OECD Environment Working Papers No. 115

Managing multi-purpose water infrastructure: A review of international experience

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https://dx.doi.org/10.1787/bbb40768-en

OECD

Unclassified **ENV/WKP(2017)2**

Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

15-Feb-2017

English - Or. English

ENVIRONMENT DIRECTORATE

ENV/WKP(2017)2
Unclassified

Cancels & replaces the same document of 07 February 2017

MANAGING MULTI-PURPOSE WATER INFRASTRUCTURE: A REVIEW OF INTERNATIONAL EXPERIENCE - ENVIRONMENT WORKING PAPER No. 115

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Authorised for publication by Simon Upton, Environment Directorate.

JEL Classification: Q25, Q15, Q18, D62

Keywords: multi-purpose water infrastructure; water management; externalities; nexus;

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JT03409022

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ABSTRACT

In this paper, the term multi-purpose water infrastructure (MPWI) encompasses all man-made water systems, including dams, dykes, reservoirs and associated irrigation canals and water supply networks, which may be used for more than one purpose (for economic, social and environmental activities). While MPWI plays a significant role in the socio-economic development and ensuring water, food and energy security of many countries (not least in water-stressed Central Asia), many MPWI projects face various challenges. These including unsustainability of business models for financing, operation and maintenance, lower-than-expected performance or the emergence of unforeseen risks and negative externalities.

This paper explores the complexity in designing, financing, regulating and managing MPWI projects, with the objective to inform policy and decision-making. It attempts to identify key issues related to managing MPWI, lessons learned from international experience and possible solutions to the challenges. It examines several principles, approaches and instruments to enhance the sustainability of MPWI, drawing on international experience. Finally, the paper identifies knowledge and experience gaps, needs for further research and possible areas of future work.

Keywords: Multi-purpose water infrastructure; water management; externalities; nexus;

JEL Classification: Q25, Q15, Q18, D62

RÉSUMÉ

Dans cette étude, les infrastructures polyvalentes de l’eau désignent tous les réseaux d’eau artificiels – barrages, digues, réservoirs, canaux d’irrigation et réseaux de distribution d’eau connexes – susceptibles d’avoir plus d’une finalité (activités économiques, sociales et environnementales). Ce type d’infrastructure contribue de façon notable au développement socio-économique ainsi qu’à la sécurité hydrique, alimentaire et énergétique de bien des pays (en premier lieu ceux d’Asie centrale, soumis à un stress hydrique). Pourtant, nombre d’ouvrages hydrauliques polyvalents s’accompagnent de difficultés diverses : précarité des modèles économiques de financement, d’exploitation et de maintenance, performance moins bonne que prévu ou apparition de risques et d’externalités négatives inattendus.

Il s’agit ici d’étudier la complexité attachée à la conception, au financement, à la règlementation et à la gestion des projets d’infrastructures de l’eau polyvalentes, en vue d’éclairer les responsables de l’élaboration des politiques et les décideurs. À cette fin, on tentera de mettre en évidence les principaux problèmes liés à la gestion de ces ouvrages, les enseignements tirés de l’expérience internationale et les solutions envisageables. Plusieurs principes, concepts et instruments visant à renforcer la viabilité des infrastructures de l’eau polyvalentes seront ensuite passés en revue, à la lumière de l’expérience internationale. En dernier lieu, on recensera les lacunes à combler en termes de connaissances et d’expérience, les besoins à satisfaire en matière de recherche et les domaines dans lesquels engager de nouveaux travaux.

Mots-clés : Infrastructures polyvalentes de l’eau; gestion de l’eau ; externalités ; nexus ;

Classification JEL : Q25, Q15, Q18, D62

FOREWORD

This subject was identified as a high priority by the stakeholders of the on-going National Policy Dialogue on water in Kazakhstan. This desk top study was initiated under the Kazakhstan-OECD Country Programme, as part of the OECD GREEN Action Programme Task Force's work on the water-food-energy-ecosystems nexus, with the financial support from the governments of Germany, Norway and Switzerland. This support is gratefully acknowledged. To implement a desk study and draft the paper, the OECD commissioned two water experts, Ms. Meleesa Naughton (principal author) and Ms. Nicole DeSantis (co-author). They worked under the supervision of Mr Alexandre Martoussevitch (OECD GREEN Action Programme Task Force secretariat), manager of the project and contributor to this working paper. The authors thank Ms. Kumi Kitamori, Mr Matthew Griffiths and Mr. Krzysztof Michalak of the OECD for their valuable comments that helped improve both the content and structure of the report. In addition, they thank Ms Maria Dubois, Ms Stéphanie Simonin-Edwards and Ms Lupita Johanson of the OECD for respectively formatting, web dissemination, and organising review of the paper in-house.

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ABBREVIATIONS, ACRONYMS AND SPECIFIC TERMS

3Ts	Taxes, tariffs and transfers
ADB	Asian Development Bank
AFD	Agence Française de Developpement
AFKED	Aga Khan Fund for Economic Development
BOOT	Build-Own-Operate-Transfer
BTO	Build-Transfer-Operate
CBA	Cost-Benefit Analysis
CBO	Community-Based Organisation
DH	Moroccan Dirham
DSS	Decision Support Systems
EDF	Electricité de France
EECCA	Eastern Europe, the Caucasus and Central Asia
EGAT	Electricity Generating Authority of Thailand
EU	European Union
FAO	UN Food and Agriculture Organisation
GBAO	Gorno-Badakshan Autonomous Oblast
GDP	Gross Domestic Product
ICOLD	International Commission on Large Dams
IDA	International Development Association
IFC	International Finance Corporation
IFI	International Financial Institutions
IHA	International Hydropower Association
IUCN	International Union for Conversation of Nature
IWA	International Water Association
IWRM	Integrated Water Resources Management
MDB	Multilateral Development Bank
MIGA	Multilateral Investment Guarantee Agency
MPWI	Multipurpose Water Infrastructure
MUS	Multiple Use Services
MW	Megawatt
NAPOCOR	National Power Corporation of the Philippines
NDB	National Development Bank
NGO	Non-Governmental Organisation
NPD	National Policy Dialogue
NTPC	Nam Theun 2 Power Company
O&M	Operation and Maintenance
OBA	Output-Based Aid
ODA	Official Development Assistance
OIEAU	Office International de l'Eau
ONEMA	Office National de l'Eau et des Milieux Aquatiques
P&L	Profit&Loss
PPP	Public-Private Partnership
PSP	Private Sector Participation
RBA	River Basin Agency
RBC	River Basin Committee
RBMP	River Basin Management Plan
ROM	Rehabilitate-Operate-Maintain

SADC	Southern African Development Community
SCP	Société du Canal de Provence
SMADESEP	Syndicat Mixte d'Aménagement et de développement de Serre-Ponçon
SRPC	San Roque Power Corporation
TVA	Tennessee Valley Authority
USD	United States Dollar
VNF	Voies Navigables de France
WCD	World Commission on Dams
WEF	World Economic Forum
WMPA	Watershed Management Protection Authority
WSP	Water and Sanitation Program
WSS	Water Supply and Sanitation
WUG	Water User Group
WWC	World Water Council

Stakeholders	In this report are defined as "persons or groups who are directly or indirectly affected by a project, as well as those may have interests in a project and/or the ability to influence its outcome, either positively or negatively. Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organisations and groups with special interests, the academic community, or other businesses". (IFC, 2007)
Full supply costs & full economic costs	Full supply costs in this report are defined as the costs of O&M, capital costs (including for renewal investments and new capital investment costs) and the costs of servicing debt (i.e. inter alia include full financial costs), while full economic costs include full supply costs as well as the resource costs (reflecting the scarcity value of water) and the net costs of externalities.

EXECUTIVE SUMMARY

Population and economic growth, ageing water infrastructure and climate change will all have profound consequences for water resources management in the coming decades. The 2015 World Economic Forum ranked water-related risks, in terms of shortage, quality or water-related disasters as the key short- and long-term global risk having the single greatest economic impact over the next decade.

In this paper, the term **multi-purpose water infrastructure (MPWI)** encompasses all man-made water infrastructure, including dams, dykes, reservoirs and associated irrigation canals and water distribution networks, which are used or may be used for more than one purpose, for economic, social and environmental activities. Water infrastructure may be multi-purpose either by design or by practice.

Two main observations triggered the initial research work presented in this paper:

- MPWI plays a significant role in the socio-economic development of many countries and provinces (e.g. in water-stressed Central Asia) including ensuring water, food and energy security;

- Many MPWI projects face various challenges including unsustainability of business models used to operate, maintain and finance respective MPWIs, to lower than expected performance or the emergence of unforeseen risks and negative externalities.

The issues related to managing MPWI were acknowledged as high priority issues by the stakeholders of the on-going National Policy Dialogue (NPD) on water in Kazakhstan.

To address this country demand, a desk-study was undertaken focussing on:

(i) **policy and decision making**: what are the key issues related to managing MPWI and what could we learn from international experience? and

(ii) **methodology** for future work on MPWI in the region of Eastern Europe, the Caucasus and Central Asia (EECCA): what would be the most topical issues facing MWPI? What are key knowledge and experience gaps? Where would future work add most value? How best to design future case studies? Which tools could support decision making and implementation?

This paper explores the complexity in designing, financing, regulating and managing MPWI projects, with the objective to inform policy and decision-making. It examines several principles, approaches and instruments to enhance the sustainability of MPWI, drawing on international experience including four key case studies from San Roque multi-purpose project (the Philippines), Nam Theun 2 project (Laos), the Guerdane irrigation project (Morocco) and the Canal of Province multi-purpose scheme (France).

A key conclusion from the study is that though many MPWIs generate significant net benefits, realising them in full requires a good understanding of the underlying economic, financial, regulatory and management conditions. The following key issues and challenges should be highlighted:

Factoring in positive and negative externalities and risks

MPWI projects typically have multiple positive and negative externalities. These include biodiversity and eco-systems services, tourism and recreation development in the MPWI project site, environmental degradation, the loss of cultural heritage and relocation of populations. Some externalities cannot be fully foreseen, assessed, monetised and internalised.

The long life time of an MPWI facility, typically 50 to over 100 years, means there is inherent uncertainty about future developments and risks. This can create local resistance, especially where stakeholders are not appropriately informed or engaged. Proven instruments including proper planning and decision making, stakeholder engagement, sound regulation and social safeguards help to mitigate this.

Planning and decision making

Upfront Strategic Impact Assessment and Strategic Environmental Assessment are useful instruments for enhancing the economic, environmental and social sustainability of MPWI projects. Decision making and planning processes can also be informed by the "decision points" instrument from the World Commission on Dams and the Hydropower Sustainability Assessment Protocol from IHA.

The full range of externalities and multiple, often inter-related, risks at a given location should be assessed in the planning stages and re-evaluated over time. Cost-effective interventions for managing the risks should be determined while capitalising on opportunities for investment. MPWI projects should engage with stakeholders to fully address respective concerns and impacts early in the planning process.

MPWI Stakeholders engagement

A major challenge for MPWI is allocating water among competing users, as well as fairly distributing risks, costs and benefits among stakeholders. Early stakeholder consultation and co-operation is critical for the success and sustainability of MPWI projects. The SHARE concept, based on the principle of "*Shared vision, Shared resource, Shared responsibilities, Shared rights and risks, Shared costs and benefits*", is a tool that was developed to minimise conflicts and project delays. It helps to strengthen the decision-making process and multi-stakeholder dialogue throughout the MPWI project development, management and operation. Policy dialogue can benefit from the inclusion of stakeholder perspectives and results-oriented stakeholder engagement to enhance knowledge-sharing, transparency and conflict resolution.

Regulation and compliance

Sound environmental, technical, social and economic regulations can safeguard against foreseen material risks and negative externalities. Regulatory demands are more complex for MPWI projects as they provide more than a single function. Compliance is a key aspect of successful regulation. The World Commission on Dams recommends five policy principles to strengthen compliance: having clean and consistent criteria and guidelines for compliance; a Compliance Plan; built-in costs for compliance mechanisms in project budget; enforcement of legislation; and incentives.

Business models

There is no "*first best*" business model for MPWI projects. The choice of a sustainable business model needs to account for specific sets of water uses, foreseen risks and externalities, risk mitigation options, the stage of project (investment phase versus routine O&M),financial viability, financing sources and available subsidies.

Public-Private Partnerships (PPP) are expected to increase for MPWI projects with sound economic and financial viability and risk mitigation, as well as innovative models such as Split Ownership. However, an adaptive approach may be useful, as evolving environment (e.g. emergence of new water uses, risks or externalities) over the life of a MPWI project can require adjustments in the business model.

Addressing financial challenges

MPWI projects present specific financial challenges due to the high upfront costs and low financial returns (even if economic returns are large). Some components might be not financially profitable under strict market conditions. Also, many different stakeholders are affected and there are a number of competing users, often leading to conflicts over priorities. In addition, many large projects are transboundary, involving two or more countries. MPWI projects rely on the 3Ts (Tariffs, Taxes and Transfers) as the ultimate sources of finance, complemented by additional instruments and repayable sources of finance such as credit enhancement facilities/guarantees; export credit; commercial lending; and equity (e.g. by institutional investors).

MPWIs have historically been financed through public sector funding (especially upfront capital investments). To complement limited public finance, there has been a shift since the 1990s to engage private sector funding and expertise. Though it still remains a challenge, in the future, PPP models for MPWI are expected to grow and this can contribute by directly co-financing MPWI projects and improving O&M of water services by making them more efficient and commercially oriented.

Management and operation

The O&M cost of MPWI was found to be typically between 1-3% of total project costs and therefore considered marginal compared to large up-front capital investment. Thus it often receives much less attention than the capital investment. This neglect can result in challenges for financing O&M costs and an over-reliance on public subsidies.

Need for further research and possible areas of work

The study helped identify a set of key issues and challenges typically faced by MPWI projects. These findings are already in use in an MPWI project in Kazakhstan and may be useful for preparing a check list for future case-studies in the EECCA region and beyond. It also helped identify a number of gaps in terms of: (i) publicly available information about MPWI, especially on “brown field” projects; (ii) certain weaknesses in planning and assessing MPWIs, including Cost Benefit Analysis (CBA) in the situation where not all risks and externalities can be fully foreseen, monetised and assessed; and (iii) methodologies for planning infrastructure objects with life up to 100 years in the context of uncertainty and unforeseen events.

Addressing these gaps may require (a) dedicated case-studies on evolution of business models over the life time of MPWI and (b) development of supporting tools and methodologies.

Areas where further research is needed to better support MPWI and other water-related infrastructure projects are: (i) developing effective mechanisms for fairly sharing the risks, costs and benefits among stakeholders of respective project; (ii) identification and dissemination of best practices in adaptive business models to adjust to evolving socio-economic and regional development priorities; (iii) development of a comprehensive database on MPWI projects to share the experience with various business models, data on financing and investment trends and best practices.

Continued efforts to foster stakeholder engagement, facilitate transparent policy dialogue, adaptive business models and management, and greater information-sharing can strengthen MPWI projects and provide benchmarks and best practices to inform future policy and decision-making.

1. INTRODUCTION

Two key observations triggered the initial research work on MPWI presented in this paper:

- MPWI plays significant role in socio-economic development of many countries and provinces (not least in water-stressed Central Asia) including ensuring water, food and energy security;
- Many MPWI projects face problems including: unsustainability of business models used to operate, maintain and finance respective MPWI, lower than expected operational performance or emergence of unforeseen risks and externalities.

The issues related to managing MPWI were acknowledged as high priority issues by stakeholders of the on-going National Policy Dialogue (NPD) on water in Kazakhstan. To address this country demand, a desk-study literature review, presented in this paper, was undertaken with key research questions as follows:

(i) **policy and decision making**: what are the key issues related to managing MPWI and what could we learn from international experience? What are current trends in investment, the planning and regulatory frameworks, business models and project financing, and the management and operations of MPWI projects?; and

(ii) **methodology** for eventual future work on MPWI in the region of Eastern Europe, the Caucasus and Central Asia (EECCA): what are the most topical issues facing MWPI? What are key knowledge and experience gaps? Where would future work would add most value? How best to design future case studies? Which tools could support decision making and implementation?

A key initial assumption of the study worth mentioning: as MPWI projects are plenty, availability of data and info, including on business models, was expected not to be a problem. However, the study revealed that this assumption holds only partly: indeed, for many "green-field' projects there is relatively easily available data and information on how the MPWI was planned and how the upfront capital expenditure were financed; but it turned very difficult to find data and information on how the business model for operating, maintaining and financing evolved over time after completion of construction of respective MPWI, what were the drivers of change, etc. For instance, regarding "brown-field" projects, needed information was found only for one project: a single-purpose infrastructure, not MPWI. Nevertheless, this case is also presented in the paper to have at least one example of business model for financing capital investment in a "brown field" project.

After an initial screening of literature (Section 2), the study analyses experiences of both greenfield and brownfield[1] MPWI from a number of countries (Section 3) and presents mechanisms for managing MPWI projects, as well as financing capital investments and the costs of O&M and rehabilitation.

In Section 4, four case studies from San Roque multi-purpose project (the Philippines), Nam Theun 2 project (Laos), the Guerdane irrigation project (Morocco) and finally the Canal of Province multi-

[1] Greenfield schemes refer to projects that were started from scratch on undeveloped sites, while brownfield sites have been developed prior to the project or refer to projects that entail rehabilitation, or eventual extension or modernization of existing infrastructure.

purpose schema (France) are presented to explore existing MPWI projects including their business models and risk allocation. Other examples from around the world are also used where appropriate.

The study presents an analysis of major challenges of operating, maintaining and financing such schemes, and briefly discusses factors impacting selection of business model and derives lessons learned that are relevant to transition and emerging economies.

Finally, the study identifies areas where further research is needed to better support MPWI and other water-related infrastructure projects. These include developing effective mechanisms for fairly sharing the risks, costs and benefits among stakeholders of a respective project and identification and dissemination of best practices in adaptive business models to reflect evolving socio-economic and regional development priorities. Development of a comprehensive database on MPWI projects to share experience with various business models, data on financing and investment trends, as well as best practices is recommended.

2. LITERATURE REVIEW

2.1 Definition and scope

2.1.1 Definition of MPWI

The term multi-purpose water infrastructure (MPWI) encompasses all man-made water infrastructure, including dams, dykes, reservoirs and associated irrigation canals and water distribution networks, which are used or may be used for more than one purpose, for economic, social and environmental activities.

Water infrastructure may be multi-purpose either by design or by practice: while such infrastructure may be designed for a single use, water is often used in practice in a multi-faceted way. This review will follow the World Commission on Dams' definition of multi-purpose infrastructure, which consists of infrastructure that has been designed from the outset to be used for multiple purposes, and which aims to maximise economic efficiency through shared costs and shared infrastructure of the proposed scheme (World Commission on Dams, 2000). Given this review's emphasis on the economic and financial dimensions of water infrastructure, particular attention will be given to large schemes, where financial and economic challenges are likely to be most acute.

2.1.2 Main purposes and benefits of an MPWI, public and private goods and services

MPWI are generally designed to provide a combination of the following goods and services (ICOLD, 2014):

- Hydropower generation: When combined with a hydropower plant, dams can be used for hydroelectric power generation.
- Irrigation for agriculture: Water stored in a reservoir can be used to irrigate agricultural crops, typically through a distribution network of canals.
- Drinking water supply: Reservoir storage capacities and water distribution networks can be used to supply drinking water for human consumption.
- Water supply for industrial needs: Water storage can also be used for industrial purposes, including power plants for electricity generation.
- Transport and navigation: Multi-purpose water systems such as canals and regulation of surface water by dams can provide navigation and transport services.
- Flood control: Dam structures and reservoirs may offer flood protection by regulating water discharge and balancing runoff differences.
- Strategic water storage: MPWI are also used to mitigate the effects of climate variability and provide a strategic water "buffer" which may be used for some of the above purposes.

MPWI projects provide a number of private goods and services to certain users (they can typically be sold) as well as functions which are often public goods and remain difficult to monetise and capture (WWC & OECD, 2015). For example, flood management, strategic water storage, and water transport with a network of waterways all provide public goods. Some of them (e.g. navigation) can be used year round or limited to a few months, while the others (e.g. flood management) may only be needed a few weeks or even days in any particular year; therefore large dams and reservoirs used for flood control or strategic water storage virtually always have another purpose, such as power generation or irrigation (Nile Basin Initiative, 2008).

Once created for some of the above purposes, MPWI have also often been used for recreational, touristic and biodiversity services, including aquaculture and fishery (World Commission on Dams, 2000). Additional benefits can be leveraged from large MPWI, such as capacity building, local employment, infrastructure or benefits through integrated water resource management (IHA, 2011). In the case of large infrastructure projects, these additional benefits need to be allocated between the project-affected communities, the beneficiaries (who may reside far from the project site), and the public and the private sector (when relevant).

2.1.3 Positive and negative externalities

MPWI projects may have a number of positive and negative externalities, which are often difficult to factor in when calculating the economic viability of a project and even more so when assessing its bankability (see section 2.3.1) as not all externalities can be assessed or quantified monetarily and internalised.

A specific set of externalities may influence financing of an MPWI project: MPWI projects rely on a range of financing instruments and mechanisms that are determined on a case-by-case basis and can be informed by certain identified or anticipated positive and negative externalities (see section 2.4).

Positive externalities

In addition to the benefits derived from their primary purposes, MPWI often generate positive externalities, including:

- Biodiversity and ecosystem services: MPWI can be designed to preserve biodiversity and provide environmental benefits by supporting ecosystems. In some cases, the ecosystem services provided can then be turned into a source of income by the local population (e.g. aquaculture), for example, the Nam Theun 2 project (section 4.1.2);

- Recreational use: lakes created through water storage and water distribution canals can also provide recreational and touristic value; for example, the Canal de Provence (section 4.2.2).

