. After 20 years of application, some of the contents in the *Guidelines* need to be updated in accordance with the latest developments in the irrigation sector and the recent insights gained from irrigation investment operations. Furthermore, the 1996 *Guidelines*, which specifically aimed to provide guidance to TCI work on World Bank-funded projects, could be further developed for broader application by various practitioners in diversified investment projects.

In this context, TCI led the formulation of the *Guidelines on irrigation investment projects* during 2014-2017, through the work of a joint team, including members from FAO, the World Bank, the International Fund for Agricultural Development (IFAD), the

International Commission on Irrigation and Drainage (ICID) and individual consultants. The new *Guidelines* were formulated based on evaluation of current trends and developments in the global irrigation sector and the experiences and lessons learned from recent irrigation investment operations. They complement the 1996 *Guidelines* in the following ways:

- The scope of the new *Guidelines* is extended. It covers all phases of the project cycle, from project identification to preparation, appraisal and negotiation, to implementation and evaluation, and includes step-by-step guidance for each phase.
- The contents of the new *Guidelines* are updated. They provide guidance on incorporating good innovations and lessons into each phase of the project cycle and available information sources. Specific innovations incorporated include: water governance and land tenure; water accounting and auditing; AWM under the framework of integrated water resources management (IWRM); irrigation modernization; evapotranspiration (ET)-based water-saving; advanced economic evaluation; principles for responsible investments; climate-smart approaches; and modern information and communication technology (ICT). Major operational experiences highlighted include: avoiding implementation issues through better project identification and preparation; conducting strict feasibility studies and economic and financial analyses (EFAs); applying a programmatic approach to enhance flexibility and relevance of project design; ensuring project readiness before commencing implementation; adopting a participatory approach from the outset; enhancing water measurement and water accounting (WAc); making better use of project restructuring; improving procurement management, capacity development and project monitoring and evaluation (M&E); and ensuring a proper exit strategy.
- The applicability of the new *Guidelines* is broadened. They take into account the requirements of various international financing institutions (IFIs) and development partners, have generalized the procedures and formats of project processing and are applicable to all types of irrigation investment projects funded by different funding sources.

The new *Guidelines* are a practical tool for guiding the procedures and processes of investment operations. They neither repeat the technical details of any particular irrigation innovation, nor substitute for any existing norm or manual for specific system design, construction, operation or management. They can be used by international and national professionals involved in irrigation investment projects, including staffs of IFIs, development assistant agencies, government departments and consulting firms, and freelance consultants. They can also be used as a reference by professionals of relevant research, education and extension institutes.

II. Structure of the guidelines

The *Guidelines* are structured into three major parts and seven annexes.

Part 1, Trends, Lessons and Issues, provides a brief introduction on sector development trends and multiple challenges faced, major lessons learned from recent investment operations and key issues to be addressed in future irrigation investments. It comprises three sections: 1.1 Trends in the irrigation sector; 1.2 Lessons learned from recent investment operations; and 1.3 Issues to be addressed.

Part 2, Processing Investment Projects, introduces the key steps and phases of a typical investment project cycle, elaborates irrigation-specific issues to be handled, suggests suitable innovations that could be incorporated at each step and phase and possible ways of incorporation, and provides sources of practical tools and information. It comprises five sections: 2.1 Project identification; 2.2 Project preparation; 2.3 Appraisal and negotiation; 2.4 Project implementation; and 2.5 M&E.

Part 3, Innovative Approaches and Tools, provides a brief introduction on selected innovative approaches and tools. It comprises seven sections: 3.1 Water governance; 3.2 Water accounting and auditing (WAA); 3.3 Irrigation modernization planning and design; 3.4 Agricultural water management investment planning; 3.5 ET-based water saving; 3.6 Advanced approaches and methods for economic evaluation; and 3.7 Adoption of the Committee on World Food Security's *Principles for Responsible Investment in Agriculture and Food Systems* (CFS-RAI) in irrigation projects.

The seven annexes comprise samples of project processing documents and templates and lists of practical tools and sources.

III. Key elements and typologies of irrigation schemes

A typical irrigation scheme normally comprises three key elements – engineering system, information and management system, and institutional system.

The engineering system normally comprises three major parts – a water source part, a water conveyance and delivery part, and a field irrigation and drainage part.

The water source part provides the source of irrigation water, which may include reservoir dams, ponds, weirs, diverting gates, surface water pumping stations, wells, tube-wells, pump sets and associated structures and facilities.

The water conveyance and delivery part supplies irrigation water from the source to irrigation blocks, which mainly include canals, pipelines, buffer storages and associated control structures and equipment.

The field irrigation and drainage part applies water to and drains water from the irrigation fields and mainly includes: (i) for irrigation – canals, pipelines, siphons, other water distribution and application facilities and associated structures; and (ii) for drainage – open canals, buried canals and pipes and associated structures.

The information and management system may include water and engineering monitoring and control facilities, data acquisition, transmission and processing facilities, information management and decision-making support systems.

Table 1. Typologies of irrigation schemes

Typology	Group
Engineering scale	• Large-scale systems • Medium-scale systems • Small-scale systems
Water source	• Surface water irrigation systems • Groundwater irrigation systems • Combined surface and groundwater irrigation systems
Technical model	• Surface irrigation systems, including furrow, border and basin irrigation systems • Sprinkler irrigation systems, including set systems and continuous move systems • Localized irrigation systems, including drip, spray and bubbler irrigation systems • Subsurface irrigation systems, which rely on the raising or lowering of the water table in order to effect groundwater flow to the root zone
Energy use	• Gravity (from diversion weirs, reservoir dams, falls capture) systems • Pumping (electricity, fuel, solar pumping from rivers, ponds, wells and tube-wells) systems • Combined gravity and pumping irrigation systems
Water control level	• Full irrigation systems, with adequate water control/regulating capacity, which can meet the crop water requirements in respective command area • Partial/supplementary irrigation systems, without adequate water control/regulating capacity, which can only meet part of the crop water requirements in respective command area, including spate and tidal irrigation systems
Ownership nature	• Publicly owned irrigation systems • Privately owned irrigation systems • Public-private jointly owned irrigation systems

Source: Authors.

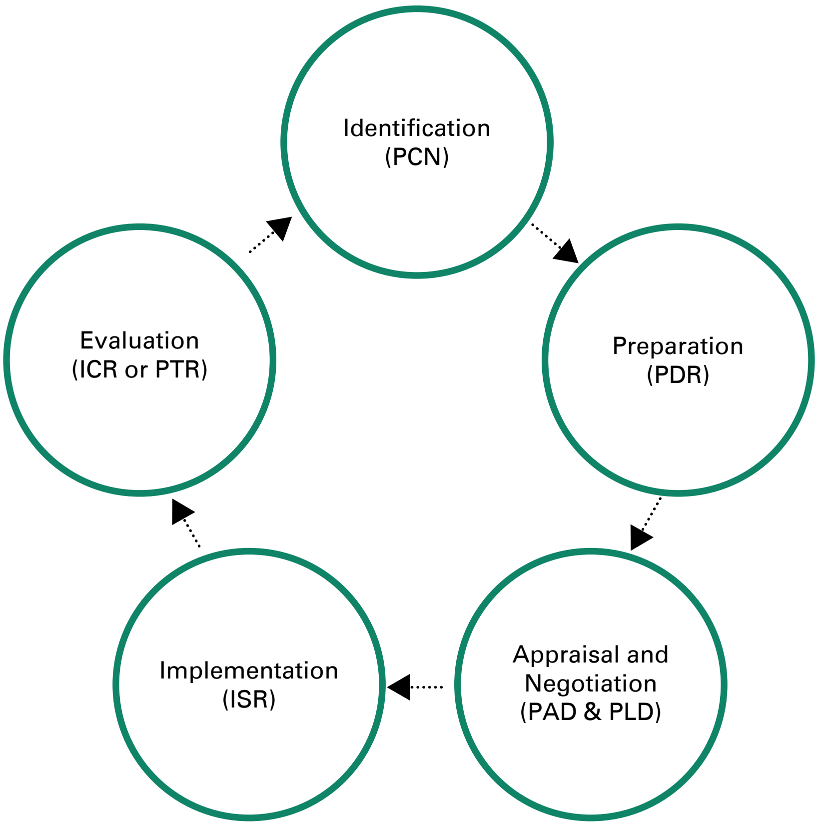
The institutional system may include governing bodies and operation and maintenance (O&M) institutions/teams. The governing bodies may comprise representatives of various stakeholders, including government departments, O&M institutions/teams and irrigation farmers, and are normally responsible for decision-making in system O&M. Typical governing bodies include irrigation committees, irrigation associations and water users' associations (WUAs). The O&M institutions/teams may be: professional agencies formed by government departments or hired by governing bodies to carry out O&M tasks, mainly for large or medium-scale systems; professional teams hired by governing bodies to carry out O&M tasks, mainly for medium or small-scale systems; or non-professional teams or groups formed/mobilized by governing bodies to carry out O&M tasks, mainly for small-scale systems.

Table 1 summarizes different typologies of irrigation schemes based on their scale, water sources, technical models, energy use, water control level and nature of ownership.

IV. The project cycle

The phases of the project processing cycle may vary with different IFIs and types of projects. The *Guidelines* adopt a generalized cycle consisting of five phases. Specific phases and major outcomes from each phase are illustrated in Figure 1.

Figure 1. The project cycle



Key reports during the project cycle:

PCN	Project Concept Note
PDR	Project Design Report
PAD and PLD	Project Appraisal Document and Project Legal Document
ISR	Implementation Status Results Report
ICR or PTR	Implementation Completion Report or Project Termination Report

Source: Authors.

Phase 1: Identification. The IFI and client jointly identify project rationale, scope, development objective, structure and outcomes, and prepare and agree on the project concept note (PCN), under the framework of relevant IFI and client strategies.

Phase 2: Preparation. The client conducts studies and investigations and prepares a project design report (PDR) based on the agreed concept note and all stakeholders' views and expectations. The IFI may provide needed policy, technical and/or financial assistance.

Phase 3: Appraisal and negotiation. The IFI assesses the economic, technical, institutional, financial, environmental and social aspects of the project, and prepares a project appraisal document (PAD) and a project legal document (PLD). The IFI and the client prepare, negotiate, agree on and approve the project and funding agreements, as well as implementation arrangements.

Phase 4: Implementation. The client implements the project. In addition to project financing, the IFI provides needed implementation support to ensure the compliance of project implementation with relevant donor and client policies and procedures, as well as investment efficiency and effectiveness. Implementation progress and achievements are regularly monitored and documented in ISR reports.

Phase 5: Evaluation. The IFI and client jointly organize self- and third-party evaluation of the project preparation and implementation. A project ICR report or project termination report (PTR) will be prepared to evaluate the performance of both the IFI and the client.

PART 1 TRENDS, LESSONS AND ISSUES

1.1 Trends in the irrigation sector

1.1.1 Status and further needs

Irrigation has played a very important role in increasing global agricultural production and improving global food security in the past decades. From 1961 to 2009, the global area equipped for irrigation increased by 117 percent. Currently, more than 40 percent of global agricultural products are produced on irrigated land, which is less than 20 percent of global arable land area (FAO, 2012a). In the meantime, irrigation has also been criticized for inefficient water use, poor system performance and some negative externalities, including irrigation-induced soil salinization, groundwater depletion, water-borne diseases and water pollution.

To meet the requirements of a growing global population, which is projected to reach more than 9 billion by 2050, food production needs to be increased by 70 percent globally and by 100 percent in developing countries. About 91 percent of the global production increase and 79 percent of the production increase in developing countries would have to come from increases in yields and cropping intensity on currently cultivated land. Irrigation is expected to play an increasingly strategic role in reaching the targets. By 2050, the global irrigation area needs to be increased by 6 percent, while the global irrigated cropping area needs to be increased by 17 percent (FAO, 2012a).

1.1.2 Challenges faced

Further development of the global irrigation sector must contend with the following challenges:

Water scarcity and competition. Global social and economic development in recent decades has brought a steady increase in water demand. Water scarcity has occurred in many countries and regions, and water competition among various users and uses is spreading. Currently, irrigation is the biggest water user in the world, accounting for 70 percent of global annual freshwater withdrawal. With current water use patterns and water productivity, the water demand for producing the required food amount by 2050 will increase by 70 to 90 percent, which is far beyond the level of water availability by that time. Under a sustainable development scenario, FAO estimates that the increase of global annual irrigation water withdrawal will have to be limited to 10 percent (FAO, 2012a). Irrigation is requested to produce more "crops" with less "drops" in the coming decades.

Economy and agriculture transformation. Globalization and urbanization in the past decades were accompanied by economic transformation and demographic change, especially in developing countries and transitional economies. Agricultural systems are shifting from traditional subsistence farming to more diversified and commercialized systems linked with agribusinesses and value chains. These require more reliable, flexible and diversified water services, along with innovative institutional and financing arrangements. Irrigation needs to be better integrated with agricultural development and broadened to include an AWM; however, many of the current irrigation systems are not keeping up with this transformation. Their deteriorated engineering systems, rigid operation strategies and outdated institutional arrangements need to be updated systematically to live up to their expectations.

Environmental degradation. Rapid environmental degradation, especially in rising economies, has caused global concern. The "Green Revolution" in the agriculture sector in recent decades is considered to be a major contributor to land and water degradation.

Irrigation is responsible for overuse and misuse of water resources, the spread of nonpoint source pollution, irrigation-induced soil salinization and groundwater depletion in some areas. More restrictive environmental regulations are being developed and applied by international communities and national governments. The global agriculture sector is now promoting a shift from the first generation of "Green Revolution" to sustainable agriculture intensification. Irrigation will also need to watch its environmental footprint more carefully.

Climate change impacts. The earth's climate is changing at an alarming rate, causing temperature rises and shifting precipitation patterns, resulting in more frequent and intensified extreme weather events. Water scarcity and flooding are further exacerbated, and crop water requirements may increase under these conditions. The current weather and hydrological conditions of existing irrigation and drainage systems are different from the ones that existed when the systems were developed. Existing irrigation and drainage systems will have to adjust their engineering facilities, technical approaches and management strategies to respond to these impacts effectively. Development of new irrigation and drainage systems will also need to adopt new design criteria that build on historical hydrological records but also take into consideration projected impacts of climate change (FAO, 2012b).

Investment limitation. In order to reach the targeted irrigation area by 2050, substantial investment is needed to cover about 172 million hectares of irrigation-equipped area each year, of which 90 percent is for rehabilitation or substitution and the balance for net expansion. Global irrigation investment peaked during the late 1970s and early 1980s. Since then, it declined until the mid-2000s. Water competition from other sectors along with low cost recovery from irrigation systems are considered to be the main reasons. After the last world food crisis during 2007-2008, there has been a return to irrigation investment, but the overall scale is still far below the demand. Irrigation will have to better justify its continuous use of public resources and diversify its funding sources for further improvement and development (FAO, 2009a).

1.1.3 Evolution and innovations

In response to the multiple challenges faced and emerging needs arising, the irrigation sector has been evolving. The following are some innovations that have been advocated and practiced in recent years:

Water governance and land tenure refer to the range of political, social, economic and administrative systems for water and land resources development and management, at different levels of society. They help irrigation investment operations in addressing issues such as conflicts of interest between stakeholders, equity of access to land and water resources and sustainability. Relevant concepts and options have been intensively discussed and well documented by international organizations and national governments, such as by the publication of *Global Water Partnership: Effective Water Governance* (GWP, 2003).

WAA refers to systematic studies on status and trends in water supply, demand, accessibility and use in specified domains. They provide a basis for bringing irrigation development under the framework of river basin IWRM in the context of water scarcity, competition, degradation and climate change. Relevant frameworks and tools have been developed and practiced by different partners, including the International Water Management Institute (IWMI), United Nations Statistic Division (UNSD) and United Nations Environmental Programme (UNEP) (FAO, 2017a).

Water-saving irrigation (WSI) aims to improve irrigation water use efficiency and productivity. Early efforts in WSI focused on reducing water losses through seepage and runoff, which resulted in bias in canal lining under many irrigation projects. As part of the seepage and runoff water might be used by downstream users and local ecosystems, they are not real "losses" from the point of view of basin-wide water management. The latest initiatives have focused on managing total ET from the irrigated agriculture area, which imply changes in engineering and technical and managerial options for water saving. The World Bank has been piloting and disseminating these options in China since the mid-2000s.

Irrigation modernization refers to technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes with the objective to improve resources utilization (labour, water, economics, environmental) and water service for farmers. It has been advocated for more than ten years. A series of tools, publications and training modules have been developed, such as the FAO MASSCOTE (Mapping System and Services for Canal Operation Techniques) series (FAO, 2007a), which are especially relevant to modernization planning of large and medium-scale irrigation systems. The World Bank, in cooperation with national governments, implemented a number of projects piloted in Asia and the Near East regions.

Multiple use of water systems aims at maximizing the benefits of water systems through diversified services, including irrigation and drainage, fishery and aquaculture, hydropower generation, navigation and culture and ecosystem conservation. Multiple use is a common characteristic of irrigation systems worldwide; more than 90 percent of them are performing multiple functions, either by design or by nature. Recognizing this characteristic and better addressing it in future investment will help to better explore and realize the potential of multiple benefits. The international community has been cooperating on this topic since the Fifth World Water Forum in 2008. FAO developed a specific framework for promoting multiple use of irrigation systems and carried out a number of case studies (FAO, 2013a).

AWM aims at providing comprehensive and diversified water services to agriculture and rural development. Driven by rapid transformation of agriculture and the economy, as well as development of agribusiness and value chains, irrigation has been evolving to a more comprehensive AWM approach. Water system design, investment standards and institutional and financing arrangements are also becoming more flexible and diversified, to respond to the specific models and demands of agribusiness development. Relevant planning and implementation approaches and frameworks have been developed and practiced, including the Water Investment Planning through Livelihood Mapping, developed by FAO in cooperation with IFAD during 2010-2014, and piloted in a number of countries in Africa and Asia (FAO, 2008).

Water-energy-food nexus assessment aims at assessing the interdependences among water, energy and food and to inform nexus-related responses in terms of strategies, policy measures, planning and institutional setup or interventions, such as how to address the competition between bio-energy development and food production for land and water resources use. FAO recently developed a quick appraisal tool, which can be used to assess the interactions among water, energy and food systems in a given context and evaluate the performance of a technical or policy intervention in this given context. Several case studies have been carried out using this tool (FAO, 2014a).

Climate-smart agriculture aims at sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change and reducing and/or removing greenhouse gas (GHG) emissions, where possible. Irrigation is expected to upgrade its water services under changed conditions, build resilience of agricultural systems to drought and flood risks and manage its own carbon footprints through improved water management in paddy irrigation, reduced fertilizer and pesticide losses in irrigated areas and optimized use of energy and industrial products. Numerous initiatives have taken place at different levels and in different regions, and documented in publications such as the *Climate-smart Agriculture Sourcebook* published by FAO (FAO, 2017b).

Participatory irrigation management (PIM) aims at sufficiently involving various stakeholders, especially beneficiary farmers, in O&M of irrigation systems to ensure sustainability. PIM has been advocated for several decades and has been evolving over time. While the early efforts were mainly initiated by government departments to transfer or decentralize management responsibilities of existing public systems, recent developments have extended stakeholders' participation in the entire process of planning, design, construction, operation and management of all irrigation systems. Negotiation on irrigation service agreements and establishment of functional O&M institutions are key in this process, enabling service-oriented irrigation development and management based on local needs and conditions.

Public-Private Partnership (PPP) aims at encouraging private sector participation in financing irrigation development and management, corresponding to the benefits they receive, to diversify financing sources, collaborate with public efforts and speed up sector development. Traditionally, beneficiary farmers have contributed to public systems worldwide, mainly in the form of in-kind contributions and water tariffs, although the issue of water tariff standards has yet to be well addressed. With the development of agribusinesses, value chains and commercialized agriculture systems in developing counties and transitional economies, good opportunities emerged for new PPP models. National governments and donor agencies have been piloting these in recent years, and outcomes so far have shown that they have worked under certain conditions.

Modern ICT have been developing quickly and provide a good basis for informed decision-making and smart water management. These include remote sensing, telemetry, geographic information systems (GIS), Google Earth, Internet and mass media technologies. Many ICT-based systems and tools have been developed and applied in the water and irrigation sector, including various hydrological models for WAA, ET monitoring systems for ET-based water management, Supervisory Control and Data Acquisition (SCADA) systems for irrigation modernization, and digital and mobile information systems for water information services, early warning and extension.

Responsible investment aims at contributing to food security and nutrition, thus supporting the progressive realization of the right to adequate food in the context of national food security. The CFS-RAI was endorsed by the Committee on World Food Security (CFS) in 2014 (CFS, 2014). The ten principles cover the elements of food security and nutrition, tenure rights, transparency and accountability, consultation and participation, rules of law, social and environmental sustainability, gender equity, empowerment of women and youth, and cultural heritage. They are the guiding principles for all types of investment in agricultural value chains and food systems, including investment in irrigation and drainage.

1.2 Lessons learned from recent investment operations

These can be grouped into lessons learned from project identification and preparation, implementation, and M&E.

1.2.1 Lessons on project identification and preparation

Adopting good innovations requires special efforts. A number of issues constrained the adoption of innovations, including technical complexity, limited awareness and capacity among local partners and delivery pressure faced by the project teams; however, technical dissemination and good lobbying during project identification and preparation can normally increase the chances of adoption.

Integrated options can better realize investment benefits; however, segmented management often hampered proper integration of irrigation with agricultural and value chain options, especially when irrigation and agriculture sectors were managed by different agencies. Stakeholders' consultation and inter-departmental cooperation may enable opportunities for joint planning and implementation.

Investment without proper WAc can be very risky. This practice has caused overuse or misuse of water resources and unsecured water supplies under many irrigation investment operations. Irrigation water demands need to be integrated into and verified through IWRM planning at river basin or watershed level, through proper WAc. This also applies to small systems, as a large number of small systems can aggregate major impacts.

Participatory process needs to start from the beginning. Very often, PIM interventions, especially establishing and strengthening water users' organizations (WUOs), only start after commencement or even completion of construction. These need to start from the beginning, to enable participatory discussions on agribusiness models, irrigation demand, service agreements and beneficiaries' responsibilities, and to inform irrigation system planning, design, construction and O&M.

Some common issues have yet to be addressed in climate change mainstreaming. These include: limited knowledge of local technicians on climate change adaptation and mitigation; insufficient data and information on climate change and its local impacts; uncertainty about climate change trends and induced vulnerability; and lack of inclusion of climate change considerations in prevailing technical guidelines and norms, which are mainly based on historical weather and hydrological records.

EFA needs to be strengthened. Currently, EFA only comes in during project preparation and so cannot inform project identification. The EFA results of many irrigation projects tend to be overly optimistic. In the meantime, positive and negative externalities of irrigation investments are not sufficiently included, due either to difficulty in identifying or quantifying them, or to limitations of available EFA models. It would be helpful to advance EFA in project identification, improve EFA application in project design and create relevant EFA models.

Capacity development could be done in a more effective way. Current capacity development interventions for many projects tend to be fragmented, characterized by a large number of brief training workshops. It could be more effective to design and implement well-structured capacity development activities, based on needs assessment, following a cascade approach and with a good balance between training of trainers, upscaled training and general dissemination.

Smallholder farmers deserve more attention. More than 90 percent of the world's farmers are cultivating less than 2 hectares. They produce more than 80 percent of the global food value and play a key role in meeting the increased demand for agricultural products. Special efforts are needed to respect their land tenure and water rights, secure their participation in decision-making and O&M and design simplified, low-cost but technically and economically sound small systems tailored to their special needs.

Irrigation provides good opportunities for social inclusion. Irrigation systems, as the collective systems in rural areas, link men and women, the poor and the rich alike. Experience from many irrigation projects shows that carefully designed and implemented social consultation and development activities can normally help to enhance gender balance, social inclusion and harmonization.

Many issues encountered in implementation are rooted in preparation. These include: (i) insufficient technical preparation, such as feasibility studies, engineering design, cost estimation or tendering documents; (ii) lack of essential training on important technical topics, procurement and financial management procedures, safeguard policies or project M&E; (iii) failure to identify SMART (specific, measurable, attributable, realistic and time-bound) indicators or targets; (iv) lack of proper exit strategy, especially institutional arrangement, financing mechanism or water pricing policy for sustainable O&M; (v) unrealistic implementation plan or time schedule; (vi) insufficient budget allocation for technical supervision; (vii) outstanding safeguard issues, such as land acquisition and compensation; and (viii) lack of proper M&E facilities or arrangements.

1.2.2 Lessons on project implementation

Significant turnover of project staff affects implementation. A project cycle may last multiple years, and the project team may change during the process. When preparation and implementation are done by different teams, this often makes it difficult to correctly translate the project concept and design into implementation. Major turnover of project staff during implementation also affects project progress.

Limitation of technical capacity is a common issue. Projects dealing with large and medium-scale irrigation systems often have difficulty finding qualified technical persons for implementation support due to unavailability of expertise, while projects dealing with small-scale irrigation systems often face limitations in expertise due to budget limitations.

Project restructuring could play a better role. Timely and proper project restructuring helps to maintain investment responsiveness and relevance, especially the response to changes in land and water availability, irrigation requirements, project scope, targets and costs. Project inception is the first change; however, many project teams tend to be reluctant to process any restructuring until after the mid-term review.

Procurement and financial management are often bottlenecks. For projects funded by the IFIs, it takes time for the project teams to learn and familiarize themselves with these procedures, as IFIs apply their own procurement and financial management procedures, which frequently hamper project progress and delivery rate.

Tendering and contract management deserve more attention. Irrigation projects normally involve civil construction and equipment procurement. Tendering and contract management comprise a major part of project implementation. Poor performance in tendering processing and contract management often leads to corruption, poor construction quality, overspending or delays in progress.

1.2.3 Lessons on project M&E

Proper M&E systems need to be in place. This observation is based on the fact that many projects did not identify sufficiently SMART monitoring indicators or targets, or provide sufficient training on M&E.

This caused confusion or bias in project monitoring and reporting, often focusing too much on progress monitoring, and overlooking M&E of project outcomes and achievements.

Qualified M&E teams need to be mobilized in a timely manner. Delayed deployment of M&E teams has been observed in many projects. Some projects only deployed the M&E team when they reached the mid-term review stage. Some M&E personnel were not properly qualified, which affected M&E quality. Some projects did not extend the third-party M&E consultancy contract when the project duration was extended, which created gaps in project M&E.

Field monitoring facilities need to be made available. Water measurement equipment and structures are often needed for monitoring and evaluating water flow, level and amount, irrigation efficiency and water productivity. Such facilities were often not sufficiently included in the relevant engineering design or financial and procurement plan, making field monitoring difficult.

Baseline surveys need to be done properly. Ideally, the baseline survey should be carried out during project preparation or at the beginning of project implementation. Unfortunately, many irrigation projects failed to do so. Baseline surveys were done retroactively, which caused difficulties in project evaluation.

Impact evaluation and EFA need to be improved. In addition to the issues related to EFA, attention also needs to be paid to proper assessment of the positive and negative externalities of irrigation investments on the aspects of rural livelihoods, social and economic development and ecosystem conservation. This would facilitate a good mechanism for encouraging multiple functioning of irrigation systems, and also measuring and managing their negative impacts or risks.

1.3 Issues to be addressed

Taking into consideration the lessons learned from recent investment operations, the following issues need to be properly addressed to make future irrigation investments more relevant, efficient and sustainable:

Innovation of investment strategies and policies, to make future irrigation investments more responsive to the multiple challenges and emerging needs faced in the irrigation sector, create more encouraging and favourable policy environments and mobilize more diversified and sufficient funding sources.

Development and dissemination of technical approaches and tools, to meet the requirements of future irrigation investment operations, especially in land and water governance, water measurement and accounting, climate change screening and mainstreaming, ET-based water saving and irrigation modernization, multiple water uses and integrated AWM, PIM, ICT and sustainable O&M.

Improvement of investment processing, to enhance the technical quality of investment projects by properly incorporating innovative approaches and up-to-date technologies, and to address the common operational issues by taking lessons and experiences from recent investment operations. Part 2 of these *Guidelines* provides step-by-step guidance on how these will be processed within a specific project cycle.

PART 2 PROCESSING INVESTMENT PROJECTS

2.1 Project identification

2.1.1 Introduction

Tasks and teams. At the identification phase, IFIs and clients are expected to work together to conduct preliminary assessments, which include: reviewing the irrigation sector or system; analysing local development needs and constraints; discussing project proposal and objectives; examining alternative approaches or options; defining project scope and interventions; and identifying major issues to be addressed during project preparation and implementation. The ultimate outcome from the identification phase is the PCN. A joint IFI-government task team can be established to carry out the above-mentioned work, comprising members such as the IFI task team leader (TTL), the designated government counterpart, selected technical and operational experts, and representatives from government departments, beneficiary communities and other stakeholders.

Process and steps. Different IFIs and government departments may have different requirements on the project identification process and steps. In general, the eight-step process illustrated in Figure 2.1 can be applied to most of the irrigation and drainage investment projects, including steps on sector and system review, project scoping, preliminary water resources assessment, financing and implementation arrangements, risk assessment and mitigation measures, preliminary cost-benefit analysis (CBA), planning for project preparation, and preparation and processing of the PCN. Depending on the results from some specific steps, especially from preliminary water resources assessment and the CBA, iteration of steps may be needed in the process to ensure technical, economic, social and environmental feasibilities of the project proposal.

Issues to be addressed. The identification phase sets out the stage for project preparation and implementation. It is crucial to address all the conceptual issues at this stage. Many issues encountered in preparation and implementation are rooted in the identification phase; it is also important to address them properly. Major issues to be addressed during the identification phase include: rationale for project intervention; compliance of proposed project concept and approaches with relevant IFI and government strategies and priorities; clarification of client's commitment and ownership; feasibility of project development objectives (PDOs) and time frame; suitability of technical models and methods; appropriateness of financing instruments and models; sustainability of project investment; and balance between risks and results.

Innovations to be considered. Depending on specific project concept and scope, application of relevant innovative approaches and practices summarized in Part 1 and further described in Part 3 could be considered. For example, the AWM investment planning approach can be used for defining water service demand, financing model and O&M arrangements in the context of local value chain and agribusiness development. The WAA approach can be used for preliminary water resources assessment. The water governance and land tenure approaches can be used for proposing water management and land acquisition options. The irrigation modernization and ET-based water-saving approaches can be used for identifying comprehensive and systematic options for irrigation development and improvement. The advanced methods and approaches for economic evaluations can be referenced in the preliminary CBA. The responsible investment principles and PIM approaches can be used for identifying safeguard issues and proper options for social inclusion and gender balance. The climate-smart approach can be used for vulnerability assessment and proposing adaptation and mitigation options. The advanced ICTs can be used as tools for both investment interventions and project management.

The following sections of Part 2 describe in detail how the above-mentioned operational issues can be addressed, and the innovative approaches that can be incorporated at each step of the project identification phase.

It may not be feasible to go through all the listed analyses and studies for every investment project. Different projects may require different choices based on their budgets and time availability, and different focuses based on their scope and nature – i.e. whether an irrigation project, an irrigated agriculture project or an integrated agricultural water management project.

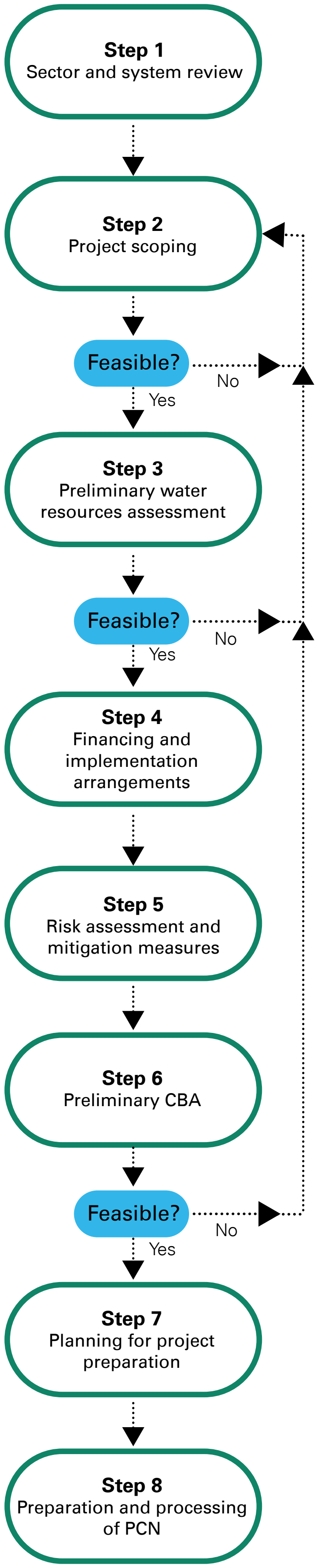
2.1.2 Step 1: Sector and system review

The identification phase normally starts with a sector and system review. Its major purpose is to review sector context, analyse development needs, assess irrigation and AWM system performance, identify constraints and gaps, verify development opportunities and justify the rationale for project intervention. Major activities to be carried out include: (i) sector context review; (ii) rapid system appraisal; and (iii) social and environmental assessment and institutional evaluation.

Sector context review analyses the market potential of irrigated agriculture products, value chain development needs, requirements for irrigation and AWM services, and relevant sector strategies, policies and initiatives, as shown in Box 2.1. Depending on project scope, the review may cover different levels, from national to river basin and local levels. Transboundary projects also need to take into consideration relevant transboundary strategies, policies and agreements.

The market, value chain and agribusiness analysis will help to identify local demands for irrigation and AWM services, and inform design of the project financing model and system O&M mechanism.
In cases where national, river basin or local master plans for water, irrigated agriculture or irrigation are available, these can be the primary sources for sector context review.

Figure 2.1. 8 steps of project identification



Source: Authors.

Box 2.1: Key issues to be considered for sector context review

- Nature and socio-economic background, and the role of irrigation and AWM
- Market potential and agribusiness models of local-advantage value chains, and their demands for irrigation and AWM services
- Status of irrigation and AWM sector, including physical scope, infrastructure condition, technical level and institutional settings
- Major constraints encountered and opportunities for further development
- Sector strategies, policies, priority programmes and initiatives

Source: Authors.

Box 2.2: Key issues to be considered for irrigation and AWM system appraisal

- Land and water availability, in terms of both quantity and quality
- Farming systems and cropping patterns and their linkage with irrigation and AWM systems
- Suitability of technical model and engineering design of irrigation and AWM systems
- Adequacy and suitability of drainage systems and structures
- Suitability of institutional setting, O&M mechanism and water pricing
- Technical capacity of local farmers, water users' groups and irrigation agencies
- Farmers' demands for irrigation services and willingness to pay for them

Source: Authors.

Supplementary analysis may still be needed to verify the information provided in existing literature and to update with the latest developments. If no relevant strategy or plan is available, the approach and format for an irrigation sector review provided in Annex 1 of the *Guidelines for Planning Irrigation and Drainage Investment Projects* (FAO, 1996a) could be applied. The review also needs to understand the strategies, policies and priorities of IFIs for irrigation and AWM to guide identification of project scope and interventions at the next step. Relevant information can often be found in country strategies and sector policy/programme papers of IFIs, such as the Country Partnership Strategy (CPS) of the World Bank and the Results-Based Country Strategic Opportunities Programme (RB-COSOP) of IFAD.

