# IMRR

# Integrated and sustainable water Management of Red-Thai Binh River System in a changing climate.

## POG

## Piano Operativo Generale

## General Management Plan

POLITECNICO DI MILANO

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# PART I: Technical Section

# 1 Introduction

The collaboration between Politecnico di Milano (POLIMI) and the Institute of Water Resources Planning (IWARP) under the Ministry of Agriculture and Rural Development (MARD) of the Socialist Republic of VietNam dates back to 2007 when a two days workshop was organized by POLIMI, following a request from IWARP, to describe to Vietnamese IWARP managers the expertise developed by Gruppo di Modellistica e Gestione dei Sistemi Ambientali del Dipartimento di Elettronica e Informazione del Politecnico di Milano about designing management policies for multipurpose multi-reservoir systems. Afterwards in 2008 IWARP invited POLIMI to organize a summer school in Hanoi to train IWARP personnel. Following this experience IWARP showed interest to formalizing a collaboration with POLIMI to design models and tools to manage the multipurpose, multi-reservoir system of the Red-Thai Binh river basin. MARD submitted to the Italian embassy in Hanoi a project for technical assistance (ODA TECHNICAL ASSISTANCE PROJECT A-01). MAE judged interesting the proposal and asked POLIMI to submit a project proposal for cofounding (ex art. 18 - cooperazione universitaria - del Regolamento Attuativo della Legge 49/87). The project proposal dates back to 2008 and the Ministero Affari Esteri (MAE) Comitato Direzionale per la Cooperazione e lo Sviluppo (DGCS) approved the IMRR project with their resolution n.142 of the 8th of November 2010 , signed for acceptance by Politecnico di Milano on 21 October 2011.

Given the three years gap between the writing out of the project proposal and its approval, the present general management plan (POG) adopts a few changes regarding the project development with respect to the original proposal, in order to update the project needs to present day conditions. In these three years some of the activities originally included in the project have been partly explored with two MSc and one PhD theses. Specifically, some of the tasks foreseen in the original Macro-Phase A, concerning the tuning of the project methodology on the Hoa Binh-Da-Delta subsystem, have been already partially addressed, thus allowing for the allocation of more project resources on the modelling of the complex multipurpose multi-reservoir system of the Red-Thai Binh river basin (Marco-Phase B). We have identified two areas where the current state of art of research promises interesting potentials that the project could benefits from: I) an improved representation of the current delta river network and associated crop typologies in order to produce more sophisticated evaluation of water demand; II) the characterization of the river geomorphic processes (e.g. river erosion, channel bed incision etc..), which can be severely affected by the construction of new dams and can severely destabilize flood protections and water intake points, and degrade the delta ecosystem. The potential of exploiting these two research topics will be carefully assessed, but at the present it is difficult to identify specific objectives since these developments will be strongly influenced by data availability.

Given the novel project conditions the project structure, the GANTT and some cost items have been reviewed. However the total amount of project budget and co-funding allocated are unchanged and the re-allocation of cost items regards small switches between similar tasks.