- Health benefits and accrued productivity of the beneficiary population through improved access to water supply for drinking, irrigation, or through additional electricity services, depending on the purpose of the scheme.

- Flood control (when this is not the main purpose of the MPWI) through management of reservoir levels;

- Decreased travel time for affected communities thanks to improved transport infrastructure in the area of the MPWI site.

- A potential reduction in carbon emissions through the use of hydropower over fossil fuels for electricity generation (Liden, 2013).

Negative externalities

MPWI are similar to other large water infrastructure schemes in that they may lead to a number of negative environmental and socio-economic externalities. These can be mitigated, depending on the parameters of the proposed MPWI scheme (location of the site, size and management of the infrastructure) and through solutions to ensure that social and environmental externalities are appropriately addressed during the planning, construction and operation of MPWI. Greenfield MPWIs, particularly those which include large reservoirs, have been found to generate more acute negative social and environmental externalities. Negative externalities may include the following:

- The relocation of population directly affected by an MPWI project, ranging from people displaced by new reservoir flooding to properties affected by canal construction, and the need to create new jobs and (or) housing for displaced people;

- Effects on communities' socio-economic status and their livelihoods, for instance through impacts on fisheries downstream of a dam, or waterlogging of soil close to irrigation canals;

- Public health may be impacted, particularly through the increased prevalence of water-related diseases such as *schistosomiasis* or malaria near reservoirs and canals, in which vectors may breed, e.g. the Manantali Dam in Mali (AFD, 2009);

- Cultural heritage may be lost through reservoir construction and flooding;

- Biodiversity may be threatened, including through hindering the migration of aquatic species by damming rivers and favouring the prevalence of pests over threatened species (e.g. the Lower Kihansi Hydropower project in Tanzania, which threatened a rare species of toad that was then successfully reintroduced (WPP, 2014);

- Due to sediments being trapped, erosion may occur downstream of a dam, and water quality may be negatively impacted (Kondolf G., 1997); furthermore, reservoir siltation may decrease storage capacity in the long-term and require sediment management measures.

- Ambient environmental quality may be negatively affected, e.g. air pollution due to construction, increased traffic, or noise pollution.

Dam collapse and flooding with an immense potential for negative impacts on human life (affecting local and resettled people) and economic assets (OECD 2014), *Recommendation of the Council on the Governance of Critical Risks*) For example: “Flooding of the Tokwe Mukosi dam in south eastern Zimbabwe in February 2014 displaced thousands of people, and forced the Government to declare a national disaster, after water levels rose higher than expected causing a partial collapse of the dam being constructed” (Sibanda, 2014[2]). Externalities may also emerge from some regulatory gaps, governance and management failures such as the lack of decommissioning rules. This creates the incentive for MPWI owners to operate the scheme until the net benefits of operation become negative, and then abandon the scheme. Abandoned small dams may cause significant environmental damage, including severe erosion, destruction of aquatic habitat, and loss of fisheries. The cost of removing these small abandoned dams is typically borne by taxpayers (Aylard, 2001).

Specific combination of, and the balance between, negative and positive externalities may depend on geographic location of respective MPWI: e.g. on a river in a deep and narrow gorge in the mountains versus a river crossing a plain / flat relief.

[2] **Sibanda, T.,** “Zimbabwe: Thousands evacuated as dam begins to collapse”, All Africa web site, 10 February 2014.

Some of the aforesaid negative externalities had for a long time not been fully appreciated by decision-makers and have only recently been incorporated in the process of planning, designing and operating large water infrastructure, including MPWI. This may explain why in several cases the construction of MPWI was, and continues to be, met with strong local or international opposition.

The debate over whether the negative externalities of large water infrastructure outweigh their benefits continues to be of relevance and to polarise stakeholders (Ansar, 2014).

Negative externalities may be tackled during preparation and construction phases through the application of technical, economic, social and environmental regulations (see section 2.1.4). as well as through stakeholder engagement (see section 2.1.5). In addressing these negative externalities, MPWI projects can integrate regulations as safeguards on a case-by-case basis. However, the process for managing (and fully anticipating) externalities over the lifetime of the scheme remains problematic. For instance, sedimentation management, which is crucial to ensure the full potential of dams with storage purposes, is rarely adequately factored into, and budgeted for, over the lifetime of the scheme and may exacerbate negative environmental and social externalities downstream of the MPWI (Kondolf, 2014).

2.1.4 Regulation

Regulation for MPWI is often focused on addressing negative externalities and safeguarding against various risks and concerns.

General national regulations require Environmental Impact Assessments and Strategic Environmental Assessment to be conducted prior to the construction of new (greenfield) infrastructure, including MPWI. These assessments typically anticipate public consultations with key stakeholders as well as stakeholder engagement (see sections 2.1.5 and 2.3.2)

Comprehensive analysis will examine compliance with the environmental and social regulation and technical and economic regulation. Environmental, technical and social regulations are often specific to local laws, regulations and policies but often share certain principles and practices such as fair compensation, securing of permits and licenses, and abiding by construction standards. MPWI managers typically rely on Decision Support Systems (DSS) to manage the technical and economic regulation of the day-to-day operations; the latter regulation should aim to recover at least full water supply costs (i.e. even if not the full economic cost) through a combination of the 3Ts (Tariffs, Taxes, or Transfers).

2.1.5 Key stakeholders

Successful planning and operation of MPWIs is based on an adaptive and participatory approach, inclusive of all key stakeholders. Stakeholders in this report are defined as "persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organisations and groups with special interests, the academic community, or other businesses" (IFC, 2007). Given the multi-sectoral nature of MPWI, and the localised use and effects of water, the range of stakeholders[3] involved in the lifecycle of an

[3] Stakeholders here are defined as "persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either **positively or negatively**. Stakeholders may include locally affected communities or individuals and their formal and informal representatives, national or local government authorities, politicians, religious leaders, civil society organisations and groups with special interests, the academic community, or other businesses". (IFC, 2007).

MPWI scheme is wide and varied, but remains context-specific. Key stakeholders that may need to be engaged in the development and operation of MPWI may be categorised as follows (Table 2.1).

Table 2.1 Key Stakeholder Categories Involved in MPWI Schemes

	Local Stakeholders	National Stakeholders	International Stakeholders
Direct project beneficiaries and their formal or informal representatives	Direct beneficiaries and representatives, including residential, commercial and government entities; Water User Groups (WUGs)	Any other direct and indirect beneficiaries at the National level.	Any other direct and indirect beneficiaries at the international level, e.g. utility customers in cross-border schemes (see Nam Theun 2 Project).
Persons affected by the project and their formal or informal representatives	Persons directly affected by the project; Local/ Subnational public authorities (municipalities, village authorities, regional authorities); NGOs and CBOs; communities living in the River Basin impacted (upstream and downstream); Water User Groups.	Persons directly or indirectly affected by the project; NGOs/CBOs.	Countries with which the Host Government share the River Basin (when applicable); NGOs/ CBOs.
Project sponsors/ financiers	Local Private Sector;	Host Government; NDBs; Private Sector (including banks);	International Financing Institutions; Private Sector (including Banks);
Regulatory stakeholders	River Basin Organisation; Water User Groups	Regulatory authorities for the sectors concerned by the MPWI (energy/ water supply/ agriculture)	Transboundary river organisations

Source: Authors' own, based on (IFC, 2007).

Consultation with stakeholders in MPWI projects has become common practice as it enhances project sustainability and minimises delays due to conflicts between users regarding water allocation. Stakeholder engagement is critical for success in multipurpose reservoir management in terms of sustainability and efficiency. When planning multi-purpose water reservoirs, it is “very necessary to identify all stakeholders likely to influence or be impacted by decisions on the reservoirs, and engage them in the early stages and participate in consultations and the dialogue on a voluntary basis”. “It is important that the groups need to see there is a reason for them to engage, i.e. that they can influence decisions and outcomes that would be better than if they had not participated. It is crucial to understand early in the process stakeholder interests and power relations between these stakeholders.” (Branche E., 2015)

Incorporating stakeholder perspectives is also crucial for the day-to-day operations of MPWI schemes. Tools such as the SHARE concept (Branche E., 2015) and the IHA Hydropower Sustainability Assessment Protocol can provide a framework for identifying and engaging key MPWI project stakeholders in the consultation process for sustainable MPWI planning, management and operations (see Figure 2.1, and section 2.3.2 for further discussion).

Figure 2.1 SHARE concept principles

The multipurpose water uses of hydropower reservoirs

Shared vision,	**S**ustainability approach for all users
Shared resources,	**H**igher efficiency, equity among sectors
Shared responsibilities,	**A**daptability for all solutions
Shared rights and risks,	**R**iver basin perspectives for all
Shared costs and benefits	**E**ngaging all stakeholders

Source: Branche E. (2015).

Consultation meetings for hydropower MPWI projects in particular, can adopt the Hydropower Sustainability Assessment Protocol (see Figure 2.2) as a tool that can be used to strengthen consultation with stakeholders. This tool provides a common language to discuss sustainability issues as well as a framework for assessing performance of the hydropower project with clear topics that will appeal to a variety of stakeholders.

Figure 2.2 The IHA Hydropower Sustainability Assessment Protocol

The Hydropower Sustainability Assessment protocol: a sustainable measurement with a neutral platform for dialogue

The Hydropower Sustainability Assessment protocol is a tool that promotes and improves the sustainable use of hydropower. It provides a common language that allows governments, civil society, financial institution and the hydropower sector to talk about issues of sustainability. It offers a way of assessing the performance of hydropower over more than 20 sustainability topics.

Environmental	Social	Economic Financial	Technical	Cross-Cutting
Biodiversity and Invasive Species	Indigenous People	Financial Viability	Siting and Design	Climate Change
Water Quality	Resettlement	Economical Viability	Hydrological Resources	Human Rights
Erosion Sedimentation	Public Health	Project benefits	Asset Reliability and Efficiency	Gender
Downstream Flow	Cultural Heritage	Procurement	Infrastructure Safety	Livelihoods

Source: Reference to IHA Protocol adopted from (Branche E, 2015).

2.1.6 IWRM principles and social safeguards from development institutions

Integrated Water Resources Management (IWRM), which has become the prevailing paradigm in the water sector, has led to a reconsideration of MPWI planning and operating principles to give due consideration to environmental and social impacts (McCartney, 2007). This has been particularly evident in MPWI projects financed by international financing institutions (IFIs), which require the application of thorough environmental and social safeguards.

Social safeguards from IFIs, multilateral and national development banks (MDBs and NDBs, respectively), play an additional important role in ensuring that public authorities seek adequate consultation from stakeholders when permitting or financing large infrastructure projects, including MPWI. This involves consultation meetings coordinated by the Host Government with direct and indirect beneficiaries and persons affected by the project as well as their formal and informal representation (Table 2.1) once they have been identified, prior to decision-making on the type of construction and throughout construction and operations.

2.1.7 Business models

MPWI projects are naturally more complex due to the reality that some public goods and externalities cannot be monetised and the fact that various services provided can compete for differing water needs and water levels (such as hydropower which requires higher water levels compared to the need for lower water levels for agriculture or flood management).

There is no "*first best*" business model for MPWI projects. Selecting an appropriate business model for MPWI is a challenge as it is influenced by many factors, including: specific sets of water uses; of risks and externalities, and risk mitigation options; the stage of respective project (investment phase versus routine O&M); the project "bankability" and financial viability; and the subsidies available. Externalities from MPWI projects can influence business model selection with the model often being a public sector venture or a form of public-private-partnership (PPP).

Selecting the business model for capital investment in an MPWI project is typically the host government's responsibility. Instruments such as a *decision making tree* can assist in deciding on which option for potential business model is best for this specific MPWI project, with three main choices: 1) a private project, 2) a public-private partnership (PPP) project, and 3) a public sector project. Single-purpose water infrastructure, such as hydropower, may be more appealing to private investors due to the diminished risks and increased security of financial returns on the energy produced.

Externalities that can be monetised, such as hydropower production, can engage PPP opportunities where construction, site or commercial risks are adequately mitigated and private partners are able to take over the financially-profitable components with the public sector managing the less profitable components or providing subsidies (WWC & OECD, 2015, p.67).

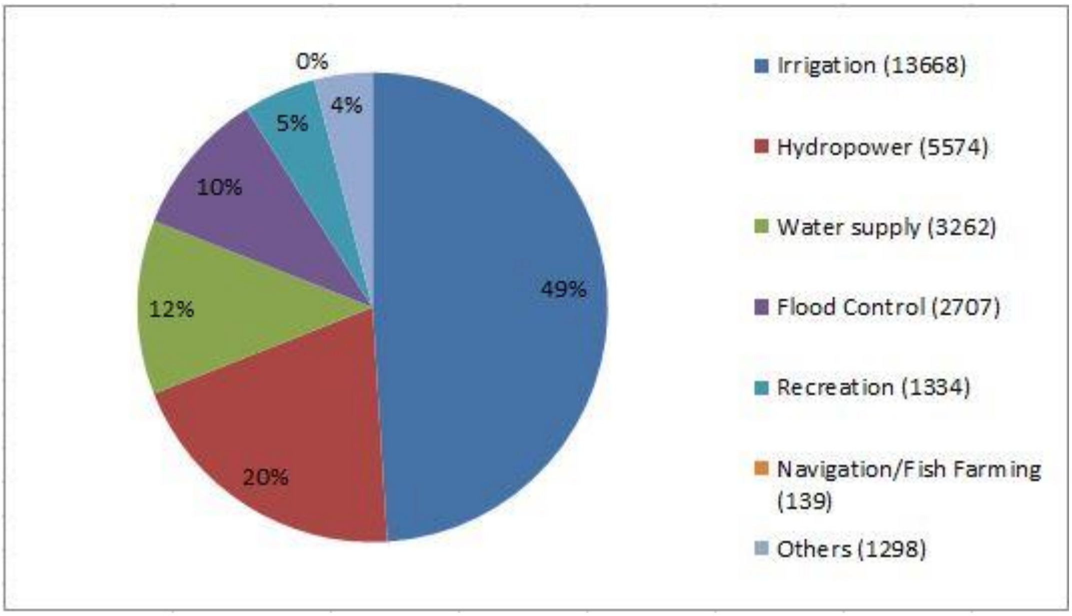
For example, the San Roque Multipurpose Project in the Philippines (section 4.1.1), originally had difficulty attracting sufficient financing. Though the project was expected to generate strong economic value, the package was financially weak due to the low returns from the irrigation function. The MPWI project split ownership into a public and a private part, with the power complex serving as a commercially separate build-own-operate-transfer (BOOT) project. The power complex was financed through a blend of export credit and commercial lending as a private-led project. This split ownership enhanced the financial viability and provided an appropriate vehicle for private sector engagement.

2.2 MPWI: current status of development and trends in investment

2.2.1 Multipurpose dams and reservoirs

On a global scale, the International Commission on Large Dams (ICOLD) registry reveals that 70% of dams and associated reservoirs (out of almost 28 000 currently in operation) are designed to be single-purpose[4]; around half of the single-use dams worldwide have been built for irrigation purposes, followed by hydropower generation, water supply and flood control (Figure 2.3).

Figure 2.3 Global breakdown of dams designed as single use (2014)



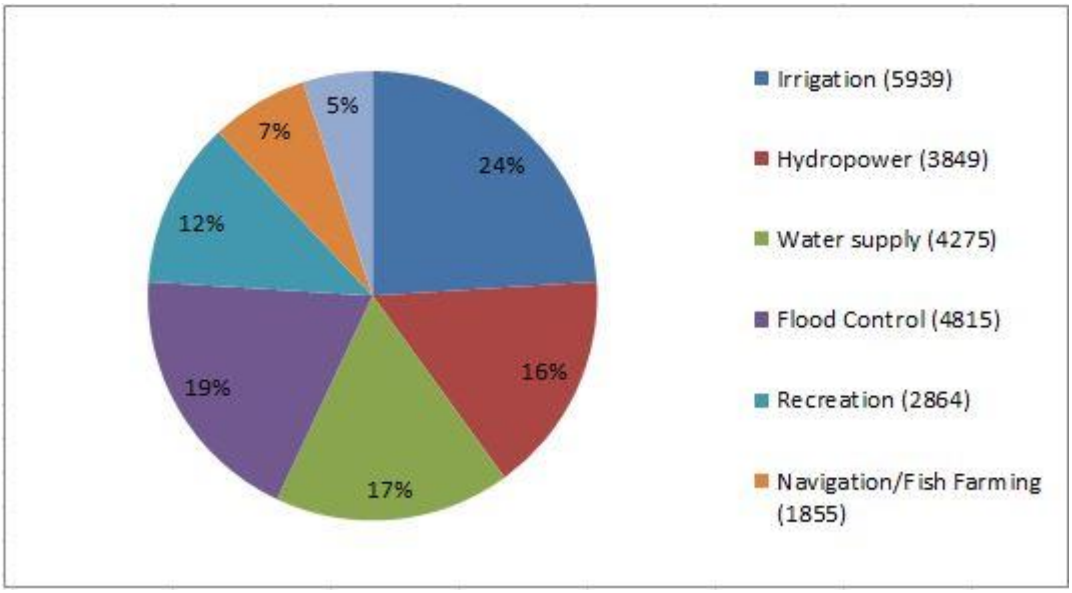
Source: ICOLD website.

From a macroeconomic perspective, multi-purpose dams provide multiple benefits from a single investment, which should make them more attractive to private and public investment. However, in practice, the complexity in planning, financing and operating multi-purpose dams and reservoirs remains a major challenge for multi-usage projects, which explains why they only constitute 30% of dams and reservoirs worldwide.

Multi-purpose dams and reservoirs tend to be evenly used for irrigation, flood control, water supply and hydropower (Figure 2.4).

[4] http://agriwaterpedia.info/wiki/Multi-purpose_dams; however, as outlined elsewhere, single-use dams are typically used also for other purposes, e.g. for recreation, not envisaged by designers, owners and sponsors of the project.

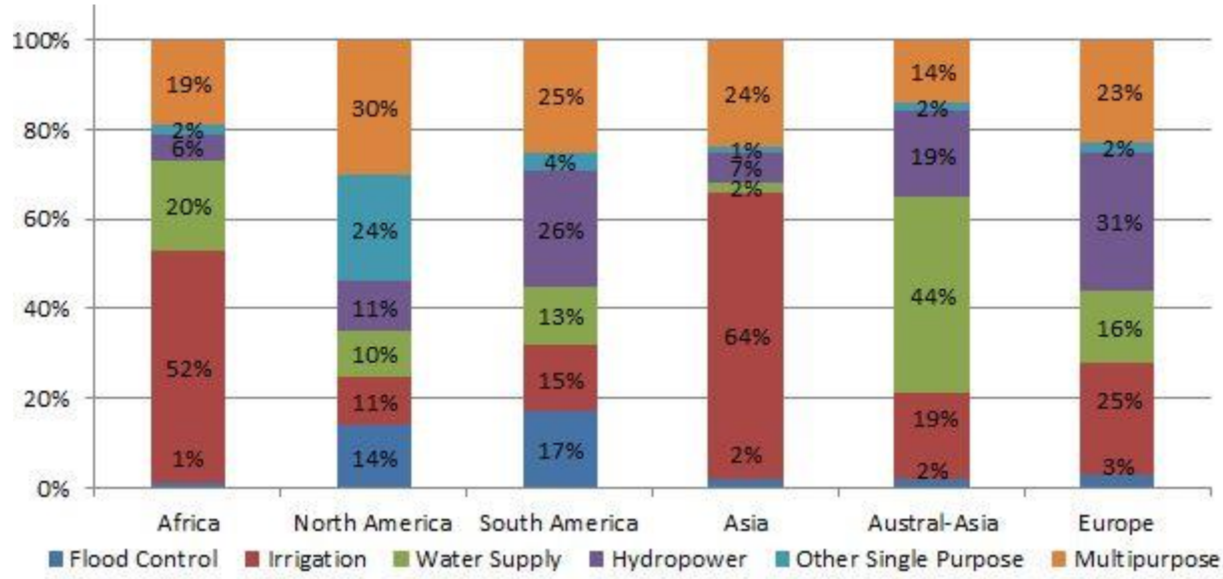
Figure 2.4 Global breakdown of multi-purpose dams (2014)



Source: ICOLD website.

Figure 2.5 gives an overview of the regional repartition of MPWI when compared to single-purpose dams; in any given region, they constitute between 14% and 30% of all dams.

Figure 2.5 Regional breakdown of dams' purpose



Source: (World Commission on Dams, 2000) adapted from ICOLD, 1998.

ICOLD notes that capital expenditure for greenfield multi-purpose dams in the developing world is typically partly funded by public authorities, with possible international donor support. While not as economically appealing to private sector investors (often due to the lack of a sustainable business model), multi-purpose projects are often more attractive to international financial assistance, as they may fit well into regional development goals: e.g. to improve food production, flood mitigation, water supply, or electricity supply in rural areas. Furthermore, they can complement strategies for climate change adaptation; for example, if hydropower generation is combined with increased water storage or flood regulation.

Promoting a single purpose dam, especially for hydropower, is typically more financially attractive to private investors as it promises fewer risks and secure financial returns on investment.

Attracting private investors to finance multi-purpose projects is becoming increasingly relevant but remains difficult due to the inherent complexity and need for sustainable business models. In particular, and as outlined earlier, conflict of interests among the different uses, e.g. hydropower requiring maximum storage levels and irrigation causing lower levels, result in complex and potentially vulnerable contract structures.