Irrigation and AWM system appraisal is intended to evaluate the performance of existing systems against their expectations. Key issues to be examined are shown in Box 2.2. Depending on the specific types and characters of targeted irrigation and AWM systems, different approaches and tools could be applied.

For improvement of small-scale community irrigation systems, participatory rapid appraisal approaches may be applied, such as the planning and assessment framework described in IFAD's *Investment Guideline for Smallholder Agricultural Water Management.*

For modernization of large and medium-scale irrigation systems, more professional and systematic tools may be required, such as the FAO MASSCOTE method (FAO, 2007a).

For any appraisal, the associated farming system and its linkage with the irrigation and AWM system need to be included to ensure the integrity of the irrigated agriculture system.

Social and environmental assessment investigates irrigation-related social and environmental aspects in the project country and areas. Compensation for project-affected landholders and needed resettlement arrangements are often major pre-investment concerns and can extend beyond the irrigation scheme if downstream river-training works or upstream dam/intake storage is involved. Following a proper procedure to engage with the local community is a prerequisite for a number of IFIs to be involved in greenfield irrigation projects. Some of them require project planners to follow the FAO's *Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fishery, and Forests in the Context of National Food Security* (VGGT) (FAO, 2012c) for this process. Specific issues to be investigated as part of the social and environmental assessment are shown in Box 2.3.

Box 2.3: Key issues to be considered for social and environmental assessment

- Composition and characteristics of local society
- Interests and requirements of different social groups on irrigation services, especially those of women, youth, poor, minority and vulnerable groups
- Ensuring social equity and gender balance within project area
- Linkages between irrigation, water, land and local environment
- Irrigation-induced environmental issues, especially soil salinity, surface water over-withdrawal, groundwater depletion, nonpoint source pollution, water-borne diseases and ecosystem degradation
- Any other issues related to environmental sustainability

Source: Authors.

Relevant government and IFI safeguard policies should be well studied and understood, such as government policies and guidelines on environmental protection, land acquisition and compensation. The FAO series *Social Analysis for Agriculture and Rural Investment Projects* provides a comprehensive framework and practical procedure for social analysis. Of the ten World Bank safeguard policies, the following are highly relevant to irrigation projects: dams; indigenous groups; agriculture chemicals; resettlement; and international waters.

Institutional evaluation assesses the setting and performance of irrigation institutions in the context of local political, social and economic conditions. Major aspects to be evaluated are shown in Box 2.4.

Major focus areas of institutional evaluation include: organizational structures of irrigation management agencies and WUOs; their capacity and roles in irrigation development and O&M; and fitness with national and local political and social contexts.

Box 2.4: Institutional aspects to be evaluated

- Legal and policy frameworks related to water, land and irrigation institutions
- Capacity of private sector in construction and O&M, current setting of irrigation institutions at national, river basin, system and local levels
- Their suitability and capacity in meeting the requirements of irrigation sector development
- Further needs for irrigation institutions according to local irrigation development trends
- Major gaps and constraints affecting the functioning of irrigation institutions
- Options for institutional strengthening and issues to be addressed in preparation and implementation

Source: Authors.

Based on the development needs, constraints and gaps, and project opportunities identified, sector mapping of the potential project could be considered as one of the following: an irrigated agriculture development project or value chain/agribusiness development project with an irrigation component or activity; a broad AWM management project with an irrigation component or activity; or a stand-alone irrigation project.

Some practical tools, which could be applied for sector and system review at Step 1, and their information sources are provided in Annex 7.

2.1.3 Step 2: Project scoping

The main purpose of project scoping is to identify the PDO, expected results and beneficiaries, and possible components and activities. This could be done through preparation of a logframe following the logical flow of problems and solutions. IFIs may have specific requirements, such as preparation of the results framework required for World Bank-funded projects.

PDO. As shown in Box 2.5, PDO defines the principal outcome for the primary target group. Ideally, each project should have one PDO, focusing on the outcome for which the project reasonably can be held accountable, given the project's duration, resources and approach. Identification of a suitable PDO is subject to the results of sector and system review. It should effectively respond to the interests and requirements of relevant stakeholders at different levels, comply with relevant donor and client strategies, and be realistic and achievable within the possible time frame and resource availability of the project.

A typical PDO for a stand-alone irrigation project includes expansion of the irrigation command area and improvement of irrigation reliability, water productivity, irrigation efficiency and irrigation service quality – i.e. reliability, equity and flexibility. In the case of an irrigated agriculture development project, agribusiness/value chain development project or broad AWM project, irrigation interventions may be structured into a component or an activity. Accordingly, these objectives will be downgraded to intermediate outcomes or activity outputs.

Box 2.5: Definition of a PDO

PDO defines the principal outcome for the primary target group, if the project is successful.

Example: Irrigation farmers in the targeted project area increase their crop water productivity.

The following questions can help frame the PDO:

- What is the primary target group of the project? (e.g. irrigation farmers)
- What problem has been solved for this target group? (e.g. crop water productivity)
- What will the target group be doing differently after the project? (e.g. will have increased their crop water productivity)

Source: Authors, based on an interpretation of the World Bank, 2013.

When it is required and possible, multiple functions of irrigation systems should be maintained and promoted, such as for forestry and fishery production, domestic water supply, hydropower generation, drainage and flood control, ecosystem and landscape service, and conservation of culture and social heritages. Under these circumstances, PDOs for the investment projects need to be broadened accordingly.

Beneficiaries. Identification of beneficiaries must balance the requirements of economic efficiency with social and environmental benefits, especially with respect to food security, poverty reduction, smallholder farmers and water environment. Accounting for poverty/shared prosperity impacts is the common priority of government and donor investments. For most of the irrigation projects/ components, while the identification of a project area could be selective, targeting of beneficiary groups often needs to be inclusive due to the collective nature of irrigation systems. Therefore, special efforts need to be paid in project preparation and implementation to address specific needs of smallholders and vulnerable groups. A preliminary beneficiary assessment during project identification will inform project targeting, justify the use of public financing and set the baseline for project preparation, implementation and M&E.

Project type. Based on the identified PDO and beneficiaries, a suitable project type can be selected. There are many different types of irrigation projects, as shown in Table 2.1, depending on investment purpose, project nature, means of intervention and scale, water source and technical model of irrigation system, and project approach. While their comparison and selection are mainly subject to specific local conditions and development needs, the following experiences generated from recent global irrigation investment operations may provide general guidance:

- Projects for emergency assistance and post-disaster restoration need to take into consideration the needs for normative development, and projects for normative development need to take into consideration the need for disaster prevention.
- The current global trend is to move from stand-alone irrigation projects to more comprehensive AWM projects, integrated irrigated agriculture development projects, agribusiness development projects or rural development projects.
- For either stand-alone irrigation projects or integrated projects with irrigation components/activities, good integration of water options with agricultural value chains and other options is in high demand.
- It is often more cost-effective and quick impact to improve/modernize existing irrigation systems than to develop new irrigation systems.
- The decision regarding scale of irrigation/AWM systems will depend on local conditions. Good combinations of different system scales within a

river basin/watershed may help to ensure water supply reliability while improving flexibility and simplifying system O&M. For small-scale system projects, readiness of external key water storage and regulating systems would be a prerequisite for ensuring water supply.

- When selecting between gravity and pumping irrigation options, all aspects of water source and conservation, costs for investment and O&M, energy source and consumption, and carbon emissions need to be considered in an integrated manner to ensure project sustainability.

Components and activities. Identification of possible project components and activities depends on specific local conditions and project type. In general, these can be grouped into five categories: legal and policy framework; physical development or improvement; institutional strengthening; technical innovation; and capacity development. Typical activities under each category are listed below:

- Legal and policy framework includes development, completion and improvement of national and local-level irrigation and AWM laws, policies, strategies, regulations and technical guidelines, especially irrigation investment and water pricing policies.
- Physical development or improvement includes construction or rehabilitation of civil works and installation or replacement of equipment for water delivery, distribution, measurement, monitoring and control.

Table 2.1. Typological classification of irrigation investment projects

Classification	Type
Investment purpose	• Emergency assistance • Post-disaster restoration • Normative development
Project nature	• Stand-alone irrigation project • Integrated project with irrigation components/activities
Means of intervention	• Improvement of existing irrigation system • Development of new irrigation system • Combination of both
Scale of irrigation system	• Small-scale irrigation system • Medium or large-scale irrigation system • Combination of both
Water source	• Surface water • Groundwater • Treated wastewater • Combination
Technical model	• Gravity irrigation • Pressurized irrigation • Combination of both
Project approach	• Activity-defined project • Framework project

Source: Authors.

- Institutional strengthening includes establishment, completion and improvement of government irrigation departments, academic irrigation institutes, professional irrigation management agencies and various WUOs, especially farmer WUAs and groups.
- Technical innovation includes dissemination and adoption of suitable technologies on irrigation planning, design and O&M, especially new concepts and technologies for water governance and land tenure, WAA, irrigation modernization, WSI, ICTs, climate change adaptation and mitigation, and better handling of the water-food-energy nexus.
- Capacity development includes sector management capacity of government departments, technical capacity of academic institutes and irrigation agencies, and O&M capacity of WUOs. Large numbers of segmented technical training sessions may not be an efficient mode of capacity development; more systematic approaches should be adopted. For WUAs, farmer field schools have proven to be an effective approach.

At this stage, land and water rights for the irrigation scheme should be clarified, together with the approach and steps for organizing the WUOs. Orientation training could be organized for relevant stakeholders on identified topics.

2.1.4 Step 3: Preliminary water resource assessment

The major purpose of water resource assessment is to examine the water resource conditions in the project area and within the river basin, and the suitability of the proposed project interventions. While a detailed assessment will be conducted at the project preparation phase, a preliminary water resource assessment at the identification phase will help to shape the project scope before going to a detailed feasibility study or project design. Main water assessment activities include assessment of water requirements, water availability and quality and analysis of water balance.

Water requirements are subject to the needs of the proposed PDO and expected outcomes, such as the irrigation command area to be developed or improved, the production of irrigated agriculture to be achieved and other multiple functions to be performed. They are also subject to water use efficiency and water productivity of the proposed irrigation systems, which are determined by the combination of engineering and technical standards, management skills and agriculture structure. The impacts of climate change on water requirements need to be assessed and incorporated. While accurate calculation of water requirements is not possible at this phase, a quick estimation can be made based on initial project scoping and experiences generated from existing irrigation projects.

Water availability is subject to local water resource conditions, readiness of external water control and regulating systems, and priorities of government and local community for water resource allocation. Possible availability through external water diversion and the impacts of climate change also need to be taken into consideration. While community-based natural resource management is being promoted by many donor agencies and governments, it is important to verify local agricultural water use under the framework of IWRM at the watershed or river basin level. Assessment of water availability in the context of a watershed or river basin can be complicated and time-consuming. An easy initial approach is to check the availability of local watershed or river basin water resource management plans. In case a relevant water resource plan is not available, a quick qualitative and quantitative estimation needs to be conducted based on existing experience and knowledge. Some IFIs require that any greenfield irrigation and drainage project proposed for financing should have already been included in an existing river basin management plan; however, these plans are often non-existent in developing countries. If this is the case, the first step is to initiate the process of developing such plans.

Water balance analysis assesses the sufficiency of water availability against requirements to justify the feasibility of project scoping, taking into consideration possible future changes in both water availability and requirements due to changes in natural and socio-economic conditions and impacts of climate change. In case the water balance cannot be reached, alternative project scoping needs to be considered, either to improve water use efficiency and productivity through adopting advanced technologies and higher level investment standards, or to lower the PDO and targets. This process may require several iterations until a feasible project scoping is identified that can secure the needed water resources.

Water use efficiency and productivity. In view of increasing water scarcity in many countries and increasing competition for water among different water users and uses, a general policy of IFIs and governments is to enhance water use efficiency and productivity. This has implications for identification of the PDO and outcomes. The level of system efficiency and water productivity are normally decided by: the investment level, which should be economically feasible for the proposed agribusiness model; the technical standards, which should be suitable to local society; and the agricultural structure and farming style, which should fit with local conditions and customs.

As summarized in Box 2.6, due to the fact that some of the seepage and runoff from irrigation systems could be recycled by downstream users within the river basin, improving irrigation efficiency may not necessarily result in real water saving at river basin or watershed level. Projects aimed at water saving and transferring saved water to other users should target reduction of ineffective ET. The latest ET-based water management planning approach and ET-based water-saving technologies can be referenced for project scoping and water assessment.

On the other hand, over-withdrawal of water resources does have consequences in water availability at specific locations and during specific periods, and in water quality and financial cost, which means that improving irrigation efficiency is also needed, especially for projects involving a large number of non-consumable water uses, such as aquaculture, hydropower generation, mining and transportation. Depending on the specific PDO and expected outcomes, both irrigation efficiency and water productivity may need to be targeted in investment projects.

Box 2.6: Summary on WSI

- Improving on-farm or system-wide irrigation efficiency does not necessarily result in real water saving at river basin or watershed level.
- Converting improved irrigation efficiency into amount of water saving could result in double counting of water availability.
- Reducing consumptive water use can lead to real water saving, which can be realized mainly through reducing ineffective ET.
- Projects aimed at water saving should target reduction of ineffective ET. The practice of investing in canal lining for water saving needs to be revisited.

Source: Authors.

2.1.5 Step 4: Financing and implementation arrangements

Financing needs and possible sources need to be studied carefully. Cost estimation can be rough at this step, based on project scope, experiences from other similar projects/activities and available information on local market prices of goods and services. Major types of irrigation financing include loans, trust funds, grants and in-kind contributions. Possible financing sources include donor agencies, government departments, IFIs, the private sector and beneficiaries. Normally, there will be a combination of several sources, such as IFI-government co-financing or joint IFI-government-beneficiary contributions, depending on the specific conditions, requirements and opportunities of each project.

As shown in Table 2.2, available IFI financing instruments for irrigation projects include investment project financing, development policy financing and programme-for-results. Investment project financing provides financial support to governments for implementation of agreed project activities. Development policy financing provides financial support to governments or a political subdivision for a programme of policy and institutional actions in agreed areas. Programme-for-results links disbursement of funds directly to the delivery of defined results, helping countries improve the design and implementation of their own development programmes and achieve lasting results by strengthening institutions and building capacity.

Typical financing models include activity-defined projects and framework programmes. An activity-defined project relies on one or just a few well-defined activities to achieve its PDO. Clear definition of all project activities can be achieved from the outset. Detailed technical designs for each of the activities can be completed at the preparation phase, which allows for relevant assessments (technical, economic, social and environmental, fiduciary, etc.) and full development of specific plans (procurement, safeguards, mitigation, etc.) In contrast, a framework programme only defines the type of programme-financed activities and a few specific activities (usually those to be financed during the first year or so of project implementation) at the preparation phase. Further project activities will be identified during project implementation following established eligibility conditions and management frameworks. This allows more flexibility in project implementation to adapt to specific or changed local conditions. One example of this category is the rolling programme of yearly interventions targeting different geographical areas, such as a community-driven development (CDD) project.

Co-financing by different partners can be arranged through either joint financing agreements or parallel financing. In the case of joint financing, different donors combine financial resources into a single common agreed project supported by appropriate legal arrangements. On most occasions, pooled funds follow joint procurement, disbursement, reporting and auditing mechanisms. These arrangements enable harmonized policy dialogues, although they may require extra coordination efforts. In the case of parallel financing, different donors finance separate projects or project components supporting a common programme, without any formal linkage through a legal agreement. Each financing institution applies its own policies and procedures. This system is useful when pooling of funds is difficult, but usually poses higher coordination/transaction costs.

Different IFIs have different policies for their financing instruments. It is important for the project identification team to be familiar with the different alternatives available in order to better assist clients in defining the best option for their particular needs, taking into account the pros and cons of each alternative and the implications each of them may have in terms of assessing results and risks to results. Under joint financing, results frameworks include the results financed with different sources, so risks to achieving results have additional dimensions related to this interdependence.

The ownership and commitment of government and local society to the proposed project need to be clarified at this step, especially their commitment to project co-financing and O&M of irrigation systems, based on the irrigation service agreement and consequent investment standard agreed during project scoping through a participatory approach. The rate and modality of government co-financing are subject to relevant IFI and government policies as well as local conditions. O&M commitments involve joint efforts from government departments, extension agencies and beneficiaries to enable suitable policies, proper institutions and continuous technical and financial support for the sustainable functioning of irrigation systems. When commercial farmers or agribusiness entities are included in the project area and receive significant portions of the project benefits, the PPP model can be considered and explored for project financing. When there is a need to maintain certain environmental functions or ecosystem services, the approach of payment for environment service (PES) can be considered and explored.

Implementation arrangements to be discussed and agreed with stakeholders at the identification phase include:

- Overall time horizon along the whole project cycle of preparation, appraisal, negotiation, implementation and evaluation, taking into consideration the workload estimated for each phase and the procedures required by the client and the IFI;
- Suitable agencies for project implementation and their responsibilities;

Table 2.2: Financing models of irrigation investment projects

Financing type	Loans, trust funds, grants and in-kind contributions
Financing source	• IFIs, government departments, private sector investment and beneficiaries
Financing instrument	• Investment project financing, development policy financing, programme-for-results
Financing model	• Activity-defined project, framework programme
Co-financing	• Joint financing, parallel financing

Source: Authors.

- Key processes and procedures for project implementation – for instance, budget allocation, planning, investment prioritization, technical design, work execution, M&E and training;
- Gaps and/or capacity constraints of the counterpart agencies in project preparation and implementation, and actions to be taken; and
- External expertise needed for building local capacities and for assisting specific work in project preparation and implementation.

2.1.6 Step 5: Risk assessment and mitigation measures

Purpose and scope. The main purpose of risk assessment is to identify and evaluate potential risks to the achievement of the PDO, and to design proper mitigation measures. At the identification phase, risk assessment and mitigation planning are expected to be carried out for both project preparation and implementation. The results of risk assessment have direct implications for project cost, resource allocation, process and timeline of project processing and implementation. In general, large-scale mitigation measures mean high project costs; areas burdened with major risks need more resource allocation, and special processes/procedures and extra time may be needed for implementing mitigation measures.

Approaches and tools. There are various approaches and tools for risk assessment. The Operational Risk Assessment Framework (ORAF) adopted by the World Bank considers potential risks at four different levels: project stakeholder risk; operating environment risk; implementing agency risk; and project risk (Annex 3).

Project stakeholder risk refers to risks in the IFI's relationship with borrowers, donors and other key stakeholders that can affect the achievement of PDO.

Operating environment risks include country risk and sector/multisector risk, referring to risks where, across the sectors involved in the operation, institutions are weak and organizations lack adequate ownership and commitment, accountability and oversight, capacity, fraud and corruption control, or decision-making ability.

Implementing agency risks include capacity risk and governance risk (including a subcategory of fraud and corruption risk) that are related to the specific agencies that implement the project. There is scope to influence the risk level over the course of the project through mitigation measures and project design.

Project level risks include design risk, social and environmental risk, programme and donor risk, delivery monitoring and sustainability risk, as well as other operational risks. These risks are directly related to the project, where there is the most scope for mitigating and controlling risk levels through project design and implementation.

Frequently encountered risks. As shown in Table 2.3, some risks are frequently encountered in irrigation projects, such as change in government irrigation policies, confusion regarding mandate areas of relevant government departments, weak capacity of project implementing agencies, lack of proper cooperation mechanism between relevant stakeholders, irrigation-induced water or environment degradation, lack of sustainable O&M of irrigation systems, reluctance of beneficiary farmers to adopt irrigation, security issues, low design quality due to limited local capacity, and hydrological and climate change risks. Common mitigation measures adopted include participatory stakeholder consultation, multisector collaboration, institutional capacity development, improvement of the policy environment, continuous technical and financial support to irrigation institutions, enhanced security measures and climate change mainstreaming.

Climate change risks induced by temperature increase and alteration of the hydrological cycle, such as changes in precipitation patterns, glacier caps, water viability, water demands and extreme weather events, need to be assessed carefully. Relevant implications for water assessment, system planning, engineering design, construction and O&M need to be sufficiently considered. Suitable mitigation measures need to be incorporated and budgeted in project preparation and implementation, following relevant donor/government framework and screening procedures for climate change mainstreaming in investment projects.

2.1.7 Step 6: Preliminary CBA

Each stage of the project processing involves decision-making that should be based on evidence and expected economic returns on proposed investments. Although a detailed EFA would only be available from project preparation, a preliminary CBA at project identification would help in deciding whether to go ahead with the proposed project objectives, pre-identified solutions and scope of interventions before substantial resources and time are committed to further preparation studies. This preliminary CBA would set out the public sector rationale for the project and estimate whether the proposed investments will generate enough benefit to have a satisfactory economic rate of return on the preliminary estimated costs.

Lack of reliable data and information, especially baseline data, is often the major constraint to implementation of qualified CBA. Learning from experiences of relevant government and donor investment projects, within and outside the project area, may help to overcome this weakness. Another important task during the identification phase is to review the availability and quality of data and information, and propose relevant plans for additional

Table 2.3. Examples of frequently encountered risks and mitigation measures

Categories	Risks	Mitigation Measures
1. Project stakeholder risks		
	Overlap of project area or activities with those of other donor/government projects	Conduct closer consultation and collaboration with stakeholders
2. Operating environment risks		
2.1 Country	Change in government irrigation policies and strategies	Conduct more thorough review and closer monitoring on national policies and strategies; provide project support for irrigation policies and strategies
2.2 Sector/multisector	Confusion or overlap regarding mandates of government departments involved in the project activities	Provide project support for institutional capacity development
3. Implementing agency risks (including fiduciary)		
3.1 Capacity	Lack of expertise or staff in the implementing agency required by the project	Mobilize sufficient work forces to the implementing agency; partner with other national agencies; bring external expertise
3.2 Governance	Weak legal and policy frameworks, institutional setting and administrative process; lack of coordination mechanism with other stakeholders involved in irrigation development and management	Improve legal and policy frameworks; provide institutional strengthening and administrative enhancement; discuss and agree with stakeholders on proper cooperation mechanism and include this in project implementation arrangements; provide project support for its implementation
- Fraud & corruption (subcategory of 3.2)	Likelihood of fraud and corruption in contract performance	Provide training on procurement, financial management and contract management; apply stricter review, monitoring, auditing and reporting procedures
4. Project risks		
4.1 Design	Complex components and activities; project spread over a wide geographic area	Simplify project components and activities; concentrate project activities in prioritized areas
4.2 Social & environmental	Irrigation-induced water or environment degradation	Design and implement relevant environment protection plan following safeguard policy
4.3 Programme & donors	Difficulties in cooperation among multiple donors	Establish and implement proper donor cooperation mechanism
4.4 Monitoring & sustainability	Lack of sustainable O&M of irrigation systems after project completion	Clarify government and beneficiary commitments on O&M; establish and strengthen proper irrigation institutions; provide technical and financial support

Source: Authors, based on an interpretation of the World Bank, 2013.

data collection and studies during project preparation and implementation.

2.1.8 Step 7: Planning for project preparation

Provided the preliminary CBA shows feasible results, discussions with the project stakeholders can move on to general requirements and key steps in project preparation. A plan of action can be prepared and agreed, which would include the following major components:

- Actions to be taken for project preparation and responsible agency;
- Time schedule and milestones of each agreed action;
- Approach and methodology to be followed;
- Composition of project preparation team; and
- Cost estimation and financing for project preparation.

Typical preparation work required for irrigation projects includes: preparatory training on specific new approaches, technologies or tools that are expected to be adopted during project implementation; collection and analysis of additional data and information; specific studies on selected technical, engineering or socio-economic subjects; project cost estimation and feasibility study; environmental and social assessment and processing of safeguard documents; preparation of PADs and implementation plan; preparation of work, budget and procurement plans for the first project year; preparation of technical specifications and bidding documents for procurement of goods and civil work; and preparation of terms of references, request for proposals and list of potential candidates for consulting services.

Preparatory trainings organized for the national stakeholders at the beginning of project preparation are often deemed necessary and helpful when a project wishes to introduce approaches, technologies or tools that are new to local society, such as high-efficiency irrigation techniques, PIM approaches, irrigation modernization technologies or climate change mainstreaming tools. Trainings at the beginning of project preparation will build awareness among the project stakeholders on the need for relevant policy, institutional and technical innovations, lead the flow of thoughts and improve the efficiency and quality of project preparation.

Sufficient and quality data and information are important for project preparation. Data and information most commonly required by irrigation projects cover the aspects of climate and hydrogeology, water resources and environment, land and soil, engineering and technology, farming and farmers, and local society and economy. Some data may be available from government statistics and study reports, but need to be reviewed and verified; some may need to be newly collected or updated. The work plan for data and information collection and analysis needs to be based on the availability of resources and time for project preparation, especially when planning the baseline data survey. Planners should avoid postponing baseline data surveys to be conducted during project implementation. This practice, often seen to speed up project approval, clearly decreases the quality of the project design.

Sometimes specific studies are required to provide in-depth information or allow proper judgement on specific issues to prepare for or complement the feasibility study. Typical examples include: system appraisal and development visioning for an irrigation system that aims to implement modernization activities; geological survey for a project involving major construction work; social survey for a project that wishes to establish new WUAs. Proper methodologies and approaches and specific technical requirements need to be discussed and included in the studies' plans, together with resource and time allotments, to ensure the quality of specific studies.

A feasibility study is the prerequisite and fundamental condition of project preparation. Its contents and depth are subject to project scope and feature. For small-scale scattered projects, a feasibility study may include a detailed engineering design or sample design for engineering work. For large-scale concentrated projects, a feasibility study may only be able to provide an initial design for major engineering work, up to the requirements of bidding process. In either case, technical, economic, social and environmental feasibilities of the project need to be reviewed and studied following an integrated approach. For all irrigation projects, a detailed water resources assessment is required at the preparation phase.

Specific features of irrigation projects often trigger IFIs' social and environmental safeguard policies, especially those on safety of dams, involuntary resettlement, international waterways, indigenous peoples, disputed areas and natural habitats. In addition, an environmental assessment is a must for all irrigation projects. Different IFIs apply different procedures and requirements for implementation of safeguard policies. It is very important to enable needed expertise and resources to help process all the necessary safeguard documents in a timely manner, following relevant IFI and government policies.

2.1.9 Step 8: Preparation and processing of PCN

The major outcome from the identification phase is the PCN. It is normally a short document – only a few pages – focusing on project concept, not design. The PCN helps to: examine the project rationale and IFI involvement; promote consideration of alternative project concepts; seek a go/no-go decision from IFI management; obtain early guidance/agreement on issues and approach; flag risks and potential mitigation measures; seek early guidance on potential safeguard issues; and agree on resource estimate, schedule and team for project preparation. Annex 1 illustrates the PCN templates of the World Bank, IFAD and FAO.

The World Bank PCN template includes seven sections with a maximum length of five pages, including: (i) cover sheet; (ii) key development issues and rationale for World Bank involvement; (iii) proposed PDO; (iv) preliminary project description; (v) potential risks and mitigation; (vi) issues on which the team seeks guidance; and (vii) proposed preparation schedule, team composition and budget estimate.

The IFAD PCN template includes 13 sections with a maximum length of three pages, including: (i) strategic context and rationale for IFAD involvement, commitment and partnership; (ii) possible geographic area of intervention and target groups; (iii) justification and rationale; (iv) key project objectives; (v) ownership, harmonization and alignment; (vi) components and activities; (vii) costs and financing; (viii) organization and management; (ix) M&E indicators; (x) risks; (xi) timing; and (xii) country programme management team composition.

The FAO template includes four sections with a maximum length of five pages, including: (i) basic information; (ii) background; (iii) summary of proposed action; and (iv) implementation arrangements.

Detailed guidelines for preparing the PCN and guiding questions for each section of the templates can be found in relevant guideline documents of the respective organizations. When writing the PCN it is important to have a clear and concise story line responding to the content required in relevant PCN templates and to ensure consistency across the document. Processing of a PCN normally needs to go through steps of preparation, review, approval, finalization and disclosure. Annex 2 illustrates the World Bank guidelines on PCN processing.

2.2 Project preparation

2.2.1 Approach and methods

The project preparation phase requires thoughtful planning to guarantee that all necessary documentation is properly prepared for a swift appraisal by the financing institution. At the end of this phase of the process, a complete project document should be produced, including all necessary information to allow for its appraisal. This project document should clearly demonstrate that:

- The project is in line with the country's sectoral priorities;
- Relevant stakeholders, especially the users, have been adequately consulted about the interventions in the project;
- The feasibility studies have considered realistic options, and the option selected is the most technically sound and economically viable one;
- The institutional arrangements for project implementation and maintenance, operation and management (MOM) afterwards will guarantee sustainability and return on investment;
- For any eventual adverse social impact there are mitigation measures planned to be implemented as part of the project, and the social group affected is adequately compensated and in agreement with these measures;
- The selected option is sustainable from the technical, environmental and social perspectives;
- The selected option is economically and financially viable; and
- All arrangements for implementation have been completed.

The most common approach to irrigation and drainage projects nowadays is the **programme approach**, also called sectoral programme, where objectives and criteria for later selection and inclusion in the project are set either for the development of new small-scale irrigation schemes or for the modernization of selected hydraulic units within existing irrigation schemes. The main reason for the popularity of this approach is that final decisions on inclusion of specific areas can be made during project implementation, given opportunities for consultation with communities and users, allowing for development to be demand-driven. An additional benefit of using this approach is that capacities for design and implementation increase over time as they proceed at the pace set by the implementing agency, which learns by doing over the period of project implementation. When using this approach, it is not possible to carry out feasibility studies before the start of the project, as the actual locations and project interventions have not yet been identified. Specific project interventions are then developed as subprojects for which the feasibility study and design are done throughout the lifetime of the project. A comprehensive sourcebook for investment in AWM published by the World Bank (World Bank, 2005b) provides a useful compilation of good experiences that can guide project planners in the design of quality investments.

Projects using this programme approach can be appraised when there is clear demand from participating stakeholders, once a clear implementation plan with a precise schedule has been prepared and the criteria for identifying and appraising specific interventions within the project have been agreed. These criteria need to be carefully thought out and widely discussed and agreed with relevant stakeholders. They often include a cap for investment per hectare, a minimum economic internal rate of return (EIRR), a minimum level of capacity of the WUOs, and their contribution either to capital costs and/or to cover MOM costs, in addition to technical, social and environmental viability.

The **conventional project approach** is preferred when the objective is to invest in major infrastructure development or a substantial modernization of the entire scheme. In order to be able to accurately determine the project budget, these types of investments require that realistic cost estimates deriving from detailed designs and an adequate level of technical studies be prepared before appraisal. The importance of accuracy in cost estimates at this stage cannot be overestimated, as lack of it is often cited as a reason for cost overruns during project execution.

The final selection of the most appropriate approach, together with the existing institutional capacity, defines the planning of the project preparation studies. The project preparation studies can be carried out by government institutions, such as design institutes or the local planning offices within irrigation agencies. Alternatively, external agents may be engaged in project preparation studies; these may include consultancy firms or technical agencies. Project preparation, depending on the overall approach, can be carried out as an integrated operation or broken down into several project preparation studies. The review of the project dossier thus produced is the so-called appraisal process. This process leads to the preparation of a document wherein a multidisciplinary team representing the financing agency summarizes the project's interventions, reviews the EFA, assesses the compliance with social and environmental safeguards, and sets the boundaries for the investment to take place. This multidisciplinary team for the appraisal of irrigation and drainage projects should include, as a minimum, specialists in irrigation and drainage engineering, agronomy, economics, institutional and social aspects, water resources development and environmental aspects. Some projects may require additional expertise such as dam construction, land management, legislation, procurement and asset management. Complementary project components may require expertise in other related areas such as agroprocessing, extension services, microfinancing, value chains, etc. The appraisal team's main task is to verify that the project interventions satisfy technical, social, environmental, financial and economic criteria for viability. The project preparation studies detailed in the following section have to be prepared with this objective. Annex 4 shows a typical outline for what is sometimes called the PAD or the PDR.

2.2.2 Project preparation studies

Water resources and demand assessment. The water resources and demand assessment at this stage of the project preparation has three objectives:

i. Determine the amount of water that the irrigation or drainage system is expected to provide or evacuate with adequate precision and time resolution, typically decadal. For existing systems, the study should include an analysis of current water use from both surface and groundwater resources. If it is a new development or if substantial changes in withdrawal are expected, the studies should include hydrologic precipitation/runoff analysis of the catchment, using well-known hydrologic methodologies and simulation models, when relevant;

ii. Characterize the water resources from which the system will be withdrawing and/or discharging with the adequate time scale; and

iii. Determine the impact of the project on water resources, including on groundwater resources and water quality.

The water resources assessment should quantify water availability versus demand during the entire foreseeable life of the project at the adequate time scale. Assessing changes in water quality during the cropping season needs to be part of the analysis. In addition, groundwater assessments need to be conducted, where relevant, to assess the dynamics of recharge, variations of the water table and quality of groundwater.

An important element in the water balance is the crop ET, which could be calculated with the Penman-Monteith equation (FAO, 1998b). FAO also developed a computer programme called CROPWAT (FAO, 2009b), which allows not only the calculation of crop ET but also studies on different irrigation alternatives, including deficit irrigation and the effects of possible cropping patterns on canal flows. FAO has developed a crop growth model called AquaCrop to assess the effects of the environment and management on crop yields (FAO, 2012f). It is a crop-water productivity model particularly suited to study conditions where water is a key limiting factor in crop production.

The water balance (IIMI, 1996; ITRC, 1999) will allow planners to identify possible project impacts and plan for mitigating measures. If the project is within the basin of a transboundary river, the water balance will help to quantify that the impacts are within the terms of existing agreements and to provide the basic information for riparian notification to neighbouring countries. The water balance can also show the project's impact on overall water abstraction. Besides preparing a water balance assessment, a salt salinity assessment should also be conducted to allow planners to clearly identify leaching requirements (FAO, 1999a) to manage salinity. The need for surface and/or subsurface drainage should be determined based on local subsoil drainage conditions, dynamics of the water table and a design storm with a reasonable return period. FAO has published detailed technical guidance for proper drainage system design (FAO, 2007b).

The water balance assessment can also serve as a basis for long-term planning of water resources development and use, which can use the water scarcity action framework proposed by FAO (FAO, 2012e). This framework provides an opportunity to think strategically in terms of water resources planning, and determine the limits for further investments in water supply and how to start promoting water demand management, curbing excessive demand that the system cannot sustain over the long term.

Soil and land capability studies. Soil and land capability mapping and analysis should be prepared at the adequate scale and standard, with special attention to drainage requirements. The latter aspect is important because interventions to improve water supply will make more water available within the irrigation system, increasing the risk of over-irrigation and possibly the need for additional artificial drainage. The *Guidelines on Land Evaluation for Irrigated Agriculture* (FAO, 1985) provide detailed methodologies and procedures as well as insights into crop suitability according to soil capacity and information regarding the specific irrigation and management alternatives for sustainable irrigated agriculture.

For this stage of project preparation, it is necessary to conduct detailed land surveys with scales ranging from 1:10 000 to 1:25 000, and with maps showing soil series, topographic features, groundwater, existing land use and other aspects relevant to the local conditions. More detailed soil surveys (e.g. at 1:5 000) may be required to identify land levelling needs, when determining the layout of open canal networks and defining the command area.