# 2 Logical Framework

| | Description | Evaluation Indicators | Source of check | External Condition (C) |
|---|---|---|---|---|
| **Long term Objective** | *Promoting sustainable and effective water management of these systems*: improving the efficiency, effectiveness and environmental sustainability of water management in this basin through advance modelling tools which can support multi-stakeholder dialogue, coordination and negotiations<br>*Building Technical and Institutional Capacity*: promoting capacity-building in water governance by favouring experience-sharing and transfer of expertise, methodology and tools to Viet Nam. | | | |
| **Short term objective** | I. To assess current conditions of the management of multipurpose multi-reservoir system in the Red-Thai Binh river basin.<br>II. To design optimal operating rules for the multipurpose multi-reservoir system (including Hoa Binh, Thac Ba, Tuyen Quang and under construction reservoirs such as Son La, Lai Chau, Huoi Quang, Ban Chat, etc) for water supply for domestic, industry, agriculture, navigation, power generation, flood control, and environment of the Red river delta in adapting to climate changes.<br>III. To contribute to harmonize conflicts generated by water allocation and distribution. | | Deliverables D1.2 , D10.1 | |
| **Expected Results** | I. A web portal, based on Wiki technology, to disseminate project results and to enhance public participation. The web portal might be used in future to support the future stakeholder engagement. | Web portal installed and operational | Public access to the web portal<br>Deliverable D1.1 | |
| | II Design of a set of regulation policies for the large-scale multi-purpose, multi-reservoir systems of Red-Thai Binh, balancing water supply (domestic, industry, hydropower, irrigation, environment, aquaculture, navigation), flood control and environment protection. Different regulation policies will be designed accounting for different climate scenarios (i.e. present and future climate scenarios). | Evaluation criteria, indicators and indexes calculated for different regulation policies by the modelling tools developed | Deliverables D3.1, D4.1, D4.2 , D5.1, D6.1, D7.1, D8.1, D8.2 | Availability of information on current management of water releases<br><br>Availability of hydrological models of the Red and Thai Binh basins. |
| | III Set up modelling tools at IWARP for planning the management of large-scale multi-purpose, multi-reservoir system of Red-Thai Binh. These tools will compose a TWO moduLEs (TWOLE) decision support environment: a Planning module (Red_Twole/P,) and a Management module (Red_Twole/M). | Modules Red_Twole/P and Red_Twole/M installed and operational | Availability of the operational Red_Twole system<br><br>Deliverable D9.1 | |
| | IV Capacity building will be promoted by training a few staff members of Vietnamese institutes on the system optimization methodology that will be apply within the IMRR Project. The training will take place at DEI | Two Vietnamese students have completed their PhD and have been trained to use Red_Twole<br>Three Vietnamese students have completed a Master course and have been trained to use Red_Twole<br>Experts from IWARP have collaborated in the project and have been trained to use Red_Twole<br>Around 40 participants are foreseen at the final workshop | - PhD and Master courses at Politecnico<br>- Final Course in Hanoi | |
| **Activity** | I.1 Project Management<br>I.2 Stakeholder engagement and support to public participation<br>II.1 Reconnaissance of the system<br>II.2 Conceptualization (identification of actions and evaluation criteria).<br>II.3 Models identification<br>II.4 Scenario building (climatic, demographic etc..) for project and policy evaluation<br>II.5 Design of regulation policies for multi-purpose multi-reservoir systems and prediction of their effects (algorithms here developed compose the core of Red_Twole/P).<br>II.6 Evaluation and negotiation of those regulation policies, in order to identify the ones which determine the best trade-off for different climate scenarios; mitigation of their possible negative effects<br>III.1 Setting up of Red_TwoLe/P and Red_Twole/M<br>III.2 Testing of Red_Twole/P and Red_Twole/M.<br>IV.1 To establish 2 PhD and 3 Master scholarships in the Politecnico di Milano for brilliant Vietnamese students.<br>IV.2 Participation of Master and PhD students and IWARP staff in the development of modelling tools that will be included in Red_Twole.<br>IV.3 Organization of the final Workshop where Red_Twole will be presented and its application to other regions within the country promoted. | **Resources**<br>**Costs extrapolated from the financial plan**<br>1. Italian staff costs € 412,492.00<br>2.1 Attend conference/workshop for PhD students € 13,000.00<br>2.2 Consultants € 288,050.00<br>2.3 Vietnamese staff € 282,050.00<br>2.4 Meetings/Workshops € 30,000.00<br>2.5 Scholarship in Italy € 184,110.00<br>2.6 Equipment € 57,800.00<br>2.7 Financial resource (operating costs) € 80,000.00<br>2.8 Travels € 100,000.00<br>2.9 Overheads € 144,748.00 | | Possible coordination issues with IWARP |
| | | | | **Previous Condition (I)** |
| | | | | |

# 3 Background and Necessity of the Project

The Red river basin originates from China and flows into the South China Sea covering an area of 169,000 $Km^2$. The part in Viet Nam occupies about 86,660 $Km^2$ including lands of the Hanoi capital and other 25 provinces in the North of Viet Nam with a population of 26 million persons and total agricultural lands of nearly 1.1 million hectares. Conflicts among water issues such as agriculture, environment protection and power generation, are becoming more and more serious, especially in dry seasons. Downstream water flow in the dry season of 2006 and 2007 has reached the minimum volume in the last 100 years. Hundred thousands of hectares of agricultural lands faced water shortage, navigation was interrupted, and water environment was seriously polluted resulting in mass fish death in Ha Nam province. At early 2006, water shortage interrupted domestic water supply to Phu Ly town and surroundings for a week causing inconveniences and difficulties to local people. Lately, two sub-basins of the Red river basin, i.e., Nhue-Day and Cau sub-basins became the most polluted in Viet Nam mainly because of the draught. In the flood season, water conflicts rise among flood control, power generation and water storage for future agricultural supply.
At present, a more effective management of the multi-purpose multi-reservoir systems in the Red-Thai Binh river basin is an urgent objective but still shortcoming due to inadequate methodologies, technologies and financial resources. Inefficiencies in coordination, regulation and maintenance of large-scale reservoirs resulted in frequent droughts, severe loss of agricultural production and environment degradation.
Politecnico di Milano is a pioneer in water resources management and planning thanks to their advanced optimization tools and expertise (VietNam does not possess a similar methodology or technology either). The Italian methodology and technology [Soncini-Sessa *et al.* 2007a, 2007b] are suitable to address the problems of water use conflicts in the Red-Thai Binh river basin, likely to exacerbate in the near future due to further pressures such as climate changes.