Decision support tools, such as computer-based models, may help to find a solution acceptable for all stakeholders by clearly demonstrating and assessing in economic and monetary terms costs and benefits, and showing how eventual losses of some stakeholders could be compensated by fairly sharing the net benefits gained by the whole society.

2.2.2 Multi-purpose water distribution networks

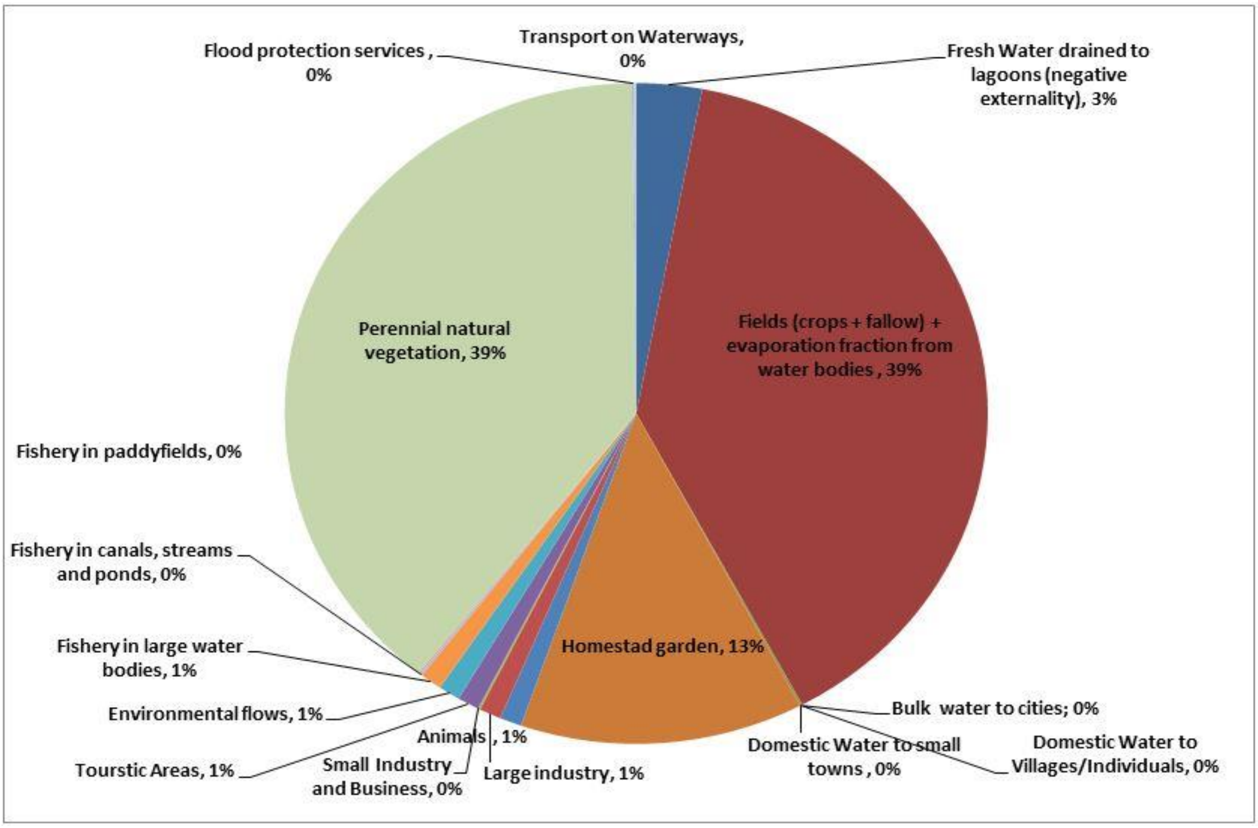
As outlined earlier, multiple uses of water systems may be the result of a multipurpose scheme's design, but can also frequently arise from local practices. While this may apply to some extent to reservoirs, which are frequently used for fishing and/or recreational purposes whilst designed for other purposes, it is especially the case for canals and large water distribution networks, which are almost always designed for irrigation but have multiple uses in practice, which may include some (or all) of the following services and externalities (Renault, 2013):

- Domestic water supply to villages;
- Streams and water bodies for fishing activities;
- Water supply for livestock;
- Transportation;
- Environmental benefits and impacts (groundwater recharge, waterlogging, salinity, and drainage);
- Recreational needs;
- Health and sanitation.

These multiple purposes are increasingly taken into consideration in the management of distribution networks, particularly in rural areas.

Figure 2.6 shows an example of the water balance for a single-purpose distribution system, the Kirindi Oya Irrigation System in Sri Lanka for one full year (1998). This shows that a significant proportion of the water brought in by the irrigation system was not actually used just for the irrigation of crops, but for domestic purposes in homestead gardens, and a number of additional activities; this is the case for a large number of single-purpose water distribution schemes in developed and developing countries alike. In France, for instance, the Canal de Provence, which was designed for irrigation only, is a tourism landmark and is also used for recreational activities (see section 4.2.2).

Figure 2.6 Water Use in the Kirindi Oya Irrigation System, Sri Lanka (1998)



Source: Renault (2013).

2.2.3 Investment in MPWI

Though no database specific to investments in MPWI is currently available, many of the peculiarities of investing in large water sector projects apply to MPWIs. Historically, large water infrastructure projects had been financed through public sector funding, including through Official Development Assistance (ODA) in developing countries. However, in the 1990s, the sector underwent a paradigm shift, caused by a realisation of the limitations of public resources to address the significant investment needs of the water sector, and underpinned by the belief, prevalent at the time, that higher efficiency could be achieved through the involvement of the private sector in infrastructure investment (Head, 2006).

Large water sector investments, and MPWI in particular, present a number of challenges that make it difficult to attract private sector investment. They are capital intensive, prone to high risks and low financial returns over a long time horizon, with some even disputing their value-added for economic development in the long-term (Ansar, 2014). This has contributed to relatively low levels of private investment in large water infrastructure, when compared to sectors such as energy or transport. In the case of dams and reservoirs, this has been limited to small, high reward/low risk projects, and mostly hydropower. Irrigation projects (including reservoirs and distribution networks) have not been attractive to private sector investment and have generally continued to receive most of their funding from public resources.

The most recent investment trends highlight the impacts of the financial crisis, which has diminished both public resources and the ability of governments to access private finance. Private investment in water infrastructure in developing countries has taken a hit since 2008 (Rodriguez, 2012).

The recent trends also suggest geographical concentration, for example more than half of the global private investment in water infrastructure (including water supply and sanitation infrastructure) implemented in the last decade was in China (PPI 2014).

In response, International Financial Institutions (IFIs) have increased financing to infrastructure sectors, including water, to mitigate the risks associated with the financial crisis. However, the ability of IFIs to follow through on their commitments is uncertain because it depends on future impacts of the financial crisis, not least on financial position of potential borrowers. Across all sectors, ODA fell by 3 percent in 2011, which was the first major drop since 1997 (Rodriguez, 2012).

High construction costs coupled with poor cost recovery rates in water distribution networks for irrigation has not made these types of investments attractive to the private sector. However, management of the existing infrastructure under a Public-Private Partnership arrangement is becoming increasingly common, in developed and developing countries (see for example the Guerdane Irrigation project in Morocco, section 4.2.1). Public-Private Partnerships (PPP) are expected to grow and while the value of PPP projects have fallen, the number of PPPs in water infrastructure have increased.

2.3 Selected elements of planning and decision-making for MPWI and related regulatory frameworks

There are two key areas of decision making associated with the planning and management of MPWI (McCartney, 2007):

- Strategic planning decisions: should an MPWI be built at all, and for what purposes? What are the guiding legal and regulatory principles and rules for its operation?
- Day-to-day operations: how should MPWIs be managed in order to balance trade-offs between a range of complex requirements so as to fulfil multiple purposes?

An important additional consideration is how to fairly share risks, distribute costs and benefits of respective MPWI project between all stakeholders involved or affected?

Section 2.3.1 discusses the stages of planning, considerations from which the idea of an MPWI project typically emerges, and the decision-making process for MPWI projects. Section 2.3.2 presents stakeholder consultation and the SHARE concept and further examines the role of participatory stakeholder engagement in policy dialogue. Section 2.3.3 discusses the legislation and regulation of MPWI operations and considers environmental, social, technical and economic regulation. Finally, section 2.3.4 explores the rules that determine water allocation between different users of an MPWI.

2.3.1 Stages of planning and the decision making process

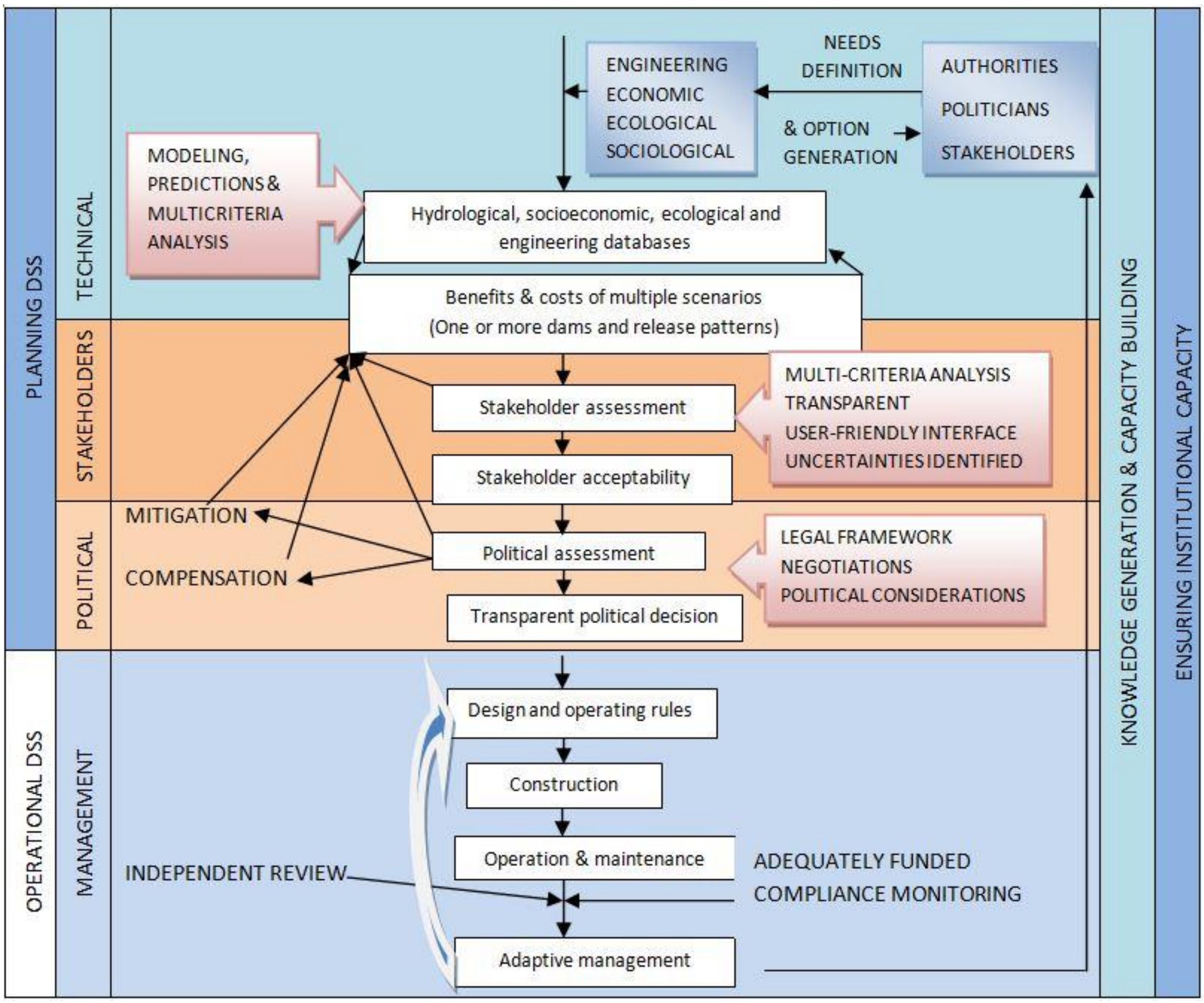
This section focuses on strategic planning. The process of planning MPWI is usually initiated by demands and possible technical solutions to meet the demands, before moving on to stakeholder consultation and finally, to political decision-making. The decision points include (World Commission on Dams, 2000):

1. Needs assessment: validating the needs for water and energy services;
2. Selecting alternatives: identifying the preferred development plan from the full range of options. Where a dam emerges from this process as a preferred development alternative, three further critical decision points occur:
3. Project preparation: verifying that agreements are in place before tender of the construction contract;
4. Project implementation: confirming compliance before commissioning; and

5. Project operation: adapting to changing contexts.

Types of decisions, and the lead stakeholder group associated with each step of the decision-making process (decision tree), are illustrated in Figure 2.7:

Figure 2.7 Decision tree for complex water infrastructure planning (Planning Decision Support System, or DSS) and operations (Operational DSS)



Source: adapted from McCartney (2007).

The process for strategic planning of a MPWI scheme is usually as follows:

A proposal (see Figure 2.7) is initiated, usually by the national technical agency or agencies, depending on the purposes envisaged: this could be the construction of a new canal for irrigation and transportation, a new dam for water supply and hydropower, or changes to the operating rules of an existing scheme to improve operations. A process of consultation with all stakeholders, including upstream or downstream, helps to identify the options for development, which can be put forward for political decision-making. Once a decision has been made and an option retained by policy-makers, the project can then be implemented. It is important, during this process, to ensure adequate monitoring of biophysical and socioeconomic indicators in order to adapt management decisions (McCartney, 2007).

Of the case studies examined in this review, the impetus for the first stage of MPWI planning, the proposal stage, varied depending on the context. In the case of the Canal de Provence in France, the process of identifying and bringing MPWI to political decision-making was largely driven by the French national electricity utility and the Ministry of Agriculture, while in Laos, the proposal was strongly backed by a foreign electricity utility willing to purchase most of the hydropower produced by the MPWI.

A common factor to the success of MPWI planning is co-operation of all key stakeholders in the planning stage and operation stage of MPWI. A sound risk sharing and fair distribution of costs and benefits is critical for this, the interests of all key stakeholders need to be carefully considered. According to SADC (2010), sustainable co-operation for the long-term management of MPWI can only thrive "when costs, risks and benefits are shared, reviewed and updated when conditions change", and is therefore dependent on the risk profile, cost and benefit sharing of the MPWI (see section 2.4.2).

In the absence of meaningful consultation and co-operation with stakeholders, conflicts between users may arise due to their different needs. For instance, hydropower typically needs maximum storage levels in the reservoir in order to generate electricity, while for effective flood protection, it is necessary to keep the water level low at certain times in the year. Similarly, low water levels will result from using water for irrigation. Examples where those purposes have led to conflicts between users are described in the World Commission on Dams report (2000).

The need to coordinate between multiple sectors during planning and operation adds a layer of complexity, which may pose additional risks to MPWI when compared to single-purpose water infrastructure projects. One of the main challenges with planning MPWI seems to be optimism bias. The World Commission on Dams (2000) reports that MPWI are more prone to not meeting project targets (including project schedule, hydropower and water supply performance) than single-purpose large water infrastructure. In particular, MPWI had higher cost overruns than single-purpose projects. Only MPWI projects with irrigation components showed little difference between single and multi-purpose projects in terms of performance. The report concluded that "multi-purpose schemes are inherently more complex, and many experience operational conflicts that contribute to under-performance on financial and targets" (World Commission on Dams, 2000). Planning MPWIs therefore requires thorough research and expertise in order to adequately estimate project targets and schedule, as well as expected costs and benefits and revenue streams.

The World Commission on Dams provides a targeted set of recommendations (Table 2.2) to further strengthen projects at various stages (feasibility, design and under construction). These recommendations should engage the regulators, developers and, where appropriate, the financing agencies. They provide a process of review that may result in additional financial costs which will be recouped through lower overall costs to the operator, government and society through greater compliance and the avoidance of negative outcomes and conflict (World Commission on Dams, 2000).

Table 2.2 Recommendations for MPWI project stages

Projects at feasibility stage	Projects at detailed design stage	Projects under construction
The stakeholder forum confirmed that the set of options considered was appropriate, or identified other alternatives to consider as part of the project impact assessment	The stakeholder forum is consulted on decisions related to project layout, operation and risk mitigation and development measures and relevant agreements are negotiated with affected groups.	The record of compliance is reviewed and a compliance plan is developed for remaining mitigation measures.
Any bias in selection of alternatives is removed or justified in a transparent fashion (for example subsidies to particular sub-sectors or groups).	Environmental flow requirements are determined and incorporated into the design and operation rules.	Existing commitments for resettlement and benefit-sharing are converted into formal contracts.
Demonstrated public acceptance exists for the recommended options.	A Compliance Plan is prepared, and recourse mechanisms are identified.	An adequate social, environmental and technical monitoring plan is financed by the developer.
The assumptions underlying the economic, financial, and risk analysis are justified and subject to sensitivity analysis.	Compliance mechanisms are provided for in tender documents.	The operating rules and commissioning plan are agreed with a stakeholder forum.
Mechanisms for risks, cost and benefit-sharing are identified.	Cost and Benefit, and risk sharing contracts are negotiated for displaced and project affected people.	A comprehensive post- project review is agreed for two to three years after commissioning, and every five to ten years thereafter.
An environmental flow requirement is determined.	A process for stakeholder involvement during operation is established.	

Source: Authors' own, adapted from World Commission on Dams (2000).

In addition, risk-based approach and cost-benefit analysis (CBA) can be used to analyse the costs and negative externalities compared to the benefits and positive externalities of large-scale MPWI projects, which can have significant impacts. A cost-benefit analysis should be conducted prior to any design and building of a new project and it should incorporate the social and environmental impacts, often through non-market valuation techniques, which can assist in understanding the full cost and value of MPWI projects.

There remains a concern that, if standard economic CBA is used, it can put water projects at a disadvantage. This is partly because some of their benefits are intangible, difficult to monetise, and do not promise early returns to the public finances. It is also partly due to the discount rate applicable to projects of great longevity with delayed, but substantial, benefits. (WWC & OECD, 2015) To understand trade-offs, a cost-benefit analysis should be conducted, as good quality cost-benefit analysis requires accurate estimations of the future benefits and costs of an investment. However, while the costs of proposed investments are often predictable, the natural variability of water resources makes predicting the benefits less straightforward. (OECD, 2013)

2.3.2 Inclusive decision-making

Stakeholder engagement

It is now considered a common and best practice to engage stakeholders and incorporate stakeholder perspectives into an MPWI project throughout the decision-making process. Branche E. (2015) notes “Multi-stakeholder process is an investment, but it is one of the most effective governance instruments to inform decisions on complex and potentially controversial operations and can improve policy decisions within a shared vision. Moreover, overlooking such procedures may cost more eventually if the project is thereafter delayed or halted due to stakeholder opposition”. The integration of stakeholder engagement can be used to strengthen the decision making process and to address eventual conflicts between user groups.

Challenge of balancing interests of competing users and the SHARE concept

Sharing and managing water resources among competing users is a major challenge for multi-purpose water infrastructure projects. Certain frameworks, such as the SHARE concept (Table 2.3), can be adapted and utilised in a local context to create and uphold sustainable water management.

Table 2.3 The SHARE concept

S	**Sustainability approach for all users**	• Ensure the 3 aspects of sustainable development (economy, social & environment) are included in any river development from the beginning and continue through all stages of project development • Customise the governance model to local context according to strong and best practises requirements (e.g. OECD water governance initiative) • Promote sustainable assessment with the Hydropower Sustainability Assessment Protocol (*www.hydrosustainability.org*) • Use an ecosystems based approach for the reservoir design and operation
H	**Higher efficiency and equity among sectors**	• Ensure water use is balanced between all water users and ecosystems in the most efficient and effective ways for existing & future uses inc. water quality • Put economic analysis at the very centre throughout the process (strategy, planning, decision-making and operation) for better cross-sectoral collaboration • Use best practises & innovative economical/financial approaches (public, private, PPP) • Recognise, quantify and optimise all benefits and value created at reservoirs for all multi-purpose water users (e.g. using EDF value creation methodology)
A	**Adaptability for all solutions**	• Incorporate flexibility options for design and operation of reservoir to be able to adapt to the evolution of social and environmental requirements, climate change, etc. • Require stable local and state regulations covering development (dams and hydro are long-term investments and highly capitalistic) • Highlight the role of hydro storage for climate mitigation & adaptation • Address mitigation of sedimentation issue on a multi-stakeholder approach
R	**River basin perspectives for all**	• Map and understand all the river basin implications for any prospective development to enhance regional co-operation in a sustainable way • Negotiate and set priorities/water allocation among water uses and environmental sector at basin, cascade and reservoir levels • Ensure adequate and effective governance among water users • Enable better transboundary co-operation for water infrastructure development and operation, and use proven river-basin development approaches (e.g. RSAT in Mekong)
E	**Engaging all stakeholders**	• Map all stakeholders and identify/nominate a leader • Initiate the dialogue and foster participative approach for co-construction since early stages (i.e. non-coercive participation) in an efficient & effective way (learn, adjust, improve) based on appropriate and equitable share of resources • Build understanding between stakeholders and sectors • Make the information accessible, timely, understandable, usable and useful • Create platform/for a (formal and informal) for all stakeholders with equity, transparency, accountability and trust as principles (e.g. Hydro Sustainability Protocol forum; water-energy food nexus dialogue IUCN/IWA *www.waternexussolutions.org*) • Ensure stakeholder support, acceptance and agreement is reached before proceeding with appropriate consultation

Source: (Branche E.; 2015, p.34).