Projects for irrigation modernization also require a re-evaluation of land suitability, as there has often been a decline in productivity due to a combination of poor asset management, underinvestment in maintenance and suboptimal management, frequently coupled with socio-economic changes and environmental degradation. This land re-evaluation would allow the project to include the appropriate measures – to deal, for example, with waterlogging or salinization issues – in order to improve land suitability for irrigated agriculture.

Engineering studies. For projects addressing modernization of existing irrigation schemes, a participatory assessment of the scheme's performance with a focus on operational bottlenecks and associated infrastructure shortcomings, as well as opportunities to increase productivity of resource utilization, is needed (FAO, 2012f). New standards of irrigation service may need to be defined for specific crop models anticipated in the investment. A systematic approach should be followed for assessing the conditions of the irrigation scheme prior to identifying the interventions the project will undertake. As a minimum, an assessment using the Rapid Appraisal Procedure (RAP) (Burt, 2001) should be conducted as early as possible during the project preparation phase. Ideally, in addition to the RAP, a more comprehensive assessment such as the one obtained with the MASSCOTE methodology (FAO, 2007a) would provide more detailed insights into how to address key bottlenecks to improve system performance. The methodology is designed to support the development of an irrigation modernization plan. MASSCOTE also provides an opportunity to introduce service-oriented management (SOM) and improve the client orientation of the service provider, whether public or private, such as a WUO. Through the interaction with the water users, MASSCOTE also allows for a better assessment of the opportunities to involve users in the financing of system improvements, and guarantees they will at least be able and willing to raise enough resources for system O&M.

For modernization of irrigation schemes, the topographic surveys mentioned in the previous section should include the existing canal network, major structures and the command area. In addition, it is necessary to conduct geological and/or geotechnical studies for foundation designs of new structures and seepage studies in case seepage losses are excessively high. These studies will allow actual losses to be quantified and possible mitigating measures assessed. A complete canal seepage study will include risk assessment, identification and measurement of seepage, remediation, CBA and selection of mitigating measures. Far too often decisions to invest large amounts of resources in lining canals to decrease canal seepage are made without this basic information.

Civil and irrigation engineering analyses based on this and other relevant information can then be prepared, identifying scheme layout for irrigation, drainage and flood control infrastructure. Detailed design, construction drawings, bills of quantity, specifications and tender documents should all be part of the final project dossier. Where relevant, these should include hydraulic designs, which may require the use of steady and unsteady flow simulation models to understand different scenarios, such as the hydraulic behaviour of the system at full and partial supply, wave propagation and time lags, filling of canal reaches, effects of rotational operation, effects of operating cross-regulators and even potential for sedimentation at different operating regimes. A variety of commercial simulation models are available nowadays, making this task within reach of most designers. These tools also allow better planning of conjunctive surface and groundwater use.

Irrigation engineers and managers are often very keen on proposing SCADA systems for irrigation investment projects. SCADA systems are effective means for improving the knowledge of a system's behaviour and can potentially help to substantially increase the water delivery service to users, make operations more effective and reduce water use and sometimes overall costs of running large systems. It is a technical challenge, however, for most engineers to achieve these benefits, particularly in the context of a time-bound project. Careful thinking on how to design such a system is therefore advised, as the complexity of the system can be greater than what can be handled by the managers of most irrigation schemes. A good first guidance and introduction to SCADA can be found in the experience of the Irrigation Training and Research Centre of California Polytechnic State University (ITRC, 2009). SCADA systems can range from basic monitoring, advised as the first step in systems new to SCADA, to automated control structures, at which systems normally arrive through a gradual learning process.

At this stage of project preparation, preliminary engineering designs for roads, electrification and other required related infrastructure should be carried out.

Agricultural services and credit and marketing studies. Based on the project concept and objectives, field work may be needed to verify assumptions made and to assess farmers' perceptions and possible responses to the opportunities created by the project implementation and their support for it.

These studies should give detailed information on current and expected production systems. Improvements in water delivery service may prompt changes in cropping patterns. For example, as a result of system improvements, shallow-rooted and drought-sensitive crops could be grown in systems where unreliable or infrequent water supply existed previously.

Farm irrigation practices may also change as a result of project implementation, including the possible introduction of on-farm pressurized systems, which may provide opportunities to practise the application of fertilizers through the irrigation water, a practice also known as fertigation, greatly saving on labour and other resources.

Availability of credit facilities from public or private sources as well as access to credit by farmers within the command area should be assessed. If deemed necessary, projects may be designed to include a component to promote microcredit to farmers, thus enhancing their capacity to invest in better agricultural inputs and practices. Techniques and practical guidelines for the design and implementation of diagnostic studies of target groups and their farming systems have been published by FAO (FAO, 1992).

Market studies should determine current market linkages and potential changes due to variations in cropping patterns, mechanization, increased yields and labour availability. This information may lead project designers to address deficiencies in market linkages through the project to maximize opportunities for farmers to benefit from the project investments. This may include support to activities to add value to local produce, particularly when high-value or perishable crops are part of the production system.

Health and socio-environmental impact assessment. All positive and negative health impacts due to project implementation should be considered and mitigation measures foreseen, when necessary. According to the social and/or environmental safeguards that the project could trigger, the relevant analyses should be conducted, including social and environmental impact assessment (FAO, 1995), land acquisition, resettlement and dam safety, among others. Action plans should then be prepared on those aspects identified as requiring intervention from the project. All possible costs for preparing and implementing these plans should be included in the project budget.

New irrigation development projects face the risk of increasing the incidence of water-related vector-borne diseases – e.g. bilharzia (schistosomiasis), river blindness (onchocerciasis), malaria – within the project area, particularly in subtropical and tropical climates. Proper canal design is critical to avoid this risk, and attention must be paid to actual water velocities in canals so as not to provide breeding environments for mosquitos or snails. Insufficient attention to these risks may mean that the very system that is expected to bring about benefits to the communities could end up increasing the incidence of disease. A number of measures for avoidance, mitigation and compensation have been proposed by IWMI (IWMI, 2007b) and the World Health Organization (WHO, 1996). Similar concerns are part of the justification for drainage development, as described in detail by FAO (FAO, 1997).

Climate change impacts. Nowadays, no project design can be complete without having given careful thought to the possible implications that climate change may have on the investments proposed by the project and mitigation measures, if those are considered necessary. FAO has prepared guidelines to help project designers in this type of assessment (FAO, 2012b).

Land tenure and water use rights assessment. This assessment should identify possible impacts on land and water use rights for current users/inhabitants within the proposed command area. New irrigation projects, in particular – but also modernization of existing irrigation systems – may require taking or limiting access to private lands, either as a result of construction of a new reservoir or during the construction of a new waterway, such as a canal or a pipeline. During the project preparation phase all private assets that will be affected by the project should be identified and mitigation and/or compensation measures discussed and agreed with each affected individual.

New irrigation projects or modernization of existing irrigation systems can also interfere with established legal or customary water users' rights. When these situations occur, the involuntary resettlement safeguards are triggered, requiring the government to prepare a complete plan for avoiding, minimizing and mitigating the adverse impact on the concerned population. Resettlement action plans may need to be prepared as part of the adopted safeguard measures.

During project preparation, it is important that complete understanding is obtained regarding the existing arrangements, customary or otherwise, for land tenure and water rights. In most cases, this would include having detailed and updated cadastral information, including sizes of farms and properties, proportions of owner- and tenant-operated farms and possible implications for cost contributions, if envisaged by the project. Land consolidation and land titling to facilitate irrigation are contentious matters, and discussing them should follow a thorough consultation process with the current land users. These changes also require considerable time to materialize, and this should be considered if the intervention is part of a typical investment project, which has limited duration.

For more details about safeguards, readers are advised to review the World Bank's *Safeguard Policies for Projects* (World Bank, 2016a) or IFAD's *How to Do Land Tenure in Project Design* (IFAD, 2014b). More information about tenure of natural resources and information on internationally accepted practices can be found in FAO's *VGGT* (FAO, 2012c).

The land tenure and water use rights assessment should also include reconfirmation, during early stages of project preparation, of any possible impacts or outstanding issues related to transboundary waters to guarantee they will not affect project approval. Projects within transboundary basins should follow the principles of good practice as described in the United Nations Watercourses Convention (UNWATER, 1997), regardless of whether the country where the project will be located is a signatory or not. These principles include:

- The principle of 'Equitable and Reasonable Utilization' is the cornerstone of international law related to transboundary watercourses;
- The principle above creates the correlative obligation not to deprive other states of their respective rights;
- The Convention is based on the allocation theory of 'limited territorial sovereignty' which stipulates that watercourse states enjoy equal rights to the utilization of an international watercourse;
- The Convention provides a list of factors and circumstances to be taken into account when determining what constitutes an equitable and reasonable use;
- According to the Convention, states are obliged to take all appropriate measures not to cause significant harm to other watercourse states; and
- While no use of a transboundary watercourse has inherent priority over others, special regard has to be given to vital human needs and the protection of the ecosystems of international watercourses.

It is good practice that whenever a project is being proposed within a transboundary basin, an official riparian notification is issued to all riparian (upstream and downstream) states, giving them an opportunity to raise any possible concerns. See the World Bank policy for further details on the process to follow during project preparation (World Bank, 2012c).

Institutional assessment. The first objective of this assessment is to determine the capacity of the institutions to implement the project as proposed. This relates not only to technical capacities but also fiduciary and operational capacities to undertake overall coordination, procurement, financial management, supervision and M&E tasks at the rates required for project implementation.

Secondly, given the centrality of institutional aspects for long-term sustainability of irrigation schemes, local institutional capacities need to be assessed realistically in relation to project interventions and future requirements. In particular, it is necessary to study:

- Capacity of relevant government entities involved in irrigation MOM;
- Establishment or need for strengthening WUOs; and
- Future arrangements for MOM.

As a result of this assessment, an action plan should be prepared to address possible weaknesses identified and to strengthen local institutions as needed. This assessment may also lead to redesigning working arrangements for project implementation.

As mentioned above in Section 2.1, a governance analysis should be a major part of the institutional assessment. In this context, governance analysis also encompasses possible conflicts of interests between different organizations or stakeholders as well as issues of power and diverging incentives. These issues are of particular relevance in the context of functioning WUOs. If there are not sufficient incentives on the side of the users or other stakeholders, it is unlikely that the WUO will be able to properly deliver its basic services. This issue is often underestimated by project planners, and very often institutional analysis only looks at capacities of organizations (FAO, 2012h).

In the absence of incentives for action, the project planners need to take these realities into consideration and design the project based on realistic assumptions with respect to incentives, motivations and power constellations.

This assessment may lead to the proposal of profound sector reform, including the transfer of irrigation management services and strengthening the legal foundation to better empower the WUAs. FAO published a guideline on the subject, which is recommended as a starting point for reform proposals (FAO, 1998a). More recently, FAO also conducted a worldwide review of experiences of countries with irrigation management transfer programmes (FAO, 2007c).

2.2.3 User participation in project preparation

Nowadays, water users are being asked for full O&M cost recovery to ensure financial sustainability. This should be coupled with users being recognized as the real decision-makers of any irrigation and drainage investment. Therefore, users should be involved from the earliest possible stages of project conceptualization, including during the feasibility and design phases.

While user participation is justifiable from several different perspectives, from the investment point of view, participation guarantees user buy-in and an increased sense of ownership, which is expected to result in good O&M practices and long-term beneficial effects from the investment made by projects. Although initiating farmers' participation has higher costs and is more time-consuming than just developing a project without including them, experience demonstrates that the benefits can be substantial. User participation can be better organized if there is a WUO that legitimately represents users. This is particularly useful when a large number of users would make it difficult to engage them all in a meaningful interaction.

Besides user participation, the participation of other stakeholders can also benefit the project preparation. This includes community members other than farmers, staff of the organization that will implement the project and other sector institutions, particularly from the area where the project will be implemented. As much as possible it would be useful to include not only those supporting the project but also those who express concerns.

It is important to devise mechanisms to ensure proper stakeholder participation, which includes consultation and collaboration rather than mere information sharing. During the preparation phase of the project, farmers could play a significant role by participating in: (i) identifying lands to be irrigated and evaluating their suitability; (ii) providing local knowledge for assessing the project's environmental impact; (iii) providing labour for topographic, soil and socio-economic surveys; (iv) providing information on past experience with natural disasters and relative risk areas; and (v) providing information on crop patterns and possible changes due to project implementation.

Designers should fully understand the level of service required by different groups of water users and respond to their needs as closely as possible. Further guidance on how to achieve meaningful participation has been prepared by FAO (FAO, 2002a) and the World Bank (World Bank, 1995). Specific guidance on gender-responsive participatory planning of irrigation schemes has also been developed by FAO (FAO, 2001).

2.2.4 EFA

The EFA's objective is to provide a financial and economic rationale for the irrigation and drainage investment based on credible crop productivity models and producer price assumptions. The financial analysis needs to demonstrate cost-benefit ratios for specific farm/crop models and assess the impact of the project in terms of the crop value chain. The economic analysis is undertaken to determine the EIRR and is generally based on direct costs and benefits plus social benefits. Some IFIs also include indirect benefits generated by the investment over time. Crucially, the economic analysis considers the effects of subsidies and protection tariffs to generate economic prices. These economic prices can then be used to assess the sensitivity of the EIRR to varying levels of import tariffs, cropping intensity, unit cost variations or any other risk identified. The role of financial analysis is to identify and assess cost recovery levels and mechanisms that should be agreed with the government and users. Long-term recurrent costs for O&M after project completion need to be quantified and the capacity of government and users to afford such costs determined. In case a loan repayment is foreseen, the analysis should also evaluate different options of repayment levels and schedules, in conjunction with cost recovery assumptions.

In addition to the common issues like market prices, shadow prices and exchange rate, EFA for irrigation projects needs to properly address some specific issues, such as: estimation and quantification of positive and negative externalities of irrigation systems – e.g. benefits from drainage, water supply, multiple water uses, conservation of ecosystem functions and social and cultural heritage; impacts and costs due to soil salinity, groundwater depletion and water pollution; and clarification of possible financing sources for system O&M – e.g. expected water fee collection and farmers' in-kind contributions and confirmed government subsidies for expected social and public services provided by the irrigation systems. Further details on how to conduct the financial and economic appraisal of irrigation projects can be found in Module 11 of FAO's *Irrigation Manual* (FAO, 2002c).

2.2.5 Preparation of PDR

The aim of a project document is to facilitate appraisal by the funding agency. The PDR includes the entire set of documents and working papers mentioned above and prepared during the planning process and should be part of the project report either in a summary format or as annexes. The PDR should closely follow the guidelines of the financing institution, as these may vary substantially in content, format and other requirements.

The PDR is structured and detailed differently according to the focus area, policy and procedures of each IFI or bilateral development agency (BDA), but convergences have been noted during recent years. Generally, the document is composed of a main text (15 to 40 pages) and technical annexes containing details summarized in the main text. The structure and content for a PAD are suggested as Annex 4 (synthesis from main IFIs, types of irrigation, geographical location and BDA practices), providing for each section the key aspects to be addressed in the PAD and the specific features to be taken into account, which are summarized as follows:

- *Chapter I: Strategic Context,* including country physical and socio-economic context, sector-specific context, institutional context and the higher level objectives to which the project will contribute. Irrigated agriculture performance and its role in reducing poverty and food insecurity, major constraints and necessary reforms are also discussed.
- *Chapter II: PDOs* (and Global Environment Objectives [GEOs], for large-scale irrigation projects affecting shared water resources management), project beneficiaries and PDO/GEO level results indicators.
- *Chapter III: Project Description,* including description of project components/subcomponents (two or three technical components and a fiduciary one), financing/lending instrument, expected results and benefits, lessons learned and reflected in project design, and costing.
- *Chapter IV: Project Implementation,* describing implementation partnerships to be built, institutional arrangements for implementation, M&E of outcomes/results and sustainability (based on incentives, ownership and reforms).
- *Chapter V: Key Risks and Mitigation Measures,* including identification and assessment table of major implementation and sustainability risks and confirmation that project design and monitoring measures adopted will mitigate those risks, explanation of risk ratings and controversial aspects, if applicable.
- *Chapter VI: Appraisal Summary,* including: EFA (farm-level benefits to ensure full water fee recovery for adequate O&M, economic viability through projected internal and overall EIRR, including sensitivity analysis); technical analysis (confirming adequacy of the project design, highlighting technical innovations and advantages, and accuracy of O&M standards and funding mechanisms); fiduciary arrangements (appropriateness of the financial management system and auditing mechanisms, and staff qualifications); and social and environmental analysis (including safeguard policies and mitigation measures).
- *Chapter VII: Project Work Planning (*systematic sequencing and scheduling of the tasks comprising the project), including: an implementation manual covering how all activities will be implemented, by component and subcomponent; a detailed implementation plan for the first year (18 months for some IFIs); and financial and administrative management procedures and project auditing, as well as a detailed procurement plan. Diagram models using dedicated project management software could be useful.

- Key Annexes (Depending on IFIs and BDAs), including:
  - Annex 1: Result Framework and M&E System
  - Annex 2: Detailed Project Description
  - Annex 3: Implementation Arrangements and Support Plan
  - Annex 4: Risk Assessment Framework
  - Annex 5: Project Costs
  - Annex 6: Financial Management and Disbursement Plan
  - Annex 7: Procurement Plan
  - Annex 8: EFA
  - Annex 9: Social and Environmental Analysis (including Safeguard Policies)
  - Annex 10: Country at a Glance
  - Annex 11: Maps
  - Other relevant annexes (Depending on IFIs/DAs)
  - Major operations financed by the IFIs/DAs
  - Statement of Loans and Credits
  - Documents in the Files

2.3 Appraisal and negotiation

2.3.1 Introduction

Lessons learned in Part I and practical tools introduced in Part III of these *Guidelines* should be taken into account at Appraisal and Negotiation level, making sure that planners are: (i) adopting good innovations; (ii) integrating irrigation with value chains; (iii) adopting WAc for integrating into IWRM; (iv) adopting a participatory process; (v) adopting a climate-smart approach; (vi) improving EFA; (vii) adopting well-structured capacity development; (viii) paying more attention to smallholder farmers (over 90 percent of the world's farmers are small family farmers, cultivating less than 2 hectares); and (ix) taking into account that many issues encountered in implementation are rooted in identification and preparation (e.g. insufficient technical preparation, political intrusion in project staff selection, failure to identify SMART indicators or targets, lack of proper exit strategy, insufficient or unbalanced budget allocation for project management and supervision, insufficient inclusion of M&E facilities or arrangements in engineering design, budget allocation or procurement plan).

At the appraisal phase, every aspect of the project idea is subject to systematic and comprehensive evaluation, and a project plan is prepared. Appraisal follows the project identification and preparation process and constitutes the last step before operation is negotiated between the beneficiary government and the donor, whether an IFI or a BDA. The requirements and formats of appraisal documents for irrigation investment projects vary according to the strategies and policies of the donors and beneficiary governments. In recent years, a convergence of approaches has been developed for contents and structures of PADs. This section introduces the generalized approach and formats applicable for various irrigation investment operations supported by IFIs/BDAs as well as country governments. It includes three parts: (i) appraisal objectives and methodology; (ii) appraisal procedure and process; and (iii) project negotiation.

2.3.2 Appraisal objectives and methodology

Appraisal of irrigation investment projects should aim at: (i) ensuring good understanding of project conditions; and (ii) analysing the project's acceptability and merit with reference to specific criteria including, among others: the adequacy of proposed engineering options; the viability of value chain development; institutional and legal feasibility; economic justification for investment; financial sustainability of irrigated farms; social viability and gender equity; environmental sustainability; and potential good organization and full financing of water management and maintenance of irrigation and drainage networks and other hydraulic structures. The ultimate goal is to achieve a good investment decision that will be acceptable for the IFI, the recipient government and the national beneficiaries.

To appraise an irrigation investment project, a qualified multidisciplinary team is needed and the methodology to be used includes: (i) checking the basic data and assumptions used in the project identification and preparation; and (ii) undertaking an in-depth review of technical/institutional/organizational/management aspects, investment and recurrent cost estimates, financing plan, economic and social benefits, environment and social sustainability assessment and mitigation plans, implementation work plan, O&M plan (e.g. WUAs/ WUOs) and costs (e.g. water fees), to ensure overall project viability.

2.3.3 Appraisal procedure and process

Each funding institution has its own appraisal procedure and process. Generally, appraisal requires two missions. The first (so-called pre-appraisal) mission leads to a preliminary report, which is reviewed through a quality enhancement review (QER) meeting. The QER multidisciplinary team is composed of senior technical staff from the IFI or development agency (DA) with wide experience in irrigation development, including agriculture sector issues, irrigation policy, water management, EFA, fiduciary, environment and social sustainability with safeguards, project preparation, appraisal and implementation support aspects. After appropriate improvement of the draft appraisal document, the appraisal mission is authorized by management of the IFIs/DAs in a decision meeting. The decision meeting reviews key elements of the finalized pre-appraisal document including the sectoral context, the project design and risks, project sustainability and safeguards issues and status. In some cases, additional work is needed prior to appraisal. Otherwise, the project team receives authorization to appraise and negotiate the project during an appraisal mission. The appraisal mission is then carried out, taking into account all the comments received from the peer reviewers and the decision meeting.

2.3.4 Project negotiation

Project negotiation is organized between the IFI/DA team and government-authorized officials to determine mutually satisfactory terms to be included in the financial agreement. The objective is a face-to-face agreement regarding all the critical aspects on which the project rationale, design and sustainability, among other considerations, are based. These include: the context analysis; lessons learned from previous operations; project design; main shared policies and development issues to be addressed; project objectives, components and costs; institutional arrangements for implementation; risk assessment and mitigation; counterpart funds mobilization; financial and organizational audits; arrangements for multiple water uses; reforms needed for project sustainability (O&M funding and implementation arrangements); safeguards and mitigation measures; and other conditions discussed and agreed.

Negotiations also include conditions required for project effectiveness, such as: staff recruitment process and qualification; comprehensive project implementation manual; opening of account and initial deposit; and, in some cases, draft reform documents to be prepared. Assuming that both parties have been involved in the project identification, preparation and appraisal processes, the negotiations will have been well prepared so that all the pending issues have been addressed before D-Day – i.e. the date of negotiations.

Use of international waterways. As a policy matter, before appraisal and negotiation some IFIs may request a technical note on water resources to be diverted by the project (compared with the total average inflow) and notification sent to riparian neighbours to obtain their agreement.

Negotiations are concluded by the preparation and signature of a financial agreement to be endorsed by the country parliament or, in the case of many countries, through a legal ruling from the high court, before a project can become effective.

Roles and responsibilities of major stakeholders

At appraisal phase. Major stakeholders in the appraisal phase are the government team, including representatives of beneficiary communities, the private sector and the IFI team. The government team is responsible for project preparation at national level, including definition of the sectoral strategy, the investment priorities, the project area, etc., to inform project preparation and appraisal. During the appraisal it is mandatory to ensure sufficient private sector capacity to cover the key tasks, including implementation of various studies and works, operation of agricultural equipment and input supply, product processing and commercialization, etc. The IFI is responsible for financing the investment project using its own strategies and procedures, including project structuring and costing, technical, economic, financial, environmental and social analyses, etc.

At negotiation phase. Negotiations are carried out by government officials and the IFI team. Each partner has to ensure that the financial agreement and the appraisal document content are coherent and will lead to successful project implementation, based on a full review of the project objectives, components, implementation strategy and institutional arrangement, costing, etc.

Sources of finance. For World Bank-funded projects, a Project Preparation Facility (PPF) is agreed on and designed to finance the entire government participation process until negotiation (World Bank

2013). The PPF is financed by the IFI and included in the project cost (and reimbursed by the beneficiary government in case of successful negotiation). IFAD uses a Project Preparation Grant; in other cases, a bilateral grant from a donor is used to finance the preparation and appraisal/negotiation process.

Programmatic approach. A "programmatic approach" is an overarching vision for change that is achieved through a series of interconnected projects with common objectives, for a result that is greater than the sum of its components. Its overall objective is to secure large-scale, sustained impacts on the global environment, and its interlinked projects aim to achieve this goal. The programmatic approach can be thematic or geographic.

IFAD is one of the main IFIs using this approach. The first step is the approval of a Programme Framework Document by IFAD's Governing Council, prepared through a work programme; then fully prepared subsidiary projects are adopted under the programme.

2.4 Project implementation

Introduction of a proper implementation arrangement is among the major determinants for project success. Even when projects are designed with a satisfactory level of professionalism, often results are unsatisfactory due to weak implementation. Inadequate implementation plans, limited technical and managerial capacities, inadequate remuneration to attract and retain skilled staff, inadequate monitoring, inappropriate supervision and quality control, difficulties of coping with institutional changes, such as decentralized irrigation management transfer (IMT), and lack of preparedness to learn from project experiences and feed into a country's knowledge base could jeopardize project success. To this end, attention must be paid to capturing and incorporating the lessons learned from previous projects, as described in section 1.2.2, throughout the implementation process.

The steps and actions to be followed to ensure effective and efficient implementation are described below. See also Figure 2.2 for Project Implementation Phases and Key Steps.

2.4.1 Readiness and effectiveness

Following project negotiation and approval, readiness for project implementation needs to be ensured through: (i) meeting legal covenants for project effectiveness; (ii) enabling other conditions for project implementation; and (iii) project inception.

Examples of legal covenants and activities include: (i) reaching subsidiary agreements between the recipient and all subprojects under a framework project or a national project implemented by semi/autonomous regional states; (ii) adopting a project implementation manual; (iii) developing an operational manual (for framework projects or CDD projects);[1] (iv) establishing a Project Management Unit (PMU) with terms of reference for staff prepared as per the organogram in the approved project implementation manual, key positions filled and operational resources mobilized to the satisfaction of the IFI; (v) instituting a management information system (MIS) and computerized accounting system; (vi) establishing a procurement filing and tracking system; (vii) securing eligibility for retroactive financing; and (viii) appointing independent auditors.

Examples of other conditions for project implementation include: (i) institutional arrangements and establishment of pertinent committees; and (ii) separate bank account opening and initial funds transfer.

PART 2

In addition, allocation of financing from the government and other partners must be met as per the agreed amount and timelines. Competent and reasonably remunerated project staff should be recruited and trained to understand the PAD, the project implementation manual and other above-mentioned manuals and the MIS, as well as becoming familiar with governing guidelines of the IFIs in contract management.

In addition to the above-mentioned, the following issues need to be addressed to enable effective and smooth implementation:

- Reassess project conditions for confirmation, carry out the necessary due diligences, make adjustments, fine-tune and rephrase the detailed project design;
- Carry out the project inception process before proceeding to implementation to capture major changes that might have arisen after project formulation; and

[1] These types of operations rely on management frameworks, eligibility criteria and processes defined during the preparation phase to be followed during implementation, as opposed to having detailed designs, specific management plans, etc., which apply to activity-defined projects. The operating manual details in simple terms the procedures to be followed at local level.

- Prepare detailed annual work and budget plans for the overall project and specific subprojects.

Projects designed under a series-of-projects approach[2] or multiphase programmatic approach to be implemented over the life of a single project or in phases over time will follow the same principle for the initial phase of the series. However, the implementation plan for subsequent phases or series should build on lessons learned from and achievements of previous phases, while avoiding a loss of momentum to ensure continuity.

Although indicative financing should be committed initially, actual financing for subsequent phases should be made available only if implementation progress of the previous phase is satisfactory and if the bank has the financial capacity. Separate legal agreements would be signed for each phase.

2.4.2 Initial activities

At the onset of the project, initial policy-level dialogues should be initiated, leading to policy reform as deemed in the PAD. In addition, legal provisions should be drafted to establish WUAs or to decree the breakdown of O&M responsibilities, including irrigation service fee collection and utilization.

The initial activities should give specific attention to an analysis of institutional capacity, and provide a detailed plan to enable the implementers to carry out the tasks expected of them after the project becomes effective.

Technical assistants can be hired as determined during project formulation and in response to the gaps identified through the above-mentioned institutional assessments rather than indiscriminately, to ensure implementers are prepared to undertake their responsibilities and a sustainable capacity is built locally. In case of a project prepared to include feasibility studies and detailed design as part of project formulation and appraisal, the hiring of technical assistants should take place prior to project effectiveness. When it comes to projects designed to perform these exercises after effectiveness and/or formulated under framework operation (e.g. CDD projects), which applies to a majority of cases, the hiring of technical assistants should take place at this stage.

Furthermore, environmental assessment, dam safety plans and resettlement action plans should be conducted as per governing guidelines of the host country and the IFI. Land and water rights for the irrigation scheme should also be clarified, together with the approach and steps for organizing the WUOs. If the project baseline survey was not conducted, there is a need to prepare (or reconfirm) it at this stage.

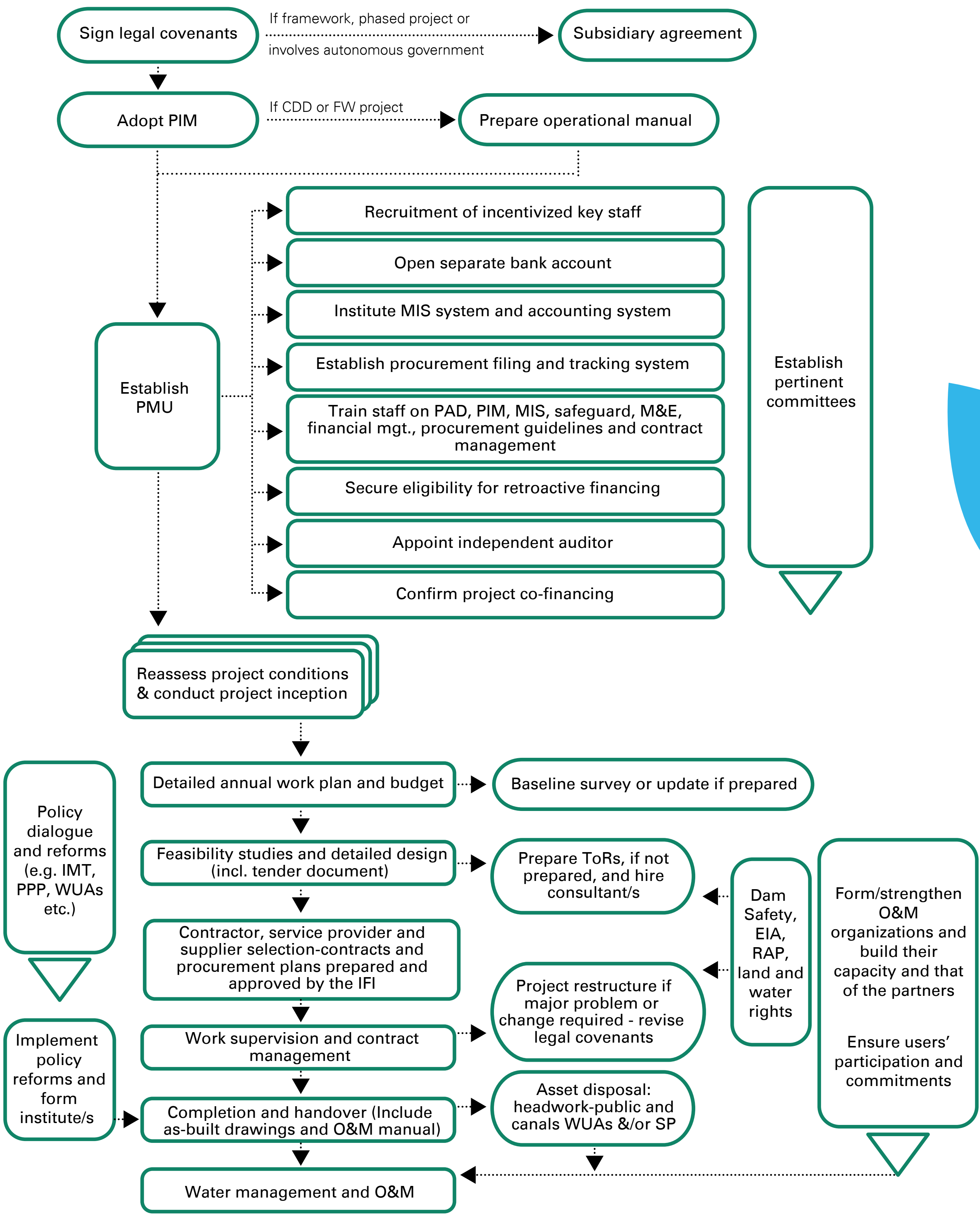
Preliminary training should be organized for relevant stakeholders on identified topics, such as: (i) monitoring of new water use points for water management institutions; (ii) arrangements for land use registration for cadastres; (iii) participatory approach for irrigation departments; (iv) improvement of curricula for academic institutions; (v) development of new training modules for extension services; (vi) organization and operation for scheme operators (including WUAs); and (vii) implementation plan proposed under the project for irrigation departments and irrigators.

In the endeavour to improve irrigation reliability and efficiency, further institutional reform may be needed for the irrigation subsector to link up to:

- The energy sector – to increase the revenue base when energy is produced, or to decrease operational costs for water mobilization and distribution.
- Other water users within the command area who may be willing to contribute financially to maintain or improve service delivery.
- Public and private extension service providers – to improve the use of the irrigation scheme, and eventually support the capacity of irrigation water management and O&M institutions such as WUAs to contribute their share of O&M costs.
- Rural finance institutions – to make sure adequate financial products are available for irrigators to invest at plot level.
- Under this context, policy dialogue may be needed to bring about the necessary institutional and related legal and policy framework changes.

[2] A series of projects could be designed to support a single borrower as part of a programme consisting of a series of two or more projects, or multiple borrowers who are facing a common set of development issues or share common development goals.

Figure 2.2. **Project implementation phases and key steps**



Source: Authors' interpretation of FAO, 1996a.

Disposal of asset rights and arrangements for O&M of irrigation schemes after project implementation should be clarified as early as possible. In a majority of cases, the irrigation headwork infrastructures serving multiple demands remain under public or parastatal institutions responsible for their management. These entities may need to develop new capacities to effectively and efficiently manage the headwork and to expand their revenue base. Sometimes these new capacities may involve a change in the institutional setup itself.

Depending on irrigation system complexities, the O&M of the main system, which includes main and secondary canals, falls under the irrigation service provider and/or the WUAs, while tertiary canals and on-farm structures remain the responsibility of the WUAs.

Irrigation O&M manuals should be prepared and submitted by the supervising engineer together with the as-built drawings at project completion. In addition to providing detailed operational rules and maintenance requirements, the manual should describe the water supply/demand estimation and allocation procedures. The O&M guidelines developed by the government of Gujarat, India, in 2009 (Government of Gujarat, 2009) can be used to prepare an O&M manual for canal irrigation. The *Guidelines for Preparing Operation and Maintenance Manual for Dams*, prepared in January 2018 by the Central Water Commission Ministry of Water Resources, River Development & Ganga Rejuvenation Government of India (Government of India, 2018), could be used to prepare an O&M manual for dams.

2.4.3 Support to O&M organizations

Irrigation O&M organizations can be classified according to whether the organizational structure covers all or several development activities (e.g. water management, agricultural extension, applied research, supply of inputs, credit, marketing and basic infrastructure and social services) or only those related to water management. Within each of these categories a further distinction is made depending on the degree to which management is controlled by the farmers and/or the government. Figure 2.3 illustrates the main forms of irrigation management organizations, including specialized irrigation organizations: (i) irrigation associations (e.g. WUAs); (ii) public (government); (iii) specialized service providers; [3] and (iv) mixed (government/specialized service providers and farmers). More focus is given to WUAs in these *Guidelines* since most of the IFI-financed irrigation projects are mainly centred on WUAs in new or transferred schemes, whether managed or mixed, as described above.