## 3.1 Problems to be addressed

The main issues to be tackled and addressed by the project are:

- To better handle the conflict due to water allocation and distribution between various water uses of private and public sectors
- To minimize economic losses (for agriculture and hydropower sectors), decrease the risk of flooding and enhance environmental quality through a more effective and sustainable water allocation and distribution.

## 3.2 Direct beneficiary of the project

The direct beneficiaries of the initiative are:

- The technical staff of IWARP directly involved in the project for a total of 300 months/man. It will acquire expertise in designing and using integrated and participated water resource management strategies
- Vietnamese students that will be involved in Phd and Master courses at Politecnico di Milano

The project will actively involve principally *secondary* stakeholder (water boards and operational staff) rather then primary stakeholder (people directly affected by water system operations). The POG specifically refers to secondary ones from now on, when stakeholder are generally mentioned. Stakeholder support will provide a definition of specific interests affected by water management and then will identify the specific requirements of the modelling tools that will be developed.

## 3.3 Indirect beneficiary of the project

They will include all the primary stakeholders (like inhabitants and workers in the sub-basin) interested in flood control, hydropower, industry, water supply, navigation, environment, and recreation and then affected by water management of Red-Thai Binh River basin. In particular, vulnerable rural communities and agricultural production, which were the most affected by droughts and water shortage in past years, will benefit of a more effective management of water resource. Ecological issues, related with water allocation and distribution, have been so far ignored. The project will provide tools able to start keeping into consideration the impacts of water management on ecological processes aiming at a more sustainable use of the water resource.

## 3.4 Strategy and Objectives

*Overall objective:* Making tangible progress in water management practices in the Red-Thai Binh River system with the purpose of meeting Vietnamese society's long-term needs for water resources while maintaining essential ecological services and improving the economic benefits coming from hydropower production and agriculture.

1. *Long - term objectives*

*Promoting sustainable and effective water management of the Red-Thai Binh system*: improving the efficiency, effectiveness and environmental sustainability of water management in the basin through advanced modelling tools which can support multi-stakeholder dialogue, coordination and negotiations
*Building Technical and Institutional Capacity*: promoting capacity-building in water governance by favouring experience-sharing and transfer of expertise, methodology and tools to VietNam.

2. *Short - term objectives*

- To assess current conditions of the management of multipurpose multi-reservoir system in the Red-Thai Binh river basin.
- To design optimal operating rules for the multipurpose multi-reservoir system (including Hoa Binh, Thac Ba, Tuyen Quang and under construction reservoirs such as Son La, Lai Chau, Huoi Quang, Ban Chat, etc) for domestic, industrial, agricultural water supply, navigation, power generation, flood control, and environment conservation of the Red river delta in a changing climate.
- To contribute to harmonize conflicts generated by water allocation and distribution.

The project will be based upon the Participatory and Integrated Planning procedure (PIP) for water resource developed by DEI-Polimi [Soncini-Sessa *et al.*, 2007a, 2007b], see Annex A2 for a short synthesis.

# 4 Expected Results and Activities

The expected results of the project are:

I. A web portal, based on Wiki technology, to disseminate project results and to enhance public participation. The web portal might be used in future to support the future stakeholder engagement.
II. Design of a set of regulation policies for the multi-purpose, multi-reservoir systems of Red-Thai Binh, balancing water supply (domestic, industry, hydropower, irrigation, aquaculture, navigation), flood control and environment protection. Different regulation policies will be designed accounting for different climate scenarios (i.e. present and future climate scenarios).
III. Set up modelling tools at IWARP for planning the management of multi-purpose, multi-reservoir system of Red-Thai Binh. These tools will compose a TWO moduLEs (TWOLE) decision support environment: a Planning module (Red_Twole/P) that will integrate the simulation and optimization code developed during the project for the design of optimal operating policies. A Management module, called Red_Twole/M will consist in a graphical interface to assist daily operations by implementing the optimal policy. Both the modules will be referred generally as Red_Twole. If due to technical reasons

some modules of Red_Twole would require the use of external property software (e.g. MIKE11 or MatLab) it will be IWARP duty to acquire it. Possible integration of the present tools with software and models currently available at IWARP or in other agencies is out of the scope of the project.

IV. Enhanced capacity of staff members of Vietnamese institutes on integrated water resource management and specific methodologies applied during the IMRR Project.

Expected results will be achieved by the following activities:

I.1 Project Management

I.2 Stakeholder engagement and support to public participation

II.1 Reconnaissance of the system

II.2 Conceptualization (identification of actions and evaluation criteria).