Specifically, the SHARE framework relies on the following principles: "*Shared vision, Shared resource, Shared responsibilities, Shared rights and risks, Shared costs and benefits*".

The SHARE concept presented in Figure 2.1 and Table 2.3 provides a comprehensive set of principles that should guide MPWI project decision-making with a specific focus on hydropower multipurpose projects. It highlights that multipurpose hydropower reservoirs often serve many functions beyond electricity generation and "while these objectives (renewable and power services, water quantity management, ecosystem services, economic growth and local livelihoods) can conflict at times, they are also often complementary" (Branche E., 2015, p.6).

Participatory tools

Participatory tools can be incorporated to engage key stakeholders and improve management of water with competing uses. Also, decision-making should strive to fully incorporate the conservation of ecosystems. Local ecosystems, such as wetlands, are often essential for agriculture and aquaculture, irrigation, tourism, hydropower[5] and sustainable operation and management of an MPWI project is reliant on long-term ecosystem health and conservation.

Participatory tools can include water supply agreements, approved water allocation rules, and Memoranda of Understanding. The Arthurs Lake Project in Tasmania, Australia is an example where participatory tools were commissioned to improve the multipurpose water uses of the reservoirs in Tasmania and increase value for the water manager, Hydro Tasmania. The water manager examined the multiple uses of water in addition to hydropower generation, adjusted operating rules to accommodate multiple uses, and developed a water pricing principle. On this case, it was noted: "Considering the economic and financial benefits (and costs) was a key step when considering changes to the storage operating rules. With respect to both accommodating recreational fishing and irrigation needs, Hydro Tasmania evaluated the implications on electricity generation and revenues. The water pricing principle developed by Hydro Tasmania, in a transparent way, is an effective way for water sharing." (Branche E., 2015) In many ways, Hydro Tasmania developed an adaptive management model for effective water sharing recognising the competing water uses and how these uses could increase overall value for the water manager. Adaptive management acknowledged that the planning phase cannot anticipate all future eventualities and is supported by a knowledge base developed by the WCD which shows that satisfactory social and environmental outcomes requires constant adaptive management (World Commission on Dams, 2000).

Management of MPWI requires judgment on very complex or uncertain variables (e.g. socio-economic and environmental impacts or of water releases on specific crops) which are often difficult for systems to model. Human judgment and the inclusion of different stakeholders' point of view are crucial to the sound design and management of day-to-day operations of MPWI. This is more valid in developing countries, where lack of hydrological and biophysical as well as financial and economic data renders the application of computer-based Decision Support Systems difficult; or in the case of transboundary river basins, where countries may not share hydrological data considered important for national security. In practice, day-to-day operational management of MPWI relies on contextual information and local and national institutions, as well as knowledge of the political economy within which the MPWI operates (Box 2.1).

[5] For additional information on ecosystem conservation for MPWI see Box 3 in Branche, E. 2015: 17 – the Arenal project: a wetland multi-purpose project classified as a Ramsar site.

Box 2.1: Management of the Pongalapoort Multipurpose Dam (South Africa)

The Pongalapoort Dam in South Africa is designed to meet multiple purposes, including water for irrigation, flood control, and environmental flows for biodiversity. Local water committees (comprising domestic water users, farmers, health services and fishermen) relay information between the national water authority and the local population, and negotiate water releases from the dam in consultation with other stakeholders. This process was originally successful in managing water releases from the dam up until the late 1990s, when one party (the cotton farmers) threatened to sue the national water authority if water releases from the dam were made at times that were inappropriate for their crop. Since then, the decision-making process has been largely driven by the cotton farmers' requirements, though the national water authority still tries to involve all affected parties in decision-making.

Source : McCartney (2007).

Role of policy dialogue

An inclusive decision-making process integrates stakeholder perspectives and can result in more sustainable MPWI projects. This is achieved by addressing in each project stage the sometimes conflicting or controversial views and expectations in pursuit of compromise and resolution, while minimising project roadblocks. "Communication and diplomacy will be essential. Policy makers should also provide the enabling environment for result-oriented stakeholder engagement, and strive to include the inputs of engagement processes towards improved decision making." (Branche E., 2015).

Policy dialogue has a role to play as a proven effective means to ensure engagement and ownership. Policy dialogue can be strengthened when policy makers include stakeholder perspectives, which enhance opportunities for knowledge sharing and conflict resolution and foster a transparent discussion of MPWI project externalities, risks and impacts. Stakeholder engagement and consultation is a key feature National Policy Dialogues (NPDs) on water policy on-going in EECCA countries (EU, OECD and UNECE, 2016). The NPD could be effectively used in the planning and decision-making process regarding MPWIs: one such project is being implemented through the NPD in Kazakhstan. It examines options for increasing the contribution of the Shardara MPWI located on the transboundary Syr-Darya river to the economic development of South Kazakhstan as well as to greater levels of water, food and energy security. In a transboundary context, the work of Kyrgyzstan and Kazakhstan stakeholders in the framework of the Chu-Talas inter-governmental commission is another good example of stakeholder engagement and dialogue. Though it concerns water allocation, operation, financing of a single-purpose water system to supply the two countries with irrigation water, a similar approach would be applicable also to MPWI.

2.3.3 Legislation and regulation of MPWI operations at national and subnational levels

Regulation of MPWI can be effective in safeguarding against technical (e.g. dam safety), environmental and social concerns, particularly for addressing negative externalities

However, regulatory demands are more complex for multi-purpose dams when compared to projects with only a single function; mechanisms for managing trade-offs between different uses of water should be in place, which requires strong governance, solid information and institutional capacity. Mechanisms for adapting management of, as well as business models for, MPWI should also be integrated at national and subnational levels, particularly as water availability becomes more unpredictable due to the impacts of climate change (Milly, 2004) and new water uses can emerge or new externalities identified over the life-time of the MPWI project.

Regulators can rely on governance, planning, and coordination mechanisms as critical tools to enforce respective regulations for MPWI operations and management. Assessment of decision points (section 2.3.1) and compliance, and adaptive business models (section 2.5.1) are useful with this regard, as well as participatory tools, and transparent interactions between regulators at different levels of the governance system. Such tools support greater compliance with regulatory requirements, consistency, adaptability and coherence of regulatory policy and practice.

The World Commission on Dams (2000) notes that social, environmental, governance and compliance aspects have been undervalued in the decision-making process. It identified five key decision points and stages to verify regulatory requirements and improve project outcome from early project planning and assessment through operations.

Once all decision points related to the regulatory requirements have been assessed, governments and other key stakeholders need assurance that once informed decisions are made and agreed upon, all parties will continue to regularly monitor and comply with the commitments and obligations for the duration of the project life (World Commission on Dams, 2000).

The WCD recommends five policy principles (Figure 2.8) that provide a set of mechanisms for both regulatory and non-regulatory measures, incentives and sanctions to strengthen compliance. The policy principles are: having clean and consistent criteria and guidelines for compliance, a Compliance Plan, built-in costs for compliance mechanisms in project budget, enforcement of legislation, and incentives.

Figure 2.8 Policy Principles for Compliance

Key Message

Ensuring public trust and confidence requires that governments, developers, regulators and operators meet all commitments made for the planning, implementation and operation of dams. Compliance with applicable regulations, criteria and guidelines, and project-specific negotiated agreements is secured at all critical stages in project planning and implementation. A set of mutually reinforcing incentives and mechanisms is required for social, environmental and technical measures. These should involve an appropriate mix of regulatory and non-regulatory measures, incorporating incentives and sanctions. Regulatory and compliance frameworks use incentives and sanctions to ensure effectiveness where flexibility is needed to accommodate changing circumstances.

Effective implementation of this strategic priority depends on applying these policy principles:

6.1 A clear, consistent and common set of criteria and guidelines to ensure compliance is adopted by sponsoring, contracting and financing institutions and compliance is subject to independent and transparent review.

6.2 A Compliance Plan is prepared for each project prior to commencement, spelling out how compliance will be achieved with relevant criteria and guidelines and specifying binding arrangements for project-specific technical, social and environmental commitments.

6.3 Costs for establishing compliance mechanisms and related institutional capacity, and their effective application, are built into the project budget.

6.4 Corrupt practices are avoided through enforcement of legislation, voluntary integrity pacts, debarment and other instruments.

6.5 Incentives that reward project proponents for abiding by criteria and guidelines are developed by public and private financial institutions.

Source: World Commission on Dams (2000, p. 244).

MPWI projects require transparent interactions between regulators at different levels of the governance system as well as with project operators which can be public or private entities depending on the business model. A good practice here is where both national, basin and province (state) level agencies and regulators have developed tools and frameworks to enhance collaboration and coordination across watersheds, often by forming a region- or state-specific association that incorporates the main stakeholders involved in water use and management.

For instance, in the USA, the Tennessee Valley Authority (TVA) provides water management and power generation in the region. It is an example of promoting water-supply planning that integrates regulators and policymakers at different levels of the governance system to strengthen coherence of regulatory practices. Both "federal and state policymakers recognise that co-operation and coordination are essential for water-supply planning. TVA works with local and state governments to promote regional water-supply planning and project implementation" (Branche E., 2015).

In 2004, TVA formed a watershed-wide partnership with regional states to enhance regional co-operation and collaboration for water resource management and provide a framework for information exchange between states, basin and government agencies.

Regulators at different levels of government can also advance tools, such as tariffs, engaging stakeholders and operators. In Cameroon, the Government introduced a water tariff for hydropower producers on the Sanaga River, which is "a payment for water fees by plant operators (users) who will benefit from the "service" of regulating the flows of the Sanaga thanks to storage capacity of the Lom Pangar reservoir.

It should be noted that this is the State of Cameroon who "advances" the funds for the completion of the work, but the real funding is ensured by the operators who benefit from this regulating capacity" (Branche E., 2015). This tariff assists in recovering the O&M costs of managing and regulating the dam as well as costs from basin management and requires all hydropower producers to comply with fees calculated and adjusted to the installed capacity for each hydropower plant.

The MPWI scheme is usually subject to specific technical, economic, social and environmental laws, regulations and policies of the host country's relevant authority. These regulations are briefly discussed below.

Environmental and social regulation

MPWI schemes are subject to the same regulatory restrictions as other large water and energy infrastructure schemes, including:

- Conducting open and informed consultations of all impacted stakeholders in the river basin, including riparian countries in the case of a transboundary scheme.
- Compensating fairly the people affected by the construction or rehabilitation of the MPWI scheme. This may include providing livelihood and development activities to the community(ies) that will be affected by the construction of the scheme.
- Securing environmental permits, licenses and clearances related to the environmental impacts of the schemes. This may include the costs of watershed management, of obtaining and maintaining the water rights necessary for the construction and operation of the power station, as well as abiding by legislation regulating water quantity and quality.
- Securing *Right of Way* for infrastructure, including power transmission lines for hydropower schemes, and related infrastructure (e.g. roads, power lines for access to the site during construction, irrigation canals) as well as real estate and land taxes, environmental impact assessment, and charges linked to the site.
- Abiding by national construction standards in place, including dam safety standards, and operating under the required safety licence for a pre-determined number of years. Dam safety is a recognised critical issue for the ageing dams worldwide.

The processes linked to the environmental and social clearances required for the MPWI scheme can be undertaken either by the sponsor of the host country, or the operator, depending on the risk allocation between stakeholders and their contractual obligations.

In developing countries, if a scheme is financed by MDBs such as the World Bank, the more stringent environmental and social regulatory requirements (whether they come from national regulations or World Bank policies) prevail throughout the lifetime of the project (but not necessarily the lifetime of the scheme). Due to the fact that Loan Agreements with the World Bank have the standing of international treaties, these may supersede national law, and lead to "ring-fencing" of a project if national environmental or social policy is not consistent with them or not reformed (World Bank, 2013). However, the World Commission on Dams (2000) notes that national regulatory systems and MDBs safeguards alike are generally "more concerned with project planning, design and financial management [at the project stage] than with [...] the operational phase of a large dam project" (p. 188). In other words, the caution that is applied during the planning phase of an MPWI may in practice not be as stringent once the MPWI is operating, and MDBs are no longer involved, unless it has been adequately applied in national or subnational laws, policies and regulations.

It is worth highlighting that the International Hydropower Association (IHA) has developed its own set of guidelines (called the Hydropower Sustainability Assessment Protocol) to address the environmental and social sustainability of dams (IHA, 2011) throughout the lifecycle of a dam, including the operational stage; however, these are fairly recent and have only been applied for a dozen projects so far (for instance in the Akosombo Hydropower Project in Ghana and the Shuibuya Hydropower Project in China). The IHA Sustainability Assessment Protocol is usually applied on a voluntary and nonbinding basis, and most of the schemes that applied the IHA Sustainability Assessment Protocol were for hydropower purposes only; no examples of MPWI for which the Protocol had been applied could be found.

Economic regulation

The economic regulation of MPWI is context-specific and depends on the purposes of the scheme, its ownership and operational rules, legislation as well as contractual obligations of stakeholders (when relevant). Nevertheless, key issues around economic regulations for MPWI concern cost recovery and public subsidies which are in turn discussed below.

As with other types of water infrastructure, MPWIs should aim to recover at least full supply costs through a combination of the 3Ts (Tariffs, Taxes, or Transfers) (OECD, 2009). This means that the 3Ts should cover the costs of O&M, capital costs (including for renewal investments and new capital investment costs) and the costs of servicing debt. This is necessary in order to attract private debt, which may be needed to finance the capital expenditure of MPWIs: for instance, around 85% of the capital expenditure of the Nam Theun 2 scheme in Laos was mobilised by the private sector.

To a certain extent, MPWI for irrigation and drinking water supply have traditionally benefited from public funding. This still remains the norm but is changing in developed and developing countries alike. For instance, the Tennessee Valley Authority in the US, which is federally-owned and was publicly financed during construction and its first decades of operation, has not received any public funding for the provision of public or private goods since 1999 (including navigation, environmental benefits and flood protection, water for irrigation, drinking water supply and hydropower), thanks in part to cross-subsidies from its more lucrative electricity-generation component and increased operational efficiency[6] (Tennessee Valley Authority, 2014).

[6] Though the Tennessey Valley Authority (TVA) manages a large number of MPWI schemes, it is worth pointing out that the TVA also manages assets that go beyond the traditional MPWI functions (e.g. nuclear, gas and coal power plants) and is therefore not a "typical" MPWI management scheme.

When tariffs are applied to private goods provided by the MPWI, such as water supply for drinking or for irrigation, or electricity supply, they may be subject to additional regulation depending on the type of service and/or beneficiary. For instance, the economic regulation of an MPWI producing electricity for export may seek to increase revenue from sales (e.g. Nam Theun 2 in Lao PDR - see section 4.1.2), whereas if the electricity generated is destined for the national market, regulation of the MPWI may seek to keep tariffs low out of affordability concerns (see for example the Pamir Hydropower Project in Tajikistan in Box 2.3). MPWI may also sell power to wholesalers that can then sell it on customers; in this case, the price of power sold by the MPWI is subject to contractual arrangements as well as the regulatory restrictions that may apply to the national wholesale and retail electricity markets.

When the MPWI operator sells private goods that are regulated by the Host Government, and regulation does not enable MPWI operators to recover costs from tariffs alone, public funding in the form of taxes or transfers may be needed to bridge the gap, i.e. to subsidise. In the case of the Pamir Hydropower Project, the gap between the recovery of operational costs of hydropower and affordable tariffs for electricity was covered by a lifeline subsidy scheme funded by a grant from the Government of Switzerland, which was given upon delivery of electricity services. In another MPWI in Tanzania, the tariff applied to electricity sold by the state-owned utility which operated the MPWI scheme was regulated at US$ 0.0656/kWh; this was inferior to the Long-Run Marginal Cost of electricity generation of US$ 0.1271 per kWh. In the case of Tanzania, the MPWI operator was also the national utility, which facilitated the use of public funding through transfers to bridge the gap (Kadigi et al., 2008).

Other regulation

Technical regulation (not least on construction, on dam safety and on routine operations) is key for sustainability of any water system, including MPWI.

Concerning regulation of operations, managers typically rely on Decision Support Systems (DSS) to inform the technical and economic regulation of the day-to-day operations of MPWI schemes. These may include simulation and optimisation models based on reservoir "rule curves" that specify reservoir storage volumes or desired water releases based on a set of parameters, including hydrological and temporal data and existing reservoir volume. Reservoirs can have multiple rule curves for wet and dry seasons.

DSS rely on high quality hydrological and meteorological data, as well as economic and financial data which may be lacking in emerging economies and developing countries. For instance, in the Durance-Verdon MPWI system in France (see section 4.2.2), the operator draws upon a high-performance meteorological forecasting system (with over 30 meteorological and hydrological measurement points, identifying snow cover, precipitation and temperatures), in order to anticipate future water flows. Infrastructure management is adjusted around the clock, in order to reconcile the needs resulting from all forms of use and the safety of individuals and property. A dense network of sensors (flow, snow, rain, and temperature) allows, by means of hydrological models developed by the operator, the evaluation of the hydrous stock of the Durance and Verdon valleys and its fluctuation over time, as well as the volume of flow and its probability (Branche E., 2014).

2.3.4 Water allocation rules

Water allocation rules for MPWIs are generally based on hydrological, technical, economic and social factors and rooted in national water policy, laws and regulations. Water allocation for MPWI may differ at the subnational or basin level, based on historical and legal factors, but also on adaptation to the local context.

Water allocation rules are sometimes applied under specific hydrological conditions. For instance, for the MPWI located in the Great Ruaha River Catchment in Tanzania, water allocation rules only apply in times of water scarcity, when demand is high for water for irrigation and when there may not be enough water to satisfy both the needs of the irrigators upstream and hydropower generation downstream. This is usually at the beginning of the rainy season if rains are late, or at the end of the wet season if rains end early. Although the use of water for hydropower generates higher economic value than for irrigation, allocation rules also protect irrigators' abstraction out of social concerns; in times of scarcity, it is usually allocated to each secondary canal for a fixed period of time (Kadigi et al., 2008).

The case of the Durance-Verdon hydroelectric system, which the Canal de Provence is a part of (see case study in section 4.2.2), yields interesting insights on water allocation for MPWIs (Branche E., 2014). The Durance-Verdon hydroelectric system consists of 30 plants and 17 dams based in the South-East of France. It is regulated by the French water legislation and policy, which is coordinated at the national level by the Directorate of Water in the Ministry of Ecology, Sustainable Development and Energy. It is located within the territory of the Rhone-Mediterranean River Basin Agency (RBA), which defines, implements and coordinates water management at the basin level, based on IWRM principles. RBAs levy taxes based on the "polluter pays" and "user pays" principles, which are earmarked to fund water resources management activities, based on the principle of "water paying for water". The aim of these "water taxes" is to integrate environmental costs in order to provide incentives for all water users (domestic customers, industrial users and farmers) to reduce their impact on water quality and/or quantity. Tax rates are determined by the River Basin Committee (RBC), which is a participatory body gathering all key local stakeholders in a given River Basin (e.g. regional and municipal authorities, water user associations, farmers and others) (Branche E., 2014).

In addition to this, RBCs also arbitrate over water conflicts and define a 5-year River Basin Master Plan (RBMP), which provides a legal framework for public policies; any decision impacting water resources in the basin must be compatible with it (Branche E., 2014). More recently, as several successive drought episodes affected France in the early 2000s, the Ministry of Ecology prescribed the drafting of Drought Plans by the RBCs. These plans are designed to anticipate, rather than decide in an emergency, the measures for managing droughts. Furthermore, in direct application of the EU Water Framework Directive, RBMPs have now started a process of quantifying the uses of surface and underground water by sector, and comparing them to the maximum volume of water that could be abstracted from basins without negatively impacting the aquatic environment. In basins that are over-exploited, this would lead to a contractual or regulatory requirement, or public investments in deficient (public) infrastructure, to bridge the deficit of water at the basin level. This process is participative and benefited from a public consultation process in 2013 in the Rhone-Mediterranean River Basin; it was scheduled to be finalised in 2015, with a possible extension until 2017 (Eau France, 2014).

Using the case of Durance-Verdon MPWI scheme as example**,** Box 2.2 outlines the multiple legal and regulatory layers that may be involved in determining water allocation between the different users of an MPWI. However, some common features remain between this case and that of the Pongalapoort Dam in South Africa: co-operation, adaptation of MPWI management to contextual circumstances, and a participatory approach remained key to success and to the sustainability of both schemes. In the case of France, public authorities did end up bearing most of the costs of hydrological risks; this was not planned when the MPWI scheme was designed, but was an outcome of adaptive management of the scheme.

Box 2.2: Water Allocation in the Durance-Verdon MPWI scheme (France)

In the South-East of France, MPWI operations by the Durance-Verdon hydroelectric system have to take into account multiple stakeholders' demands: the private sector involved in the tourism industry around the upstream reservoir, which requires high water levels; the electricity utility, Electricite de France (EDF), which operates the system and also needs high water levels in the Serre-Ponçon reservoir for hydropower; and the downstream farmers, which rely on releases from the reservoirs via the Canal to irrigate their crops.

Historically, EDF (then a state-owned company) was given the task (codified by a 1955 law) of developing the entire Durance-Verdon hydroelectric system for the purpose of water supply for irrigation and human use, flood prevention, and hydropower. The Ministry of Agriculture participated in the financing of the initial infrastructure and secured an allocation of 200 million cubic meters of water per year for irrigators downstream (formalised in a convention between EDF and the Ministry of Agriculture in 1952).