In order to facilitate full participation of WUAs in project implementation and system O&M, relevant information needs to be made available to them from the beginning, using participatory tools such as farmer field schools. This relevant information includes:

- Project activities, costs and implementation plan;
- Land maps (topography and soils) and irrigation scheme map;
- Water and land rights allocation;
- The resettlement action plan;
- The legal status and mandates of WUAs;
- Disposal of assets rights, overall O&M arrangement and responsibilities of relevant stakeholders; and
- Estimation of O&M costs and cost recovery plan as well as clarifying WUA contributions.

Clarifying O&M responsibilities and implications, including commitments of resource requirements to be met, which starts during project preparation, should be reaffirmed and formalized during initial consultation and not during the last minutes of handover.

As part of the exit strategy, such consultations should be combined with adequate and regular technical support to WUAs and practical arrangements, including realistic funding (e.g. O&M fees by WUAs).

Although WUAs are specific interest groups with the objective to manage, operate and maintain irrigation systems at field and on-farm levels, often they are confused with cooperatives. Unless justified and dictated by country or site-specific conditions, it is advisable to establish (or strengthen, if existing) a separate entity of WUAs. In case legislation for WUAs, subject to periodic update, is lacking, bylaws of existing schemes in the country or typical ones from another country (tailored to the country/site-specific situation) could be used to establish and operate WUAs.

Often, ambitious estimates at appraisal level regarding production and market prices of agricultural inputs

[3] Service Providers of Public Private Partnership (PPP) arrangements for new or existing schemes under IMT.

and products may not favour farmers during the actual operation. Unrealistic estimates, combined with inadequate consultation prior to commencement of development regarding the risk factors involved, may compromise farmers' ability and willingness to pay irrigation water/service fees. This in turn will have an adverse impact on O&M and irrigation scheme sustainability. In addition to what has been described in the feasibility studies, there is a need to prepare a more realistic estimate of the parameters of future income stream scenarios for farmers in close consultation with beneficiaries and all stakeholders to come up with more realistic and beneficiary-owned projections and commitments.

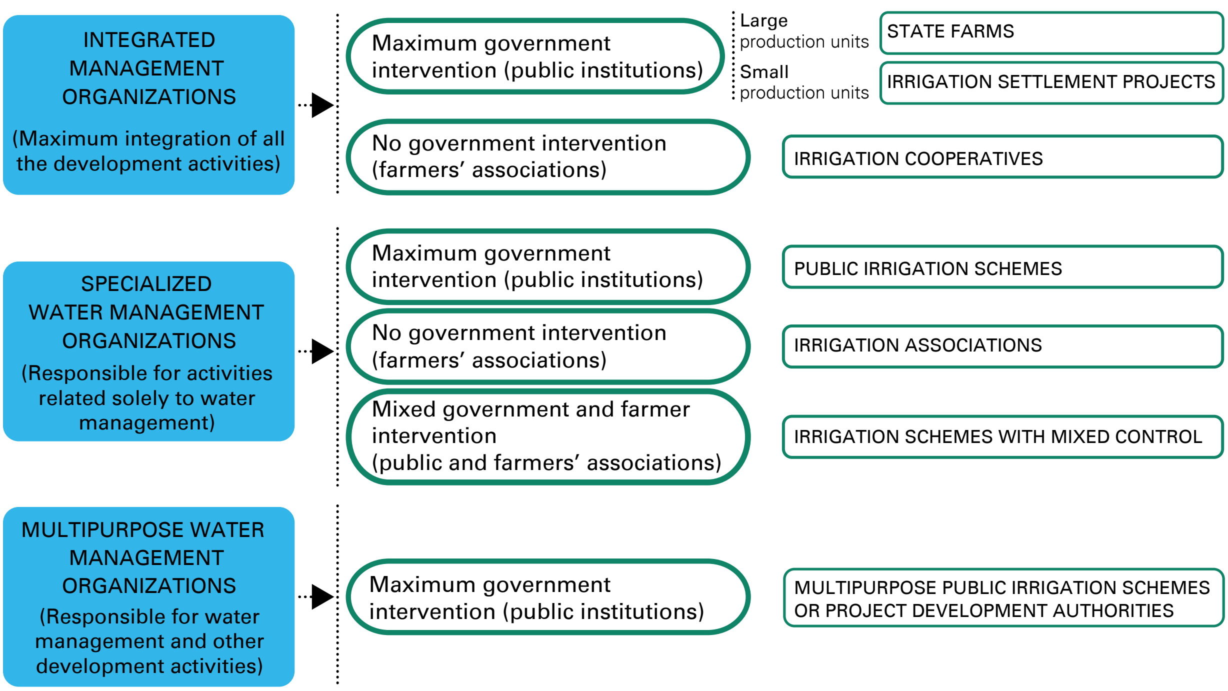
2.4.4 Procurement and contract management

In preparing irrigation construction tender documents, it is important to know the types of contract under which the work can be classified. While observing governing guidelines of the corresponding IFI, the tender document should reflect the type of contract. Contracts can be classified into: (i) measurement contract (the two most common types being bill of quantities [BoQ] contract and schedule of rates contract); (ii) fixed fee or lump sum contract; (iii) cost-reimbursable contract; and (iv) all-in-all contract, package contract or turnkey contract. Any combination of the types of contracts can be incorporated into one contract, depending on their suitability, the prevailing practices in the country and governing project implementation modalities as technically justified (e.g. schedule of rates contracts are preferable for rehabilitation work since quantification is difficult, making BoQ contracts problematic) or as determined in the project implementation manual.

Although the construction bid process can proceed (as per the IFI's procurement procedures) concurrently with the RAP preparation, signing of construction contracts and mobilization of contractors should not resume before the RAP is finalized to avoid conflict and liquidated damage.

Different IFIs have their own procurement procedures, processes and approaches to be followed. For example, the World Bank developed a new *Project Procurement Strategy for Development* in 2016 (World Bank, 2016b) to improve procurement, focusing on: (i) enhanced analysis to ensure that procurement processes are fit for purpose, allow choice and are appropriate to the size, value and risk of the project; (ii) value for money – a shift from the lowest evaluated compliant bid to bids that provide the best overall value for the money, taking into account quality, cost and other factors as needed; (iii) resolution of procurement-

Figure 2.3. Main forms of irrigation management organizations



Source: Authors' interpretation of FAO, 1986.

related complaints by introducing a standstill period between identifying the winner and awarding the contract to allow other bidders to voice any concerns; and (iv) increased involvement of the World Bank in contract management of procurements with high value and high risk.

The procurement plan should be prepared and agreed with the IFI prior to negotiation. For example, the World Bank and IFAD require preparing the first 18 months of the procurement plan of the project during negotiation and updating it every 12 months or earlier during implementation.

Inasmuch as in-kind community contributions are to be encouraged, such contributions may also create problems of quality due to substandard local construction materials and/or mismatch of timing for delivery of supplies to contracted civil works. This may even lead to potential disputes with contractors unless contributions are carefully planned and adequately supervised. In addition to clarifying to the community the quantity, quality and timeliness of the required local materials and labour they are going to provide, these contributions should be indicated in the agreement with the contractor. Moreover, the project should assign a separate quantity and quality surveyor technician to work closely with the community and the contractor to ensure that quantities and qualities are controlled and these tasks are carried out in a well-coordinated manner.

Furthermore, specific attention needs to be paid to how property and use rights for irrigation water and land are created and enforced, with an emphasis on possible gender differences in both willingness and ability to invest labour or other resources in construction work. Similarly, if farmers are paid by contractors, "equal pay for equal work" should be promoted regardless of gender difference.

Depending on the complexity of the project, promoting a culture of enhancing community involvement and/or awareness of the contracting process – as assisted by the implementing agency staff – is to be encouraged. Once the community understands what the contractor is committed to, their role may include creating an enabling environment (e.g. land acquisition, security) for the contractor and the consultant, agreeing on the final acceptance of infrastructure (if possible, as co-signatory) and ensuring that adequate O&M arrangements are in place before handover.

Issues to be avoided, based on lessons learned from implementing irrigation projects, include, among others:

- **i.** inadequate consideration given to assessing past performance and technical capacity when selecting contractors;
- **ii.** tendency of some governments to undertake construction using forced accounts and "friendly" contractors, and to use in-house supervisors, without compelling reason;
- **iii.** selection of contractors being based on lower price without careful performance evaluation;
- **iv.** subcontracting to incapable entities without careful review;
- **v.** improper sequencing (e.g. deployment of contractor before RAP issues are addressed); and
- **vi.** poor supervision and contract management practices resulting in discrepancies affecting the timely and cost-effective delivery of agreed products at the required quantity and quality.

In addition, sometimes consulting companies do not provide the staff proposed during bidding. Strict agreements to avoid such misconduct should be included during the signing of the contract, and if these agreements are not adhered to the contract should be re-tendered.

2.4.5 MIS

Staff of public institutions or contracted project staff with more experience in routine operational/administrative work are often responsible for implementation. It is necessary to improve their capacity by introducing results-based management tools and systems; therefore, a project-wide MIS is required for decision-making and monitoring of project progress and achievement. Preparation of an MIS that is tailored to the specific nature and needs of a given project can be outsourced to a competent specialized service provider to generate a decision-making and problem solving/prevention tool with emphasis on: (i) schedule (time management); (ii) cost (budget management); (iii) scope (performance and quality); (iv) resources (personnel, material, equipment and facilities) management; and (v) comprehensive report.

Use of the MIS software enabling staff and managers to analyse resources, budgets and timelines should be promoted. Such tools can also easily measure progress and anticipate resource needs with acceptable details, as well as generate customizable reports. In addition to the acquisition of computers and required software, training of project staff and managers is equally important.

A project management flow chart (network diagram) that displays the relationships between all components of a project can also be generated using, for example, Microsoft Project software, to determine project progress and links between parallel and successive activities within a project. Customized graphical reports of project data of interest can also be generated easily.

Moreover, in the interest of gaining lessons from ongoing projects for ultimate use in other ongoing and/or potentially upcoming projects in the country and beyond, it is useful to establish a system of: (i) preparing and periodically updating a database of consultants and contractors; (ii) estimating realistic implementation rates by type of work, taking the baseline situation and realistically achievable capacity (given the project scenario) into consideration; and (iii) collecting and periodically updating national unit cost data for construction work items and consultants.

2.4.6 Project restructuring

During the course of implementation, supervision missions may agree with governments on modifications to projects – for instance, to reallocate funds among components or to adjust targets or phasing. The need for such changes may emerge from the findings of monitoring or MIS, or in the course of mid-term reviews conducted as foreseen in the project design.

Different IFIs have their own guidelines to follow for project restructuring and the required procedures to follow during implementation. For example, restructuring of World Bank projects (World Bank, 2014d) is triggered when the bank, the borrower and the member country, as appropriate, agree to restructure the project to: (i) strengthen its development effectiveness; (ii) modify its development objectives; (iii) improve project performance; (iv) modify indicators; (v) address risks and problems that have arisen during implementation; (vi) make appropriate use of undisbursed proceeds from a bank loan; (vii) cancel unwithdrawn amounts of a bank loan prior to the loan closing date; (viii) extend the closing date; or (ix) respond to changed circumstances. Modification of the project's development objectives, an extension of the bank guarantee expiration date, a change in safeguard category – from a lesser category to a Category A (as defined in OP 4.01 or OP 4.03, as applicable) – or the trigger of a safeguard policy not triggered originally by the project is referred to as a "Level One" restructuring. A restructuring involving any other modification of the project is referred to as a "Level Two" restructuring.

The borrower or the project participant who proposes the restructuring should prepare the required documentation, describing the rationale for restructuring and the analysis of associated benefits and risks. Restructurings take effect through amendments to the legal agreements or, if so established in the original legal agreements, through written notice to the borrower.

All restructurings are taken into account when conducting self- and independent evaluation; however, upon a request from the borrower or project participant(s), the bank may decide to extend the closing date if the project's development objectives remain achievable, the performance of the borrower or project participant(s) remains satisfactory and the bank and the borrower or project participant(s) agree on actions that will be undertaken by the borrower or project participant(s) to complete the project. Then the bank processes the extension as a restructuring.

When it comes to IFAD, project restructuring is triggered when the project status and review report indicates that the project is not achieving the desired results as envisaged in the original design, hence calling for mid-course correction and reconsideration of the approach. This, in turn, calls for a restructuring policy that identifies: (i) when a project adjustment is sufficient to merit reconsideration of the approach; and (ii) what actions need to be taken should a project need to be restructured.

2.5 Monitoring and evaluation (M&E)

2.5.1 Purpose, concepts and definitions

M&E is a central part of project management. M&E tools are used by project managers, governments and funding organizations to measure and evaluate project progress and outcomes. M&E data are fed back into the management loop to inform and improve management decision-making.

M&E is necessary to:

- Check that the project (and its individual activities) is on course for completion within the set time frame and budget, and to the required standard;
- Identify and address problems early on; and
- Review project performance and learn lessons.

M&E are distinct but complementary activities (see Box 2.7). Monitoring provides managers and other stakeholders with regular information on progress relative to targets and outcomes. Through the judicious selection of indicators, monitoring should be able to provide a reliable flow of information during project implementation to keep managers informed on project progress. Such data must be both timely and accurate so that decisions can be made to adjust operations to suit progress, and to prepare budget requests for future works. An effective MIS is an essential part of any M&E system.

Evaluation is not a single activity carried out at the end of the project; rather, it is a process carried out periodically during project implementation to assess why targets and outcomes are, or are not, being achieved, and to identify the linkages between the recorded (monitored) performance and possible causes. Frequent evaluation is required during project implementation to "steer the ship" and make measured adjustments to project activities to keep the project on track. Evaluation can be formal or informal: formal for events such as mid-term reviews and end-of-project impact studies; informal or ongoing, with the project manager meeting with project staff each month or week to review project progress.

M&E is clearly intertwined with project design, which is based on a clear and logical hierarchy to achieve the project objectives. The project hierarchy is outlined in Box 2.8, ranging from higher level development objectives to individual project activities and inputs. This hierarchy then leads to a structure for project M&E, as shown in Table 2.4.

Thus, in a results-based project, the M&E programme and indicators are divided into two processes: (i) results monitoring of project objectives and outcomes; and (ii) implementation monitoring of outputs, activities and inputs.

In recent years there has been a shift in emphasis from "implementation monitoring" to "results monitoring" in an effort to ensure that project managers and key stakeholders place sufficient focus on achieving the desired project outcomes and impact. This shift is most clearly seen in the World Bank's use of the results framework; however, results-based M&E systems will still need to build upon the basic processes of implementation M&E, and project design can still make good use of the logical framework approach for identification of project objectives, components and activities.

Box 2.7: Definitions

Monitoring is the continuous collection of data on specified indicators for a development intervention (project, programme or policy) to assess its implementation in relation to activity schedules and expenditure of allocated funds, and its progress and achievements in relation to its objectives.

Evaluation is the periodic assessment of the design, implementation, outcomes and impact of a development intervention. It should assess the relevance and achievement of objectives, implementation performance in terms of effectiveness and efficiency, and the nature, distribution and sustainability of impacts.

Sources: OECD, 2002; Casley & Kumar, 1987.

2.5.2 Structure and stages of project M&E

The project M&E framework is established at the project planning and appraisal stage when the objectives and components of the project are identified. During this stage the indicators to be used for M&E of project progress are chosen, together with the accompanying data requirements and data collection procedures. These indicators and data are then drawn together into an M&E framework, with different organizations and levels of project management using different M&E frameworks. For example, the World Bank and the Asian Development Bank (ADB) use the results framework and logical framework, respectively, to track progress at the higher level (outputs and outcomes), while project management needs a separate framework to track progress with individual, more detailed implementation activities.

As noted above, it is important to understand that there are two distinct M&E frameworks required for internationally funded projects:

i. A higher-level M&E framework is required by the funding organization and government to track progress towards achieving higher-level project objectives such as number of beneficiaries, increase in agricultural production, number of schemes, command area rehabilitated, etc. This M&E framework should be prepared at the project appraisal stage, in the form of either a results framework or logical framework.
ii. A project activity M&E framework is required by the project management to track progress on individual activities. This framework will track progress for activities such as amount of survey work completed, number of designs carried out, number of contracts let, number of water users trained, number of WUAs formed, number of agricultural demonstrations carried out, etc. This M&E framework should be prepared as part of the project plan or project implementation programme, with milestones set for achievement of key activities (such as completion of survey work, completion of designs, letting of tenders, completion of works, etc.) The progress of the individual project activities and outputs feeds into progress towards project results and outcomes.

The key variables in both M&E frameworks are time, cost and quality. In preparing the project plan, it is obviously important that project activities be sequenced and coordinated to achieve the desired outputs (e.g. operational scheme and functioning WUA). It is also important, therefore, that the project management M&E programme track situations where separate activities combine to form a desired output (e.g. a functioning scheme) or outcome.

Box 2.8: Definitions for the levels of a project hierarchy

Higher-level development objective: the longer-term objective, change of state or improved situation to which achievement of the PDO(s) is intended to contribute.

PDO: the combination of one or more project component outcomes which make up the physical, financial, institutional, social, environmental or other development changes that the project is designed and expected to achieve.

Project component outcomes: the effects of project components in terms of observable change in performance, behaviour or status of resources.

Outputs: the products, capital goods and services that result from a development intervention and are necessary for the achievement of project component outcomes.

Activities: the actions taken by project implementers that deliver the outputs by using the inputs provided.

Inputs: the human and material resources financed by the project.

Source: World Bank, 2008b.

During project implementation there are usually four key stages for M&E (Figure 2.4):

- Implementation of a baseline study at the commencement of the project or key project activities;
- Mid-term review, for which studies to ascertain progress are often carried out;

Table 2.4. A logical structure for project M&E

Project logic	Types of indicator	Focus of M&E	Characteristics
Objectives	• Impact	*Results monitoring*	• long-term widespread improvement in society
Outcomes	• Outcome		• intermediate effects for beneficiaries
Outputs	• Output	*Implementation monitoring*	• capital goods, products and services produced
Activities	• Process		• tasks undertaken to transform inputs to outputs
Inputs	• Input		• human and material resources

Source: World Bank, 2008b.

- Impact assessment studies on completion of the project or key project activities; and
- ICR report following completion of the project.

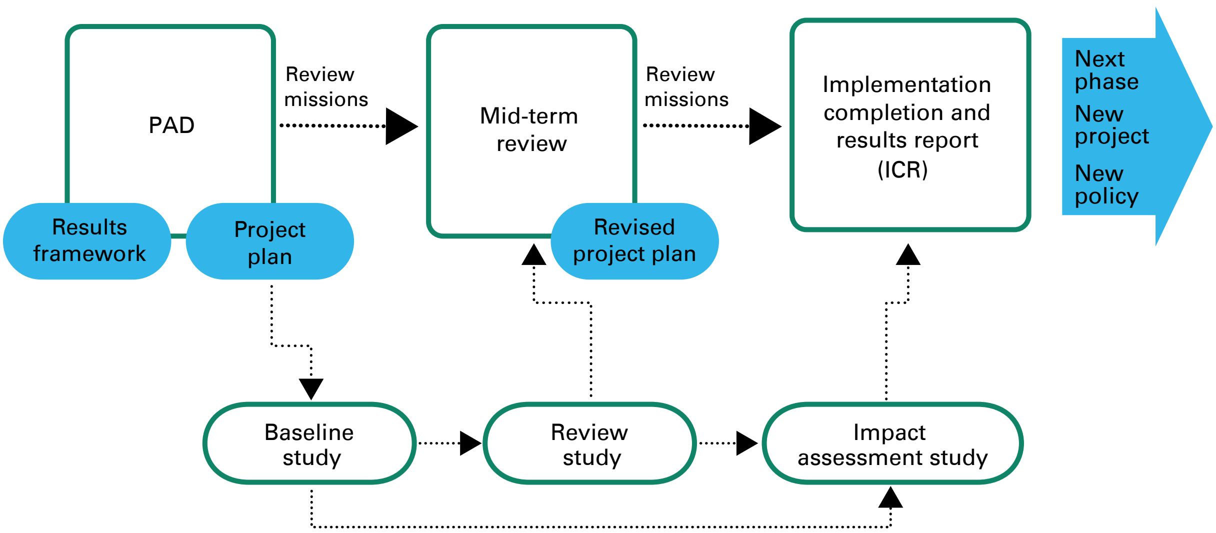
In between these stages there will be periodic review missions.

Depending on the nature and scale of the project, the baseline, mid-term and impact studies may be for the whole project (if the project relates to one relatively small irrigation scheme) or for representative parts of the project. For the rehabilitation of a large irrigation scheme of 40 000 hectares, for example, the studies might be of sample commands or sections of the scheme. For a project rehabilitating 100 minor irrigation schemes ranging in size from 50 to 1 000 hectares, the studies might be carried out for a representative sample of individual schemes.

Baseline study. As the name suggests, the baseline study is carried out to provide the baseline (before project scenario) against which to measure project performance. This study is designed to measure the changes (both beneficial and negative) that are expected to occur as a result of the project activities, such as increase in cropped area, changes in cropping patterns, changes in farmer income, impacts on the environment and the like. It is unlikely that the study can survey all parts of the scheme, so a statistical approach is often adopted to select locations or schemes to survey. In some cases, it is also useful to select locations or schemes as controls, which are not included in the project but have similar characteristics to the project scheme(s). When surveyed again during the impact study these control locations or schemes can provide a valuable measure of changes that may also have occurred in the "without project" scenario. When designing the baseline survey, it is essential to consider the design, components and structure of the impact study, as it is through comparison of the values of the selected performance indicators in the baseline and impact studies that the overall performance and achievement of the project and its objectives will be assessed.

Generally, a specialized M&E organization is hired to carry out the baseline study. Provided that its performance is satisfactory, it is preferable that the same organization also carry out the mid-term and impact studies. In some cases where investments are being made in several schemes, feasibility studies are carried out for each scheme to ascertain whether the scheme is economically feasible and if it satisfies the selection criteria. Sometimes these studies are used as the baseline for the scheme, but they often do not prove satisfactory for this purpose when evaluated at the impact study stage, as insufficient data were collected for purposes of thorough evaluation. Therefore, a specific, tailor-made M&E baseline study is recommended.

Figure 2.4. World Bank project cycle with M&E activities



Source: Masylkanova, 2013.

Mid-term review study. The mid-term review is carried out halfway through the project's duration. The purpose of the review is to:

- review progress;
- review the project's objectives and targets and assess whether they are still relevant and attainable by the project end date; and
- based on the above, assess whether the project date or funding needs to be revised, and in some cases whether a formal restructuring of the project is required.

The mid-term review report should cover the topics outlined in Box 2.9. It can be carried out by the PMU, or the PMU can hire a specialist M&E organization to do the study.

Impact assessment study. The impact assessment study is carried out towards the end of the project, usually by a specialist M&E organization contracted by the PMU. The purpose of the study is to:

i. assess whether the project has achieved its objectives; and
ii. review and assess project implementation.

A clear delineation needs to be made in the impact study between outputs and outcomes (results). Often surveys measure outputs (e.g. lengths of canal or command area rehabilitated) rather than outcomes (e.g. agricultural production increased, farmer income increased). Careful selection of outcome-oriented performance indicators is thus essential.

Review missions. Review missions are organized periodically during project implementation, typically every six months. The review teams are headed by the bank's TTL and generally comprise a multidisciplinary team of bank and FAO or consultant staff. The purpose of the review missions is to review project progress and provide support and guidance to project management. Provision of support and advice to the PMU and staff by the team specialists is an increasingly important part of the review missions, particularly where the PMU is relatively inexperienced in implementation of internationally funded projects. An important role for the review team is to monitor progress on key activities to make sure that these activities are on track or, when not, to advise on how to bring them back on track.

The importance of good quality quarterly reports as a means of reporting on project progress to the review team cannot be overemphasized. In some projects, the PMU prepares reports for the review missions; however, well-structured, regular quarterly reports are far preferable as they provide a consistent reporting format for all project components and activities.

ICR reports. Preparation of ICR reports is an integral part of project management. The ICR process is intended to:

- provide a complete and systematic account of the performance and results of the project and its component parts;
- capture and disseminate experience from the project design and implementation in order to: (i) improve the selection, design and implementation of future projects; and (ii) help to ensure greater development impact and sustainability of future projects;
- provide accountability and transparency with respect to activities of the bank, the borrower and individual stakeholders;
- provide a vehicle for realistic self-evaluation of performance by the bank and the borrower; and

Box 2.9: Topics to be covered in the mid-term review report

- Project summary (project objectives, components, scope, etc.)
- Project progress for key components and activities – planned and actual
- Progress towards achievement of project objectives (values for PDO and intermediate indicators)
- Disbursement of funds – planned and actual, in total and by component
- Assessment of fiduciary matters – procurement and financial management
- Consideration of fund reallocation, if required
- Assessment of difficulties encountered (if any) and action required to resolve them
- Conclusions and recommendations – objective assessment of project progress and potential for achieving objectives and targets by planned project end date; recommendations for action to improve performance, if required.

Source: Authors.

- contribute to databases for aggregation, analysis and reporting on the effectiveness of lending operations.

The audiences for the ICR report are both internal (IFI board members, managers and staff) and external (governments and their agencies, stakeholders and beneficiaries). The final ICR report is also disclosed to the general public.

The ICR report is prepared by a team of specialists, either just before closure or immediately after closure of the project. The World Bank requests that the ICR report be submitted and approved by the bank within six months of project closure.

The ICR team should review the data available, interview project and bank staff and make field trips to see the work done and speak with project staff and beneficiaries. The team should then analyse the data and information gained from their discussions, particularly with respect to achievement of project objectives. They should also look at patterns of implementation, procurement and disbursement profiles and performance of bank, project and government with respect to the planning, design and implementation of the project. The contents of the ICR report are shown in Box 2.10. The data sheet is an important part of the ICR report, summarizing the key data, particularly the analysis of the performance indicators from the results framework.

M&E reporting

(i) Quarterly reports. Preparation of good quality quarterly and annual reports is often a weakness in project M&E, but, if done properly, they can contribute significantly to project management and preparation of the mid-term review, impact studies and ICR report.

The key is to set up the quarterly report in a standardized format at the start of the project and then to fill in the data as the project progresses. Box 2.11 shows a typical format for the report. The final quarterly report of the year doubles as the annual report, with data being reported for the fourth quarter but also for the year overall (using data reported in each of the preceding quarterly reports).

In setting up the report format it is useful to identify and set out summary tables and graphs to show project progress, such as a table and supporting figure on quarterly progress with establishing and registering WUAs (Figure 2.5) or a table and graph to show quarterly progress on completion of surveys, designs, letting of contracts, completion of construction work, etc.

(ii) Review mission reports. Project review missions submit reports to the lender and to the organization's management. For the World Bank these reports consist of reports to the TTL by individual team members, which are then compiled by the TTL into an aide memoire that is submitted to bank management and the borrower. In addition, an ISR report is prepared.

The individual specialist reports on the areas of the project assigned by the TTL and summarized in the statement of mission objectives issued before the mission. The aide memoire should summarize the findings of the mission's team by reporting on progress with project activities, disbursement, project management and issues affecting project implementation. Similarly, the ISR report describes project progress but in a more structured format than the aide memoire. The ISR report describes progress towards attainment of objectives and provides a rating of project progress according to eight grades – Highly Satisfactory (HS), Satisfactory (S), Moderately Satisfactory (MS), Moderately Unsatisfactory (MU), Unsatisfactory (U), Highly Unsatisfactory (HU), Not Applicable (NA) and Not Rated (NR). It also reports on planned and actual disbursement of funds, key issues facing project implementation, compliance with safeguards and covenants, risks, financial management and composition of the review team. It should report on project results using the indicators given in the results framework by giving the current value of each indicator together with the baseline, previous mission value and end target value. The ISR report is an essential part of reporting for bank management but also forms an important source of data for the ICR report.

2.5.3 Organizing project M&E

An M&E unit needs to be established in the PMU at the outset, with a staff of at least two to three people, including an M&E specialist and two data managers/processors. For projects that have activities spread out over several regions or districts there may also need to be one to two people in each regional/district project office who are responsible for data collection and processing. The M&E unit should report to the project director for all matters relating to M&E, including all surveys (baseline, mid-term, impact), preparation of monthly progress reports,

Box 2.10: Contents of the ICR report

Data sheet

1. Project context, development objectives and design
2. Key factors affecting implementation and outcomes
3. Assessment of outcomes
4. Assessment of risk to development outcome
5. Assessment of bank and borrower performance
6. Lessons learned
7. Comments on issues raised by borrower/implementing agencies/partners

Annex 1. Project costs and financing

Annex 2. Outputs by component

Annex 3. EFA

Annex 4. Bank lending and implementation support/supervision processes

Annex 5. Beneficiary survey results

Annex 6. Stakeholder workshop report and results

Annex 7. Summary of borrower's ICR and/or comments on draft ICR

Annex 8. Comments of co-financiers and other partners/stakeholders

Annex 9. List of supporting documents

Source: World Bank, 2014a.

Box 2.11: Typical format for quarterly reports

1. Introduction
2. Background
   - i. Project objectives
   - ii. Project indicators
   - iii. Project components and activities
3. Project financing and costs
   - i. Budget
   - ii. Progress against budget
   - iii. Procurement and financial management
4. Report on Component 1 activities
   - i. Summary of component activities
   - ii. Report on progress with each activity
5. Report on Component 2 activities
   - i. Summary of component activities
   - ii. Report on progress with each activity
6. Report on Component 3 activities (etc.)

Supporting annexes

A.1. Budget and expenditure data

A.2. Procurement details

A.3. Supporting data for key activities

A.4. Additional useful data

Source: Authors.

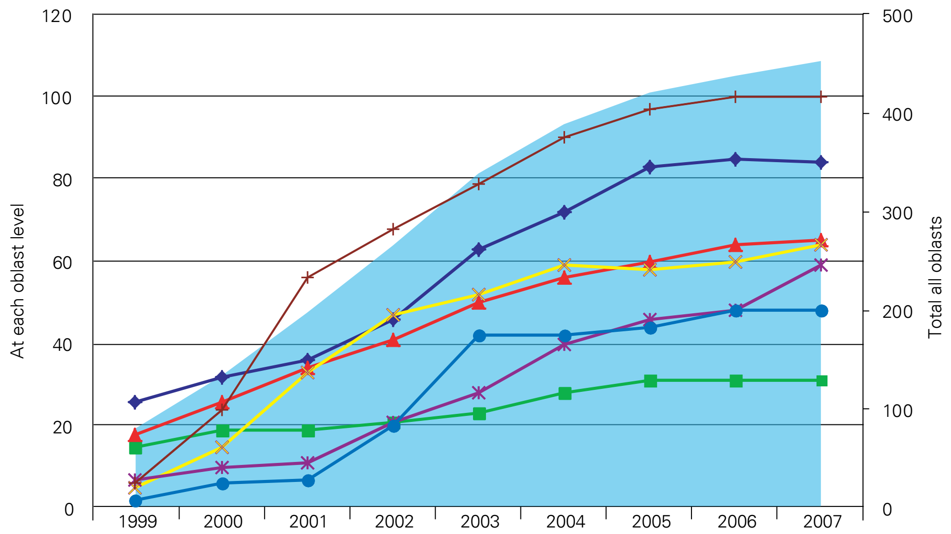
preparation of quarterly and annual reports, preparation of data for mission review teams, etc. The M&E unit is also responsible for organizing data collection at all levels within the project, and for organizing data processing and reporting systems. If the members of the M&E team are inexperienced, a short-term specialist consultant may be hired to train them and help them set up these procedures.

In some cases, an M&E consulting firm may be employed to assist the M&E unit in data collection, processing and analysis. This has both merits and drawbacks – merits in that there is an obligation for the consultants to collect, process, analyse and report on project progress, but drawbacks in that the consulting firm may be seen as an external agent rather than as an integral part of the PMU, and the responsibility for M&E as lying with the consultants rather than with the PMU. The responsibility for M&E should always be with the PMU.

Before the project begins, the processes and procedures for implementing the project should be set out in a project implementation plan. This plan should cover all aspects of M&E, including the indicators to be used to monitor progress and performance, the data to be collected and how they will be processed, analysed and reported on. The plan should also detail by whom, when and how frequently the data will be collected and reported on. Key questions that have been found useful in establishing M&E frameworks are presented in Box 2.12.

As noted in the previous section, systematic and regular reporting is an essential part of M&E, for which

Figure 2.5. Example of a table and graph to report progress on establishment of WUAs



	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total	79	132	196	264	337	387	419	436	451
Osh	26	32	36	46	63	72	83	85	84
Batken	15	19	19	21	23	28	31	31	31
Jalalabad	18	26	34	41	50	56	60	64	65
Talas	5	15	33	47	52	59	58	60	64
Issyk-Kul	7	10	11	21	28	40	46	48	59
Naryn	2	6	7	20	42	42	44	48	48
Chui	6	24	56	68	79	90	97	100	100

Source: Field data collected by OIP Staff, September 2007.

Box 2.12: Useful questions to ask in setting up an M&E framework

The following questions can be used to prepare the plan for data collection, processing, analysis and reporting:

- **What** – the data to be collected, in what form, with what degree of aggregation or consolidation, and for what purpose;
- **When** – the frequency of data collection and reporting;
- **Who** – the responsible persons, their responsibilities and capacities;
- **How** – methods and procedures for data collection, checking, validation and storage, and for analysis and reporting;
- **Where** – locations for data collection and processing, and the destinations for reported information.

Source: World Bank, 2008b.

processes and procedures should be established at the outset. Standardized quarterly reporting greatly simplifies the task of M&E; by setting up systems early on, the process will become routine for the project team members and will greatly simplify the process for both annual report and final project evaluation reporting. The key is to include all the core project activities and impacts in the quarterly report, and to establish standard reporting formats, tables and figures for these activities and impacts, together with the associated project processes of management and financial control.

With the advent of the Internet, Web-based MIS are becoming the preferred option for project reporting and data collection. These systems can be used to enable project staff in regional and district offices to enter data directly into the system and thus avoid the double handling of data associated with paper-based reporting systems. If Internet connections are not feasible, then computer-based systems should be set up with standardized spreadsheet reporting formats, such that when data are sent in to the central M&E unit from outlying stations that data can be readily abstracted and compiled for project reporting.

Table 2.5. A logical structure for project M&E indicators

Logic	Indicators	Nature of the Indicators	
Objectives	Impact	• Long-term statistical evidence	Exogenous and cross-cutting indicators
Outcomes	Outcomes	• Social and economic surveys of project effects and outcomes • Leading indicators giving management advance warning of beneficiary perceptions, responses to the project and other measures of performance	
Outputs	Output	• Management observation, records and internal reporting	
Activities	Process	• Task management of processes • Financial accounts • Management records of progress • Procurement processes	
Inputs	Input	• Financial accounts • Management records of inventories and usage	

Source: World Bank, 2008b.

2.5.4 Selection and use of indicators

Indicators are used to provide quantitative and qualitative information required to monitor and evaluate the progress and achievement of the project objectives. Selection of these indicators is a central part of project design. Table 2.5 summarizes the nature of the indicators and the typical sources of information to quantify them. Table 2.6 shows the types of indicators and their role in M&E.

The World Bank results framework uses outcome indicators to measure achievement of the PDO and each of the project components. To enable comparison across projects in the same sector, a number of core results indicators have been identified; these and other possible indicators for irrigation projects are presented in Table 2.7.

Note that it will also be important to collect data to measure these indicators in the "without project" scenario in order to properly assess the contribution (attribution) of project activities.

Table 2.6: Structured indicators for project M&E

Impact indicators: measures of medium or long-term physical, financial, institutional, social, environmental or other developmental changes to which the project is expected to contribute. **Outcome indicators:** measures of short-term change in performance, behaviour or status of resources for target beneficiaries and other affected groups. **Output indicators:** measures of the goods and services produced and delivered by the project. **Progress indicators:** measures of the progress and completion of project activities within planned work schedules. **Input indicators:** measures of the resources used by the project.	**Leading indicators:** advance measures of whether an expected change will occur for outcomes and impacts.	**Cross-cutting indicators:** measures of cross-cutting concerns at all levels. For example: gender-disaggregated differences; regulatory compliance; legislative provision; capacity building.	**Exogenous or external indicators:** measures of necessary external conditions that support achievement at each level.

Source: World Bank, 2008b.

Table 2.7. Possible indicators for irrigation and drainage projects

Indicator	Remarks
A. Commonly used indicators	
(i) Results (outcome) indicators	
Average increase in crop production per unit command area (kg/ha)	Composite measure of increased area and increased crop yields. Can be monetized to express average total increase in value of crop production per unit command area (USD/ha) to allow for mixed cropping.
Average farm income of project beneficiaries (USD/ha)	Can be set as a value or as a percentage increase in farm income. Needs to be measured relative to the "without project" scenario.
Targeted families with increased incomes (%)	Percentage of the target beneficiaries whose incomes are increased. Needs to be measured relative to the "without project" scenario.
Increased crop production per unit of water delivered (kg/m^3)	Increasingly important composite indicator, measures improvement in water delivery, agronomic practices and institutional arrangements (WUA formation). Measured for predominant crop(s). Needs to be measured relative to the "without project" scenario.
Increased crop production per unit of water delivered (USD/m^3)	Similar to the above but useful for mixed cropping. Converts kg into gross or net value of production. Needs to also monitor crop prices before and after to monitor and discount for inflation.
Average fish productivity in reservoirs (kg/ha WSA) WSA = water spread area	Required if fisheries are part of the project. Fisheries can add significant value and benefit an additional group of beneficiaries.
(ii) Intermediate results indicators	
Systems where performance management targets are established and being met by system managers (number)	Performing systems are an intermediate result contributing to increased agricultural production and farmers' livelihoods. Used where there are several or many schemes in the project.
Irrigation service delivery by service providers (Irrigation Department and/or WUAs) assessed as satisfactory or above by at least 60%* of water users in schemes that are already completed (number)	Qualitative measure of water users' perceptions. Need to define service delivery, usually defined in terms of reliability, adequacy and timeliness of water supply, with data obtained from a survey of water users. -This figure can be adjusted as required.
Irrigation schemes completed (number)	Should match the target number of schemes planned. Used where there are several or many schemes in the project.
Systems ready and able to supply the planned volume of water at specified delivery points (number)	Intermediate indicator of ability to provide the required level of service to water users. Used where there are several or many schemes in the project.
Schemes where intensified agricultural production practices have been adopted by at least 60%* of water users (number)	Used where there are several or many schemes in the project. Can be adapted to apply to a single scheme by taking percentage of farmers in the scheme adopting improved practices. - This figure can be adjusted as required
WUAs formed and operational (number)	Useful intermediate indicator for institutional component of the project.
B. Core indicators (World Bank)	
Area provided with irrigation and drainage services – new (hectare)	Core indicator for new scheme(s).
Area provided with irrigation and drainage services – improved (hectare)	Core indicator for rehabilitated, upgraded or modernized scheme(s).
Operational WUAs created and/or strengthened (number)	Can use as an intermediate results indicator to measure progress on formation of WUAs.
Water users provided with new/improved irrigation and drainage services (number)	Total number of water users (men and women).
Water users provided with irrigation and drainage services – female (number)	Total number of female water users benefiting from the project.

Source: World Bank, 2013b.

PART 3 INNOVATIVE APPROACHES AND TOOLS

3.1 Water governance

3.1.1 Concept and approach of water governance

Water Governance – an innovative approach. Water governance encapsulates issues that have always been part of the identification, planning, implementation and assessment of irrigation systems. Introducing a systems perspective, the water governance approach integrates policy, legal, institutional/organizational aspects and also adds issues of power and political economy to the analysis, particularly in the design phase. It draws attention to the interrelated nature of the above-mentioned factors influencing the decision-making environment as well as the decision-making processes themselves – in this case related to the preparation of investment programmes in the irrigation sector.

From "good governance" to problem-driven governance and political economy. For more than two decades, beginning in the early 1990s, expert thinking in the international development community has been predominantly, though not exclusively, organized around the concept – and political project – of promoting "good governance". During its heyday from the early 1990s to the late 2000s, the good governance agenda was elaborated in a way that generally prioritized commitments to greater transparency, broadening participation and ensuring social inclusion in deliberative processes, eliminating corruption and promoting institutional reform. Enormous investments were made, backed by good governance programme lending, to enforce new standards of financial management and public administration. These were matched by an expansive work programme centred at the World Bank to develop indicators and implement monitoring systems to track progress by governments towards meeting these normative and highly formalized criteria of good governance.

The expectation was that, over time, a strong positive correlation between progress toward "good governance" (as defined by the good governance indicators) and high or improved economic performance would be established. By the mid-2000s, however, it was becoming clear that this expectation would not be met. A key limitation of the good governance agenda was that it was too formal and procedurally oriented to address the complex policy bottlenecks and political conflicts that impede effective governance. At the same time, host governments became less and less willing to invest in programmes that offered few tangible benefits and were increasingly viewed as a diversion from more important developmental pursuits. Finally, during the past decade, the preponderance of expert opinion has moved away from the "good governance" project in favour of a more modest and pragmatic agenda, defined by a commitment to iterative, bottom-up, problem solving and experimental approaches to improved or more effective governance. Today, these new governance approaches are frequently supplemented by political economy analyses that seek to identify and evaluate the roles, interests and likely responses of key stakeholders and institutions. The goals of such analyses are three-fold. First, they provide key guidance for the design and evaluation of technical solutions, which must be informed by a realistic appraisal of the political, economic and social context for which they are being designed. Second, they help to identify key stakeholders – including the poor and politically voiceless – who must be consulted and engaged, and the vital substantive issues and interests that need to be addressed in the decision-making process to ensure outcomes that are both workable and legitimate. And third, they help provide guidance for potential institutional adaptation and development that can provide lasting solutions to the identified problems.

Governance in irrigation project design and implementation. The political and institutional environment has direct implications for project design and implementation. The principles applied to obtain "good governance" (transparency, accountability, etc.) are regularly used in the context of the projects' risk assessment of the capacities of the institutions involved. Some specific governance issues, such as conflicts of interest between stakeholders or inequalities of access to land and/or water, also influence project design and implementation and could determine whether the project will be successful.

3.1.2 Process and steps of governance analysis

How to approach governance. Irrigation projects cannot be properly designed or implemented without recognizing the roles of politics and institutions. When analysing potential solutions to identified problems, it is as important to understand the actors and politics surrounding the issue as it is to develop a sound technical approach. Very often, governance issues have hindered successful implementation, even though adequate technical solutions were adopted. Governance analysis helps to understand how structures, institutions and the use of power interact in the deliberation over ideas, interests, values and preferences, and how different individuals, groups, organizations and coalitions contest or cooperate over resources, rights and public rules to find political arrangements or shape institutions and policies in an ongoing process.

Governance is "the process of political decision-making that, beyond the rules, regulations and other institutional processes, considers the underlying dynamics of the relationships between the involved stakeholders determined by e.g. power and influence and other incentives for behaviour". (FAO, 2016)

Governance analysis can help to identify, analyse and then propose solutions to potential governance bottlenecks, in order to invest in understanding the politics around a given technical issue or problem. This will increase the chance of the operation being effectively implemented and sustainable. This does not mean that investment projects should be getting involved in country politics, but to find solutions which are technically sound and politically feasible.

Analysing and addressing governance in the project cycle. The problem-driven governance analysis approach can be applied to the project cycle. This will help to identify potential governance issues and/or problems at every step of the project cycle, from identification to preparation, appraisal and implementation, in particular during context and institutional analysis.

Problem-Driven Governance Approach: 3 Steps (FAO, 2016)

This approach can be applied at either country or local level, starting with a problem diagnosis. As mentioned above, the assumption is that a problem-driven approach is more likely to lead to specific findings and actionable recommendations than would approaches that have a broad emphasis on "understanding the context" or a focus on testing existing theories.

Step 1: Identification of the governance problem

As illustrated in Figure 3.1, the first step is to identify specific governance challenges that might affect the project design and implementation. There are generally two possible cases: (i) governance issues are at the heart of the project interventions, such as a water sector reform project; or (ii) project interventions focus on technical solutions, but governance options can help ensure project success, such as an irrigation modernization project, for which expectations and interests of all major stakeholders need to be adequately analysed, addressed and incorporated. Governance problems arising from these types of situations typically involve conflicts of interest in the access to resources or fear of marginalization of certain target groups (e.g. ethnic minorities, smallholders in value chains) and can be understood and addressed through stakeholder or political economy analyses.

Step 2: Analysing the governance issues

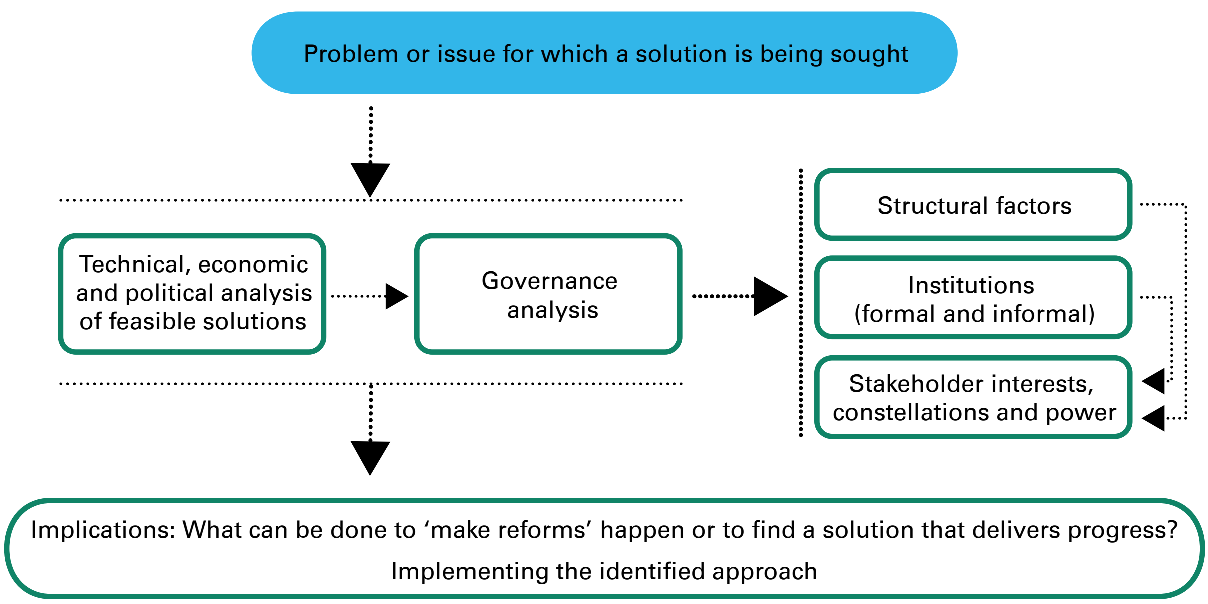
The second step consists of analysing why the observed dysfunctional patterns exist. The analysis will likely have to cover three dimensions: (i) relevant structural factors that influence stakeholder positions; (ii) existing institutions, including institutional dysfunctions that channel behaviour, as well as ongoing institutional change; and finally, (iii) stakeholder interests and constellations. Also, as shown by the arrows on the right side of Figure 3.1, structural factors, stakeholders and institutions are interdependent.

Structural factors influence stakeholder incentives and opportunities. Relevant structural factors in the context of FAO-related interventions can include the orientation of the country's (agricultural) economy (export-oriented vs. domestic), predominant land tenure regimes, or the existence (or absence) of a significant subsector of smallholder agriculture. These factors may have significant effects on stakeholder incentives and opportunities. Existing institutions and their capacities, in addition to well-designed and established legal frameworks, are fundamental for the success of policies and programmes supporting agriculture, food security, nutrition and natural resource management – particularly in a context in which any option to improve the situation of currently disadvantaged segments of the population requires institutional and legal prerequisites to ensure the participation and access to resources of these target groups. Being aware not only of the expectations and sensitivities of the stakeholders involved, but also of the inherent power relationships, is fundamental for the success of any policy change agenda. Programmes can be adapted to better incorporate existing power constellations, and these can sometimes be altered through careful and time-consuming negotiation processes (as some of our case studies will show). However, in some cases, conflicts of interest between equally powerful stakeholders may lead to the decision to abandon a desired programme.

Step 3: Developing priorities for action

Once the salient governance problems have been sufficiently analysed, the third and final step is to identify ways forward, including how to initiate change. Hopefully, the analytical recommendations will help to develop a road map for operational engagement at potential entry points and ways to engage. As the case studies will show, there are numerous options to address governance problems. They might not solve all problems, and sometimes important project objectives might not be reached. But in many cases, they will help to improve the impact of the project, which is exactly what governance interventions are intended to achieve. The policy and operational recommendations must be clear about risks and offer options and positive ways of engaging in a politically sensitive way in a given context. These options may include how to identify the areas with the greatest potential overlap between political incentives and policies that foster development progress, how and with whom to engage to expand opportunities for progress, or how to increase the prominence of certain policies on a government's agenda. The implementation of the proposed recommendations – whether in addressing governance problems in primarily technically oriented programmes, or in institutional reform or promotion of multistakeholder and multisectoral processes – will require step-by-step approaches and may need ongoing repetition of the above-presented three-step approach under frequently changing environments. However, manifold experience and cumulative learning has shown that for complex social change, iterative processes addressing clearly identified (governance) problems are the most successful way to achieve impacts in the long run.

Figure 3.1. Key aspects of problem-driven governance analysis



Source: FAO, 2016.

3.2 Water accounting and auditing (WAA)

Water scarcity (defined as an excess of water demand over the available water supply) is an important global challenge (FAO, 2012e). In order to address this challenge, it is necessary to make better use of water-related information when matching and adapting coping strategies for demographic, economic and dietary trends and climate change in different biophysical and societal contexts. Therefore, WAA should be a central element of any project that aims to improve water security under conditions of increasing water scarcity.

Over the last two decades, various initiatives have started to develop a system of WAA to support water managers and decision-makers; however, up to now a clear standard has not emerged, given the fact that quite a diverse set of frameworks have been proposed. As of today, the most relevant WAA frameworks developed include:

i. International Water Management Institute – WAc Framework;

ii. United Nations Statistics Division – System of Environmental-Economic Accounting for Water;

iii. WAc Standards Board – Australian WAc Conceptual Framework;

iv. UNEP's Water Footprint, Neutrality and Efficiency (WaFNE); and

v. Challenge Programme on Water and Food (CPWF) – Water-use Accounts Framework.

These WAc frameworks have been demonstrated to be useful in the context of specific studies, often with a strong research focus. There is a growing group of policy-makers, water managers and donors who realize that, like the financial accounting of organizations, WAA is essential to ensure a sustainable use of water worldwide.

The WAA process summarized below is the result of an in-depth study conducted by FAO in 2016.

3.2.1 Objectives and rationale for WAc

FAO (2012) describes WAc as the systematic study of the current status and trends in water supply, demand, accessibility and use in domains that have been specified. In a practical sense, WAc is used as a basis for evidence-informed decision-making and policy development. WAc provides a solid framework for systematically acquiring, quality controlling and analysing water-related information and evidence. In most cases, this information and evidence will be interdisciplinary and derived from a wide range of independent sources. A crucial aspect of WAc is that it considers and assesses both the supply and the demand sides of water supply systems.

WAc is important because, without reliable information, stakeholders have no basis for challenging factually incorrect or biased positions. In fact, effective planning is nearly impossible if stakeholders are working with their own differing information bases, as often occurs. WAc also matters because disconnects often exist between hydrological knowledge (based on scientific evidence) and popular understanding of hydrology (based on beliefs, folklore and hearsay).

The typical objectives of WAc include:

- producing a rigorous quantitative and qualitative description of the current status and trends in water supply, demand, accessibility and use;
- developing a sound understanding of the predominant biophysical mechanisms, processes and pathways that determine flows, fluxes and stocks of water;
- identifying the underlying biophysical causes of problems relating to imbalances in water supply and demand;
- assessing the probability of risks and scales of extreme events, and the resilience or vulnerability of society and the environment to these events;
- identifying (and resolving) fundamental differences of opinion or understanding between stakeholders and/or specialists and establishing a shared information base that contains uncontested information;
- using multiscalar analysis to identify consumptive and non-consumptive water uses at different scales and the potential for using recycled water or return flows to increase the net beneficial use of water and reduce risk of pollution;
- identifying the scale, severity and nature of intersectoral or upstream or downstream conflicts over the allocation of water resources and the exercise of formal or informal rights to water;
- assessing whether or not existing water policies and practices are working well; and

- using state-of-the art modelling, scenario building and similar techniques.

3.2.2 Existing approaches to WAc

A distinction needs to be made between WAc approaches that are designed to support a project and those that are part of an adaptive management programme that aims to achieve long-term policy objectives. When planning WAA, an important trade-off is between rapid or comprehensive WAc.

3.2.3 Water accounting plus (WA+) – remote sensing

The newly developed water accounting plus (WA+) framework builds on a combination of systems and approaches developed in the past. WA+ is based on remote sensing data and should therefore be easily applicable in all basins. The basis of the WA+ framework is the standard water balance approach, with specific emphasis on the various water users.

Because of the wide variability of options, WA+ divides the river basin landscape into use by four main land and water groups:

- Conserved Land Use: areas where changes in land and/or water management practices are prohibited by law; examples include national parks, wetlands, etc.
- Utilized Land Use: areas where vegetation is responding to natural processes and human interference is minimal; examples include forests, natural pastures and savannas.
- Modified Land Use: areas where vegetation and soils are planned and managed by people, but all water flows are natural; examples include urban areas, rainfed agriculture and forest plantations.
- Managed Water Use: areas with water use sectors that abstract water from surface water and/or groundwater resources; examples include irrigated agriculture, urban water supplies and industrial extractions.

Results of WA+ are presented in three so-called accounting sheets:

i. Resource Base Sheet;
ii. ET Sheet; and
iii. Productivity Sheet.

3.2.4 Objectives and rationale for water auditing (WAu)

According to FAO (2012), WAu goes one step further than WAc by placing trends in water supply, demand, accessibility and use in the broader context of governance, institutions, public and private expenditure, legislation and the wider political economy of water of specified domains. The focus of WAu is on assessing and understanding the broader societal context of water management, water supply or water services delivery. Similar to WAc, WAu can take many different forms, ranging from a relatively rapid one-off activity designed to achieve a specific purpose to a long-term M&E programme. Data collected during WAu and its outputs vary in form, formats, target audiences and uses.

There is a wide consensus that governance assessment and political economy analysis are

PART 3

Figure 3.2. Trade-offs between rapid vs. comprehensive approaches to WAc

Rapid	Comprehensive
Initial identification of priority problems or issues relating to trends in water supply, demand and access within a specified domain.	Aimed at developing a comprehensive water-related information base that covers all water-related supply and issues relevant to a specified domain.
Initial assessment of relatively easily accessible quality-controlled secondary data relating to trends in water supply, demand and accessibility. Primary data collection restricted to gap filling. Initial assessment of causes of problems.	Comprehensive consolidation, quality control and assessment of secondary data relating to trends in water supply, demand and accessibility. Primary data to fill gaps and to find new insights into the causes of and potential solutions to problems.
Stakeholder dialogue aimed at identifying priority issues or problems. Preliminary identification of possible causes of and solutions to problems.	Establishment of a multistakeholder platform to ensure that stakeholders are actively involved in identifying root causes of and solutions to individual and/or combinations of all problems.

Source: FAO, 2016.

essential steps in programmes that, for example, aim to achieve and maintain acceptable levels of water services. WAu is also important if key stakeholders are supposed to "do better" by:

- learning from the past, consolidating and making good use of biophysical and societal evidence that can indicate whether specific policies and practices are or are not working;
- making choices that are informed by evidence rather than intuition or guesswork;
- developing new policies and practices or adapting existing policies and practices to, for example, take better account of imbalances in water supply and demand; and
- communicating information in ways that increase the probability that it will be owned, accepted, valued and used.

However, it is important for stakeholders to recognize that there may be scope to do better either in formulating policies and practices or in the ways in which these are interpreted and implemented.

Objectives of WAu include:

- identifying the underlying societal causes and feedback mechanisms that lead to the unsustainable use of water resources, the lack of infrastructure and the inadequate, unsustainable, inequitable or inefficient delivery of water services;
- identifying, adapting or developing solutions to priority water-related problems that are politically, socially and culturally acceptable;
- providing a coherent framework for assessing the wide range of societal factors that influence trends in water supply, demand and access;
- gaining a good understanding of how water-related decisions are made in specified domains;
- assessing the effectiveness and utility of statutory and customary laws and systems of enforcing these laws;
- using a range of proven investigative and diagnostic methods and tools to gain insight into the reasons why carefully designed water sector reform programmes often fail to deliver desired outcomes; and
- using expenditure reviews, life-cycle cost assessment, cost curve analysis, input tracking and other tools to track both public and private expenditures.

3.2.5 Existing approaches to WAu

Before selecting the most appropriate approach to WAu, a crucial first step is to identify needs and priorities and the institutional levels at which WAu will be of most value to key stakeholders. The attributes of three approaches to WAu (governance assessment, political economy analysis and a combination of both) are compared below.

Consideration should also be given to the potential synergies between WAc and WAu. Mutual support and integration of interdisciplinary biophysical and societal analysis will be easier and more productive if the same or similar spatial and temporal scales and granularities are used when collecting, processing and analysing information and making recommendations.

There are practical reasons for combined WAc and WAu. For example, there is a higher probability of identifying the underlying causes of water-related problems and viable opportunities for addressing problems. However, a more fundamental reason is that WAc is more likely to prompt change if it is carried out in conjunction with WAu. One lesson from water sector reform programmes is that changes often fail or take decades to achieve their goals.

WAc and WAu are mutually supportive: WAc supports WAu by providing insights and a better understanding of information, such as physical availability of water stocks and flows in time and space, and balance between water supply, demand and access. WAu supports WAc by providing information such as stakeholder roles, responsibilities and interrelationships at different levels and governance systems.

3.2.6 Overall approach to WAc and WAu

According to FAO, the overall approach to WAc and WAu unfolds according to the following sequence (FAO, 2017a):

i. Inception activities: Some are one-off activities, while others may need to be repeated or continued during the WAA processes.
ii. Stakeholder engagement activities or inputs: There are significant benefits to be gained when stakeholders are actively engaged in inception activities.
iii. Cycles of WAA: This means starting with relatively rapid or coarse assessments or analyses and, with

Figure 3.3. Comparison between different approaches to WAu

Attributes	Governance assessment	Political economy analysis	Combination of both approaches
Adaptable and flexible	All three approaches can be adapted to meet specific needs or a specific context		
Guidelines and case studies available on the web	No major differences		
Problem-focused	More likely to be prescriptive	Designed to identify and analyse problems and/or opportunities	Can be both prescriptive and problem-focused
Interdisciplinary/holistic	Focus mainly on governance principles and indicators	More wide-ranging. Can also include expenditure review, accountability assessment, reviews of legislative frameworks, approaches to managing demand	
Multilevel analysis	More likely to be used at one level (i.e. the macro or national level)	Designed to study governance and the political economy of a specified domain at different levels	
Stakeholder sensitivities	Less threatening especially if indicators are modified following stakeholder dialogue	May be perceived as more intrusive and threatening	Can start with a governance assessment and progress towards political economy analysis
Specialist inputs	Relatively fewer required	Relatively more required	
Presentation on maps along with biophysical info	Relatively easier especially if geo-referenced ordinal scoring is used	Relatively more difficult	Relatively easier especially if geo-referenced ordinal scoring is used
Strategic governance objective	Emphasis is on achievement of "good governance"	Emphasis is on achievement of "good enough governance"	
Operational value to strategy development, planning and M&E	Most useful for comparative analysis or monitoring of governance	Most useful for evaluating the causes of problems and identifying solutions to these problems	Can be useful for monitoring, identifying the cause of problems and evaluating opportunities
Usefulness as a "partner" to WAc	Most useful as a partner to rapid WAc	Most useful as a partner to comprehensive WAc	If sufficient resources are available, the best partner
Time and expenditure	Stakeholder/sensitivities	Stakeholder/sensitivities	Stakeholder/sensitivities
Specialist/inputs	Relatively fewer required	Relatively more required	Likely to be the most expensive and time consuming option

Source: FAO, 2017a.

each cycle, refining the analysis and increasing confidence in outputs. It is usually best to plan and implement WAc and WAu as mutually supportive parallel processes, rather than processes that are carried out in series. This requires careful planning, appropriate sequencing of activities and the willingness of all involved to share findings and participate in multidisciplinary dialogue.

iv. Outputs and outcomes: These should be identified and agreed upon during inception activities. It is always likely, however, that these will have been discussed with stakeholders and refined as more information becomes available about the domains of interest. This is best achieved through communication of provisional findings and regular formal and informal discussions with key stakeholders.

3.2.7 Planning WAc and WAu

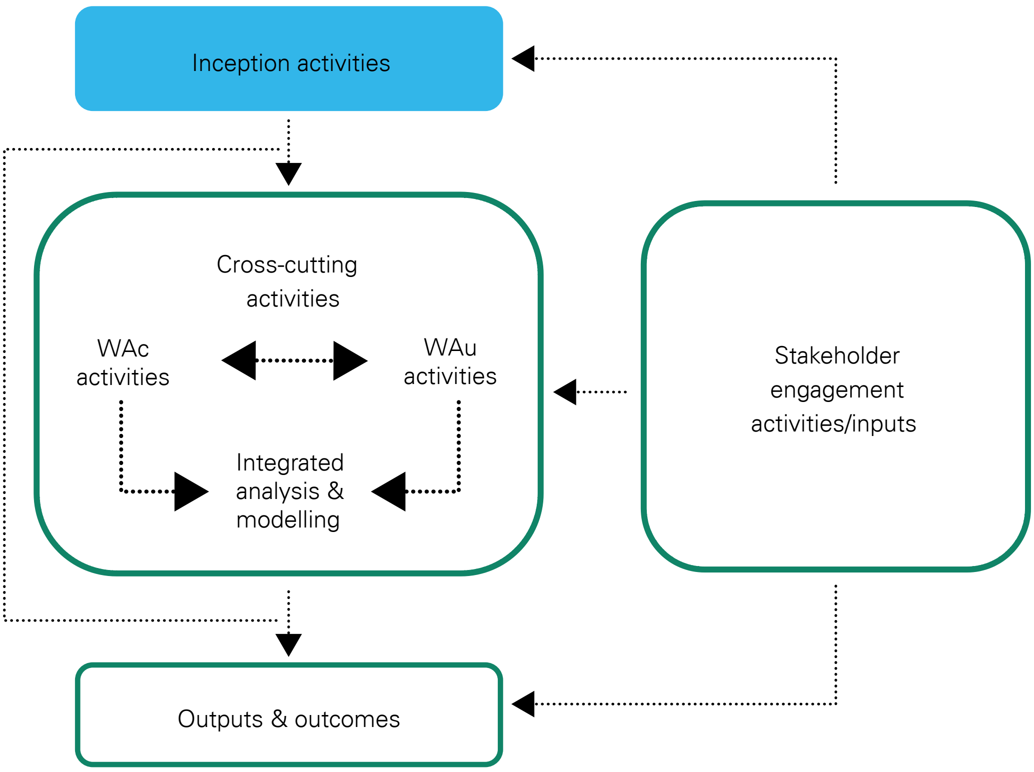
When planning WAc and WAu, some useful guiding points should be considered:

- Do not try to "account for every drop of water" in specified domains or for every detail related to governance and the wider political economy.
- Treat WAA as a cyclical learning process whereby knowledge and understanding are improved incrementally with each cycle.
- An important role of WAA is to investigate the utility of accepted wisdom and folklore concerning hydrology, climatology or the underlying causes of water scarcity.
- Make sure the entire process is open and transparent in terms of: (i) the approach, methods and procedures used; (ii) the roles and responsibilities of individuals and organizations involved; (iii) the accountability, fairness and inclusiveness of stakeholder engagement; and (iv) the strategies adopted for making raw data, outputs, findings and recommendations publicly available.
- Think seriously about stakeholder engagement, information management, communication and other critical ancillary activities when planning and budgeting WAA processes.
- Most specialists are accustomed to working within the confines of their own areas of specialization (i.e. their own comfort zones). Therefore, they may take some time to adapt to a WAA working environment.
- The more key stakeholders are actively engaged in WAA the more likely they are to accept, internalize and make use of outputs, findings and recommendations.
- In most cases, it is best to plan and implement a WAA process that builds on and supplements existing activities, practices and programmes.

It is also important to acknowledge that the following points will influence the budget, time and other resources that may be required when planning WAA:

- The level of ambition of objectives;
- Their level of complexity;
- The availability of good quality secondary information;
- The need for primary information collection to ground truth, gap-fill or update secondary information;

Figure 3.4. An overall approach to WAc and WAu



Source: FAO, 2017a.

- The need for awareness raising and capacity building; and,
- The nature and types of outputs and outcomes needed.

3.3 Irrigation modernization planning and design

3.3.1 Concept and approach of irrigation modernization

Improving irrigation water management and the performance of irrigation systems to increase productivity and minimize adverse effects such as salinization, is now perceived as a more pressing need than developing new irrigation systems on new cultivated areas. Cost reduction is also at the centre of a global focus to improve irrigation operations; because societies and WUAs, in particular, are dealing with the high costs of existing irrigation systems, there is a clear demand for irrigation to become more cost-effective. Moreover, the irrigation service fees collected are very low, translating into lower monetary allocations for operation of irrigation systems, delayed maintenance, reduced irrigated lands and poor services, even if land size remains constant.

Three types of interventions are commonly used in order to improve performance in irrigation water management and systems:

- Rehabilitation, consisting of the restructuring of a deficient infrastructure in order to restore it to the original design. Although rehabilitation is normally applied to physical infrastructure, it can also include institutional agreements.
- Process improvement, consisting of intervening during the process without changing the rules of water management. For example, the introduction of modern techniques is a process improvement.
- Modernization, which is a more complex intervention implying fundamental changes in the rules governing water resource management. It can include interventions in the scope of physical infrastructures as well as in their administration.

Modernization has always been perceived as a need globally, but the concepts behind it have evolved. It is a fundamental transformation of the management of water resources, beyond just the introduction of updated hardware and techniques. A change in the institutional and legal systems in relation to water rights, delivery services, accountability mechanisms and incentives is required, in addition to the physical structures. The 1996 FAO conference in Bangkok defined irrigation modernization as:

"…a process of technical and managerial upgrading (as opposed to mere rehabilitation) of irrigation schemes combined with institutional reforms, with the objective to improve resource utilization (labour, water, economic, environmental) and water delivery service to farms." (FAO, 1996b).

When C.J. Perry defined water rights in 1995, efficient infrastructure and assigned responsibilities – the basic elements for successful irrigation performance – were not considered, and in the early 1970s and 1980s, the general assumption when designing development projects was that improving physical structures would automatically lead to better performance (Perry, 1995). In fact, various projects included rehabilitation of physical irrigation systems, with the construction of additional tertiary channels, drains, etc. But as soon as the project completion phase was reached, maintenance was neglected in the majority of cases, and the system reverted to the initial conditions that existed before the project.

A consistent framework for modernization needs to be mainstreamed internally through the key elements of water rights, institutions and infrastructure, and externally through the different uses of water in one basin. Moreover, consistency must be maintained among the many objectives assigned to modernization, such as:

- water productivity
- cost-effectiveness of irrigation systems
- reliability of deliveries
- flexibility of deliveries
- consideration of all other uses of water
- knowledge and human development

Successful modernization is not simple, and further investigation is sometimes needed to understand the causes of an eventual failure to achieve targeted performance objectives. In developing countries, irrigation stakeholders face several constraints, including technical gaps between requirements to implement the improved technique and available local resources. There may also be financial constraints resulting from differences between equipment costs and gains in water savings, as well as social and institutional constraints. And a major impediment is often the lack of knowledge and awareness regarding the available choices for technical structures, as well as other modernization measures.

The capacity of engineers grew extensively during the 1960s and 1970s, and the role of engineers in assuring irrigation system performance has become essential. In fact, the re-engineering of irrigation system operations should consider both the spatial distribution of the effective demand for the water service and the spatial distribution of physical infrastructure characteristics. Moreover, re-engineering should involve designing the most cost-effective solution for the water service that has been redefined within the system in order to cope with the effective demand; flexibility of water service is key to modernization.

Modernization by its nature must be constantly adapting to new technologies and constraints. As irrigation systems develop, agricultural and economic contexts change and farmers' requirements evolve. It is not sufficient to set up a checklist of technological updates; in order to keep these systems modern, care must be taken to adapt intervention activities based on the environment, its constraints and new opportunities.

3.3.2 Available tools for irrigation systems modernization

Introduction and scope. FAO has developed a methodology called MASSCOTE, a step-by-step pathway for water engineering professionals, managers and practitioners involved in the modernization of medium and large-scale canal systems to improve performance of conjunctive water supplies for multiple stakeholders. The scope of this methodology concerns the modernization of management, while the focus is mainly on canal operation. The approach is formed by various steps that result in a diagnostic of performance and a map of the future path to take in order to improve cost-effectiveness and service to users of canal operation techniques.
MASSCOTE's primary goal is to find a solution for irrigation management and operation that works better and serves users in a more efficient way. The methodology aims to organize the development of modernization programmes around three main objectives (FAO, 2007a): (i) mapping various system characteristics; (ii) delimiting manageable subunits from the institutional and spatial points of view; and (iii) defining the strategy for service and operation for each unit. The overarching goal is to identify uniform managerial units for which specific options for canal operation can be designed and correctly implemented. The 11 successive steps that comprise the methodology are grouped into two main parts:

i. Baseline information and analysis through a RAP; and
ii. Vision of water services and modernization plan for canal operation.

The RAP deals with evaluation and analysis of the current situation, practices and processes. Subsequently, a vision for the irrigation system is developed and targets established. Modernization improvements are then planned to achieve these targets. An important feature of the methodology concerns the iterative nature of MASSCOTE; to reach a consistent analysis, several rounds of study at different levels of the irrigation systems (main conveyance, secondary and tertiary canals) might be required.