In a typical year, the water stored diminishes during the winter season during peak electrical production. In spring, generation is adjusted, according to water cumulative flows, in order to reach the level required for recreational activities at the beginning of summer. During the summer, through electricity production, water flows into the lower reaches of the Durance providing enough volume for peak irrigation needs, which generally results in a drop in level, also compatible with tourism in the majority of cases. The cumulative autumn flows supplement storage and replenish water storage for a new winter. Drinking water is consistently provided throughout the year. Tourism is not a contract condition but is also included in reservoir management objectives.

The resources required for the four uses - electricity, irrigation, drinking water and tourism - are sufficient most of the time, approximately 8 years out of every 10. In years of drought, EDF has had to make additional water available to irrigators, in excess of that allocation. In 1989, for the first time, the Ministry of Agriculture agreed to reimburse EDF for the resulting power loss, passing on a small portion of the costs to the farmers. In order to minimise future risks, the Ministry of Agriculture encouraged farmers to organise the management of their water allocation in associations, and in coordination with EDF. Currently, farmers associations manage the water in 95% of irrigated lands downstream of the MPWI scheme. Interestingly, the legislation specifies that all land included in the area of an association benefit from water access rights, but are forced to pay fees to the association, whether they are irrigators or not, so as to ensure institutional sustainability.

The MPWI scheme was thus able to meet the water needs of all users through successive drought events in the early 2000s, thanks to this participative and collaborative mode of management. This lasted until 2007, when a prolonged drought forced irrigators to request an additional release of water from the dam. As per the terms of the Drought Plan adopted, conditions for the supply of this additional water were discussed and adopted in a Drought Committee, involving all stakeholders and chaired by the regional authorities. Farmers argued that the compensation of EDF's losses was too high for them alone to bear, and benefited from financial support from the State, the Region and the Departments, for up to 90% of the total cost of the power loss incurred by EDF.

EDF has also engaged with the tourism sector around the largest of the reservoirs of the Durance-Verdon MPWI system, the Serre-Ponçon reservoir, through the creation of a union of tourism operators in 1997 (named SMADESEP) which has a say in water resources management for the benefit of the tourism sector. EDF has also been involved in a number of initiatives to comply with the Water Framework Directive legislation by adapting the management of hydropower plants to reach the optimal balance between minimum loss of renewable energy and benefit. to the aquatic environment.

Source : Comeau (2011), Branche E. (2014).

2.4 Business models for financing capital investment in MPWI

Business models for sustainable O&M, management and financing of MPWI projects need to fully examine and integrate expected, as well as anticipated or changing, water uses, which can result in changes to the water use patterns. Site-specific multiple purposes for an MPWI project can inform selection of, and decision-making on, the appropriate business model.

In MPWI projects where services such as irrigation are essential to one user group, a PPP agreement can be crafted to incorporate co-finance from the government, private sector, as well as the user group (farmers). For instance, the Guerdane Irrigation Project (section 4.2.1) has a BOOT model with a large public sector subsidy to support affordable tariffs as well as a concession loan (together covering over 50% of the cost), a private operator contribution of 43% of the cost, and a 10% of cost farmer contribution through a fixed connection fee. In contrast, the Canal de Provence Multi-purpose Scheme in France (section 4.2.2) uses a concession contract of 75 years managed by a semi-public company and financed by commercial loans and public funding including grants.

The San Roque Multipurpose project in the Philippines (section 4.1.1) used a business model with a split ownership to finance the hydropower MPWI project. The national power utility NAPOCOR solicited bids to develop the MPWI project with the power complex separated as its own BOOT project and the less bankable services from the dam, spillway and transmission line were directed by the public sector (see section 4.1.1 for more information). The business model was adapted as it originally failed to be financed in the public sector but was then successfully revived and implemented as Public-Private Partnership. This project is one of few examples of “Split Ownership”, where the project is geographically divided into public and private parts (Head, 2006). The BOOT PPP model was also used for the hydropower development in the Nam Theun 2 Multipurpose project (section 4.1.2) and includes a power purchase agreement.

Further, as MPWI projects evolve over time, the purposes of MPWI projects can grow and change, requiring business models and tools that are adaptable. In Tasmania, Australia, the Arthurs Lake project decided to integrate irrigation as a new purpose and evaluate the water taken from Arthurs lake for irrigation that would have otherwise been used for hydropower. An agreement was formed between Tasmanian Irrigation and Hydro Tasmania to inform water price and supply to the irrigation district and the pricing principle developed provided a transparent and effective means to share water among users (Branche E., 2015).

2.4.1 Project finance models, and ownership

There is no prescribed “*first best*” business model for all MPWI projects and, respectively, “the financial instruments need to be diverse because the technical solutions are different and the affordability for the population is also different. This means that there is no general pattern of water infrastructure financing. Models and solutions are highly country- specific and characteristically eclectic.” (WWC & OECD, 2015)

In determining an appropriate business model for capital investments in MPWI, it should be kept in mind that it is first and foremost the Host Government's responsibility to propose a financing model for the project, and prepare the project prior to eventually engaging with the private sector for financing and/or implementation. Preparation of financing models can be done with the assistance of MDBs if the Host Government has sought their support (which may be limited to technical assistance or including funding opportunities as well). This can include preparatory studies such as engineering studies, environmental and social impact assessment studies, economic studies and a clear definition of the overall project structure.

Additional key elements of a business model for an MPWI project include:

- *Objective function*: The objective function of the MPWI referring to maximising the project’s value including: (i) operator's profit versus (ii) GDP or welfare of the society by fully meeting priority water uses;

- *Financing models*: choosing the appropriate financing model is critical for MPWI and is highly country-specific. Financing models should examine the relationship between different financing options and be chosen “according to the project’s nature, components, and risk-reward structure” (WWC & OECD, 2015); and

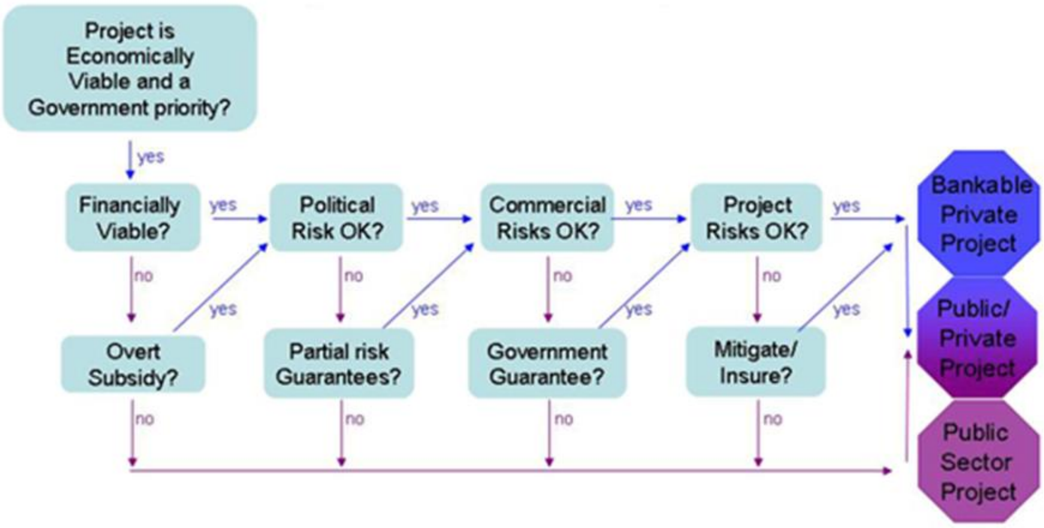
- *Equity position*: “Each project and business model needs sufficient equity to absorb risk and provide a cushion to cope with fluctuations in cash flow.” (WWC & OECD, 2015)

Figure 2.9 presents a simplified decision-making tree to determine the financing model, as part of a business model, for MPWI projects, resulting in three possible options:

- A private project;
- A public-private partnership project; or
- A public sector project.

This decision depends on several factors, including financial arrangements as well as risk allocation.

Figure 2.9 Selecting the appropriate business model for MPWIs: a decision-tree



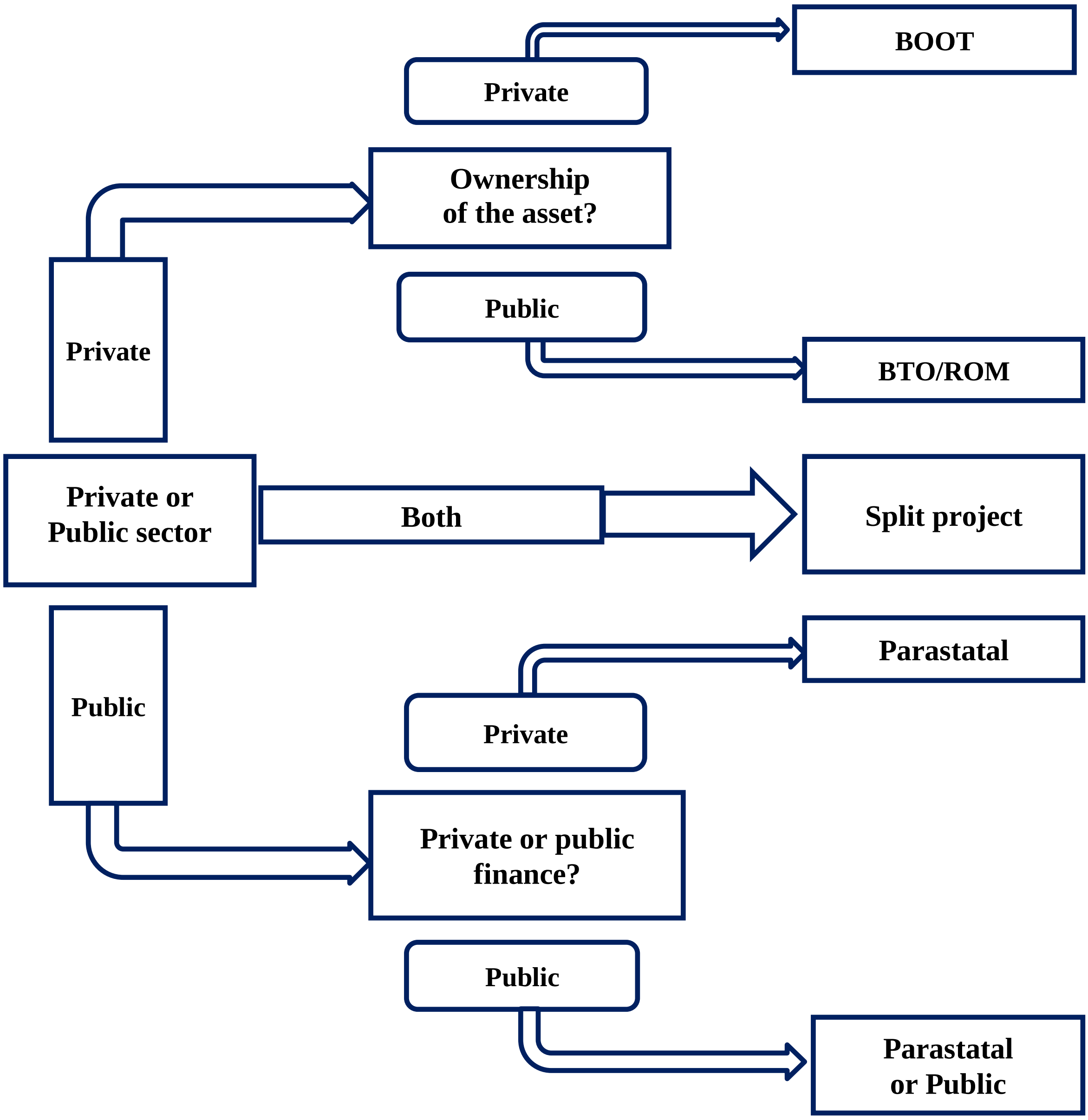
Source: Head (2006).

Most MPWI projects are either public projects or PPP projects and "the decision between the two hinges on several key factors: whether it is financially viable on its own; if not, whether an overt and sustainable subsidy is available, the nature of the risks it entails, and the extent to which these risks can be mitigated" (WWC & OECD, 2015). Once the decision of implementing the project in the public or the private sector is made, the issue of asset ownership needs to be addressed. This can be broken down in the following questions:

- Who will own the assets?
- In case the assets are owned by the public sector, will financing come from private or public sources?

Based on responses to the above questions, Figure 2.10 presents a *decision tree* that will inform the choice of the business model structure for capital investments in a new MPWI project. This can be applied to capital investments for greenfield or brownfield projects.

Figure 2.10 Choice of business model for capital investment in MPWI: a decision tree



Source: adapted from Head (2006).

Option 1: Public Sector Development

Traditionally, many major MPWI projects were both financed and implemented by governments and public agencies, including the Hoover Dam (USA) as well as more recent major MPWI projects in China (WWC & OECD, 2015). As Figure 2.10 outlines, it is sometimes appropriate to implement the project in the public sector, for instance if the project is too large and too complex to attract private sector investment; if the physical environment means that the site risks are unacceptably high; if the commercial risks cannot be mitigated; or if the appropriate enabling environment is missing.

Development institutions (banks and investment funds) are expected to remain a major source of funding for major MPWI projects, though there is increasing concern regarding the "quality" of these loans. International Financing Institutions (IFIs) are a crucial element in MPWI projects as well, especially for residual risk, to bring comfort to other financiers ("halo effect"), and due to the expertise and leadership they can bring to projects: "IFIs have a particularly vital role at the early stages of transboundary MPWI projects, e.g. by convening Round Tables of potential financiers" (WWC & OECD, 2015).

Public projects can be financed through taxes, tariffs, and transfers (including ODA) from the public sector, as well as public or private debt, provided there is a creditworthy and accountable project agency to which the loans can be made. The proposed business model should aim to recover at least the full supply costs of the MPWI (i.e. the costs of O&M, capital costs, including for renewal investments and new capital investment costs, and the costs of servicing debt).

Establishing a special-purpose parastatal company whose shareholders are the Government and that operates almost like a corporate entity can be a potential solution; it may need to be supported by sovereign guarantees to offset country or commercial risks. This may however require substantial institutional and financial support, and may not be cost effective unless it is a very complex and large project.

Option 2: Private Sector Participation

Private Sector Participation (PSP) includes both entirely private projects (rare for MPWIs, less so for hydropower schemes only, particularly in developed countries), including in the form of public-private partnership (PPP) projects. The PPP option is often pursued when the MPWI project is economically viable, risk is sufficiently mitigated, the project can have "Split Ownership" to separate profitable and unprofitable components so private entity can take ownership of the bankable component, and/or public agencies can provide a subsidy for the project.

PSP in MPWI can take several forms:

i) For existing (brownfield) schemes (dams, reservoirs, and irrigation networks) which could be managed by the private sector, PSP in MPWI can involve concession contracts, management contracts or leases. For instance, a concession arrangement was used in the brownfield Guerdane Irrigation Project in Morocco, as well as for two greenfield projects: the Canal de Provence in France and in the Pamir Hydropower project in Tajikistan. They demonstrate the possibility of raising private sector financing for greenfield and brownfield MPWI projects alike. Table 2.4 recaps the main features of these types of contracts.

Table 2.4 Types of possible PSP contract for existing (brownfield) MPWI schemes

Type of contract	Management contracts	Lease	Concession
Definition of operator duties	Supplies management services for the scheme in return for a management fee	Runs the business, retains revenue from customer tariffs, and pays a lease fee to the contracting authority.	Runs the business, finances investment, and may own the infrastructure assets
Selected responsibilities of the operator	Provides management services.	Employs staff, operates and maintains scheme. No infrastructure asset investment responsibility.	Employs staff, operates and maintains scheme, and finances investment
Typical payment mechanism for the operator	Fixed fee + bonus or penalties/fines (both can be based on performance).	Revenue from customers minus lease fee.	Revenue from customers less any concession fee
Risk level for the private sector	Low	Significant	Major
Investment responsibility	Infrastructure and operating asset investment from Contracting Authority.	Infrastructure assets from Contracting Authority. Operating assets from Operator.	Infrastructure and operating assets investment from the Operator
Ownership of infrastructure assets	Contracting Authority.	Contracting Authority.	Contracting Authority or Operator

Source: Adapted from (WSP, 2014).

ii) For schemes where financing for substantial capital investments or rehabilitation is the overriding consideration, the main private sector models in use for MPWI are:

- BOOT (Build-Own-Operate-Transfer): for instance, a BOOT model was used for the San Roque Multi-Purpose project (see section 4.1.1);
- BTO/BOT (Build- Transfer - Operate): for instance, a BOT model was used for the Guerdane Irrigation project (see section 4.2.1); and
- ROM (Rehabilitate-Operate-Maintain).

Table 2.5 recaps the main features of these types of contract.

Table 2.5 Types of contracts construction or rehabilitation of MPWI schemes

Type of contract	Definition of private company duties	Advantages	Inconvenient
BOOT	Owns the project for the duration of the concession (usually 15-25 years), then returns (transfer) it to public ownership free of charge.	No financing responsibility/ public debt for Host government (apart from Guarantees); most of the risks lay with private sector.	Difficult to attract private investors due to high risks; unsuitable for small projects due to high transaction costs.
BTO/ ROM	Contracted to provide a service while infrastructure remains in public ownership.	No financing responsibility/ public debt for Host government (apart from Guarantees); the public sector has more control and contractual arrangements simpler, making it appropriate for smaller projects.	Difficulties can arise from one party owning the infrastructure and the other being required to pay for O&M; public partner bears more risks.

Source: adapted from Head (2006).

The experience of transfers of MPWI facilities following concession expiration is varied and hydropower concessions in particular are managed and renewed on a case-by-case and country-specific basis. For example, in Italy and Spain a competitive process exists for granting concession and renewal, while in Austria concessions are negotiated, In Norway, hydropower concessions are granted without time limits for public companies but private companies must revert their concession upon expiration with only the option of leasing a hydropower plant for private companies (Glachant et al., 2014). In France, a competitive process has been drafted for a new hydropower concession regime though the proposal faces delays and opposition.

Further, examination of the status of the facility at time of transfer (and ideally statement on the facility condition in the initial concession contract) should be explored, as after a concession period of 25-30 years the facility may require rehabilitation or additional resources to continue operation. Clearly defining "the identification and allocation of risks and the means by which the facility will be transferred and assessed should be determined and agreed through the provisions of the concession agreement" (Merna & Njiru, 2002) as this will help prevent conflicts at time of transfer.

Options for closing the gap between Economic and Financial Viability to ensure Bankability

When involving the private sector is an option for an MPWI project (see section 2.4), but the gap between economic and financial viability is too large, the Host Government can consider the following options (Head, 2006):

- Restructure the project to separate the financially viable component to be taken in partnership with the private sector, and the less attractive components to be developed by the public sector (e.g. the San Roque Multipurpose Project in the Philippines; see section 4.1.1);
- The Host Government may introduce subsidies or fiscal support (in the form of tax breaks) to close the gap.

Public subsidies are most commonly introduced at the financing stage in the form of grants or loans; however, another option, which has been used recently, is to introduce them at the delivery of service, in the form of Output-Based Aid (OBA). This was done for instance in the Pamir Hydropower Project in Tajikistan, through a Swiss Government grant, in order to provide a lifeline electricity tariff for the poorest local residents for the first 5 years of the operation (Box 2.3).

If neither option is viable, the project may be developed by the public sector only. A number of financing instruments are available to ensure the costs of capital investments can be met, but the MPWI scheme needs to generate reliable revenue from the tariffs, transfers and taxes to attract these.

Box 2.3: Improving bankability through innovative financing: the Pamir Hydropower Project (Tajikistan)

The Gorno-Badakshan Autonomous Oblast (GBAO) of Eastern Tajikistan has strong hydropower potential but its isolation, combined with economic instability and the low-income status of local residents, had prevented the rehabilitation and completion of the Pamir hydropower project, which had been initiated by the Soviet authorities. The purpose of the Pamir Hydropower Project was to improve the reliability and enhance the electricity supply in the GBAO region in a financially, environmentally and socially sustainable manner. This case presents an unconventional form of successful improvement of project bankability through innovative financing in a difficult economic environment. The project was designed as a public-private partnership between the Government of Tajikistan, the World Bank Group, and the Aga Khan Fund for Economic Development (AKFED). A 25-year concession agreement was signed between the Government of Tajikistan and the Pamir Energy Company, a joint stock company owned by AKFED (70%) and the IFC of the World Bank Group (30%). The affordability of electricity for the poorest households in the local area was ensured by transfers through a lifeline subsidy scheme funded by a grant from the Government of Switzerland, which was given upon delivery of electricity services (under an Output-Based Aid approach). The World Bank through its IDA branch provided concessional financing through a US$10 million credit to the Government of Tajikistan to finance the initial USD26.4 million capital expenditure of the project. The IFC of the World Bank Group also provided $3.5 million in equity and USD4.5 million in debt, later converted to equity, to Pamir Energy Company. Thanks to this innovative financial model, the project delivered affordable electricity to 220,000 local residents, and the Pamir Energy Company later attracted grants from USAID and the Government of Norway to enable exports to villages of Northern Afghanistan.

Source : Yumssen (2010).

Financing instruments

The financial sustainability of MPWIs is usually addressed as part of the business plan, and can be broken down in two main phases:

- Construction, during which capital investment costs are the overriding consideration;
- Operation, which entails O&M costs (including operation, rehabilitation, maintenance and decommissioning of the MPWI).

Generally, upfront capital investments represent the bulk of the financial burden, as O&M costs for large MPWI dams are estimated to be around 1 to 3% of total project costs. For irrigation projects, these costs are generally slightly higher due to high maintenance costs of the irrigation network (Beukering, 2014). This section will therefore focus on the financial considerations linked with capital investment costs, while section 2.5.2 will address the challenges of financing O&M separately.