Applicable areas. While the overall goal of MASSCOTE is to modernize the management of irrigation schemes, the focus of the methodology and the entry points for the analysis are in canal operation; to achieve specific service improvement and performance objectives, an operational plan must be defined through modern design and updated management concepts. Since 2006, this approach has been widely adapted in China (Shanxi province), Egypt, India (Karnataka-Uttar Pradesh), Kazakhstan, Morocco, Nepal, Pakistan, Thailand, Turkey and Vietnam.
Users are central to this SOM approach. Beneficiaries from the application of the MASSCOTE methodology include those who provide funding for the modernization process, as well as:

- Farmers, who benefit directly from improved service at the most economic cost, and from management processes that empower them to participate in strategic decisions on system operation;
- Irrigation staff and managers, who benefit from the clear articulation of targets associated with incentives for performance achievement and from the greater demand from users for professionalism and accountability;
- Decision-makers at national and provincial levels, who benefit from improved economic and social performance of the irrigation system and the

development of workable strategies for investment with the support of key constituencies; and

- Other water users, who benefit through recognition of their service requirements and allocation needs.

Modernization focuses on making the process easier, simpler and more economical in order to achieve improved overall performance (economic, water-related and environmental) through improved service delivery to all users and improved management. Any skilled professional can apply the MASSCOTE methodology; however, whenever possible, FAO recommends connecting MASSCOTE with trainings that allows participants to familiarize themselves with the various steps of the methodology, as well as with some modern techniques of canal control.

Added value and cost effectiveness. The application of MASSCOTE for irrigation modernization has provided a clearer picture to the involved stakeholders on: (i) the type of irrigation modernization; (ii) the methodology applied; (iii) the aspects and areas of the system to prioritize; (iv) the planning and scheduling of modernization plans; and (v) the required continuous M&E of the modernization programmes. With clear insight on the modernization-related factors and the appropriate management intervention, financial investments and physical development can be properly scheduled, implemented and monitored. In fact, because modernization is a long-term and continuous process, the implementation plans, the continuous M&E process and improvement through corrective actions should be combined to ensure the ongoing, efficient operation of an irrigation system.

The adoption of MASSCOTE has provided clear direction to guide irrigation agencies in the planning and execution of modernization plans. For example, in Malaysia, the modernization plan for the irrigation scheme was laid down and scheduled for implementation based on the allocation provided by the federal government, starting with the Ninth Development Plan (2006-2010) and continuing in the Tenth and Eleventh Development Plans (2011-2020).

3.4 Agricultural water management (AWM) investment planning

Investment planning involves analysing context, understanding opportunities for concrete investment and forging consensus about priorities and means of coordinated implementation among different investment stakeholders in the public and private sectors, civil society and development partners.

In most cases, water-related investments have high capital costs and long periods of economic return. Governments, financial institutions and investors need tools and methodologies to plan effective and sustainable AWM investments. This chapter focuses on a few emerging approaches and tools being used for AWM investment that try to overcome some of the limitations of traditional water investments. It first introduces three examples of people-centred approaches and then provides a brief discussion of the integration of climate change and disaster risk in water infrastructure investments.

3.4.1 People-centred approaches

Classical investment planning in AWM has mostly focused on the supply side, considering only the availability of water and land resources and technologies. This approach has led, in many occasions, to investment plans that did not respond to the real needs and capacities of the local population or the market potential. As a result, these investments have been abandoned or not used efficiently.

In contrast, new approaches to AWM investment planning try to undertake a comprehensive analysis of the environmental conditions and understand the diversity of people’s livelihoods and country contexts. These approaches are mainly used in programmes focused on poverty reduction and smallholders.

Some examples of comprehensive approaches for investment planning are:

- Water investment planning through livelihood mapping, developed by FAO, which uses livelihood zones as the basis to assess the suitability of water investments to improve people’s livelihoods;
- Participatory Rapid Opportunity and Constraint Analysis (PROCA), developed by IWMI to identify, in a participatory manner, new opportunities for AWM investments at community level; and
- ABCDE + F framework, developed by Chris Perry (Perry, 2013), which defines the elements that need to be considered to develop effective AWM investments.

3.4.2 Water investment planning through livelihood mapping

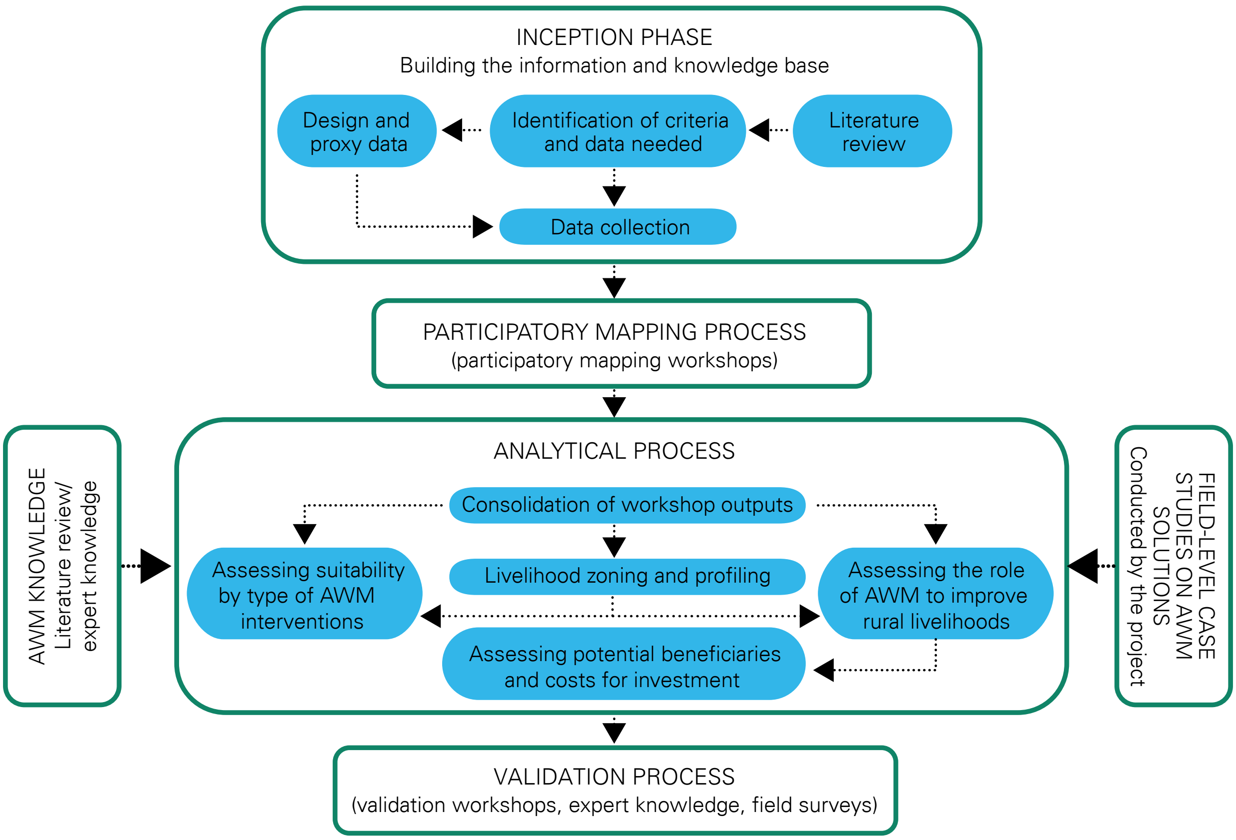
The FAO livelihood mapping approach relies on the concept of livelihood, defined as the capabilities, assets (stores, resources, claims and access) and activities required for a means of living (Chambers *et al.,* 1992). The methodology uses livelihood zones as the basis to assess the suitability of water investment for people's livelihoods through participatory mapping and analysis. Livelihood zones are the areas where rural people share relatively homogenous living conditions determined by biophysical and socio-economic aspects. They are used to identify the locations where water is a major constraint for rural development and food security, and where water investment can have a major impact on farmers' livelihoods.

The methodology is applied in five steps (Santini *et al.,* 2012):

1. Mapping of the main livelihood zones, considering the different farmer typologies, livelihood strategies and primary water-related constraints and needs in the different livelihood zones;
2. Mapping the potential and opportunities for improving smallholder livelihoods through water investments;
3. Estimating the number and percentage of rural households that may benefit from AWM investments;
4. Mapping the suitability and demand of specific AWM investments, indicating where investments have the highest potential impact on rural livelihoods; and
5. Estimating the potential number of beneficiaries, the potential investment area and the investment costs in each livelihood zone.

The framework of the methodology is illustrated in Figure 3.5, which shows the different phases of the implementation. The approach combines analytical desk work and data collection with participatory consultations and mapping workshops with country stakeholders. It can be conducted over a period of from three to six months, depending on the complexity, size of the country and availability of data.

Figure 3.5. Livelihood and AWM suitability mapping methodology



Source: Santini et al. 2012.

This methodology has been applied in a number of countries in Africa and Asia.

3.4.3 PROCA

PROCA is a methodology developed by IWMI to identify and analyse new opportunities for AWM investments in a participatory manner at local level. PROCA analyses different investment opportunities systematically, using three steps.

Step 1: Situation analysis and initial screening, which consists of elaborating on an inventory of existing initiatives in AWM. These initiatives are then screened using five criteria (contribution to smallholder livelihoods, gender and equity, scalability, ease of implementation and resource sustainability). The screening is done through a consultation workshop with stakeholders.

Step 2: In-depth case studies to analyse opportunities and constraints for the selected solutions identified in Step 1. This analysis will result in a shorter list of AWM solutions and a better understanding of the conditions under which they can be successful.

Step 3: Analysis of outscaling impacts to evaluate the positive and negative impacts and externalities of outscaling the solutions identified in Step 2.

The result of this process is a list of the most adapted AWM solutions with few negative social and environmental externalities and measures for the reduction of such externalities. PROCA has been applied in countries in Africa and Asia.

These two methodologies can be combined and applied in a complementary fashion. The livelihood mapping approach can be applied at national and regional level, whereas PROCA can be done at community level.

3.4.4 Climate change and disaster risks

Climate-smart planning is a new demand in water resource projects. Traditionally, climate change and disaster risk have not been assessed or integrated in planning water investments. However, a study from the World Bank (Cervigni *et al.*, 2015) states that proper integration of climate change in the planning and design of infrastructure investments can considerably reduce future climate risks to the physical and economic performance of hydropower and irrigation. The study evaluates, through a wide range of state-of-the art future climate scenarios, the impacts of climate change in the planning and design of hydropower and irrigation expansion plans in the main river basins in Africa. The results show that not integrating climate change in the planning and design of water infrastructure could entail a loss of 10 to 20 percent in dry scenarios and a foregone gain of 1 to 4 percent in the wet scenarios for most basins. As a conclusion, the study proposes a number of priority areas of intervention to ensure proper integration of climate change in water infrastructure planning. These areas include, among others, the development of technical guidelines for the integration of climate change in the planning and design of water infrastructure.

The concept of "climate-proof" investments needs to be central in the design of investment projects for reducing climate change-related risks. Governments and development agencies have developed guidelines for integrating climate considerations in investment projects. Some examples are:

- *Guidelines for Climate Proofing Investment in Agriculture, Rural Development and Food Security*, developed by the ADB (ADB, 2012)
- *Incorporating Climate Change Considerations into Agricultural Investment Programmes*, developed by FAO (FAO, 2012b)

PART 3

These guidelines incorporate tools and methodologies to assess the risks associated with climate change in order to include it in project planning. Some examples are:

- Opportunities and Risks of Climate Change and Disasters (ORCHID);
- Community-based Risk Screening Tool – Adaptation and Livelihoods (CRisTAL);
- Tools developed by the Cooperative for Assistance and Relief Everywhere (CARE) and the International Federation of Red Cross and Red Crescent Societies;
- The Self-evaluation and Holistic Assessment of climate Resilience of farmers and Pastoralists (SHARP), developed by FAO, which includes specific modules on water and irrigation (FAO, 2015); and
- The Climate Change Decision Tree Framework, developed by the World Bank (Ray *et al.*, 2015).

These tools can be classified as: (i) top-down approaches, when they focus on the impacts of climate change using quantitative models to design response options; or (ii) bottom-up approaches, when they focus on understanding the causes of vulnerability in rural communities in order to identify solutions to increase resilience to climate shocks.

Both approaches are necessary when designing investment projects integrating climate change. Top-down approaches favour long-term investments that take into account expected changes in water supply and demand. Bottom-up approaches usually consider short- to medium-term responses and give the opportunity to address vulnerable populations' needs for resilience and development.

For instance, the SHARP tool developed by FAO (FAO, 2015) addresses the need to better understand the interests of family farmers and pastoralists with respect to climate resilience in order to incorporate their needs into decision-making processes, including water and irrigation issues.

The Climate Change Decision Tree Framework (Ray *et al.*, 2015) is another example of a bottom-up approach. It provides a framework for climate risk assessment and management of water resource projects that can serve as support in the form of a decision tree to assist project planning under uncertainty. This approach considers that climate models fail to inform investment decision-makers because: (i) models do not usually describe the climate extremes, such as floods and droughts, which are very relevant when planning AWM investments; and (ii) models do not include an analysis of the relative significance of the effects of changes in climate on an AWM investment project compared with other, non-climate factors (demographic, technological, economic, etc.)

The approach consists of four successive phases: Phase 1 – project screening; Phase 2 – initial analysis; Phase 3 – climate stress test; and Phase 4 – climate risk management. The process allows for different categories of projects to be subjected to different types of analysis according to their needs.

3.5 Evapotranspiration (ET)-based water saving

3.5.1 Concept of ET-based water saving

Conventionally, irrigation water saving is indicated by irrigation efficiency. The concept of irrigation efficiency has evolved for over 60 years (Perry, 2007). In the 1930s, Orson W. Israelsen defined irrigation efficiency as the ratio of the irrigation water consumed by the crops of an irrigation farm or scheme to the water diverted from a river or other natural water source into the farm or scheme canal or canals (Israelsen, 1932). The equation of irrigation efficiency was defined as:

$$E_i=W_c/W_r$$

where W_c is irrigation water consumed by the crops and W_r is water diverted from a river or other natural source. This basic approach to irrigation efficiency accounting remained fundamentally unchanged for over 40 years. Irrigation efficiency was further divided into distribution efficiency and field application efficiency. Conventional water saving measures include increasing distribution efficiency by adopting canal lining to reduce seepage from canal systems and increasing field application efficiency by adopting modern irrigation techniques such as sprinkler and drip irrigation and improved surface irrigation. Since the various losses (in distribution and field application) were essential knowledge for those designing the irrigation systems, this accounting basis was appropriate and relevant for that engineering purpose (Perry, 2007). The advantage of increasing irrigation efficiency is that the water can reach the crops in a timely way. It is also directly related to engineering measures for increasing water conveyance and field application efficiency in irrigation schemes. Its disadvantage is that in most cases the water saved by increasing irrigation efficiency is not real water savings since some is return flow and used by downstream users and not a real loss.

In the water application process, water diverted to irrigation schemes can be divided into the consumed fraction and the non-consumed fraction. The consumed fraction comprises beneficial consumption and non-beneficial consumption; the non-consumed fraction comprises recoverable flows and non-recoverable flows. ET is the consumed fraction of water diverted to irrigation systems. ET is the effective indicator to evaluate water savings in irrigation systems because it does not include recoverable flows and so the reduction of ET is real water savings. ET-based water savings is based on mass continuity in the hydrological cycle. ET-based water savings emphasize taking measures to reduce non-beneficial and even beneficial water consumption of irrigation systems.

With this significant change in thinking, in 1997 Charles M. Burt defined irrigation efficiency as:

$$E_i = W_{bu}/W_{s\text{-}sc}$$

where W_{bu} is irrigation water beneficially used, which includes crop ET and water needed for salinity leaching, and $W_{s\text{-}sc}$ is irrigation water supplied minus storage changes, which includes any flows to or from aquifers, in-system tanks, reservoirs, etc. (Burt *et al.,* 1997).

3.5.2 Options and tools for ET-based water saving

Before water in a river basin is allocated to meet the demands for industrial and domestic uses and irrigated agriculture and to restore the ecological environment, it is necessary to know how much water is actually available for use by all sectors without damaging the ecological environment at river basin level – i.e. the target ET must be determined. Target ET refers to the maximum consumptive use of water for all sectors without damaging the ecological environment. Target ET could be allocated with priorities or trade-offs among urban requirements, irrigated agriculture and ecosystems through negotiations and decision processes among industrial, domestic and agricultural water users. In this allocation process, guiding principles could include:

- Consideration of essential agriculture, industries and other activities (availability of clean drinking water, domestic use and food production);
- National, regional and local administrative goals and priorities; and
- Differences in water productivity among competing entities.

After the allowable target ET is allocated to a given sector, the sector's focus will shift from limiting abstraction to increasing water productivity per unit of allocated ET. Agricultural target ET at basin level could be further allocated – down to the region and, through the irrigation scheme, to fields within the basin and then further down to each of the water users. The objective of ET-based water savings is to take measures to control water consumption at farm or irrigation system level to ensure that actual ET at those levels is at or below the target ET.

ET-based water saving measures include: reducing non-beneficial ET by levelling land; increasing irrigation water uniformity by applying advanced irrigation techniques; applying pressurized irrigation systems; applying mulching film or crop residues to cover land; and reducing beneficial ET by replacing conventional varieties with water saving hybrid varieties.

Various tools exist for ET measurement and estimation. At field scale it can be measured over a homogenous surface using conventional ET techniques, such as Bowen ratio, eddy covariance and lysimeter systems. However, these systems do not provide spatial trends (or distribution) at regional scale, especially in regions with advective climatic conditions. Remote sensing-based ET models are better suited for estimating crop water use at a regional scale. The application of remote sensing-based ET technology provides an efficient method for ET management at large scale.

The use of remote sensing to estimate ET is currently being developed using two approaches: (i) a land surface energy balance method that uses remotely sensed surface reflectance in the visible and near-infrared portions of the electromagnetic spectrum and surface temperature (radiometric) from an infrared thermal band; and (ii) a reflectance-based crop coefficient (generally denominated K_{cr}) and reference ET approach, where the crop coefficient (K_c) is related to vegetation indices derived from canopy reflectance values (Bastiaanssen *et al.,* 1998).

3.5.3 Good practices on ET-based water saving

Example 1: Case in Mexicali Valley, United States of America

In recent decades, ET-based water saving has been increasingly applied in some countries. In the United States of America, methodologies and tools have been developed for the estimation of remote sensing-based ET, and the results have been applied for irrigation water management. These include Basin-wide Remote Sensing of Actual Evapotranspiration and Regional Water Resources Planning, and an Internet ET tool to help water users estimate water requirements and the guidelines and specifications for estimating crop water use with remote sensing.

In the study for Basin-wide Remote Sensing of Actual Evapotranspiration and Regional Water Resources Planning (Howes and Burt, 2012), the ET-based water management approach was applied in the Mexicali Valley System. Mexicali Valley System water balance for a typical year (2007) is shown in the following table:

Description		Volume (Mm^3)
Inflows	Surface water	1 872
	Groundwater	358
	Precipitation	84
	Total inflow	**2 314**
Outflows	Surface water	349
	Groundwater	193
	Crop ET	1 721
	Other ET	216
	Total outflow	**2 479**
	Change in storage = Inflow–Outflow	-165
	Change in storage based on groundwater elevation	-115

In this study, global irrigation efficiency was utilized as an indicator to obtain an understanding of inflow versus beneficial use. Irrigation water beneficially used includes crop ET and water needed for salinity leaching. Water required for salinity management was estimated at about 202 Mm^3 over the Valley. An additional beneficial use is consumption by cities, such as water sent to Tijuana, Mexico, from the project. This is approximately 110 M m^3 of irrigation water, which is accounted for as surface outflow.

Two contrasting assumptions were considered in computing global irrigation efficiency in the Valley:

1. Global irrigation efficiency, assuming riparian and environmental habitat is a beneficial use of irrigation water, was calculated at 93 percent.
2. Global irrigation efficiency, assuming riparian and environmental habitat is NOT a beneficial use of irrigation water, was calculated at 83 percent.

Other estimates of global efficiency have inaccurately shown efficiency values of around 43 percent. This value was computed by extrapolating on-farm irrigation efficiency from valley-wide irrigation efficiency. This is an erroneous method because there is significant recirculation of on-farm losses within the basin.

The important conclusions from the study are:

1. There is less "conservable" irrigation water than has been believed in the past.
2. Increasing irrigation efficiency by reducing canal seepage and improving field irrigation efficiency is most useful for true water conservation if it is applied in areas that have little to no recirculation of return flows. In the Mexicali Valley, this means in the southern part of the Valley, where there is little groundwater pumping or reuse of surface drainage water.

3. The difference between the efficiency calculations of 83 percent and 93 percent is due to environmental water consumption (e.g. water used by plants in river beds, drains or non-irrigated areas with vegetation). Important decisions should be made regarding whether or not these are truly considered beneficial uses.
4. Although irrigation efficiency is an important indicator of irrigation performance, it is not the only indicator. Other important indicators include: (i) total agricultural production per unit of water consumed; and (ii) value of agricultural production per unit of water consumed.

Source: Howes, D.J, et al., 2012.

Example 2: Case in North China Plain, People's Republic of China

Another example is from China. From 2001 to 2005, China implemented an agricultural water saving irrigation project funded by the World Bank (Tian Yuan et al., 2010). ET-based water saving management was studied and piloted. The project covered an area of 106 700 hectares, including 26 counties, cities and regions of Beijing municipality, and Hebei, Liaoning and Shandong provinces. Both surface water and groundwater were used for irrigation in the project area. Before project implementation, the groundwater tables in the project area had declined, due to over-pumping, at a pace of 1 m per year over the last 20 years.

In the project area, the distributions of actual ET from farmland and non-farmland, including industrial, domestic and ecological uses, were monitored and estimated. Based on the ET distributions and precipitation, a water balance analysis was conducted. In the project area, actual ET of farmland was much higher than target ET. The following measures were adopted to reduce ET from irrigated farmland:

1. Levelling land and reducing the size of the irrigation basin to increase irrigation water uniformity and reduce non-beneficial ET;
2. Using residues to cover soil for reducing non-beneficial ET; for wide-row crops, covering rows with mulching film to control weeds and reduce non-beneficial ET;
3. Using pipelines to replace canals and applying drip irrigation under mulching film to reduce non-beneficial ET;
4. Adjusting crop patterns and replacing conventional varieties with water-saving hybrid varieties to reduce beneficial ET; and
5. Applying irrigation water based on weather forecast and soil moisture, rather than an irrigation schedule based on field capacity and crop growth stage.

For management and institutional aspects WUAs were introduced to improve irrigation system management and collect water fees. Water measurement at farm level was practised for volumetric water fee collection.

As the results of applying these ET-based water saving measures in the project area, the ET of wheat was reduced by 16.4 percent to 25.6 percent, the ET of maize was reduced by 10.6 percent to 21.9 percent, the ET of cotton was reduced by 12.9 percent, the ET of paddy was reduced by 11.0 percent and the ET of oil crop was reduced by 9.9 percent. After the five-year implementation of the project the groundwater tables in the project area in Shandong and Liaoning provinces were increased by 1.4 m, and the declining trend of the groundwater tables in Beijing municipality and Hebei province had been alleviated. This result implied that for the restoration of the groundwater tables in Beijing municipality and Hebei province it is necessary to reduce the irrigated crop areas with high water consumption.

Source: Tian Yuan et al., 2010.

In planning for the modernization of existing irrigation schemes or construction of new irrigation schemes, attention should be given to both improvement of irrigation efficiency and ET-based water saving practices to ensure the soundness and cost-effectiveness of investment and achieve real water savings and reasonable water productivity.

3.6 Advanced methods and approaches for economic evaluation

Design and preparation of a new generation of irrigation projects must effectively respond to the challenges of adapting to changing climate conditions and greater economic competition for increasingly scarce water resources. The new requirements also imply that irrigation investment decisions should be based on sound economic justification for irrigation investment proposals that adequately accounts for climate adaptation and mitigation impacts, higher risk and uncertainty effects, and that maximizes system-wide economic water use efficiency. Some advanced approaches to economic evaluation of irrigation investments, based on state-of-the art methods and participatory investment planning, are discussed below.

3.6.1. Climate change benefits of irrigation investments

Investments in irrigation and drainage improvements are often considered to be major climate change adaptation measures[4] that improve resilience of agricultural production systems to climate-induced meteorological and hydrological variability and uncertainty. For example, investments in irrigation reduce the adverse impacts of rainfall variability and allow farmers to grow high-value crops even during drought years. Introduction of water-saving technologies, such as drip irrigation, also increase the efficiency of irrigation water use and water availability in the systems, thereby reducing water scarcity effects due to climate change. Irrigation improvements may also result in the potential co-benefit of avoided GHG emissions from land use change. For example, improved management of irrigation systems can help to mitigate GHG emissions in soil of irrigated farmland (Abalos et al., 2014; Section 1.1). At the same time, investments in new irrigation development can sometimes contribute to additional GHG emissions by converting dry lands into additional irrigated areas due to changes in crop production mix, leading to induced livestock production and increased input demand, and prompting other economic activities that result in additional GHG emissions. This type of negative externality also needs to be taken into account in the economic evaluation of irrigation projects.

Another effect of climate on irrigation investments includes changes in the timing and amount of water flows, and, subsequently, the reliability of water supply for irrigation use while water demand is increasing due to higher temperatures and higher rates of ET. To withstand these climate-related changes, additional expenditure is required to ensure that proposed irrigation investments are climate-proofed. This includes such measures as development of additional water storage, drainage systems and flood protection measures, thus increasing the total cost of required investments.[5]

3.6.2. Economic evaluation of climate change benefits

Climate change adaptation. A few approaches and tools can be considered in the evaluation of investment projects with climate adaptation benefits (World Bank, 2010a):

i. Agro-economic models. An agro-economic model is a combination of a biophysical crop production agronomic model and an economic model. The agronomic model simulates the soil-plant-atmospheric linkages that determine plant growth and yield. The crop model makes it possible to assess impacts of adaptation measures on agricultural productivity and also to assess effects of different adaptation options. Combined with an economic module, it can be used to estimate reduced economic losses for farmers from climate adaptation measures in farm-level assessments. Agro-economic models can be integrated with climate, hydrological and water balance models for more technically sound evaluation of adaptation effects (World Bank, 2010b).

[4] The consideration is given to irrigation projects with adaptation co-benefits that facilitate autonomous adaptation or increase adaptive capacity as a by-product (not a stand-alone adaptation project). A project CBA in this case needs to compare a business-as-usual (without the project) option with the project scenario. An expert judgement is required to define the hypothetical without the project alternative.

[5] For project level analysis, unit costs of specific adaptation measures may be derived from an in-depth analysis of past irrigation and water management projects that financed similar types of adaptation interventions.

Table 3.1. Climate change benefits of irrigation investments

Benefits	Due to…
Losses to crop production and incomes from droughts avoided/ reduced	Reduced vulnerability to rainfall variability and water scarcity effects; stabilized water availability for food production through improved irrigation infrastructure; additional water storage; improved irrigation technologies, delivery systems, management practices; possibility to grow higher value crops in drought periods; dedicated climate adaptation project activities (e.g. introduction of drought-resistant crops)
Faster after-drought shock recovery (time needed for production to reach the pre-shock production potential levels)	Increased and stabilized water availability to the irrigated agricultural fields
Losses to crop production and income from floods avoided/ reduced	Improved resilience of farmers and communities to hydrological variability through dedicated climate-proofing flood protection measures included in irrigation projects: additional storage, dykes, protection barriers, flood management plans, etc.
Carbon sequestration, reduced GHG emissions at local and global levels	Improved management of irrigation systems to mitigate GHG emissions in soil of irrigated farmland

Source: Authors.

ii. Ricardian models. Ricardian economic models are based on the idea that the long-term productivity of land is reflected in its asset value. The impacts of changes in climatic conditions and land use improvements influence the value of farmland through changes in agricultural productivity of the land and therefore can be estimated through the expected change in the value of the land. For example, in the case of irrigation and water management investments, it should be possible to assess how the improved infrastructure, combined with climate change projections, would affect land values in the project area and thereby could be reflected in the value of project benefits.
This methodology makes it possible to incorporate adaptation responses at farm and scheme levels; however, the experience with agro-economic and Ricardian models in project–level economic evaluation is still limited due to their complexity and data requirements. Some successful applications of the approach to practical project economic evaluations can be found in China (World Bank, 2008c).

iii. Probabilistic risk analysis. The occurrence of weather shocks and the dynamics of hydrological variability, as well as subsequent economic and financial effects they may cause, are stochastic in nature and require special approaches to accounting for future uncertainty. Probabilistic methods can be used for estimating expected benefits of reduced economic and financial losses from drought (and possibly flood) events due to the project implementation. The method is based on the use of an "exceedance curve" showing the relationship between intensity and probability of a drought (or flood) event and can be used for a probabilistic estimation of economic value of damages avoided (World Bank/GFDRR, 2010).

A detailed overview of available methods for evaluating climate adaptation effects in investment projects, including such state-of-the-art methods as real options analysis and robust decision-making, can be found in a World Bank publication, *Economic Evaluation of Climate Change Adaptation Projects* (World Bank, 2010a).

Impact on carbon balance. The EX-Ante Carbon-balance Tool (EX-ACT), developed by FAO,[6] is an Excel-based model allowing for an *ex-ante* evaluation of the impact of agriculture development projects on GHG emissions and carbon sequestration. The main output of the tool consists of the carbon balance (expressed in metric tonnes of CO_2 equivalent per hectare per year – CO_2e) resulting from the difference between a "without-the-project" (baseline) and "with-the-project" scenario (Box 3.6.1)
EX-ACT can be used for the economic analysis of projects to value the mitigation potential by using a

[6] EX-ACT user guidelines (quick guidance and detailed user manual), case studies and software are available free of charge on FAO's website: http://www.fao.org/tc/exact/ex-act-home/en/

Box 3.1. Ex-Ante Carbon Balance Tool (EX-ACT)

EX-ACT is an appraisal system developed by FAO. It provides estimates of the impact of agriculture development projects, programmes and policies on the carbon balance. The carbon balance is defined as the net balance from all GHGs expressed in CO_2 equivalent that were emitted or sequestered due to project implementation as compared with a "without-the-project" scenario.

EX-ACT is a land-based accounting system, estimating CO_2 stock changes (i.e. emissions or sinks of CO_2) as well as GHG emissions per unit of land, expressed in equivalent tonnes of CO_2 per hectare and year. The tool allows for inclusion of GHG mitigation effects in project economic analysis and helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms.

Source: http://www.fao.org/easypol/output/

Box 3.2. The social price of carbon

The concept of the social cost of carbon attempts to capture the marginal global damage (cost) of an additional unit of CO_2e emitted. This approach derives a social value of carbon emissions expressed as the present value of expected future damages caused by an additional tonne of CO_2e emitted into the atmosphere in different years. A range of estimates – depending on assumptions such as the discount rate – is provided by the integrated assessment models that simulate relationships between global climate and economy. With a 5 percent discount rate, the 5 to 95 percent range in value is between USD 0 and USD 60, with no consensus of lower and upper bounds. These estimates are partial and still disputed in the literature because of under-representation of uncertainty in the models. Some aspects of uncertainty include future adaptive capacity, difficulty in valuating non-market impacts and the risk of catastrophic outcomes, as well as low levels of agreement regarding the appropriate framework for aggregating impacts over time and across regions of the world.

Source: World Bank, 2014b.

social price for carbon (Box 3.2). Depending on the level of the project's global (public) benefits from GHG mitigation, project financing can also benefit from the international climate finance funding mechanisms (such as carbon payments, carbon credit mechanisms, public funding for low-carbon agriculture). Examples and case studies on the use of EX-ACT can be found in the EX-ACT application website (see also reference: IFAD. 2016).

3.6.3. Integrating risk and uncertainty in economic evaluation

The need to account for risk and uncertainty in irrigation project EFA goes beyond the evaluation of climate adaptation co-benefits. Returns on irrigation investments are also subject to risks in market price volatilities, project cost overruns, project completion periods, yields and cropping intensities, etc. Quantification of these risks is needed at all stages of the project cycle to make informed investment decisions, but it is particularly important during project design. The evaluation of World Bank practices in the CBA of projects (World Bank, 2010b) undertaken by the World Bank Independent Evaluation Group emphasized that risk analysis emerges as one of the weakest areas in project economic evaluation. The typical analysis of risk consists of sensitivity analysis by simply varying aggregate costs and benefits by some percentage. Fewer than 10 percent of projects perform Monte Carlo analysis. @RISK, Risk Solver or Crystal Ball are the most user-friendly tools (ADB, 2002) that can be used for enhancing the quality of project economic evaluation (Box 3.3). Limitations of the probabilistic risk analysis approach are related to the reliance on probability functions that are often difficult to estimate due to a lack of representative statistical data.

3.6.4. Participatory methods for project economic evaluation

RuralInvest. Successful implementation of irrigation investments requires that project beneficiaries are actively involved in the project planning process and have a substantive influence on decisions regarding project design and preferable options. Experience has shown that the ultimate scheme design almost always benefits from involving the users in the planning process. Farmers usually have practical ideas about what works and what does not, based on

Box 3.3. Probabilistic risk analysis in project economic evaluation

The risk analysis answers questions on the likelihood of the project achieving the expected performance results (the acceptable return on investments) and the probability by which the project is likely to over- or underperform. The steps of the analysis include:

1. Conducting a traditional CBA of the project, calculating the project EIRR and Net Present Value (NPV); identifying the most critical and uncertain variables of the CBA and running a sensitivity analysis by singularly varying the parameters (deterministic analysis); and complementing the analysis with the calculation of the switching values.
2. Undertaking the risk analysis with the CBA's critical parameters using a risk-modelling programme (for example, @RISK, Risk Solver, Crystal Ball). This includes specification of probability distributions (for example, Normal/Gaussian, Uniform Discrete, Triangular, etc. suggested by the software), identification of correlated parameters and a Monte Carlo simulation performed by the risk analysis software.
3. Interpreting the results. The main output of the risk analysis is a distribution graph (in the form of a probability density chart or a relative frequency histogram) that plots the probability of different EIRR or NPV values. The obtained distribution, mean value and deviations will then be used to quantify how likely the project is not able to achieve its intended economic results. Examples of practical applications of this methodology to project economic evaluation can be found in IFAD's internal guidelines on EFA of rural investment project, Volume III: Case studies (IFAD, 2016).

Source: Adapted from IFAD, 2016.

their detailed local knowledge of weather patterns, hydrology, soils, markets, etc. Communities often have strong preferences regarding the nature and location of development that need to influence planning, such as aligning a canal to avoid excavation in sacred ground. Community-driven projects often are not subject

Box 3.4. RuralInvest: Participatory project formulation and business plans

RuralInvest allows the formulation of detailed project proposals containing all the information needed to take informed decisions concerning the viability of the proposed investment, including: definition of anticipated markets or demand; technologies to be used and training and technical assistance needs; calculation of income, expenses and gross margin by activity within the project; and financial forecasts and ratios (cash flows and profitability report).

Many calculations – such as estimation of employment generated by the investment, working capital requirements and the replacement of assets – are performed automatically. A wide range of key parameters can be pre-defined according to user agency needs, including the categories of investments, the currency, the types of beneficiary and the environmental classification. The software calculates initial investment requirements, financing costs (where loan funds are used) and annual cash flows, as well as NPV and IRR. The software can generate a variety of reports in either electronic (pdf or Excel format) or printed form.