Ultimate sources of finance - the 3Ts (Taxes, Transfers (including ODA), (OECD, 2009), can be complemented by additional instruments and sources of finance. A realistic financing plan for capital investment in MPWI typically include a combination of the following repayable sources and financial instruments:

- Credit Enhancement Facilities/ Guarantees: this can be provided by IFIs to convert sub-grade investment projects to investment grade in order to facilitate commercial financing (e.g. MIGA of the World Bank Group);
- Export Credit: this is rarely used in the water sector, but was used to finance part of the San Roque Multipurpose project (see section 4.1.1). It includes official debt financing provided by Export Credit Agencies;
- Commercial Lending: it can remain prohibitively expensive if not softened by Guarantees;
- Equity: it can be provided from public and private sources, and may be more expensive than commercial loans;
- Pension funds are another example of financing with long time perspectives, which may “unlock private sector capital to invest in long-term sustainable infrastructure, such as multipurpose hydropower dams.” (Branche E., 2015).

A solid business plan for an MPWI should aim to ensure a mix of ultimate and repayable sources of finance and financial instruments that ensure the recovery of full supply costs at minimum, and ideally full economic costs. Full supply costs cover the costs of O&M, capital costs (including for renewal investments and new capital investment costs) and the costs of servicing debt (i.e. cover full financial costs), while full economic costs include full supply costs as well as the resource costs (reflecting the scarcity value of water) and the net costs of externalities.

A key issue related to fairly sharing costs and benefits is appropriation and distribution of natural resource rent. Appropriation and distribution of natural resource rent through economic instruments such as taxation and compensation mechanisms (e.g. through subsidised tariff rates) can assist in fairly sharing the costs and benefits of MPWI. Economic instruments such as taxation and subsidised tariff rates can be utilised to appropriate or distribute the natural resource rent and support the most vulnerable users. The World Bank recommends that extraction, taxation and investment of resource rents are utilised as tools to achieve welfare-enhancing natural resource management, noting “natural resource rents must be collected by government institutions and channelled through the budgetary process so that they can be transformed into productive public assets and sustainable development” (Barma et al., 2012).

The hydropower sector often lacks a clear fiscal regime following a case-by-case basis but a resource rent taxation system is one strategy to support equitable sharing of costs and benefits. The World Bank has recommended a resource rent tax system for adoption for the Nam Theun hydroelectric dam in Lao PDR. In this specific case, "secondary taxes, such as the existing royalty arrangements, should continue to apply to extract economic rents. However, a resource tax based on kWh produced is an effective way to capture economic rents…" In addition to primary and secondary taxes, the government could consider adopting additional fiscal arrangements such as up-front concession fees, dividend returns from investment, and discounted electricity sales (World Bank, Lao PDR Development Report 2010, 2010). Rent may also emerge if positive externalities are not internalised (not reflected in the profit & loss (P&L) statements of the project sponsors or operator), or where new water uses not envisaged initially do not contribute to cost sharing.

Distribution of appropriated rent may help address affordability issue. It could be complemented by other instruments such as public subsidies, soft loans and subsidised tariffs. For instance, to ensure the water remained affordable for farmers in the Guerdane Irrigation project (section 4.2.1), the Government contributed a public subsidy and loan to keep water tariffs lower than groundwater for farmers. In another example, the Canal de Provence Multi-purpose Scheme in France (section 4.2.2), collects tariffs for water service while providing cross-subsidised tariffs for farmers. Further, its initial focus on agricultural water services have had to adapt to incorporate increasing tourism services and value. The Société du Canal de Provence, a semi-public company, levies tariffs for water services at the Canal de Provence and tariff rates for the most vulnerable (farmers) are cross-subsidised by the revenue generated from other users. In addition, tourism, which was not part of the original MPWI design, has become a large economic influence, forming an association of public interest in the late 1990s with local authorities. The tourism association now serves as a stakeholder in the EDF consultations for management of the Durance-Verdon hydroelectric system, though EDF has no contractual obligations to meet tourism objectives.

2.4.2 Risk management

Risks in MPWI projects can arise in various contexts including social, environmental, hydrological, and financial risks. Large-scale multi-purpose water infrastructure projects have additional risk present due to their complex nature, large scale, diverse stakeholders, and potentially competing water needs. For sustainable water projects, risks must be properly identified, assessed, allocated and shared amongst the financial parties based on certain principles.

Head (2006) considers the following typical risks associated with MPWI projects and discusses potential mitigation strategies (Table 2.6):

Table 2.6 Categories of risks that may affect an MPWI project

Types of risks	Examples	Mitigation strategies
Country risks	Sequestration of assets, failure to provide the site, breach of contract	Generally insurable under Sovereign Guarantees
Commercial risks	Anything that might threaten a project's revenue stream, e.g. lack of a sales market, change in tariffs, default on payments	Partly insurable[7]
Project risks	Time or costs overrun, hydrological risks, delays due to social and environmental factors	The risk of cost over-run can be covered by penalties established in contract with respective contractor. Other risks are generally difficult to insure[8]

Source: Adapted from Head (2006).

While other publications (e.g. WWC & OECD, 2015) consider a larger number of risk categories. Summarising, this paper assumes that the risks that can affect financing for MPWI include:

- Commercial risks: often inherent in MPWI project or market in which it operates;
- Construction risks: site-specific infrastructure problems;
- Technology risks: due to failing machinery, equipment and installations;
- Revenue risks: high upfront MPWI investment leaves investors vulnerable to market and regulators;
- Inputs: reliable supply of inputs, such as energy and the price risk related to inputs;
- Environmental risks;
- Macroeconomic risks: external economic effects that have potential impact on MPWI project financial viability such as growth in GDP, inflation, interest rates; and
- Political and regulatory risks: including war and civil disturbance.

Importantly, some risks (e.g. lower-than-planned performance of the MPWI or emergence of a negative externalities) might be unforeseen at the planning phase but emerge later in the process. Selected examples are provided in Table 2.7:

[7] Though the Tennessee Valley Authority (TVA) manages a large number of MPWI schemes, it is worth pointing out that the TVA also manages assets that go beyond the traditional MPWI functions (e.g. nuclear, gas and coal power plants) and is therefore not a "typical" MPWI management scheme.

[8] A recent and innovative exception to this has been the $450 million weather and oil-price insurance transaction for the Uruguay state-owned power hydroelectric utility. See *www.worldbank.org/en/news/press-release/2013/12/19/world-bank-uruguay-public-weather-oil-price-insurance-transaction*.

Table 2.7 Lower-than-planned performance and other unforeseen risks and negative externalities: selected examples

N	MPWI name, river basin, country	Lower-than-planned performance and other unforeseen risks and (or) negative externalities which materialised upon completion of MPWI construction	Likely source of the risk or externality
1	Jebel Aulia reservoir, White Nile, Sudan	Significant reduction of the irrigation function of the dam	Construction of the Aswan High Dam
2	Kapchagai reservoir, Ili river (Balkhash-Alacol basin), Kazakhstan	Raising salinity of, and decline in the fish stock in, Lake Balkhash	Lower than expected Ili river flow downstream the dam, mostly due to increased abstraction of water from Ili river upstream in China after 1990 and plan to build 15 new reservoirs there
3	Gapier Dam, Orange river, Republic of South Africa	Irrigation target not fully achieved: only some **68 %** of the projected irrigated areas of the Orange River Project is irrigated	n.a.
4	Lake Manantali, Senegal river, Mali	The initial plan to develop navigation as the service provided by the multi-purpose reservoir was abandoned.	Unfeasibility of the navigation plan
5	Lake Lagdo, Neneu river basin, Cameroon	Tendency of flood disasters for Nigeria (downstream country) due to releases of water from Lagdo dam during the periods of peak rainfall	Probably, the risk was not identified or properly assessed at the planning phase
6	Lake Assad (Tabqa Dam), Euphrates river basin, Syria	Difficulty in reaching the full economic potential of the dam: e.g. associated hydro-electric station generates only 150 MW instead of 800 MW (installed capacity)	Diminishing water flow from Turkey (upstream)
7	Hirakud Lake, Mahanadi river basin, India	Irrigation land area is just **56** % of the initial irrigation target	n.a.

Notes: n.a - data and information is not public or easily available and the authors failed to find it

* - the Hirakud Lake project (Mahanadi river basin, India) faced the same problem with the implementation of its navigation plan (not yet developed)

Source: OECD (2017, forthcoming)

Financial risks in particular can vary project-to-project and can be influenced by a variety of factors, including externalities and generic risks. "Particularly important in this context is the behaviour of the national regulatory authority responsible for monitoring the performance of the project" as the regulatory body can provide reassurance for investors and support appropriate risk allocation (WWC & OECD, 2015).

An unacceptable risk profile for investing in MPWI can be corrected by (i) guarantees from IFIs, or insurance from the commercial market or IFIs (e.g. MIGA) and (ii) rearranging the allocation of risk between the parties, i.e. the owner, the contractor, the off-taker (the purchaser of services) and the Host Government.

Appropriate risk allocation is key to determining a project's financial plan and ensuring the sustainability of an MPWI project. The commonly accepted principle for sharing risks in a project's contractual and financial arrangements is that "risks should be allocated to those parties best able to bear them, most efficiently, and at least social cost;… parties to a contract have different *risk appetites* depending on the strength of their balance sheets – their *risk-adjusted* returns must cover their cost of capital." (WWC & OECD, 2015).

When involving the private sector is an option for an MPWI project (see section 2.4), it is also important to ensure that there is a supportive enabling environment for private sector investment in the water sector as well as the project having an acceptable risk profile for the private sector to consider engaging. This should include the following elements (Head, 2006):

- The provision of sufficient funding for the project to be adequately prepared under the auspices of the private sector;
- The arrangement of an efficient 'one window' facility through which the different branches of government can negotiate with prospective partners, including the private sector; and
- A clear legal and regulatory framework (including for the water sector and for PSP).

2.5 Management and operation of existing MPWI

2.5.1 Adaptive approach to managing MPWI

MPWI project operators can be public or private depending of the business model and the objective function of the operator though “more and more countries are adopting a PPP model in which investment is largely funded by public money, with the private operator focusing on improving service and operational efficiency.” ((WWC & OECD, 2015, p.73) Public-Private Partnerships (PPP) are expected to grow and “a recent survey (Perard, 2012) records a doubling of the number of PPPs in water infrastructure in 2001-2010 compared with 1991-2000 (523 compared to 232). However, the total value of the PPP water projects in the latter decade ($29 billion) was less than that in the former ($58 billion). After peaking in 2008, activity fell for several years, but is now recovering.” While there remains resistance to private sector involvement in the financing and operation of water for household use in many countries, the *Fit to Finance?* report (WWC & OECD, 2015) notes that rising demand for expertise of private operators and the value of their financial support is projected to spur continued PPP growth. The report highlights three more aspects:

- The responsibility of the operator for the finance of water services varies depending on the business model used and if it is a public or private operator. Water supply infrastructure fully divested to private owners is rare in MPWI projects but would require finances be raised from market sources and repaid from tariffs while publically-owned MPWIs often rely on long-term private concessions (the Canal de Provence in section 4.2.2) and PPP models can be co-financed by public and private sources, or fully publically funded. The growth of private water operators and PPP models can contribute financially both directly through co-financing of MPWI projects as well as indirectly - by improving O&M of water services to be more efficient and commercially-oriented, enhance the creditworthiness of public partners and their ability to raise finance (WWC & OECD, 2015, p.73).
- The use of life cycle approaches and optimising maintenance by operators can reduce costs and attract financing. It is becoming common practice in large water infrastructure projects that “operators of water infrastructure should project levels of operating costs (opex) over the full life of their assets, in conjunction with the planning of capital spending (capex), in order to optimise costs and financing needs over the lifetime of the asset” in addition to also optimising maintenance to minimise O&M costs.
- Water services provided to specific users can often be sold and have a range of financing options while financing mechanisms for public goods and functions can be difficult to monetise and “will normally need underpinning with public finance, with the deal possibly structured to include participation by private investors and commercial lenders... The recurrent cost of providing *public goods* is normally borne by taxation, offset to some extent by various *ad hoc* measures of fundraising from beneficiaries.”

- As outlined earlier, successful planning and operation of MPWIs have been based on an adaptive and participatory approach, inclusive of all key stakeholders. The benefits that may be provided to the communities affected by the MPWI are distinct from compensation or resettlement support (which are usually regulated by law for any type of large infrastructure project). They may include:

1. Access to electricity services for project-affected communities, when relevant;
2. Non-monetary entitlements to natural resources, when relevant;
3. Revenue-sharing: project-affected communities may share the direct monetary benefits of MPWI (typically hydropower) through a predefined approach.

Adaptability to changing economic, climatic and social conditions may require changes to the rules of operation of an MPWI; these are particularly challenging to navigate and require a participatory approach to increase stakeholders' acceptability and ensure social and economic costs and benefits are recognised, assessed, and fairly shared (including through compensation mechanisms). Required adaptation needs to be cognisant of the political economy of the different actors that benefit (or not) from changes in the scheme, and ensure that such changes are based on a consensus; if this is not the case, it may be difficult to prevent some stakeholders from imposing changes that suit them best through legal or regulatory action, as was the case in the Pongalapoort Multipurpose Dam in South Africa.

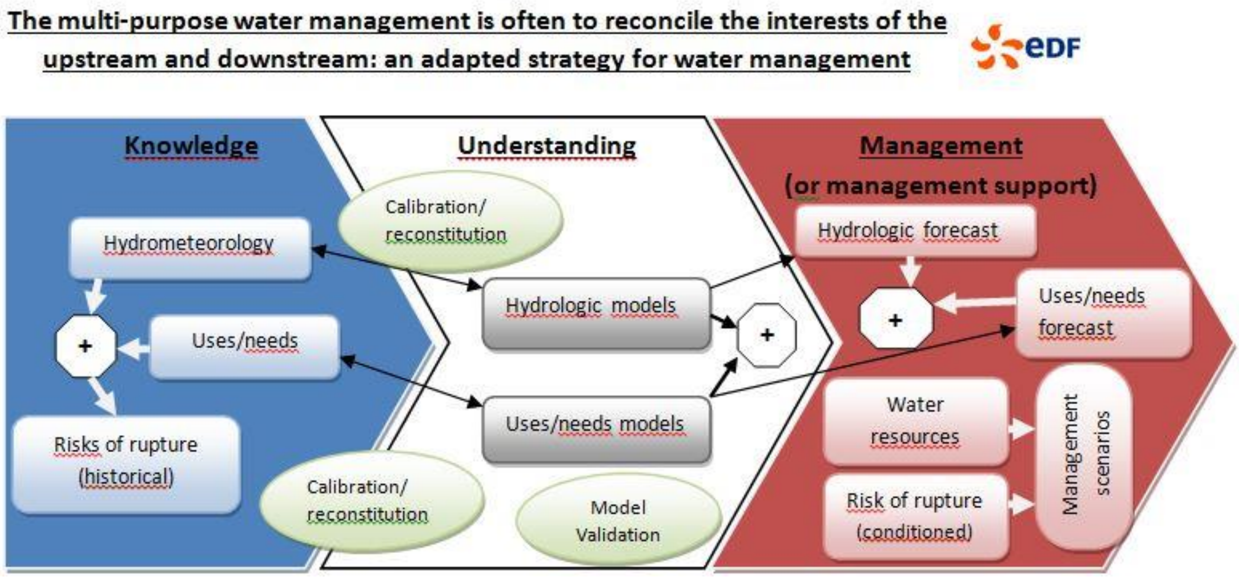
The Three Gorges project in China has adapted its operation conditions to mitigate sedimentation issues, which can have negative effects on the ecosystem as well as on the operating life and potential electricity generation of MPWIs. “The operational modes and objectives derived during the design phase are adapted according to changes in the operation conditions such as the amounts of water and sediment entering the reservoir and the efficiency of water conservancy projects.” (Branche E., 2015, pp. 25-26). As economic growth and demand increases, the operational modes are informed and optimised by scientific data and guidance in order to adjust management and operations as necessary to fulfil the project’s objectives and remain flexible to changing conditions.

There is also a need to have flexible and adaptable multipurpose management schemes to be able to adapt to the effects of climate change as it might affect some users more than others. Climate change poses additional risks for MPWI management and operation as it is difficult to determine with certainty the long-term changes and impacts on existing MPWI projects. The uncertainty of climate change impacts on water need to be considered for all stakeholders and it is up to all stakeholders to collectively manage and prepare for tomorrow's developments with less water, less money and more risks… The Durance-Verdon project has created a partnership project to engage stakeholders and assess the impacts of climate change on the water resources, biodiversity and demand to 2050 (see section 4.2.2).

Adaptive strategies for managing MPWI can be employed for various economic, social and climatic reasons and aim to reconcile competing uses and conflict that can arise from changing conditions and impacts on the reservoirs water resources. EDF utilises high-performance meteorological forecasting systems to anticipate future water influx as well as a step-by-step approach for management of MPWI hydropower reservoirs with three stages (see Figure 2.11):

1. Knowledge of the reservoir uses and needs and hydrometeorology which can inform risk management;
2. Understanding of water availability and use as well as the interests of both upstream and downstream users;
3. Management of the forecasts for hydrologic and uses/needs as well as the available water resources and the risk of rupture to produce management scenarios that can be weighed.

Figure 2.11 EDF Three Step MPWI Management Approach



Source: Branche E. (2015, p. 49).

2.5.2 Sustainability of operation and financing MPWIs over their life-cycle

Challenges related to operational costs of MPWI

Based on historical data, it is estimated that the cost of operations and maintenance represent around 1 to 3% of total project costs; for irrigation projects, these costs are generally slightly higher due to high maintenance costs of the irrigation network (Beukering, 2014). This is why much more attention is paid to financing capital investments, as the running costs of the MPWI itself are relatively small and typically well understood by technical specialists. For that reason, it may also not get the attention it deserves; in developing and developed countries alike, MPWIs can (and sometimes do) run into challenges for financing O&M costs over their lifetime and have to rely on public subsidies. Such costs have also sometimes been passed on to the public sector in the form of negative externalities, such as decommissioning of dams (see for example the case of dams in Michigan below).

The financial sustainability of MPWIs after construction and over its life-time is usually addressed as part of the business plan of the MPWI. However, planning and economic studies for reservoirs are commonly based on a design life of only 50 years, and the business plan itself may become outdated after a decade only (e.g. due to inflation, changes in the price of energy, or benefits and uses of the dam that are different than anticipated.). By comparison, MPWI schemes may have a lifespan of 100 years or longer. How has the financial sustainability of MPWI been ensured after construction and beyond the 50-years planning horizon?

From the case studies reviewed, the Canal de Provence Multi-purpose Scheme (see section 4.2.2) is the only MPWI structure that has been in operation longer than 50 years. It is worth pointing out that it was only in 1996 that a balance between profits and losses was reached, i.e. after 33 years of operations. All profits since have been reinvested in infrastructure maintenance, with no dividend distributed to shareholders as of yet (Malerbe, 2014). While this situation was perhaps expected by the sponsors of the scheme, which were for the most part public authorities, it would be a difficult situation to bear for the private sector on a BOOT contract, which needs to make a profit within the timeframe of the concession. This may explain the reluctance of private companies to engage in the management of MPWI schemes over the long-term, due to the associated risks and difficulty in forecasting profits and losses in the sector.

The EECCA region, where some MPWIs (e.g. hydroelectric stations on Dnieper and Volga rivers) have already been in operation for 50-80 years faces a similar challenge.

Furthermore, the full O&M costs associated with the goods and services the MPWI is intended to provide over its lifetime are often neglected in the initial business plan of the scheme. For instance, sediment management has historically rarely been adequately factored into the O&M costs of dams, including MPWIs. This has two negative outcomes: (i) it reduces the lifespan and the benefits from the dam, as sediment accumulation restricts reservoir capacity and performance (ii) it has negative environmental consequences as river downstream of the dam become 'sediment-starved', which increases erosion of the river channel. The fact that sediment management tends to be overlooked is partly due to the design life of 50 years, which tends to consider benefits yielded beyond 50 years in the future as extremely low in present value terms, thereby rendering additional capital and O&M costs to manage sedimentation as not economically justified. As a result, it has been estimated that global net reservoir storage has been declining since 1995 because rates of storage volume reduction due to sedimentation have exceeded rates of new storage construction (Kondolf, 2014).

Beyond the issue of sediment management, MPWI also become increasingly expensive to maintain in a structurally sound state as they age. These added costs are also rarely factored into O&M costs at the business plan stage due to a short planning horizon.

Finally, and of increasing relevance in developed countries in which many MPWIs are approaching the end of their life, is the cost of decommissioning infrastructure. When national infrastructure safety regulation fails to renew the MPWI operational licenses, or the required rehabilitation of the infrastructure is too expensive, the MPWI must stop its activity or be removed. The MPWI owner will then have to pay the costs of the decommissioning. However, this presents a paradox, as the owner will not capture all the benefits of removing the infrastructure, since those benefits are usually public (e.g. the recreational and environmental benefits made available after a dam removal or river restoration from dismantling a canal). As a result, MPWI owners will be naturally reluctant to bear the costs of decommissioning, which can be significant. The costs of removing the 30-meter Elwha and 70-meter Glines Canyon dams on the Elwha River in Washington State, U.S.A, were estimated to cost from $67 million to $80 million (Aylard, 2001). In the absence of any licensing, regulation and decommissioning rules, the incentive for private MPWI owners is to operate the scheme until the net benefits of operation become negative, and then abandon the scheme, thereby leaving it as a costly negative externality. For instance, in the United States many small dams have been abandoned by their owners: e.g. in Michigan, several abandoned small dams have caused significant environmental damage, including severe erosion, destruction of aquatic habitat, and loss of fisheries. The cost of removing these small abandoned dams was borne by the State of Michigan's taxpayers (Aylard, 2001).

For these reasons, as the real life time of an MPWI is typically much longer than its life envisaged by design documents, there has been a recent push in the sector advocating for the adoption of a life-cycle management approach to large water infrastructure including MPWI, and not a design life approach. (Aylard, 2001; Kondolf, 2014). However, in practice the design-life approach remains commonly applied in developed and developing countries alike.

Many of the challenges faced when planning, financing and operating an MPWI project, need to be assessed and examined in the early stages of MPWI planning to achieve the best possible outcome and ensure financial sustainability of the MPWI. Challenges can include crafting and adapting business plans that take into account the full lifetime costs of the MPWI project, the cost of decommissioning infrastructure, sharing water among competing users, assigning cost to environmental and social impacts, and compliance concerns.

These challenges for MPWI projects can be examined in tandem with good practice guidelines, such as the guidelines outlined by the World Commission on Dams, which can inform how best to assess and solve the planning, operational and financial challenges. The WCD provides a comprehensive set of guidelines for good practice which describes the strategies and tools to best assess options and plan and implement dam projects to meet the Commission's criteria (Figure 2.8). The guidelines are focused on seven strategic priorities including: public acceptance and stakeholder engagement; assessment tools; existing dams; ecosystem assessment; shared benefits and risks; compliance; and procedures for development, peace and security.

Figure 2.12 Guidelines for good practice for dam projects

Strategic Priority 1: Gaining Public Acceptance

1 Stakeholder Analysis
2 Negotiated Decision-Making Processes
3 Free, Prior and Informed Consent

Strategic Priority 2: Comprehensive Options Assessment

4 Strategic Impact Assessment for Environmental, Social, Health and Cultural Heritage Issues
5 Project-Level Impact Assessment for Environmental, Social, Health and Cultural Heritage Issues
6 Multi-Criteria Analysis
7 Life Cycle Assessment
8 Greenhouse Gas Emissions
9 Distributional Analysis of Projects
10 Valuation of Social and Environmental Impacts
11 Improving Economic Risk Assessment

Strategic Priority 3: Addressing Existing Dams

12 Ensuring Operating Rules Reflect Social and Environmental Concerns
13 Improving Reservoir Operations

Strategic Priority 4: Sustaining Rivers and Livelihoods

14 Baseline Ecosystem Surveys
15 Environmental Flow Assessment
16 Maintaining Productive Fisheries

Strategic Priority 5: Recognising Entitlements and Sharing Benefits

17 Baseline Social Conditions
18 Impoverishment Risk Analysis
19 Implementation of the Mitigation, Resettlement and Development Action Plan
20 Project Benefit-Sharing Mechanisms

Strategic Priority 6: Ensuring Compliance

21 Compliance Plans
22 Independent Review Panels for Social and Environmental Matters
23 Performance Bonds
24 Trust Funds
25 Integrity Pacts

Strategic Priority 7: Sharing Rivers for Peace, Development, and Security

26 Procedures for Shared Rivers

Source: World Commission on Dams (2000).

Cost recovery of MPWIs

A combination of the 3Ts is necessary to ensure the financial sustainability of water infrastructure, including MPWIs, to recover at least full supply costs of private goods provided by the MPWI (i.e. the costs of O&M, capital costs (including for renewal investments and new capital investment costs) and the costs of servicing debt). In addition, O&M costs should be covered from Tariffs (user charge revenue) while Taxes and Transfers could contribute to financing capital costs. This will help to attract other (repayable) sources of finance which are important for making the large, upfront investments required for MPWI, which need to be repaid by some combination of the 3Ts. MPWIs will only be able to attract these repayable sources of finance if revenue streams from the 3Ts are reliable and sufficient (OECD, 2009).

There are two principal configurations in the management of the private goods provided by MPWIs:

- The operator sells water or electricity services to an off-taker/wholesaler (e.g. an electricity or water utility, or WUG) that then sells them on to customers; or
- The operator provides the services directly to customers (end-users).

In the first case, the tariff rates between the MPWI and the off-taker are generally determined by contractual arrangements, while electricity or water tariffs for the end-user are a separate matter, which is determined by the service provider (e.g. water or electricity utility). Such tariffs are often subject to regulatory control or to legislation to address affordability concerns.

In the second case, the operator will have to strike a careful balance of the 3Ts to ensure cost recovery while respecting social and environmental regulation. Hydropower generally provides the most potential for revenue generation of MPWI dams and reservoirs and cost recovery. Long-term Power Purchase Agreements (PPAs) are common contractual arrangements between MPWI operator and a wholesale purchaser of electricity (called off-taker) that commits to buying a pre-determined amount of electricity generated by the scheme for a specific tariff rate for a number of years (generally 20-25 years). Also, hydropower stations sometimes have direct purchasing contracts with large end-users of electricity, such as aluminium smelters. There are several ways for MPWIs to mitigate risks of default from the off-taker: through Sovereign and commercial Guarantees (e.g. the San Roque Multipurpose Project, Philippines) to prevent risks of default from off-takers, and through a combination of currencies to avoid taking the risk of devaluation (e.g. the Nam Theun 2 project).

Water supply is also generally subject to tariff regulation concerns, and the tariff rates may not be sufficient to cover full supply costs. This may require the MPWI operator to cross-subsidise the water supply costs from more profitable services such as hydropower, or seek reliable transfers or taxes from public funding to bridge the gap for residential and industrial use, but less so for agricultural use and irrigation. Tariffs for water supply for residential use are generally regulated out of affordability concerns (e.g. the Great Ruaha River MPWI in Tanzania, in which MPWI operator was also the national utility, which facilitated the use of public funding to bridge the gap) (Kadigi et al., 2008). In the case of the Canal de Provence, the rates charged for raw water supply for drinking water were higher than for irrigation, meaning that irrigation was effectively cross-subsidised by domestic water supply (section 4.2.2).

Development of MPWI schemes may also yield unexpected revenue from other private goods, for instance through the development of the tourism industry. Though the revenues do not necessarily appear at the balance sheet of MPWI sponsors or the operator – it may well be a third party’s balance sheet. The Durance-Verdon MPWI scheme is a good example of a project in which the tourism sector has become a key stakeholder in the scheme management and an economic force to be reckoned with as it generates 10% of the tourism revenue associated with the region.

The tourism sector is composed of private sector companies, but has also joined forces with local public authorities and created an association in order to influence the management of the reservoir. However, it does not contribute financially to the O&M of the scheme, nor pay any portion of the revenue to the operator, but contributes to the economic development of the region and to public finances through regular taxation and the provision of employment opportunities for the local population (Comeau, 2011), as well as through the targeted water taxes levied by the River Basin Agencies, which are used to fund water resources management activities (Branche E., 2014).

Of all the MPWI under review, no operator of an MPWI facility that received revenue from the tourism industry could be identified. As for the navigation industry, it may provide an additional revenue stream if the MPWI was designed for this purpose. For instance, in France, toll payments from merchandise and tourism transportation, as well as right-of-way payment fees can be levied by the operator of the MPWI structure if the waterway is under concession, or by the *Voies Navigables de France* (VNF) public agency if it is in the public domain. The rules for the use of waterways which are under concession agreements are determined in the terms of the concession agreement established with public authorities, and have to conform with national fluvial transportation regulation enforced by VNF.

3. CONCLUSIONS AND RECOMMENDATIONS

Section 2 explored the complexity inherent in designing, financing, regulating and managing MPWI projects, which serve multiple purposes and require water allocation between competing users. Several principles and approaches have been examined to enhance MPWI sustainability including stakeholder engagement, regulatory frameworks, selection of sustainable business models, approaches to minimise financial challenges, and the potential for adaptive business models. More research is needed on concession transfers and the industry could benefit from the creation of an MPWI project database for information sharing.

Stakeholder engagement and consultation is becoming common practice for MPWI projects and enhances project sustainability while minimising conflicts and project delays, so long as stakeholders feel their input is influential. The SHARE concept presented (Branche E., 2015) can be adapted to the local context of MPWI projects to integrate stakeholders and uphold sustainable water management. Policy dialogue can be strengthened by the inclusion of stakeholder perspectives and results-oriented stakeholder engagement to enhance knowledge-sharing, transparency, and conflict resolution.

Regulatory frameworks (environmental, social, technical and economic regulations) aim to reduce risks and address negative externalities. Regulatory demands are more complex for MPWI projects compared to single service infrastructure and require mechanisms to manage trade-offs for competing users, approved water allocation, strong governance, and adaptive management as water availability becomes more unpredictable due to climate change.

Positive and negative externalities can influence selection of sustainable business models for MPWI projects, as well as their financial viability and should be assessed in the planning stages and be re-evaluated over time.

MPWI projects present a number of financial challenges due to the high upfront costs and low returns which can be addressed by determining the appropriate business model. An increasing number of PPP MPWI projects is foreseen, reliant on economic viability, mitigation of risk, and innovative models such as Split Ownership.

Further, MPWI projects benefit from adaptable business models and adaptive management. Many influencing factors such as funding, climate change, and changing societal needs and values can alter the set of goods and services provided, and activities that transpire. "It is essential to provide greater flexibility and adaptability in the way water is allocated among users during the entire lifetime of the reservoir… The multiple dimensions of projects as they emerge over time should be more explicitly addressed in the institutional management and operation arrangements" (Branche E., 2015).

Recommendations on the research methodology and further research needs are summarised as follows:

The available anecdotal facts of lower than expected performance of some MPWIs (see Table 2.7) and of the emergence of unforeseen externalities may signal: i) certain weaknesses in planning and assessing proposed MPWI (including related cost-benefit analysis - CBA) and indicate the need to think about required improvements in methodology and necessary tools to support decision making and implementation; and (ii) the complexity of planning infrastructure objects with an asset life of over 50 and up to 100 years in the context of uncertainties and unforeseen events.

Further research into the transfer of MPWI facility as the concession period ends for an MPWI project is needed to examine what business models are used after transfer. Are the models applied upon completion of concessions more sustainable over the life-time, more flexible and adaptive than the model employed during the capital investment stage of the project? Addressing these research questions may require dedicated case-studies on evolution of business models over the life time of MPWI (it may require a prior agreement with owners and operators of respective MPWI as this information is typically not in the public domain).

In addition to further research on adaptive business models, including after concession transfers, MPWI projects would benefit from (i) the development of a set of decision-support tools and (ii) the creation of a comprehensive database from which experience with various business models, conclusions on financing and investment trends, and management as well as best practices can be shared. ”Water financing needs to have a better database in order to provide a firmer benchmark from which to judge future financial requirements, and to monitor future progress.” (WWC & OECD, 2015).

Continued efforts to foster stakeholder engagement, transparent policy dialogue, adaptive business models and management, and greater information-sharing can strengthen MPWI projects and provide benchmarks and best practices that inform sustainable MPWI project design and management.

4. CASE STUDIES

This paper explores the complexity, risks and business models for MPWI. The first two case studies, the San Roque Multipurpose Dams and Reservoirs in the Philippines (see Section 4.1.1) and the Nam Theun 2 Multipurpose Project in Lao PDR (Section 4.1.2), examine multi-purpose dams and reservoirs. The two remaining case studies, the Guerdane Irrigation Project in Morocco (Section 4.2.1) and the Canal de Provence in France (Section 4.2.2) examine water distribution networks. For each case study, a brief overview of the project is presented, followed by a summary of the project business model and an assessment of risk allocation. Finally, two of the cases (4.1.1 and 4.2.1) include a review of the current situation and ongoing operational challenges.

4.1 Multi-Purpose Dams and Reservoirs

4.1.1 San Roque Multipurpose Project, Philippines

San Roque Multipurpose Project (Philippines)

Cost: US$ 1,200 million

Description: Large storage project adding 385 MW of peaking power to the grid and providing water for irrigation of 80,000 ha, as well as providing flood protection.

Business model: BOT project for the power complex, financed through export credit and commercial lending; and concessionary loan for the dam, spillway and transmission line.

The San Roque is an interesting example of a “Split-Ownership” multipurpose water project, which was commissioned under a PPP arrangement in 2003, after several decades of unsuccessfully trying to finance it in the public sector. It generates strong economic value through electricity generation, irrigation, flood protection and water quality benefits, but the overall package was initially financially weak due to the low returns from irrigation and secondary benefits as well as the various risks associated with building the dam (Head, 2006). Financial viability is essential for private sector engagement and the project managed to attract sufficient financing after the ownership of the scheme was split into a separate public and a private project.

Business model

In 1996 the national power utility NAPOCOR solicited bids for the development of the San Roque multipurpose project on a split basis, with the power complex being treated as a commercially separate Build-(Own)-Operate-Transfer BOT/(BOOT) project, while the dam, spillway and transmission line (which were not considered bankable by the private sector) were treated as public sector project. Six consortia pre-qualified but only one submitted a bid.

A special-purpose company (the San Roque Power Corporation, or SRPC) was set up to manage the construction of the entire project (the public and the private parts), and to undertake the development of the power complex. The SRPC will operate and maintain the power generating facility and holds a 25-year power purchase agreement with National Power Corp on a BOT scheme. At the time of set up, SRPC was 100% privately owned by the winning consortium. The power complex costs were estimated at US$ 580 million, and were financed through a blend of export credit and commercial lending.

The dam and associated works were financed as a public sector project that qualified for concessionary funding. This included a US$ 400 million, 15 year loan from the Japanese Bank for International Cooperation to the Government of the Philippines (Head, 2006).

Risk allocation

Commercial risks were transferred to the public sector, under a power purchase agreement between the SRPC and the national power utility of the Philippines, which committed to buying a pre-determined amount of power generated by the scheme, with the national power utility assuming the full market risk. The utility's payment obligations were backed by a Sovereign Guarantee, meaning that if the national power utility defaulted on payments, the State would bear the costs. There is no payment for the water used for the irrigation component, which was delivered through the public component.

Project risks were shared between the public and private partners. SRPC had responsibility for all construction risks (public and private elements, under a single contract), but hydrological risk rests with the state utility and irrigators.

Current situation and ongoing operational challenges

The construction of capital infrastructure for the hydropower component was transferred to the SRPC and made operational upon finalisation in 2003, thereby providing up to 385 MW of peaking power to the grid. As provided in the BOT/BOOT contractual arrangements, the SRPC will operate the entire scheme, including hydropower, water for irrigation, and flood management, until 2028 under a concession contract. No information on financial management is available on the SRPC website.

However, the capital infrastructure necessary to provide water for irrigation as envisaged in the project appraisal is still not completed. In 2011, construction of a re-regulating pond and distribution channels for irrigation was started thanks to a US$ 89.15 million loan from the China Export-Import Bank. This infrastructure currently supplies 20,000 ha for irrigation (far from the 80,000 ha initially envisaged). Additional water distribution systems still need to be completed and made operational, for which financing has not yet been approved. It is unclear whether this was due to cost overruns or the fact that the water distribution canals had not been initially budgeted for (Business Mirror – Philippines, 2014).

4.1.2 Nam Theun 2 Multipurpose project, Lao PDR

Nam Theun 2 Multipurpose Project (Lao PDR)

<u>Cost</u>: US$ 1,250 million

<u>Description</u>: 1,070 MW cross-border hydropower project, with the bulk of the electricity generated in Lao PDR exported for sale to the Electricity Generating Authority of Thailand.

<u>Business model</u>: BOOT for hydropower development, with a 25-year concession period and power purchase agreement.

Nam Theun 2 is one of the largest private cross-border MPWI schemes, whose main purpose is to generate electricity from hydropower for export from Lao PDR to the Electricity Generating Authority of Thailand (EGAT). This MPWI project is the world’s largest private sector hydroelectric project financing. The 1,070 MW project was started in 2000 with EDF as the lead private sector partner, and provides 995 MW of power for export, and 75 MW for domestic consumption. The Nam Theun 2 project also includes a watershed protection component. The 4,000 km^2 Nam Theun 2 forested watershed, which ensures a continuous supply of water to the reservoir, is controlled and managed by the Watershed Management Protection Authority (WMPA), established for that purpose, and funded by Nam Theun 2 operator via a contribution of US$ 1 million per year during the construction (5 years) and concession (25 years) periods. (EDF Group, 2012).

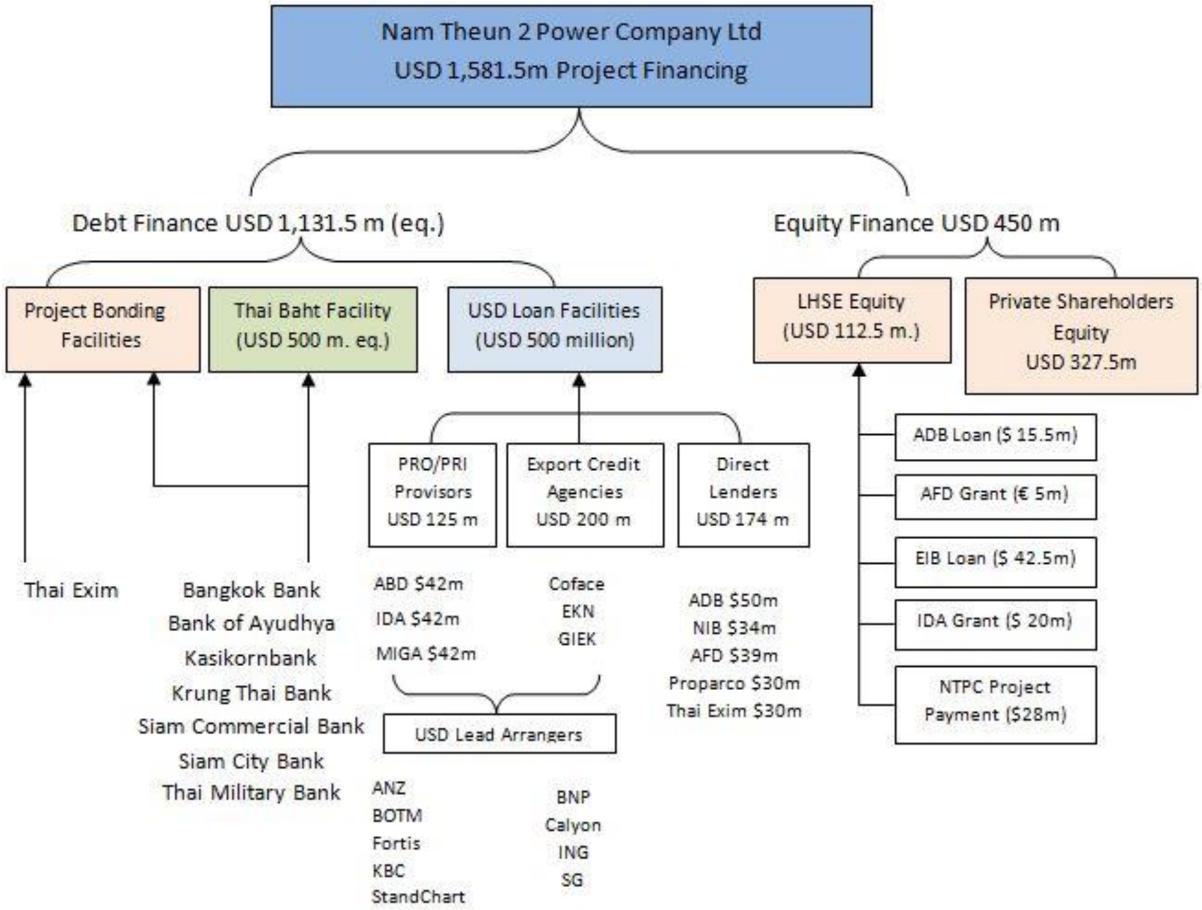
Business model

The US$ 1 250 million project was developed as a PPP structured as a private company with a public shareholding via a BOOT business model, through a locally registered, special-purpose company (the Nam Theun 2 Power Company, or NTPC), which is partly controlled by the Government of Lao PDR (with a 25% holding). The government of Laos and NTPC signed a concession agreement in 2002 contracting NTPC to finance, develop, construct, own, and operate the hydroelectric plant and facilities for 25 years - after which, it will be transferred back to the Government free of charge.

A power purchase agreement was signed between NTPC and EGAT, which conditions the sale of 5,636 GWh/ year to EGAT at a predefined tariff (half in US dollars, half in local currency in order to mitigate currency risks and avoid local currency devaluation).

The finance plan was complex, with 27 institutions involved (see Figure 4.1): 5 Multilateral Development Agencies, 4 Export Credit Agencies, 2 Bilateral Agencies, and 16 Thai and international commercial banks. Around 85% of the total financing for capital costs of the scheme (over US$ 1,000 million) was mobilised by the private sector. International debt totalling US$ 350 million was raised through Export Credit Agencies, supported by partial risk guarantees on commercial loans granted by IFIs (MIGA, World Bank, ADB). Thai commercial banks provided US$ 500 million (equivalent in local currency) to the scheme (Head, 2006).

Figure 4.1 Finance scheme, Nam Theun 2 project



Source: adapted from Rex (2008)

The Government of Lao PDR invested $87 million of equity in the scheme, which came from a mix of concessionary grants and loans from the World Bank's IDA fund, EIB, ADB and AFD. The Government of Lao PDR will receive a mix of dividends, royalties and taxes averaging $80 million per year over the concession period.

The project is providing $49 million to cover the costs of extensive social and environmental management programme, including resettlements of affected populations, social services, environmental protection, wildlife management and watershed protection. 6,300 residents had to be resettled, and 80,000 people were affected downstream.

Risk allocation

The project risks (including construction risks) are mostly borne by the Lead Sponsor and Head Contractor (French-owned company EDF). NTPC takes on most of the risks associated with O&M, while hydrological risks are shared between NTPC and EGAT; country risks are partly insured through guarantees offered by IFIs, though commercial lending from Thai banks are not covered by these guarantees.