Source: http://www.fao.org/in-action/rural-invest/en/

to detailed *ex ante* CBA because identification of specific subprojects normally takes place later, at implementation stage. However, a participatory consultative process makes it possible to conduct CBAs of proposed investments at the early stages of project preparation. A tool such as FAO's RuralInvest can be used to prepare and analyse small and medium-scale investment subprojects with greater detail and precision and from a financial and economic perspective (Box 3.4).

SHARP

For defining adaptation components of a project, in some circumstances it may be important to get an idea of the options, costs and expected benefits of adaptation at farm and community levels. One possible approach is based on solicitation of information directly from farmers and irrigation water users, who are vulnerable to climatic risks and will take adaptation-relevant decisions. This approach requires methodologies that are based on participatory appraisal methods and the SHARP tool, developed jointly by FAO and external partners, may be recommended as one of them (FAO, 2015). SHARP addresses the need to better understand and incorporate the concerns and interests of farmers relating to climate resilience and adaptation. It makes it possible to conduct farming system resilience assessments in an integrated and participatory manner that is tailored to the needs of smallholder farmers.

3.6.5. A system-wide approach for evaluation of irrigation investments

Multisectoral benefits of irrigation infrastructure. The growing water scarcity increasingly requires that development of new large irrigation systems or modernization of existing schemes must systematically incorporate interests of different water users and apply multifunctional design. Changes to the infrastructure used to carry irrigation water from the river to the farm can reduce environmental impacts, reduce transmission losses and better align farm water demand with supply. Opportunities to improve delivery infrastructure and its management and operations include upgrading infrastructure and automating operations, rationalizing storage and other infrastructure, and managing surface runoff. The total range of potential benefits of infrastructure improvement should be carefully considered, given the generally high level of associated costs.

The benefits are more likely to outweigh the costs when the project is intended for optimized multipurpose use to meet demands of different economic water users (see Box 3.5). Uses can be complementary or competing (as in the case of hydropower generation and irrigation water use from a reservoir); however, each water use benefit can be identified and valued individually for the purpose of the CBA. An economic evaluation of water use benefits depends on data availability and may follow various methods. Methodologies and approaches that can be used for economic evaluation of multisectoral water use benefits at project level are discussed in various publications (FAO, 2013a; Dixon, 1998; ADB, 2015).

Sharing investment costs among the infrastructure users can also provide good options for investment decisions. Joint investments for different economic water uses in multipurpose water infrastructure as part of irrigation systems will maximize the total benefits of irrigation systems, increase returns on irrigation investment and reduce the burden of investment costs for irrigation water users (see Box 3.6).

Box 3.5. Multisectoral benefits of irrigation infrastructure

An analysis of 30 large irrigation systems, investigated by FAO between 2004 and 2009 using a MASSCOTE approach, shows that many of the systems contribute to uses of water beyond crops (FAO, 2013a). Services or externalities of irrigation infrastructure often include:

- water delivery to farms for crop production;
- domestic water supply to local communities;
- flood control;
- fishing in streams and water bodies of irrigation systems;
- water supply for livestock;
- environmental impacts (groundwater recharge, waterlogging, salinity and drainage, and return flow from the canal systems to natural streams);
- recreation;
- health and sanitation: and
- energy production in some multiple-use reservoirs.

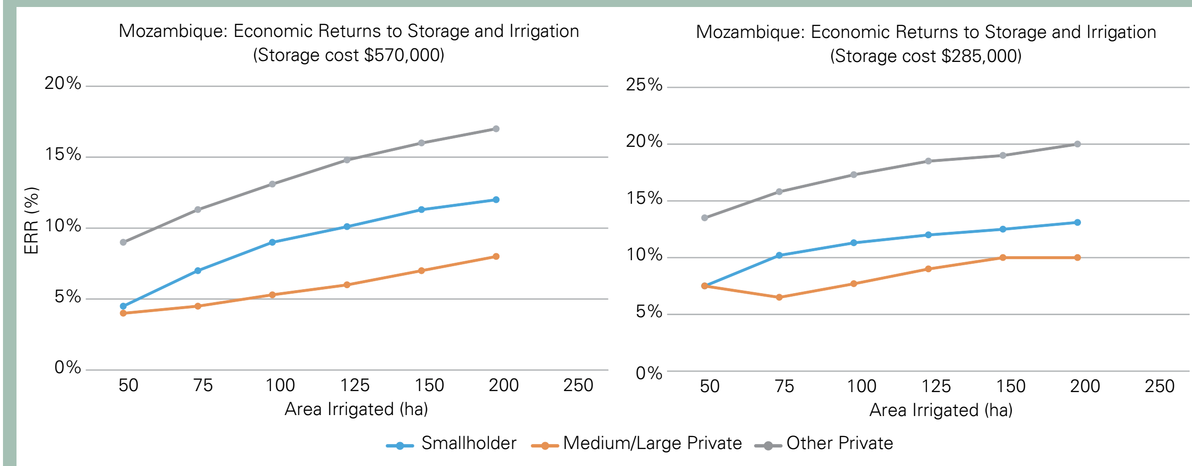
Source: Authors.

Hydro-economic modelling. Irrigation investment decisions should be based on improved understanding of the river and catchment attributes and of the impacts of irrigation investments on water availability to other economic uses in the river basin and, subsequently, on the value of total economic benefits derived from the use of the basin water resources. Hydro-economic models allow for an integrated analysis of spatially distributed river basin systems, water infrastructures, water development and management options and economic values. The models calculate water balance. On the supply side, the calculation is based on river flows, evaporation from surface water bodies, natural groundwater recharge and discharge, and return flows. On the demand side, it accounts for all essential economic water uses in the system. The infrastructure models

Box 3.6. The impact of irrigation storage cost sharing in Mozambique

Costs of irrigation development in Mozambique are very high, making smallholder irrigation unprofitable and commercial value crop-oriented schemes very sensitive to the level of irrigation development costs. Thus, future development of smallholder as well as larger private irrigation schemes will depend on improved returns on investment in irrigation. Specifically, it is becoming critically important to ensure multipurpose planning and design of smaller storage infrastructure, which would provide reliable water supplies to irrigation but also to rural and smalltown water supply systems, small-scale hydropower, fisheries, transportation, etc. This would ensure higher returns to the storage infrastructure investments and allow for effective cost sharing of investment costs among the beneficiaries.

The impact of storage cost sharing on irrigation investment returns was assessed based on simulations of the following situations: (i) when the dam construction costs of USD 570 000 are fully allocated to the irrigation development; and (ii) when costs of storage development are shared equally between irrigation and other users (the storage costs for famers are USD 285 000). The calculation results have shown that, in the first case, only irrigation schemes with the area of 125 hectares or larger are economically viable (EIRR of 10 percent or more). No medium/large private irrigation farms are viable despite the fact they benefit from higher irrigation value added than the smallholders (Figure 1). However, when storage development costs are shared equally among irrigation and other users, smallholder schemes of 75 hectares or larger and medium/large private farms of 150 hectares or larger appear to be viable (Figure 2). If the irrigation users have to cover 70 percent of the storage costs, an economically viable size for a smallholder scheme should be at least 100 hectares.



Source: World Bank/GFDRR, 2010.

may include irrigation canals, reservoirs, hydropower installations, water supply systems, water and wastewater treatment facilities, groundwater or pipeline pumping stations, artificial recharge basins and other infrastructures. Hydro-economic modelling may be used to support irrigation investment decisions by assessing effects of different investment alternatives in terms of total economic value of benefits of water use in the entire hydrological system (see Box 3.7). Hydro-economic modelling methodologies and their applications can be found in reports from IWMI and World Bank (IWMI, 2015; World Bank, 2010c).

3.7 Adoption of CFS-RAI in irrigation projects

3.7.1 Introduction

To eliminate hunger by 2030, it is estimated that an additional USD 267 billion needs to be invested annually, on average, by both the public and the private sector (FAO, IFAD and WFP, 2015). It is imperative that the level of investment in agriculture and food systems be significantly increased. However, it has also been observed that if investment is not done in a responsible way, investment projects may not achieve expected outcomes and may even cause harm

PART 3

Box 3.7. The Zambezi river basin: irrigation and multisector investment opportunities analysis

A multisector investment opportunity analysis was conducted for the Zambezi river basin with the aim to boost agricultural yields, hydropower outputs and other economic activities based on the overall increase in water use efficiency. A scenario analysis of possible irrigation and hydropower development options was carried out with the primary objective of maximizing economic benefits of water use in the basin, while meeting water supply and environmental sustainability requirements.

The analysis adopted a modelling package, HEC-3, a river basin and reservoir system model. While the focus of the analysis was on irrigation and hydropower, the river/reservoir model took into account all water-using sectors, including tourism, fisheries and the environment (through the environmental flows requirements). The model was enhanced by the economic assessment tool to provide an overall analysis of the economic implications of irrigation and hydropower investment scenarios. Based on the allocated water and development options, the appropriate models for the relevant irrigation projects were used at specific abstraction points in the river system and associated costs and benefits were calculated. The analysis has resulted in recommendations on the balanced hydropower and irrigation investments in the basin that would also ensure the acceptable level of flood protection and artificial flooding in the Lower Zambezi.

Source: World Bank, 2010c.

to the food security of local communities. The world therefore needs more – but also better – investments.

As the world endured the global food crisis in 2008, there was a strong need for a guidance framework to create an enabling environment for investments in agriculture. Moreover, the crisis also sparked a strong increase in large-scale land acquisitions – also called "land grabbing" – and other investments in agriculture and food systems that often lacked the necessary governance structures to assure that the livelihoods of local communities were not negatively affected.

In 2014, therefore, after a two-year inclusive consultation process, the CFS endorsed the *Principles for Responsible Investment in Agriculture and Food Systems* (CFS-RAI). The CFS-RAI represents the first global consensus on responsible investment in agriculture and food systems for which all relevant stakeholders were consulted, including states, civil society, private sector, smallholders, indigenous communities, United Nations (UN) institutions and others. The document therefore constitutes a strong political commitment and guidance framework for achieving zero hunger through more responsible investment in agriculture and food systems.

CFS-RAI targets all types of investment in agricultural value chains and food systems. The principles apply to foreign and domestic, public and private, small, medium and large-scale investments. Special attention is given to the role of smallholder producers with regard to investments and agricultural research, extension, sustainable management of natural resources, tenure, climate adaptation and technology transfer. Investment in irrigation, mainly led by the public sector, thus has significant potential to improve agricultural production and fits very well within the framework of the CFS-RAI principles.

The following sections will describe how the CFS-RAI principles can be applied in the context of irrigation projects, after a short explanation about the content of the CFS-RAI. Even though the principles are very broad and applied on a voluntary basis, compliance with them is useful to maximize the intended results of the investment project as well as to mitigate risks. It is imperative to contextualize CFS-RAI in each project. CFS-RAI is not a set of one-size-fits-all principles, and its implementation has only just begun. However, the principles provide a strong guidance framework which has the support of all stakeholders.

3.7.2 Content of CFS-RAI

CFS-RAI comprises ten principles as shown in the table below.

The principles have been developed to be universally applicable to address all relevant issues related to responsible agricultural investment. The core elements include food security and nutrition, tenure rights, transparency and accountability, consultation and participation, rule of law, social and environmental sustainability, gender equality, empowerment of women and youth, and cultural heritage.

Apart from the ten principles, CFS-RAI has a special section that stipulates the roles and responsibilities of the stakeholders who are involved in, benefit from or are affected by agricultural investments. States are the most important stakeholder group as they have the primary responsibility for achieving food security and nutrition. States are expected to ensure that actions related to responsible investment are consistent with existing obligations. Moreover, states play a unique role in incorporating the principles into national regulatory frameworks, fostering an enabling environment for responsible investment in a participatory manner, providing public goods and services, including infrastructure, and establishing monitoring and assessing systems to measure impacts as well as to address the negative impacts.

As agriculture and food systems vary to large extent from country to country, it is imperative to interpret the principles in the national and regional context. Also, given that the principles are voluntary and non-binding, they should be applied in accordance with existing obligations under national and international laws and regulations.

The principles can be used at different levels. At policy level, they will help to identify and highlight any gaps to be filled in the national and institutional regulations in order to enable responsible agricultural investment. At project implementation level, as discussed below, key critical points can be shown to make the investment project more responsible by respecting the principles.

3.7.3 CFS-RAI in irrigation projects

Although application of the principles should be context-specific for each field of development, some general implications can be applied for irrigation investment projects. This section highlights important key areas from the principles concerning irrigation development.

Principle 1: Contribute to food security and nutrition

Irrigation projects can enhance food security by improving food availability and access to food through increase in agricultural production. Improvement of farmers' incomes is another possible contribution to food security that irrigation projects can make, through crop intensification and introduction of high-value crops due to improved water availability. It is important, however, to examine and improve the market access of farmers if the project scope includes income generation, as it depends not only on access to water but also to markets.

On the other hand, it should be assured that irrigation projects will not harm food security. When promotion of cash crops is a part of the project, its effect on marginalization of subsistence crops as well as possible adverse effects on food security of farmers, in particular those who are already relatively disadvantaged, need to be assessed.

Principle 2: Contribute to sustainable and inclusive economic development and the eradication of poverty

Access by farmers to public and private services such as extension and capacity development for improved and appropriate cultivation technologies and farming

CFS-RAI 10 principles

Principle 1:	Contribute to food security and nutrition
Principle 2:	Contribute to sustainable and inclusive economic development and the eradication of poverty
Principle 3:	Foster gender equality and women's empowerment
Principle 4:	Engage and empower youth
Principle 5:	Respect tenure of land, fisheries and forests, and access to water
Principle 6:	Conserve and sustainably manage natural resources, increase resilience and reduce disaster risks
Principle 7:	Respect cultural heritage and traditional knowledge, and support diversity and innovation
Principle 8:	Promote safe and healthy agriculture and food systems
Principle 9:	Incorporate inclusive and transparent governance structures, processes and grievance mechanisms
Principle 10:	Assess and address impacts and promote accountability

Source: CFS, 2014.

management along with irrigation improvement will increase productivity and enhance the likeliness of poverty reduction.

Well-organized groups for water management such as WUAs are imperative for sustainable utilization of water resources. Strengthening organizations and institutions responsible for irrigation operation and water management is recommended to be incorporated as part of the project.

Principle 3: Foster gender equality and women's empowerment

Gender equality should be constantly ensured in all phases of the project for better development impacts, as women often cannot enjoy as much benefit from development as men do. Also, women may have different roles and needs in terms of irrigation. Participation and presentation of affected women should be assured. For example, forming separate groups in accordance with gender can promote participation of women if they are reluctant to attend mixed gender workshops.

Also, in terms of access to natural resources, women are often disadvantaged or neglected and thus more vulnerable than men. For instance, if women are not able to hold official land tenure rights and water rights, they cannot take part in the decision-making processes in a WUA when the membership is based on official water rights. In addition, women are likely to lose access to natural resources when they lose male relatives in the family.

In particular, as land tenure rights are closely associated with access to other natural resources, including access to water, treating women equally and recognizing their tenure rights – even if they do not have official tenure rights – will lead to more fair and responsible investment, which can enhance the development impact.

Principle 4: Engage and empower youth

Similar to women, youth in the rural area may have less representation in the society. They may have different needs and expectations from irrigation projects. Forming youth groups can promote engagement of youth with the project.

In line with the CFS-RAI principles, innovation and new technologies can be combined with traditional knowledge to attract and enable youth to be drivers of improvement in agriculture and food systems. Combining these technologies with empowerment of youth can strengthen the impacts of infrastructure development, such as for irrigation. Providing access to extension, advisory and financial services and opportunities for training will foster entrepreneurship and innovation by youth.

Principle 5: Respect tenure of land, fisheries and forests, and access to water

Securing tenure rights of land and access to water is an important factor for agricultural investment. The governing framework of tenure of natural resources differs from country to country and can be very complicated because of the co-existence of customary laws and statutory laws.

To understand correctly the tenure rights endowed to people, the VGGT (FAO, 2012c), which is referred to in CFS-RAI Principle 5, provides a concept of "legitimate tenure rights." People who historically and socially own or use the land in the traditional framework may not comply with formal regulation or fulfil the administrative requirement. However, these people are seen as holders of "legitimate" tenure rights if their lands are utilized for real and effective activities and if these are known to others and accepted. In other words, tenure rights can be seen as legitimate through informal and customary recognition, even if legal procedures or registration is lacking. The definition and conditions of legitimacy vary in each society and country.

Thus, in planning and implementing a project, it is important to identify existing legitimate tenure rights and rights-holders in the project area. In case the project needs to expropriate land for construction of an irrigation structure, expropriation and compensation should be done in a way that respects the tenure rights of those who are affected. Identification of rights is a prerequisite for safeguarding rights-holders. It also should be mentioned that, according to the guidelines, expropriation is allowed only where the rights are required for public purpose.

Also, security of tenure rights makes economic sense. Perception of better security of tenure provides rights-holders with more incentive to invest. In the case of irrigation projects, this will lead to better operation and management of the irrigation scheme after the completion of the project.

Principle 6: Conserve and sustainably manage natural resources, increase resilience and reduce disaster risks
Farmers are often unaware of the limits of water resources and their diminution due to overuse of water. The overuse of water can have a strong negative impact as the increase of water use in one area may affect water availability in another. Irrigation projects should be formulated based on river basin management where actors' rights and responsibilities of water use in the river basin are identified, considering not only water availability in the target area but also that of the entire river basin. This includes formulating a project based on water balance calculation with hydrological and meteorological data in the river basin. In addition, adoption of water-saving technologies for efficient water use will promote sustainable use of water resources.

Salinization, waterlogging, soil erosion and insufficient recharge to the aquifer are some of the environmental risks that an irrigation project could incur. Preventive measures, including transferring technical knowledge to farmers regarding proper irrigation methods, should be incorporated in the project plan.

Change of water use and land use due to irrigation projects may cause negative impacts on biodiversity. Potential impacts on biodiversity should be assessed in advance and mitigating measures should be taken.

Principle 7: Respect cultural heritage and traditional knowledge, and support diversity and innovation
Traditional techniques and traditional infrastructure for irrigation vary according to the topography and climate of the area. It is recommended to review the advantages and rationales of traditional irrigation techniques when the project aims to modernize irrigation schemes. People should have traditional knowledge to deal with floods and drought with traditional irrigation schemes. Such knowledge should be utilized even after introduction of modernized infrastructure, because these techniques may have been developed to deal with the area-specific challenges that also need to be addressed in the project.

If rivers or other water resources are linked with traditional culture or if irrigation infrastructure is seen as a form of heritage in the area, changes in the landscape by modernizing irrigation infrastructure need to be minimized. Cultural and traditional relations between people, rivers and irrigation schemes should not be overlooked while aiming for structural efficiency.

Principle 8: Promote safe and healthy agriculture and food systems
Change of hydrology of water resources due to development of an irrigation scheme could affect water quality. Agrochemicals used in the irrigation scheme may become harmful to the environment if they contaminate water resources. Also, water in the irrigation scheme may carry pathogens of communicable diseases. Mitigating measures should be taken, including construction of facilities for proper drainage, prevention of water seepage and proper control of fertilizer.

In addition to the increase of production and productivity, diversification of crops is one of the benefits that irrigation projects can bring by improving water availability. It can contribute to better nutrition if nutritious crops are introduced and consumed. Training and education on good nutrition as a part of capacity development for farmers can make irrigation projects nutrition-sensitive.

Principle 9: Incorporate inclusive and transparent governance structures, processes and grievance mechanisms
Consultation and participation are key elements of CFS-RAI. Disclosure of information and consultation should be started at a very early stage and systematically ensured throughout the process of the project. If communities affected by the project are involved in the decision-making process only after certain plans are made and little space has been left for negotiation, it often causes opposition. This is a risk for the sustainability and success of the investment project. The principle recommends engaging those to be affected prior to decisions being made, through meaningful participation.

Studies on foreign direct investment in agriculture confirm that ensuring effective participation is a determinant of success for the investment (World Bank, 2014c). They found that inadequate pre-investment consultations and a failure to involve affected communities from the early stage of the project is one of the main causes of investment failure. This finding can be analogously applied to irrigation investment projects. The consultation process can be costly and time-consuming, but these costs do not trade off against the benefit of avoiding conflict at a later stage of the project.

Therefore, all stakeholders affected by the project should be carefully identified. In this context, communities and water users upstream and downstream of the project site that could be affected by new infrastructure should be consulted. An appropriate representation system that takes into account cultural sensitivities in the interest group should be considered in order to ensure that the benefit of the project is shared fairly in the group. Failure to find appropriate representation for all interest groups results in dissatisfaction among the stakeholders. In the worst cases, this could even mean that the consultation process needs to be redone, which severely impairs effectiveness and efficiency of the project.

Also, meaningful participation calls for transparency and rebalance of power. As is often the case with agriculture investment, considerable information and power asymmetries exist between a government and farmers/community members. Measures should be taken to rebalance the power relations as well as to make the process transparent by disclosing information to farmers. Farmers and community members, including potentially marginalized people, can be empowered by, for example, strengthening local civil society organizations and farmers' organizations.

Principle 10: Assess and address impacts and promote accountability

Assessing and addressing impacts in an appropriate manner promotes responsible investment. It is often pointed out that environmental and social impact assessments are not conducted as required. Moreover, even when these are conducted, it is not done effectively or recommendations made in the assessment are not considered or reflected at the operation stage. Effective assessment should therefore be conducted prior to the project and incorporated in the management plan in order to be monitored properly during and after the implementation of the project. Defining baseline data and indicators are useful to monitor the impacts.

Furthermore, as impacts could vary according to the circumstances, it is important to regularly assess the changes and communicate with stakeholders. For instance, a cropping pattern and calculations of peak water use that are assumed at planning stage could be changeable in practice according to farmers' objectives; thus, actual water demand could vary accordingly. Continuous assessing will enable taking necessary actions properly, even at operation stage.

This principle recommends that particular attention should be paid to impacts on the most vulnerable people and measures should be taken to address them. Again, the consultation and participation of affected communities is key to measuring and addressing the impacts. The option of not proceeding with the planned project should remain open until the appropriate measures to mitigate negative impacts are identified.

In addition to environmental and social impact assessments, an economic impact assessment is recommended. In this way, not only collective benefits accrued by the project but also the distribution among stakeholders can be examined and assessed. This is particularly important in cases where poverty alleviation is a key issue.

ANNEX 1 TEMPLATES OF PROJECT CONCEPT NOTES (PCNs)

Template 1. World Bank template
(maximum length: 5 pages)

Section Name	Major Contents	Length
1. Cover sheet	• Project name and key parameters	One page
2. Key development issues and rationale for Bank involvement	• Support for borrower's objectives, policies and strategies • Borrower's commitment and ownership • Support to relevant CAS objective(s) • Lessons learned from Analytical and Advisory Assistance (AAA) and previous projects • Relationship to other partners' activities • Borrower's interest and preparedness	One page
3. Proposed PDOs	• If the project is successful, what will be its principal outcome for the primary target group?	Half a page
4. Preliminary project description	• Alternative development interventions or approaches • Selection of lending instrument • Project components and indicative costs • Issues on partnerships and co-financing	One page
5. Potential risks and mitigation	• Potential political, policy-related, social/stakeholder-related, macroeconomic or financial risks • Risks in borrower's institutional capacity • Risks identified through predecessor operations or other assessments • Safeguard policies triggered and mitigation measures	Half a page
6. Issues on which the team seeks guidance	• Sector policy and strategy • Relationships with borrower and/or other partners • Bank policies or procedures • Project design • Choice of lending instrument • Technical/analytical aspects • Institutional/capacity aspects • Risk mitigation, including fiduciary and safeguard issues • Issues related to project preparation plan	Half a page
7. Proposed preparation schedule, team composition and budget estimate	• Proposed timetable of key steps in the preparation process • Members of the project team • Estimated amount of Bank funds needed for the whole process of project preparation and approval	Half a page

Template 2. IFAD template
(maximum length: 3 pages)

Section Name	Major Contents
1. Strategic context and rationale for IFAD involvement, commitment and partnership	Background information on: poverty and rural development context; policy, governance and institutional issues; political and economic issues; IFAD country programme (note: this section is not needed if the project concept is part of the RB-COSOP).
2. Possible geographic area of intervention and target groups	Target group and targeting approach. A preliminary identification of the project geographic and administrative location should be provided.
3. Justification and rationale	Justification and rationale for the project – in other words, the key development opportunity that the project will achieve and why IFAD has the comparative advantage to respond to it.
4. Key project objectives	The project objectives and the link between these objectives and the quantified targets in the COSOP Results Management Framework. It also summarizes which COSOP policy objectives will be achieved by the proposed project.
5. Ownership, harmonization and alignment	Explain how the project targets are aligned with targets in the PRSP (or alternative), and how the project is harmonized with the activities of other donors in the same sector of intervention.
6. Components and activities	Preliminary description of components and activities.
7. Costs and financing	Indicative budget for the project. Contribution by government and beneficiaries cannot be determined at this time; however, an indication of the interest of other donors should be provided.
8. Organization and management	Government’s lead agency in the process of project formulation and the likely implementing agency.
9. M&E indicators	Relevant quantified targets included in the COSOP Results Management Framework; project contribution to their achievement; plan for baseline survey; standardization of information and reporting.
10. Risks	Potential risks and relevance of the ones described in the COSOP to the project.
11. Timing	Indication of the timing for project preparation and its compliance with the government’s investment strategy and time frames.
12. CPMT composition	Names and organizational affiliation of in-house and country-level members of the Country Programme Management Team (CPMT)

Template 3. FAO template
(maximum length: 5 pages)

Section Name	Major Contents
1. Cover sheet	1.1 Project name and key parameters
2. Background	2.1 Contribution to country-level programming frameworks (national, UN and/or FAO) 2.2 Contribution to FAO's Strategic Framework 2.3. Comparative advantage
3. Summary of proposed action	3.1 Problem to be addressed 3.2 Summary of the proposed strategy 3.3 Expected results 3.4 Participants and other stakeholders 3.5 Potential risks 3.6 Sustainability of the proposal 3.7 Synergies
4. Implementation arrangements	4.1 Potential implementation modality 4.2 Partner(s) 4.3 Prospective resource partner(s)/funding source(s) 4.4 Project task force

Source: Authors, adapted from FAO, 2010.

ANNEX 2 WORLD BANK GUIDELINES ON PCN PROCESSING

Step	Guidelines	Primary Responsibility
Preparation of PCN	• The PCN should be prepared and reviewed shortly after the first identification mission or before the amount spent on the project goes above USD 30 000. • Word-based PCN template is launched and filed through the Project Portal on the Bank Intranet.	Team Leader (TL)
Circulation of PCN	• Once the PCN is filed electronically, the document system automatically generates a draft Project Information Document (PID) and Integrated Safeguards Data Sheet (ISDS). TL reviews these, and makes any needed additions, deletions or corrections. • After approval of the draft PCN by the Sector Director or Sector Manager per regional guidelines, TL circulates the PCN and draft PID and ISDS by email at least eight working days before the review meeting to the Country Director, Country Team members, Sector Director, Sector Manager/Leader, Quality Director, Operations Adviser, Financial Management Specialist, Procurement Specialist, Regional Safeguards Coordinator, Lawyer, Disbursement Officer.	Team Leader
Comments on PCN	• Comments should be sent in writing no later than two working days before the meeting. • To be accepted, comments must recognize that this is a concept review, where the focus is on strategic issues, options and preliminary ideas of content and risk, not on details.	Recipients of PCN
PCN Review Meeting	• Country Director or his/her designee chairs. All recipients of the PCN are invited. • The key objectives are: (i) to make a go/no-go decision on project preparation; (ii) to seek early agreement on issues that the project should address, on the project's objectives and on the approach to be taken to achieve the objectives; (iii) to flag potential risks and identify measures to address them during preparation; and (iv) to provide guidance to the Bank team and borrower on priorities or criteria to follow in the project preparation and appraisal process.	Country Director
Minutes of PCN Review Meeting	• Draft minutes prepared within 5 working days and circulated to all meeting participants. • Participants have 3 working days to respond; silence is deemed approval.	Team Leader
Approval of PCN Review Minutes	• CD approves minutes within 3 working days after deadline for comments on minutes.	Country Director (CD)
PID and ISDS	• TL revises the PID; Sector Manager clears; PID is sent to Infoshop. • TL revises ISDS in consultation with safeguard unit; Sector Manager and Safeguard Coordinator clear it; ISDS is sent to Infoshop.	Team Leader
Revision of resource estimate through Activity Update Summary (AUS)	• The relevant resource management (RM) staff enters the agreed resource estimate for project preparation and approval in an AUS	TL requests RM staff

ANNEX 3 WORLD BANK OPERATIONAL RISK ASSESSMENT FRAMEWORK

Level	Categories
1. Project stakeholder risks	
2. Operating environment risks	2.1 Country 2.2 Sector/multisector
3. Implementing agency risks (including fiduciary)	3.1 Capacity 3.2 Governance Fraud & Corruption (subcategory of 3.2)
4. Project risks	4.1 Design 4.2 Social & Environmental 4.3 Programme & Donor 4.4 Delivery Monitoring & Sustainability 4.5 Others

ANNEX 4 STRUCTURE AND CONTENTS OF PROJECT APPRAISAL DOCUMENTS (PADs)

Chapter/Section	Major Aspects to be Addressed	Technical Specific Features to be Mentioned
1. Strategic Context		
A. Country and sector context	• Role and performance of irrigated agriculture in country objectives related to food security, nutrition, poverty and inequality reduction, economic growth, resilience to climate and economic shocks, etc. • Sectoral policy constraints that threaten irrigation development results and sustainability (budget support to the sector, land tenure, farmers' access to finance, agricultural inputs and equipment supply, etc.) • Sectoral reforms/restructuring (under implementation or preparation to address constraints and issues).	Reference to the types of irrigation, size/technical model/system functions and other sector activities to be integrated in each case (fisheries, water supply, forestry, ecosystem protection, etc.)
B. Institutional context	• Institutional organization of irrigated agriculture with reference to the key actors (government, central and decentralized bodies, farmers' organizations, WUAs/ WUOs) and their respective roles (planning, development, financing, management, extension, O&M, auditing and assessment, etc.) • Key institutional constraints noted (unbalanced distribution of roles among government institutions, private sector and rural organizations dealing with irrigation) and solutions envisaged to mitigate these issues.	Reference to the types of irrigation concerned (public, private, PPP).
C. Higher-level objectives to which the project contributes	• Government priority objectives with which the project is consistent – for instance, food security improvement, competitiveness strengthening, water governance, land reform, gender and youth unemployment reduction (Reference to IFIs/DAs Partnership Strategies). • Value added for IFIS/DAs in supporting government objectives. • Linkage with other IFI/DA-assisted projects/programmes. • Phasing of the donors' support to government's higher objectives (short, medium and long-run)	Reference to the types of irrigation concerned.
2. PDOs		
A. PDOs	• To be clearly improved/worded from the PCN version (for instance "(i) increase sustainably irrigated agricultural productivity of organized farmers in selected areas of high potential; and (ii) improve the participation of beneficiaries in market-based value chains".	Reference to the types of irrigation concerned.
B. GEOs (if applicable)	• Applicable generally to large projects with a high environmental impact potential (regional projects). • Examples for a regional project: "Improve collaborative management of the transboundary water resources of a river basin"; "introduce climate change adaptation and mitigation measures".	Large-scale irrigation projects including a national or regional dimension.

Chapter/Section	Major Aspects to be Addressed	Technical Specific Features to be Mentioned
C. Beneficiaries (direct and indirect)	• Beneficiaries could include: (i) farmers (number estimate) and their organizations – WUAs/WUOs; (ii) national and regional irrigation development entities; (iii) decentralized entities (districts…)	Disaggregation of farmers by type of irrigation scheme and reference to the strategic context.
D. PDO/GEO level results indicators	• A need for measurable indicators ("area provided with improved irrigation and drainage network and services"; "number of operational WUOs created and trained", etc.	Reference to types of irrigation and institutional context.
3. Project Description		**Annex 2**
A. Project components	• Regional focus, if applicable. • Technical components, including for instance: institutional strengthening of irrigation subsector; investment in small and medium-scale systems; advisory services. • Project fiduciary component including management, coordination, M&E, safeguards and oversight. • Subcomponents to be specified for each component.	Reference to types of irrigation and PDOs.
B. Project lending instrument and financing	• Lending instrument and lending terms (final maturity and grace period). • Series of project phases (if applicable). • Project cost (summary by component) and financing plan (government and beneficiaries, donors).	Reference to project size and duration
C. Lessons learned and reflected in the project design	• National and international irrigation experiences on which the project is built. • Aspects that need more focus for improvement or scaling up.	Reference to irrigation types and scales, national and international experiences.
4. Implementation		**Annexes 1 & 3**
A. Partnership arrangement (if applicable)	• Project linkage with ongoing operations funded by the same donor and others.	Reference to different IFI/DA operations.
B. Institutional and implementation arrangements	• Executing agency (ministry, ministry department, irrigation authority, private sector agency) and cooperating entities. • Distribution of responsibilities between central and decentralized levels, public and private entities, etc. • Coordination and steering mechanisms. • Implementation manual including technical, administrative and financial detailed procedures.	Reference to project dimension and type, and project components.
C. Outcomes/ results M&E	• Baseline survey to capture the existing situation with reference to core indicators. • Internal M&E and reporting system to track and assess the project progress outputs, outcomes and impacts with reference to key indicators. • External independent evaluation system (audit) to assess project impact on beneficiaries and national economy.	Reference to all project components, activities and key indicators.
D. Sustainability	• Sustainability is to be considered a core project principle and should be analysed through: - Financial incentives and/or technical support provided to beneficiaries to enhance their commitment. - Government ownership factors (counterpart financing, provision of facilities, etc.) - Sectoral reforms committed by government (modification of the legal framework to introduce WUOs, improve land access, facilitate private sector involvement in irrigation promotion segments, etc.)	Reference to project key stakeholders.