Political risks were also a major concern for the project including risks of currency transfer restriction and inconvertibility, expropriation, and war and civil disturbance. The World Bank and MIGA, with support from the government of Lao, mitigated these political risks under the project with MIGA paying compensation to lenders for specific political risks (World Bank Group, 2006)[9]

The involvement and strong backing of IFIs, such as the World Bank, EIB and ADB contributed to a positive enabling environment for private sector participation in spite of the weak institutional and regulatory framework in place in the host country.

4.2 Water Distribution Networks: Multi- and Single-Purpose

4.2.1 The single-purpose Guerdane Irrigation Project, Morocco

The Guerdane Irrigation Project (Morocco)

<u>Cost</u>: US$ 85 million, of which the Government contributed US$50 million (part loan, part subsidy)

<u>Description</u>: Brownfield operation, with the construction and operation of a new water supply system within an existing irrigation scheme, supplying water for irrigating some 10,000 ha for citrus farming.

<u>Business model</u>: BTO. Private concession awarded, but with large public sector subsidy to keep tariffs affordable.

The single-purpose Guerdane Irrigation project was selected as it provides an interesting case of a successful PSP model for a *brownfield* water distribution project for which information about business model for financing capital investment was available. The project is an example of smaller MPWI project that utilised innovative financing through large subsidies. It was the world’s first public-private partnership (PPP) irrigation project and consists of an irrigation scheme in Morocco, which managed to raise private financing on the back of an existing water distribution scheme. It also provides a good example of a project, which was successfully structured to attract private sector financing thanks to a combination of private funding, concessionary loans and subsidies (Arrifi, 2012).

[9] The World Bank Group notes that MIGA will compensate the lenders for the following events: 1) There is a default on covered loans as a direct result of a breach by the government of Lao or EGAT of the selected contractual obligations under the project agreements; 2) A final and binding arbitration award is rendered to the lenders for a breach by the government of Lao or by EGAT of their contractual obligations under the project agreements; and 3) Lenders are unable to enforce the award against the relevant government within a specified waiting period.

The Guerdane Irrigation project aimed to provide new surface water supplies to 10,000 ha of land used by citrus farmers, who were affected by the overexploitation of groundwater resources on which they depended. In 2004, a private consortium entered into a contract to provide additional water and to manage the irrigation network for a 30-year concession. In designing the project, a major concern was to ensure the affordability of the water tariffs. The Government's contribution (part loan, part subsidy) helped ensure that the resulting tariff was lower than what farmers would have had to pay for groundwater, thereby ensuring they use the new supply. While the private sector contribution was relatively small, this MPWI project demonstrates how finance can be raised when enhancing an existing scheme and that concessionary and commercial funds can be used to produce a viable project (Head, 2006).

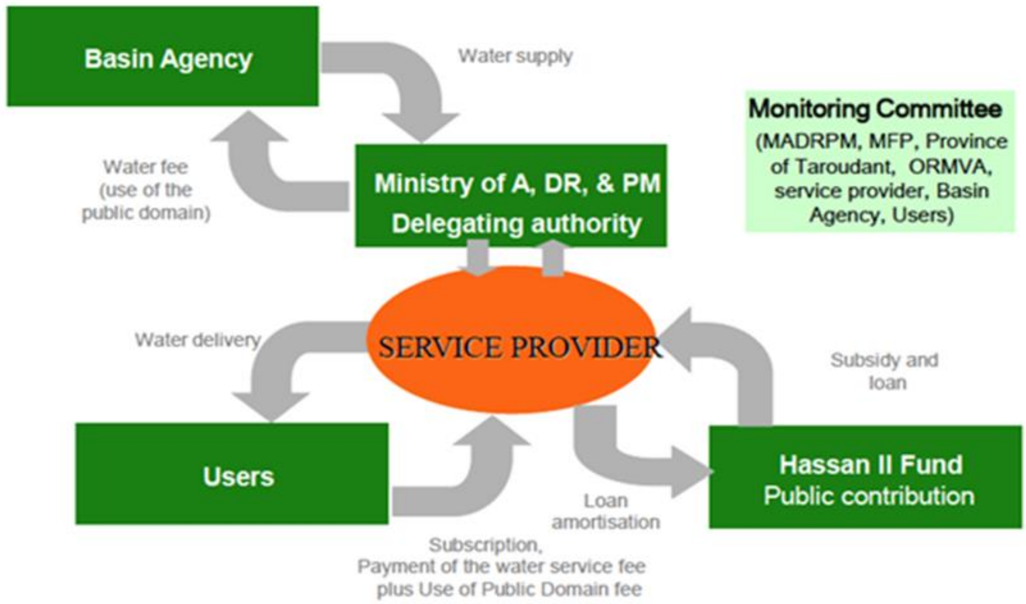
Business model

The Guerdane Irrigation project was designed in a PPP arrangement in order to co-finance the construction and operation of new water supply infrastructure to an existing irrigation scheme for 30 years. The PPP arrangement grouped together the Host Government, the private sector and the water users. The estimated capital cost of the new infrastructure was DH 850 million (currently equivalent to US$ 96 million), of which:

- The Government contributed DH 475 million through a direct subsidy through the Hassan II fund, as well as a concessionary loan of DH 237.5 million (1% interest rate).
- Water users (farmers) contributed up to DH 80 million through a fixed connection fee of DH 8,000/ ha.
- The Operator's contribution was estimated at DH 432 million, i.e. 43% of the project cost.

Figure 4.2 maps out the financial and regulatory relationships of the parties involved in the project.

Figure 4.2 Transaction Framework for the PPP Guerdane Irrigation Project



Source: (Arrifi, 2012). Notes: Ministry of A, DR & PM or MADRPM stands for Ministry of Agriculture, Rural Development and Marine Fisheries; ORMVA is the public irrigation authority; MFP is the Ministry of Finance and Privatisation.

The project was competitively procured based on technical and financial specifications. The financial specifications precluded any bids from Private Operators that could not justify their financial stability. Technical specifications were more flexible, and designed to allow for Moroccan companies (which may not have had much experience managing irrigation schemes) to bid for the project (Head, 2006). The proposed tariff for irrigation water was one of the technical criteria used to select the winning consortium; on this basis, the tariff for farmers is DH 1.48 per cubic meter of water provided. The tariffs thus collected by the operator should cover 85% of O&M costs, while the remaining 15% comes from public transfers. (USAID, 2011)

The selected consortium created a special-purpose company for the project, called Amenssous, with which the Ministry signed a Public Service Delegation contract. The Build-Transfer-Operate (BTO) contract stipulates a 30-year management of the distribution of water and maintenance of the transfer and distribution infrastructure by the company Amensouss, which is owned by the Moroccan public consortium Omnium Nord Africain (ONA) with 64% of the shares, as well as the Moroccan public investment bank Caisse de Dépôt et de Gestion (20%), the Saudi-Arabian society InfraMan (15%) and the French Compagnie Nationale d'Aménagement du Bas Rhône Languedoc (BRL) with 1%. The BTO model has the concessionaire financing, constructing and managing the project but transferring ownership of the assets to the state upon completion of the 30-year contract. "Traditionally, BTO is relatively rare in the water sector but it has been used where there is an existing scheme that needs further investment, such as the Guerdane Irrigation Project" (Head, 2006).

Risk allocation

The PPP transaction was designed to minimise the service provider's risks with the public sector and users taking on substantial commercial and project risks in order to reinforce the bankability of the project.

Commercial risks for the service provider were mitigated as follows:

- The Government contributed through a public subsidy of DH 475 million, which allowed water tariffs to remain low (at a comparable level to groundwater withdrawal costs) while maintaining the project financial return. This subsidy was proposed to all farmers wishing to purchase the available surface water.
- System users contributed through a fixed lump sum per hectare as well as a second part, proportional to the consumption of water, which reduces the risks of non-covering both capital and O&M costs, e.g. due to non-payment.
- In order to limit the service provider's risk coming from an insufficient water demand, the service provider did not start constructing the pipeline before farmers had paid lump sum subscriptions representing 80% of the project water allocation.
- Market risk is mitigated because the citrus market is well established and there are no cheaper water supplies for the citrus farmers.
- In the case of poor performance and/ or management of the infrastructure, the private operator of the project is subjected to contractual penalties.

Project risks were allocated as follows:

- In case of water scarcity/ drought, the service provider's income deficit for a specific year will be limited to 15% of a normal year; users will contribute (over and above a 15% deficit in water volume) through a specific fee; and the government will compensate the service provider for any deficit above 22.75% of expected income.
- The Private Sector takes on construction risks (e.g. delay in the construction, defect in construction, costs overrun), technical risks related to the exploitation (maintenance issues, leaks, costs of exploitation higher than envisaged) and the commercial risk (not recovering costs) (Head, 2006).

Current situation and ongoing challenges

The Guerdane irrigation project is operational and currently benefits over 1,900 individual farmers with improved irrigation and services for their plantations in order to grow citrus fruit for export with a sustainable and adequate source of water (IFC, 2013).

However, the project has had to face a number of social challenges, and has been contributing to the marginalisation of the large majority of farmers in the area who are not members of the irrigation scheme. This is due in part to two factors: (i) the marginalisation of small farmers due to the high connection fees and costs associated with the project (ii) the reduction in water availability at the basin level and lack of adequate compensations for upstream users, including farmers (Houdret, 2008).

4.2.2 The Canal de Provence, France

The Canal de Provence Multi-purpose Scheme (France):

Cost: Euro 2.4 billion (current value of the scheme), half of which was financed through commercial loans, and half through public financing. Average investments in O&M, extension and rehabilitation of Euro 40 million per year financed through revenue and loans.

Description: Multipurpose distribution scheme for irrigation, domestic and industrial water supply, supplying 180 million m^3 of water per year.

Business model: Concession contract (75 years), managed by a special purpose semi-public company.

The Canal de Provence is an ambitious multipurpose water distribution scheme, built in the 1960s, which provides over 180 million m^3 of water per year for water supply, irrigation and industries in the Provence region of France. It is part of a larger MPWI system, the Durance-Verdon hydroelectric scheme (see Figure 4.3), which was developed by *Electricite de France* (at the time a state-owned company).

In an average year, thanks to the Canal de Provence, 30 million m^3 of water are provided to the agricultural sector, 45 million m^3 to cities for domestic water supply and 43 million m^3 to the industrial sector. This represents a customer base of 110 municipalities and approximately 2 million residents, 6000 farmers with 80,000 ha of irrigated land, and 400 industries (Comeau, 2011).

Tourism was not initially planned as part of the design of the MPWI, but ended up having a large economic influence: 10% of the tourism in the department is linked with the Serre-Poncon reservoir, which is part of the Durance-Verdon hydroelectric scheme (Branche E., 2014). In order to participate in and influence the discussion on dam management, and ensure the reservoir levels stay high during the tourist season, the tourism industry, together with local authorities, joined forces in the late 1990s and created an association of public interest, which is now a stakeholder in EDF's consultations for management of the Durance-Verdon hydroelectric system, even though tourism objectives are not a contractual obligation for EDF (Branche E., 2014).

Tourism development is not a contract condition however; tourism has been included in reservoir management objectives and is an engaged stakeholder. This MPWI project has adapted the project objectives to incorporate an emerging stakeholder and tourism services beyond the initial objectives for the infrastructure. While the tourism industry does not appear to directly contribute to the financing of the MPWI scheme, the industry has strengthened the economic development and wealth of the territories and the tourism industry has emerged due to the existence of the Durance-Verdon hydropower valleys (Branche E., 2015).

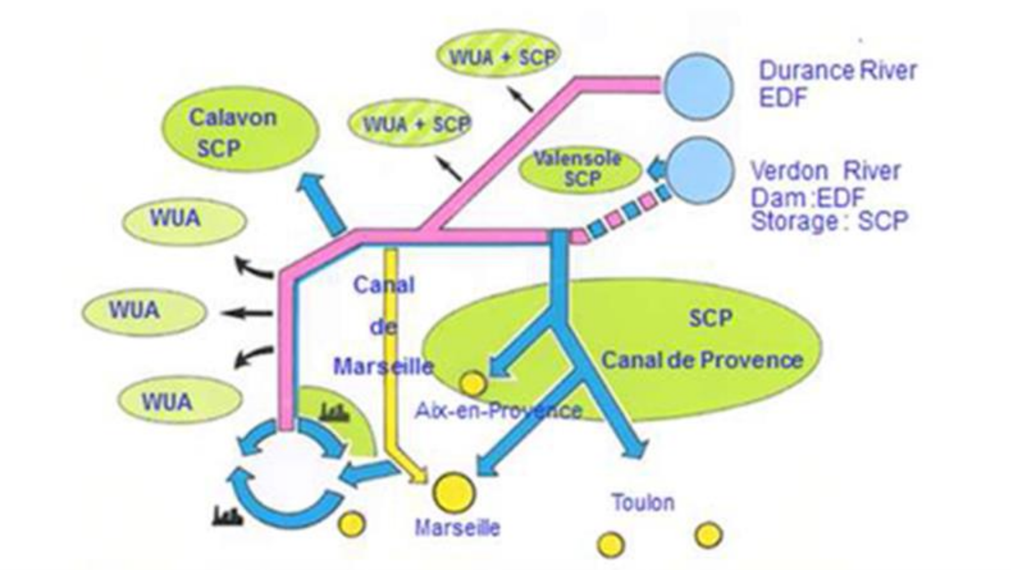
Further, EDF created SMADESEP (*Syndicat Mixte d'Aménagement et de développement de Serre-Ponçon*) on May 30, 1997 to enhance economic development on the banks of the Serre-Ponçon reservoir. This public administrative institution engages and unites nine riverside municipalities and manages the development of tourism. A framework convention of June 16, 2008 further strengthened the links between SMADESEP and EDF through the end of the EDF concession in 2052 and provides a charter of good conduct for conditions of the riverside (Branche E., 2015).

The inclusion of tourism in the reservoir management objectives and creation of a public administration institution by EDF to manage tourism is a good example of innovative strategies to adapt the MPWI business model and acknowledge an emerging stakeholder.

Business model

The hydraulic infrastructure for the Canal de Provence scheme was built under a 75-year concession contract by the Société du Canal de Provence (SCP), which was set up in 1957. The 75-year concession (from 1963-2038) stipulates that SCP will design, construct, operate and maintain the multipurpose hydraulic system of the Canal de Provence, returning all assets to the region in pristine condition in the end of concession. The SCP is a semi-public company, with 90% of the shares owned by public authorities (including the state, the region and departments), and 10% by private shareholders. The value of the assets of the SCP is currently estimated at Euro 3.8 billion; the Canal de Provence was partly financed by commercial loans (which provided roughly half of the funding) and partly by public financing including grants from the State, the Region, the Departments, the Water Agency and the EU.

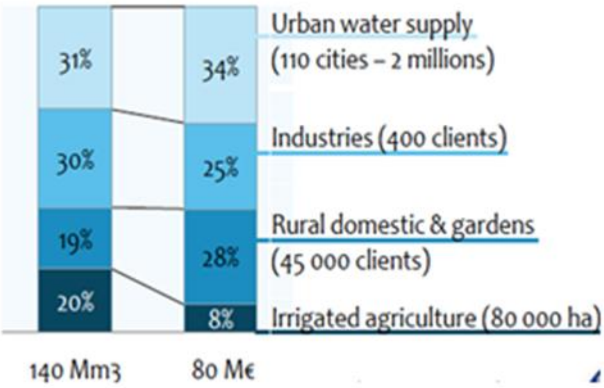
Figure 4.3 Schematic overview of the Canal de Provence in the Durance-Verdon hydroelectric scheme



Source: Comeau (2011).

The SCP employs over 450 employees and is managed as a private corporation; it does not benefit from any public subsidies, aside from the investments it received initially from the State, the Region and the Department for capital costs. The SCP levies tariffs for water services based on the marginal cost of providing water supply. Tariff rates are approved by the Board, which includes all public shareholders (the State, the Region and the Department) as well as private shareholders. Tariff rates for the most vulnerable users (farmers) are cross-subsidised by the revenue generated from other users (see Figure 4.4).

Figure 4.4 Water Distributed (volume of revenue water – (left) and Revenue Generated from Tariffs (right) (2013)



Source: Malerbe (2014).

The company engages in long-term maintenance and renovation as part of 5-year plans, which also have to be approved by the Board. For the period 2013-2017, the costs of O&M, including the capital costs of renovation and modernisation, represented € 135M. In 2013, the SCP generated an annual turnover of € 90M – including € 10M of additional revenue from activities such as engineering consultancy to other structures (€ 8M) and technical assistance to farmers. The revenue generated covers full supply costs, i.e. 100% of operations and long-term maintenance, renewal and modernisation costs and debt servicing (estimated at € 30M per year, i.e. around 1% of present asset value- see Figure 4.5).

In 1996, the company reached financial equilibrium between profits and losses, after 33 years of operations. Since then, all profits have been reinvested into the SCP, with no distribution of profits to shareholders.

Figure 4.5 Breakdown of revenue spent on cost recovery (2013)

Source: Malerbe (2014).

Risk allocation

During planning and construction of the scheme, the lion's share of the construction risks were taken on by the main financier and asset owner, which was the state (now the region). During operations, the SCP bears the technical risks associated with the SCP assets, and the commercial risks associated with the management of the scheme. The diversification of services provided, including the fact that SCP has a diverse portfolio with various groups of water users and has engaged in consulting and technical assistance activities on top of its main business, has helped mitigate the commercial risks associated with its activities.

What is interesting in the Canal de Provence case is that the scheme has been in operation long enough to assess the allocation of hydrological risks during the operation of the scheme. The reimbursement of losses incurred by EDF in the Durance-Verdon hydroelectric system during periods of drought, which was not initially included in the design of the scheme, ended up being borne by public authorities (the state and the local authorities), a small proportion of which is passed on to farmers. Hydrological risk has been effectively passed on to public authorities, and only marginally to farmers.

4.3 Concluding remarks

Of the four case studies examined in Section 4, in three cases there was a PPP arrangement, including a split public and private project (4.1.1), while the remaining case (4.2.2) has a concession contract with a semi-public company. These case studies are currently in the concession contract timeframe and have yet to be transferred, primarily returning to government ownership and management. Limited information is available regarding how the MPWI will be managed following the expiration of the facility concession.

One example, concession transfer in France, presents a process that has been initiated for the renewal of hydropower concessions to create a competitive process, with EDF currently operating 80% of the 400 hydropower concessions. Traditionally, a preference right had been granted to outgoing holders when hydropower concessions were renewed but in 2005 the European Commission stated this preference right breached EU law and in 2010 a competitive call for concessions was announced. The process has remained stalled and several concessions have expired since 2011 resulting in the decision to extend them under the previous royalty scheme.

While the implementation of a new hydropower concession regime in France requires additional enactment of an official order and faces opposition due to concerns about privatisation of the hydropower sector, the key features of the proposed and planned reform include (Lazar, 2015):

- 'Barycentre' method for renewal of concessions. "This method involves bundling together several concessions located in the same area and setting a single maturity date prior to launch of a bidding process… The draft bill sets out the principle that the concessionaire maintains an economic equilibrium, assessed on the basis of all bundled concessions"
- Exceptional extension of some concessions
- *New royalty scheme* which will be set by each concession agreement and noted a revenue-based royalty shall be paid to the state for all new or renewed concessions and that the royalty shall be set by the grantor to maintain economic equilibrium of the contract
- Establishing a *Public-private company system* to create public-private companies for the term of a concession dedicated to a specific concession.

The aforesaid general observations could be complemented by case-specific lessons learnt:

Case-specific lessons

The San Roque *green-field* multi-purpose (irrigation and hydropower) project in the Philippines presents an interesting case where the MPWI was commissioned under a PPP (BOOT) arrangement after several decades of unsuccessfully trying to deliver it by financing from the public sector. Sound risk allocation was a key success factor: the commercial risk was transferred to the public sector under a power purchase agreement. However, the project also showcase of marginalising many farmers who were not members of the irrigation scheme.

While the Guerdane irrigation project (Morocco) is an example of successful use of PSP model for a *brown-field* water distribution project. Its specificity is that it utilised innovative financing through large subsidies.

The Num Then 2 project in Lao PDR (Laos) is the case of a successful cross-border MPWI scheme; its main purpose is to generate electricity and export hydro-power to Thailand. The scheme generates some USD 80 million per year for the Government of Lao PDR in the form of dividends, royalty and taxes. These benefits seem allowing for compensation for key negative externalities (e.g. 6300 resettled residents).

Finally, the Canal de Province - built in 1960ies and associated with the Serre-Poncon reservoir of the Durance-Verdon hydro-power scheme in France - is an interesting case of emerged new use not envisaged initially: namely, the development of mass tourism to the reservoir and canal areas; and how the tourism industry contributing a lot to the regional economy became a stakeholder in EDF's consultations for management of the MPWI, even though development of tourism is not a contractual obligation for EDF.

* * *

An important consideration is what will happen once the concession contracts end. Following transfer, the MPWI facility can be fully managed and operated by the public authorities (for example, water re-municipalisation is becoming more common for water services), the contract can be renewed, or an independent operator can be hired. "After transfer, the principal is the sole owner of the facility and can choose to operate and maintain the facility directly or hire an independent operator… it can be expected that the principal will continue with the same operator, as in the concession period, due to history of involvement and experience with the facility. If the principal is the government, it may choose after transfer not to charge the final users anymore. In essence, the facility at that time will have become public, and its maintenance and operation can be funded by indirect taxation." (Menheere & Pollalis, 1996).

Further research into concession transfers and adaptive business models can inform MPWI project design and management.

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