Chapter/Section	Major Aspects to be Addressed	Technical Specific Features to be Mentioned
5. Key Risks and Mitigation Measures		**Annex 4**
A. Risks ratings summary table	• Identification and assessment of major risks relating to implementation and sustainability and confirmation that project design and implementation and monitoring measures adopted shall mitigate those risks.	
B. Overall risks rating explanation	• Ownership and commitments from government as well as capacities and responsiveness of stakeholders (including beneficiaries and service providers) are key for rating explanation.	
C. Controversial aspects (if applicable)	• Examples: water shortage, unbalanced water use, riparian issues, etc.	
6. Appraisal Summary		
A. Economic and financial analysis	• Benefits expected to flow from the project (projected incomes for beneficiaries desegregated by gender, land area to be gained, youth employment, nutrition improvement through crops diversification, etc.) • Project economic viability through projected internal and overall EIRR, including sensitivity analysis. • Projected farm-level benefits through financial analysis ensuring full cost recovery for O&M.	Annex 6
B. Technical	• Confirmation of the adequacy of the project design (highlighting technical innovations and advantages) and accuracy of O&M standards and funding mechanisms.	Annex 2
C. Fiduciary (financial management and procurement)	• Confirmation of the appropriateness of the financial management system as well as auditing mechanisms at all levels, and staff qualification to run the system. • Confirmation of procurement and monitoring capacities within the implementation staff.	Annex 8
D. Social and environment (including safeguards policies) + other policies triggered (if applicable)	• Summary of positive and negative social impacts. • Implementation of mitigation measures.	Annex 6
7. Project Plan		
A. Detailed project implementation plan	• Project implementation manual including all components, subcomponents and activities. • Implementation plan for the first year (18 months for some IFIs). • Financial, accounting and administrative procedures including audits. • Procurement plan for the project implementation period to be agreed on during the appraisal mission.	Annex 8

Key Annexes (Depending on IFIs and DAs)

Annex 1: Results Framework and M&E System
Annex 2: Detailed Project Description
Annex 3: Implementation Arrangements and Support Plan
Annex 4: Risk Assessment Framework
Annex 5: Project Costs
Annex 6: EFA
Annex 7: Social and Environment (including Safeguards Policies)
Annex 8: Project Work Plan (Implementation Manual, Financial Management and Disbursement Plan, Procurement Plan)
Annex 9: Country at a Glance
Annex 10: Maps

Other Relevant Annexes (Depending on IFIs/DAs)

- Major operations financed by the IFIs/DAs
- Statement of loans and credits
- Documents in the files

ANNEX 5 SAMPLE RESULTS FRAMEWORK AND MONITORING

Result framework

PDO	Project Outcome Indicators
To improve productivity of water contributing to sustainable growth and poverty reduction in selected focus river basins	• Average farm income of project beneficiaries (Rs/ha) • Targeted families with increased incomes (%) • Area provided with improved irrigation and drainage services (ha) • Increased crop production per unit of water delivered (kg/m^3) • Average fish production productivity in reservoirs (kg/ha) • Average fish productivity in village ponds (kg/ha) • Operational WUAs created and/or strengthened (number) • Number of female water users (number)
Intermediate Outcome	**Intermediate Outcome Indicators**
Component 1: Water Resources Management – Institutions and Instruments	• Single state water governance body established and functioning in accordance with stated roles and responsibilities (text) • River basin plans (RBP) prepared (number)
Component 2: Service Delivery – Irrigation and Drainage Institutions	• Irrigation schemes completed (number) • Systems ready to supply the planned volumes of water at specified delivery points (number) • Systems where performance management targets established and being met by system managers (number) • Irrigation service delivery by service providers (Water Resources Department and WUAs) assessed as satisfactory or above by at least 60 percent of water users in the schemes that are already completed or where works are ongoing (number)
Component 3: Improving Productivity in Selected Irrigation and Drainage Assets in Focus Basins	• Schemes with agricultural intensification and diversification (number) • Schemes with improved fish production in reservoirs and ponds (number)
Component 4: Project Management Support	• Regular reporting (quarterly and annual reports) • Procurement • Accounting and financial management • Disbursement of funds • Project staffing levels and capabilities

Sources: Adapted from World Bank, 2004; World Bank, 2011; World Bank, 2016.

ANNEX 6 SAMPLE TERMS OF REFERENCE FOR TECHNICAL SERVICE

Terms of reference for consultancy service

On feasibility and technical design study for irrigation development

World Bank Supported Third Rural Sector Support Project (RSSP3)

Ministry of Agriculture and Animal Resources, Republic of Rwanda

1. Background

The Government of Rwanda is pursuing a comprehensive Poverty Reduction Programme, which includes implementation of various sustainable development projects. The Rural Sector Support Project is one of the development initiatives designed under the Ministry of Agriculture and Animal Resources (MINAGRI) funded by the World Bank in order to tackle the issues related to food insecurity and livelihoods income in rural communities. The long-term programmatic objective of the RSSP series (RSSP1, RSSP2 and RSSP3) is to help the Government of Rwanda achieve its strategic goal of unlocking rural growth in order to increase incomes and reduce poverty. The series, at its inception, envisioned the first phase (RSSP1) would build the capacity needed to support the adoption of sustainable intensification technologies in developed marshlands and surrounding hillsides, with the second phase (RSSP2) broadening and deepening the support provided to accelerate intensification and commercialization. The third phase (RSSP3) is intended to extend and build upon the already successful growth-stimulating RSSP activities of the first two phases, while emphasizing diversification of economic activities to increase and stabilize rural incomes. It is in this regard that the project will invest in expanding the irrigation area through rehabilitation or development of marshlands including irrigation dams, diversion weirs, irrigation and drainage network canals and other irrigation facilities.

2. Objective

To undertake a comprehensive pre-feasibility study and on sites confirmed worthy of a subsequent feasibility study, to carry out feasibility studies and detailed design studies for the execution of water/agricultural development works for various marshlands totalling 1 500 hectares within Kigali City boundaries. Specifically, this consultancy service will:

i. Review previously identified potential sites, if necessary identify additional sites and carry out reconnaissance surveys, site selection and pre-feasibility studies;

ii. Undertake comprehensive feasibility studies including designs, cost estimates, socio-economic and financial analyses for the selected sites; and

iii. Undertake detailed designs for the selected feasible sites.

3. Scope of the service

3.1. General

The Consultant will perform all engineering and soil surveys, agronomic, socio-economic and financial studies, and related work as described herein to attain the objectives of the study.

3.2. Data collection and review

The Consultant will collect and review all relevant data and information on past and ongoing studies and projects related to the assignment including the following:

- Rwanda Irrigation Master Plan, August 2010;
- Marshland Development Master Plan, 2004;
- Reports and maps of potential sites previously identified by RSSP;

- Other previous studies of projects similar to RSSP including those developed by Kigali City Council;
- Topographic and soil maps at 1:50 000 scale for the entire project area.

3.3. Site selection and pre-feasibility study

The Consultant shall:

- Make visits to the potential sites previously identified by RSSP and carry out reconnaissance surveys.
- Collect and analyse all hydrological and agrometeorological data for the respective sites, including an assessment of flood occurrence possibilities.
- Carry out preliminary mapping, based on satellite imagery and limited ground inspection, at scales of 1:25 000 and 1:10 000 or 1:5 000 with 10 m and 2 m or 1 m contour intervals, respectively, of the sites. The mapping will indicate the main infrastructure including roads, houses, schools and natural features.
- Carry out a preliminary assessment of land pollution, collect samples of water from run-of-river flows and make water quality assessment for agricultural use and identify any physical, chemical, fertility or environmental constraint that would require special treatment or block the land development.
- Identify potentially irrigable land, taking account of soils, topography, flows and distance from water source for gravity water delivery to surface irrigation system.
- Where the surface water is not sufficient or scarce, assess the possibility to irrigate by using underground water or shallow aquifers.
- Select marshlands most suitable for development or identify alternative marshlands if necessary.
- Prepare the pre-feasibility study report.

3.4. Feasibility study

For each of the selected marshlands, the Consultant will carry out detailed investigations to assess their feasibility and the following subjects will be covered by the feasibility study:

- Topographic survey
- Hydrology
- Geotechnical survey
- Dam structures
- Marshland irrigation
- Socio-economic analysis
- EFA
- Environmental assessment

i) Topographic survey

The following topographic survey activities shall be carried out:

- Preparation of a topographic map for the marshland at 1:2 000 scale (or 1:1 000 if necessary). The map shall show major features including existing roads, foot paths, settlements, water courses, etc.
- Preparation of the topographic map of main structures (diversion structures) at 1:100 or 1:500 scale. All significant details must be presented on the maps and the maps should extend at least 20 m in all directions
- Construction of permanent benchmarks out of concrete with steel rod tops. Two (2) benchmarks shall be set, one at each abutment of the river weir, and additional benchmarks shall be located every 500 m alongside of the marshland where they will not be disturbed during construction activities.

ii) Hydrology

The hydrology of the feasibility studies for each of the selected sites will include, but not be limited to, the following components:

- Collect, review and evaluate for completeness and consistency all available climatic and hydrologic data relevant to the project area.
- Compute monthly runoffs and inflows using universally accepted inflow-outflow models.
- Compute various frequencies of storms, and probable maximum precipitation relevant to design of diversion structures or simple water intake using universally accepted methodologies.
- Carry out the base flow measurement of the stream during the period of the study (two measurements/month) and estimate the base flow for a return period of five years;
- Carry out all other data collection considered necessary and relevant for the hydrology component of the project.

iii) Geotechnical survey

- The geotechnical survey will be conducted on the foundation soil, quarry materials and borrow zone (and reservoir area if necessary), using hand auger, trial peat and penetrometer systems.

- Samples will be laboratory tested for grain size, Atterberg limits, density, moisture content, shear strength, compressibility, compaction, permeability, etc.
- Possible sources of construction materials, including sources for earth-fill, filter, riprap, concrete aggregate, sand, etc., will be identified and georeferenced. The study shall indicate the type, suitability, quantity, availability and proximity of construction materials.
- A comprehensive geotechnical investigation report will be prepared and will include the complete laboratory test results and interpretations.

The following table summarizes the trials and tests to be conducted on the ground (*in situ*) and in the laboratory:

iv) Dam and appurtenant structures

- Collect, analyse and evaluate all data necessary for design of the dam and reservoir. Based on the topographic survey and the hydrological, geological and geotechnical study results, the dimensions of the dam and reservoir will be determined and defined.
- The dam axis alignment shall be the shortest possible, resulting in minimum embankment volume and foundation treatment. The design shall also take into consideration shortest river diversion during construction and stable position in relation to the abutments.
- The dam height will be determined taking into account a number of factors, including topography, needed volume of storage to meet irrigation water requirements, reservoir area volume – elevation curve, sediment volumes, flood surcharge head, freeboard for waves and camber.
- The design of the dam will include dam type selection and determination of embankment section. The design shall take into account: geotechnical investigation results and recommendations; available construction materials; foundation and abutment conditions; field and laboratory test results; relevant active forces; seepage control, filter and drainage requirements; seepage and slope stability analysis under different critical loading conditions; provision of embankment slope protection from waves and erosion; coffer dam and river diversion; and instrumentations for monitoring and surveillance. Analysis and justification shall be given to support the chosen dam type selection.
- The inlet/outlet structure will be designed to regulate irrigation discharges. The main tasks

Type of survey	Test	Number of tests		
		Dam foundation	Borrow zone	Reservoir area
In situ	• Penetrometer (SPT)	5		
	• Hand auger drilling	5		
	• Trial pit	5	5	3
Total		**15**	**5**	**3**
Laboratory	• Moisture content	0	10	0
	• Grain size	10	10	10
	• Sedimentary	0	0	0
	• Atterberg limits	0	10	0
	• Consolidation and swelling	0	10	0
	• Modified Proctor	0	10	0
	• Permeability	10	10	10
	• Dry and wet density	10	10	10
Total		**30**	**70**	**30**

included in the inlet/outlet design are: determination of inlet/outlet alignment and location; determination of inlet structure type and location; determination of level of openings/gates in the inlet structure; hydraulic and structural design of inlet/outlet components including inlet channel, inlet structure, outlet conduit, energy dissipater and outlet channel.

- The spillway will be designed to regulate flood outflow discharges. The main tasks included in the spillway design are: selection of design flood (peak flow); determination of appropriate spillway type and location; determination of appropriate alignment; hydraulic and structural design of spillway components including approach channel, control section, conveyance channel, energy dissipater and exit channel.

v) River weir and appurtenant structures (basin, sand trap)

- Describe the sites of water diversion structure.
- Estimate the peak flows (design flood) for a return period of ten years.
- Describe, if possible, the access roads to the diversion structure.
- Study the bearing capacity of soil foundation (using penetrometer or other appropriate techniques if necessary) and the location of borrow materials (carrier).
- Design and size the diversion structure (preferably in concrete and stones – Cyclopean structure): height and length of the sill; sizes of the upper base slab (raft) and its cutoff wall; sizes of the stilling basin and rock fill; size of the side walls plans; reinforcement bars; types and sizes of valves; and staff gauge.

vi) Marshland irrigation system

The following work shall be carried out for marshland irrigation system development. Overall planning and design of the irrigation system shall be as simple as possible so that users can understand and participate easily in the O&M. Complex designs shall be avoided as much as possible and Consultant shall consider irrigation systems using diversion river weir or dam if necessary. The design shall use cost-effective structures and, wherever possible, the use of local materials for construction of irrigation structures should be promoted.

Agronomy and soil survey study:

Describe the perimeter by specifying the name and location of each of the units (or branches) that make up the area concerned, the dominated area, area to be developed (gross) as well as the useful area (net);

Soil studies shall be carried out for the entire project area to determine the suitability of marshland soil. The methodology for land evaluation will use the international standards.
A complete physical and chemical characterization of the soil will be carried out using laboratory and *in situ* testing and analyses. The following parameters shall be determined: particle size; organic matter; pH; water retention; permeability; electrical conductivity; calcium; total nitrogen; exchangeable phosphorus and potassium; and cation exchange capacity.
The density of sampling points required is 1 sample per 20 hectares and in every sample all the described parameters will be determined.
If problems are identified, the study shall present specific recommendations relevant to the specific utilization of the different soil types.
Based on the finding of soil analysis with soil map observation and current use of marshland, the potential (suitability) soil map will be produced.

Crop water requirement:

Crop water requirements shall be determined on a decade (ten days) basis and dry quinquennial year using long-term weather data and a cropping pattern approved by the Client.

Irrigation network conceptual design:

- Conceptual design options shall be developed considering different irrigation options. Particular attention will be paid to irrigation technology choices that bear in mind the need for ease of operation and affordability of O&M costs. Conceptual designs for the irrigation systems shall be developed with sufficient details to prepare conceptual level cost estimates. This will involve:
- Expanding the hydraulic parameters to be used for calculations of various hydraulic structures;
- Describing the outline of the canals network, the various hydraulic structures and their respective roles;
- Specifying, by reach, the lengths of different irrigation and drainage canals, sizes and slopes (bottom and embankments/slope inclination); and

- Describing the network of access and service roads of the perimeter.

vii) Socio-economic study

The study should be conducted in close consultation with district staff and communities and shall include the following activities:

- Review all available information and reports regarding the socio-economic situation of the project area and reassess the present socio-economic situation of the people in the project area.
- Review previous data at local and national levels, making use of Participatory Rural Appraisal tools.
- Identify socio-economic studies to fill information gaps and prepare a household questionnaire to collect this information as well as the attitudes of the beneficiaries towards development.
- Conduct a study of demography, education, health, living standards, gender issues, etc.
- Prepare a comprehensive demographic and poverty profile of the area, with specific analysis on household composition, characteristics, number and characteristics of female household members, employment characteristics of the population, population growth and impact on economic development, etc.
- Identify development potentials and constraints of the project area and involve all stakeholders to ensure sustainability of the project.
- Assess the project beneficiaries, urban areas, production, markets, agricultural incomes and other sources of income.
- Analyse the present economic condition of the farmers in the project area based on the survey results.
- Assess/estimate the total population that will be beneficiaries of the project.

viii) EFA

The Consultant will estimate the profitability of the project based on:

- The cost of development works and equipment including staff costs and expropriations;
- The cost of O&M of the developed scheme and equipment in place;
- The intensive use of the field and potential production share to be marketed;
- The expected profit and the expected annual total value of crop production.

ix) Environmental and social assessment and resettlement considerations

There is a need to undertake a rapid environmental and social impact assessment for the development of each marshland, as well as a mitigation plan unless full environmental and social assessment (ESA) is envisaged by another consultant to be recruited.

3.5. Detailed design study

After acceptance and approval of the feasibility study by RSSP, the Consultant will proceed with the detailed design study for the project, considering all comments and suggestions including for diversion structures, irrigation network and related facilities. The tasks will include:

- As deemed necessary, conducting additional detailed field investigations, borrow material investigations, etc.
- Preparing detailed design of each component of the project and design reports.
- Preparing detailed drawings of various structures at 1:50, 1:100 and 1:200 scales.
- Preparing bill of quantity and engineers' estimates to be used for comparison of bids.
- Updating the economic analysis from the feasibility study with the revised cost estimates for the entire project and presenting them in the detailed design.
- Designing access roads, which will connect the project to the nearby road network.
- Preparing O&M plans including estimated costs and a typical water rotation schedule.

4. Requirements for key technical persons and qualifications

Irrigation engineer (team leader)

Qualifications: university degree in the field of rural engineering (irrigation), civil engineering, water resources planning/management or any related field; at least ten years of general experience and five years of irrigation experience with three references as a team leader of irrigation scheme design studies on similar assignments (in terms of complexity and nature) in African countries (preferably in the subregion); capable of formulating an overall design of the irrigation system and all related technical aspects including irrigation water requirements and design criteria; strong managerial capacity and interpersonal relations.

Tasks: coordinate the Consultant's work to ensure the agreed implementation programme is adhered to; act as the contact person and focal point for the Consultant.

Inputs: intervene during all stages of study equivalent to duration of services of eight calendar months including four months of field work.

Hydrologist
Qualifications: university degree in rural engineering, water resources engineering or any other related field with at least ten years of relevant experience in hydrology; references in similar studies as hydrologist; and the ability to execute the work to the required standard.

Tasks: intervene mostly during the feasibility stage; collect and review all hydro-meteorological data and carry out all necessary hydrological analysis.

Inputs: two calendar months including one month of field work.

Environmental Expert
Qualifications: university degree in natural resources sciences; extensive experience in environmental studies of at least seven years with three references in similar assignments.

Tasks: intervene mostly during the pre-feasibility stage; be responsible for the environmental assessment, especially water and soil pollution assessment; work closely with Hydrologist and Agro-economist; prepare the ESA report for the project including all its components, consistent with the requirements and the prescribed guidelines of the Department of Environment and Natural Resources.

Inputs: two calendar months including one month of field work.

Agro-economist
Qualifications: university degree in agronomy or agro-economy; seven years of extensive experience in tropical irrigated agriculture and three references in similar studies; considerable working experience with farmers' organizations and urban agriculture.

Tasks: intervene mostly during pre-feasibility and feasibility stages; be responsible for all agro-socio-economic studies and EFAs of the project.

Inputs: four months including two calendar months of field work.

Topographic surveyor
Qualifications: an ordinary certificate in surveying studies with more than seven years of relevant experience in the field and five references in similar studies.

Tasks: intervene during the feasibility and detailed design stages; be responsible for all topographic surveying works and drawings.

Inputs: three calendar months.

Reports	Submission Schedule	Copies
Inception report	1st month	3 Sets +3 CDs (English & French each)
Pre-feasibility report	4th month	3 Sets +3 CDs (English & French each)
Provisional feasibility report	9th month	3 Sets +3 CDs (English & French each)
Final feasibility report	11th month	3 Sets +3 CDs (English & French each)
Provisional detailed design report	13th month	3 Sets +3 CDs (English & French each)
Final detailed design report	14th month	5 sets +5 CDs (English & French each)

5. Reporting requirements

The Consultant shall produce and submit to the Client the reports indicated below, following the specified time schedule and formats:

The Consultant shall arrange for and make PowerPoint presentations of the reports to the Client at design workshops no more than one week after submission of the pre-feasibility report, provisional feasibility report and provisional detail design report. All the reports must be submitted in both French and English versions. The client shall have 15 calendar days to check, request any modifications and approve the provisional reports and five calendar days to do so for remaining reports.

i. *Inception Report:* The report shall comprise the Consultant's mobilization, the revised work plan, methodology and time schedule for the services, site selection criteria and the proposed content and structure of the various reports. Initial findings and any constraints and problems that could affect the study or future project implementation will be given.

ii. *Pre-feasibility Report*: The report will present preliminary results of review and site investigations, rank the sites based on the selection criteria and choose the best sites for feasibility study. The selection criteria should include but not be limited to the following: water availability; marshland size and suitability; nature of soil; environmental status (water and soil pollution); land use (settlement, industry, etc.); expected benefits; etc.

iii. *Feasibility Report*: The report will include the feasibility designs and the financial and economic analyses.

iv. *Detailed Design Report*: The report will provide details of in-depth investigations on all aspects of the project. It will include all calculations, notes, layout maps, drawings, bills of quantity, and updated financial analyses.

6. Responsibility of the client

The client will:

- Ensure free access to the site and locations connected with the execution of the study;
- Provide the Consultant with any assistance the Consultant may be entitled to in accordance with the Terms of Reference;
- Provide the Consultant with all documents, information reports, data, any existing photographs and other information pertaining to the study that are available and not withhold any information pertinent to the Consultant's work.
- Facilitate the issuance of work permits and entry visas for the Consultant's expatriate staff.
- Facilitate the import and export of any required equipment, supplies and soil samples.

7. Responsibility of the consultant

- The Consultant shall carry out the Study in a professional manner in keeping with internationally accepted standards, using qualified and appropriate staff. They shall endeavour to implement the assignment with diligence and within the time agreed upon in the contract. In this regard the Consultant shall furnish to the RSSP the full curriculum vitae of each of the members of the team it proposes for the Study.
- The Consultant shall be responsible for providing all staff payments including salaries, freight, and travel including visas. The Consultants shall replace any staff member who is unable to carry out the work or is considered by the Client to be unsuitable. As per the rules in keeping with internationally accepted standards for assignment of this nature, the replacement of any of the Consultant's staff should be by a person of equal competence at the same cost and subject to the approval of the Client.
- The Consultant shall be responsible for office costs, cost of housing and other services for staff while in Rwanda and for procurement and transport of all office supplies, technical equipment, machinery and hire of vehicles needed for the study.
- The Consultant shall be responsible for arranging and meeting the cost of all, but not limited to, support services for assessments, topography survey, soil survey, geotechnical investigation, laboratory analysis, and for the printing of all reports (in English and in French).

8. Duration of the assignment

All three stages of pre-feasibility, feasibility and detailed design studies will take an estimated period of 14 months.

ANNEX 7 LIST OF PRACTICAL TOOLS AND SOURCES

Tool	Introduction	Source
World Bank. 2013. *Investment project financing: Project Preparation Guidance Note.* World Bank. Washington, D.C.	This guidance note provides step-by-step guidance on project identification, preparation, appraisal and negotiation, consistent with the World Bank operational policy and procedure. It is intended for internal use by Bank staff and applies to all investment projects supported by International Bank for Reconstruction and Development (IBRD) / IDA loans, credits, grants and recipient-executed trust funds.	http://siteresources.worldbank.org/PROJECTS/Resources/40940-1365611011935/Guidance_Note_Project_Prepration.pdf
FAO. 2012. *Guide to the project cycle. FAO.* Rome.	This guide provides step-by-step guidance on project processing throughout the FAO-defined project cycle, from identification to formulation, appraisal and approval, implementation and monitoring, evaluation and closure. It applies to all FAO technical cooperation and emergency projects, including UN joint programmes, with the exception of TCP and Telefood-funded projects.	http://www.fao.org/docrep/016/ap105e/ap105e.pdf
FAO. 1996. *Guidelines for planning irrigation and drainage investment projects.* FAO Investment Centre Technical Paper. Rome.	These guidelines cover the whole investment planning process, from formulation of subsectoral strategies, to conceptualization of project options and detailed planning of the preferred options. The intended users are FAO Investment Centre staff, trainees and consultants, as well as local planning groups set up by governments to prepare investment proposals.	http://www.fao.org/3/a-w1037e.html
Team FME. 2013. *SWOT analysis strategy skills.*	This eBook describes the basic concept, approach and process of SWOT (strengths, weaknesses, opportunities and threats) analysis, a technique that can be performed for products, services and markets when deciding on the best strategy for achieving future growth.	http://www.free-management-ebooks.com/dldebk-pdf/fme-swot-analysis.pdf
World Bank. World Bank Safeguard Policies. World Bank website.	A World Bank website which presents the Bank's social and environmental safeguard policies related to investment operation.	http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,menuPK:584441~pagePK:64168427~piPK:64168435~theSitePK:584435,00.html
IFAD. 2014. *IFAD's Social, Environmental and Climate Assessment Procedures.* IFAD. Rome.	These procedures set out a minimum risk assessment process that recognizes the necessary heterogeneity of responses, given widely different country and community circumstances. Through better risk identification they aim to avoid environmental or social harm and also create space for doing good.	https://www.ifad.org/topic/gef/secap/overview
World Bank. 2012. *Designing a results framework for achieving results: A how-to guide.* Independent Evaluation Group. World Bank. Washington, D.C.	This publication provides how-to guidance for developing results frameworks. It also provides various examples and excerpts of results frameworks used at country, project and organizational levels, and offers references for further support to practitioners in designing and using results frameworks for development effectiveness.	http://siteresources.worldbank.org/EXTEVACAPDEV/Resources/designing_results_framework.pdf

Tool	Introduction	Source
World Bank. 2011. *Guidance note on the operational risk assessment framework (ORAF): Risks to achieving results.* Operations Policy and Country Service. World Bank. Washington, D.C.	This guidance note provides detailed descriptions of the World Bank Operational Risk Assessment Framework (ORAF) and relevant processing procedure. It focuses primarily on the application of the ORAF to new investment lending operations.	http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/12/25/000333037_20121225233017/Rendered/PDF/NonAsciiFileName0.pdf
FAO. 2011. *Social analysis for agriculture and rural investment projects.* Investment Centre Division. FAO. Rome.	These guidance documents comprise three guides that demonstrate the application of social analysis to investment programmes and projects in agricultural and rural development. The Manager's Guide addresses the needs of project managers and team leaders. The Practitioner's Guide deals with the 'why and what' questions, building on the conceptual approach in the Manager's Guide. The Field Guide provides guidance on the fieldwork aspects of social analysis, based on the Practitioner's Guide.	http://www.fao.org/docrep/014/i2816e/i2816e00.htm
FAO. 2012. *Environmental impact assessment: Guidelines for FAO Field Projects.* FAO. Rome.	This publication provides guidelines for all FAO units to undertake environmental impact assessments (EIAs) of field projects. These guidelines apply to all FAO field projects and activities.	http://www.fao.org/3/a-i2802e.pdf
FAO. 2007. *Modernizing irrigation management: The MASSCOTE approach.* FAO Irrigation and Drainage Paper 63. FAO. Rome.	This paper presents a step-by-step methodology for water engineering professionals, managers and practitioners involved in the modernization of medium-scale to large-scale canal irrigation systems from the perspective of improving performance of conjunctive water supplies for multiple stakeholders. While the focus is on canal operation, the scope concerns the modernization of management. The approach consists of a series of steps for diagnosing performance and mapping the way forward in order to improve the service to users and the cost-effectiveness of canal operation techniques.	http://www.fao.org/docrep/010/a1114e/a1114e00.htm
FAO. 2008. *Water and the rural poor: Interventions for improving livelihoods in sub-Saharan Africa.* FAO. Rome.	This paper addresses the potential benefits of water initiatives under a livelihood approach, with special consideration to two major recommendations: i) investments in water infrastructure must act in concert with political, institutional, market and other related concerns; and ii) interventions must be context-specific, given the vast heterogeneity in water use and needs among the sub-Saharan African rural poor.	https://www.issuelab.org/resource/water-and-the-rural-poor-interventions-for-improving-livelihoods-in-sub-saharan-africa.html
World Health Organization. 2006. *WHO guidelines for the safe use of wastewater, excreta and greywater,* Vol. 2: *Wastewater use in agriculture.* WHO, UNEP and FAO. Geneva.	This volume explains requirements to promote safe use concepts and practices, including health-based targets and minimum procedures. It also covers a substantive revision of approaches to ensuring the microbial safety of wastewater used in agriculture. It distinguishes three vulnerable groups: agricultural workers, members of communities where wastewater-fed agriculture is practiced, and consumers. It introduces health impact assessment of new wastewater projects.	http://www.who.int/water_sanitation_health/publications/gsuweg2/en/
Ayers, R.S. & Westcot, D.W. 1994. *Water quality for agriculture.* FAO Irrigation and Drainage Paper 29, Rev.1. FAO. Rome.	This paper provides guidance to farm and project managers, consultants and engineers in evaluating and identifying potential problems related to water quality. It discusses possible restrictions on the use of water and presents management options which may assist in farm or project management, planning and operation.	http://www.fao.org/docrep/003/T0234E/T0234E00.htm

Tool	Introduction	Source
Batchelor, C., Hoogeveen, J., Faurès, J.-M. & Peiser, L. 2017. *Water accounting and auditing: A sourcebook*. FAO Water Reports 43. FAO. Rome.	This sourcebook aims to provide practical advice on the application and use of WAA, helping users plan and implement processes that best fit their needs.	http://wwAAA4w 15h(1 373.1222 138.5124 cm3he1(n4o1(n4c

Tool	Introduction	Source
Savva, A. & Frenken, K. 2002. *Irrigation Manual: Planning, development monitoring and evaluation of irrigated agriculture with farmer participation.* FAO Land and Water Digital Media Series 37. Land and Water Division. FAO. Rome.	This manual comprises 14 modules and provides support to both national and subregional training programmes in the planning, design, construction, operation and maintenance, and on-farm water management of irrigation schemes.	http://www.fao.org/docrep/010/ai596e/ai596e00.HTM
FAO. 2009. CROPWAT 8.0 Software.	Free software to estimate irrigation requirements at field and system levels and to optimize irrigation schedules with complex cropping patterns.	http://www.fao.org/land-water/databases-and-software/cropwat/en/
FAO. 2012. Crop yield response to water.	AquaCrop is a crop-water productivity model that simulates the yield response of herbaceous crops to water and is particularly well suited to conditions in which water is a key limiting factor in crop production.	http://www.fao.org/aquacrop/en/
FAO. 2012. *Coping with water scarcity.* Irrigation and Drainage Report 38.	This report aims to provide a conceptual framework to address food security under conditions of water scarcity in agriculture. It discusses issues related to supply enhancement and demand management and recommends action within and beyond the water domain to deal with water scarcity.	http://www.fao.org/documents/card/en/c/c08f0346-822f-518e-90f7-d1bdc22dc979
FAO. 2012. *Incorporating climate change considerations into agricultural investment programmes: A guidance document.* Investment Centre.	This guidance document aims to assist investment project formulation practitioners in incorporating climate change considerations into agricultural investment projects and programmes.	www.fao.org/docrep/016/i2778e/i2778e.pdf
FAO. 2012. *Voluntary guidelines on the responsible governance of tenure of land, fisheries and forests in the context of national food security.*	The guidelines set out principles and internationally accepted standards of practice for the responsible governance of tenure. They provide a framework that states can use when developing their own strategies, policies, legislation, programmes and activities.	www.fao.org/nr/tenure/voluntary-guidelines/en/
IIMI. 1996. *The IIMI water balance framework: A model for project level analysis.* Research Report 5. Colombo, Sri Lanka.	This publication presents a model to prepare a water balance framework at the irrigation scheme level to help practitioners understand the impact of the proposed project in the context of the river basin.	http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/pub005/REPORT05.PDF
IWMI. 2007. *Minimizing the negative environmental and health impacts of agricultural water resources development in sub-Saharan Africa.*	This paper provides a synopsis of environmental and health impacts arising from agricultural water development in sub-Saharan Africa and recommends ways to increase the sustainability of investments in irrigation by giving greater prominence to health and environmental concerns.	www.iwmi.cgiar.org/Publications/Working_Papers/working/WOR117.pdf
World Bank. 2005. *Shaping the future of water for agriculture: A sourcebook for investment in agricultural water management.* Agriculture and Rural Development. Washington, D.C.	This publication is a compilation of selected good experiences to guide practitioners in the design of quality investments in agricultural water.	https://openknowledge.worldbank.org/handle/10986/7298
African Development Bank (AfDB). *Guidelines for project appraisal.*	These guidelines provide guidance on the AfDB approach, procedure and steps for project appraisal.	https://www.afdb.org/en/projects-and-operations/project-cycle/project-appraisal/

Tool	Introduction	Source
Denison, J. & Manona, S. 2007. *Principles, approaches and guidelines for the participatory revitalisation of smallholder irrigation schemes.* WRC Report No TT 308/07: ISBN 978-1-77005-568-1, Set No 978-1-77005-567-4.	These guidelines comprise two volumes. Volume 1, the Rough Guide, is a quick reference guide for the more action-oriented and is written to allow easy access to the main principles, approaches and methodologies to support and guide implementing teams. Volume 2, Concepts and Cases, contains the theoretical rationale for the guidelines based on a set of arguments developed through field research and case investigation. This includes a study of South African and international revitalization approaches and commercial partnerships.	http://www.wrc.org.za/Knowledge%20 Hub%20Documents/Research%20 Reports/TT%20308-09%20 REVISED%20Agricultural%20 Water%20management.pdf
World Bank. 2106. *Procurement Strategy for Development (PPSD).* World Bank. Washington, D.C.	This summary guidance provides a structured approach for borrowers to use a modern set of procurement tools and techniques to achieve best value for money (VfM) in projects financed through investment project financing (IPF).	http://pubdocs.worldbank.org/ en/633801467334323120/PPSD-Short-Form-July-26.pdf
IFAD. 2010. *Project Procurement Guidelines.* IFAD. Rome.	This document sets out the policies, principles and standards that IFAD requires borrowers/ recipients to adhere to when undertaking the procurement of goods, works or services needed under development projects or programmes governed by a financing agreement (Section I.D of these Guidelines).	https://www.ifad.org/web/guest/ document-detail/asset/39501080
IFAD. 2010. *IFAD Procurement Handbook.* IFAD. Rome.	This handbook further elaborates on the Procurement Guidelines to be followed in the procurement of goods, works and services under IFAD- financed loans and grants.	https://www.ifad.org/web/guest/ document-detail/asset/39501121
IWMI and Interstate Commission for Water Coordination. 2003. *How to establish a Water Users Association?*	This document outlines the approach and steps for establishing WUAs.	http://www.iwmi.cgiar.org/regional-content/central_asia/pdf/wua_eng.pdf
Nile Basin Initiative. 2012. *Participatory operation and maintenance of irrigation schemes.* Training Manual 10.	This training manual summarizes some guidelines on participatory approaches for the planning, development, O&M of irrigation schemes, focusing on smallholder group schemes.	http://nileis.nilebasin.org/content/ participatory-operation-and-maintenance-irrigation-schemes-training-manual-no10
Narmada Water Resources Water Supply & Kalpsar Department, Government of Gujarat. April 2009. *Operation and maintenance guidelines for canal.*	Guidelines to prepare an O&M manual for canal irrigation.	https://guj-nwrws.gujarat.gov. in/ downloads/manual_for_canal_ maintenance_operation.pdf
Water for Food Team & World Bank. 2008. *Toolkit for monitoring and evaluation of agricultural water management projects.* Water for Food Team. Agriculture Department, World Bank. Washington, D.C.	The Toolkit comprises a set of guiding principles and helpful resources. It consists of three main parts: an introduction and overview for project M&E, followed by guidance notes with explanations and examples on specific components of the M&E system, and by a set of resources for projects. Most of the Toolkit is focused on the specifics of World Bank AWM projects. Many of the principles and techniques covered, however, are generic and widely applicable.	http://documents.worldbank.org/ curated/en/137921468140948443/ pdf/447990WP0Box321BLIC10m1 etoolkit1web.pdf

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Irrigation has been and will continue to be a priority in agricultural and rural investments. Development of the irrigation sector faces multiple challenges, including water scarcity and degradation, competition over shared resources and the impact of climate change. Innovations that address these challenges, as well as emerging needs, and promote productive, equitable and sustainable water management are needed. These *Guidelines on irrigation investment projects*, produced by an inter-agency team, highlight experiences and lessons learned from global irrigation investment operations. They introduce innovative approaches, tools and references, and provide practical guidance on how to incorporate or apply them at each stage of the investment project cycle. These Guidelines will be a useful resource for national and international professionals involved in irrigation investment operations.

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