II.3 Models identification

II.4 Scenario building (climatic, demographic etc..) for project and policy evaluation

II.5 Design of regulation policies for multi-purpose multi-reservoir systems and prediction of their effects (the modelling algorithms here developed compose the core of Twole/P).

II.6 Evaluation and negotiation of those regulation policies, in order to identify the ones which determine the best trade-off for different climate scenarios; mitigation of their possible negative effects

III.1 Setting up of Red_TwoLe/P and Red_Twole/M

III.2 Testing Red_Twole/P and Red_Twole/M at IWARP.

IV.1 To establish 2 PhD and 3 Master scholarships in the Politecnico di Milano for brilliant Vietnamese students.

IV.2 Partecipation of Master and PhD students and IWARP staff in the development of modelling tools included in Red_Twole.

IV.3 Organization of the final Workshop where Red_Twole will be presented and its application to other regions within the country promoted.

The decision-making process in the Red-Thai Binh river basin will be developed following the PIP procedure (see Annex A2). Hence this procedure represents the natural point of reference for planning the Work Packages (WP) activities. Three out of ten WPs are specifically related with the case study and project management and not with PIP:

- WP1: project coordination and management with a series of regular Coordination Meetings to monitor project schedule and progress;
- WP2: the coordination and execution of the participation activities that will ensure active involvement of stakeholder organizations through direct contacts and Basin Meetings;
- WP10: capacity-building and dissemination activities based on staff exchange and Vietnamese students following Master and PhD course in Italy.

The planned activities are described using a number of tables providing information on the actions will be undertaken, the expected deliverables and WPs schedule. Table 4-1 include the list of the ten WPs, the organization responsible of each WP, the WP leaders (WPL) and leader assistant (WPLA), the related activities accomplished and a list of contents included within each WP and their schedule. The project deliverables are summarised in Table 4-2. Table 4-3 shows the project Milestones and Table 4-4 the project GANTT. For a more detailed description of the work/activities undertaken within each WP see Annex A1.

*Table 4-1 WP description*

| Activity | WP No. | Work package title and contents | Schedule months | Leader and Leader Assistant |
|---|---|---|---|---|
| I.1 | **1** | **Coordination** | **1-36** | **POLIMI Enrico WEBER**<br>Ha Thi Thanh VAN |
| | | Setting up of the communication structure | 1-2 | |
| | | Maintaining communication with the Government Officer and the project partners | 1-36 | |
| | | Monitor project progress | 1-36 | |
| | | Project's website (D1.1) | 3 | |
| | | The 1st coordination meeting | 1 | |
| | | The 2nd coordination meeting | 11 | |
| | | The 3rd coordination meeting | 22 | |
| | | The 4rd coordination meeting | 34 | |
| | | Final Report (D1.2) | 36 | |
| I.2 | **2** | **Participation** | **1-36** | **IWARP Ha Thi Thanh VAN**<br>Nguyen Ngoc Minh |
| | | Stakeholder active involvement | 1-36 | |
| | | Community and end-users information and consultation activities | 1-36 | |
| | | The 1st Basin Meeting | 1 | |
| | | The 2nd Basin Meeting | 11 | |
| | | The 3nd Basin Meeting | 22 | |
| | | The 4rd Basin Meeting | 34 | |
| II.1 | **3** | **Reconnaissance** | **1-22** | **IWARP Le Hung NAM**<br>Nguyen Thi Bich Thuy |
| | | Identification of the system and components | 1-6 | |
| | | Data Collection | 1-22 | |
| | | Translate the Goal into a vision that is visible | 1-11 | |
| | | Prepare and held the kick-off Basin Meeting (together with WP2) | 1 | |
| | | Reconnaissance Report (D3.1) | 11 | |
| II.2 | **4** | **Conceptualization** | **3-17** | **POLIMI Simone BIZZI**<br>Quach Thi Xuan |
| | | Identification of the options for intervention that are supposed to achieve the Project Goal (provided by WP3) | 3-6 | |
| | | Defining Actions Report (D4.1) | 6 | |
| | | Identify a hierarchy of *evaluation criteria* that reflect the characteristics of the problem and the values that are at the basis of the Stakeholders' judgments | 3-17 | |
| | | Defining Criteria and Indicators Report (D4.2) | 17 | |
| II.3 | **5** | **Model Identification** | **5-17** | **POLIMI Andrea CASTELLETTI**<br>Nguyen Xuan PHUNG |
| | | Identify a set of *models* to compute the trajectories of the system variables | 3-17 | |
| | | Identifying the Model Report (D5.1) | 17 | |
| II.4 | **6** | **Scenario building** | **5-17** | **IWARP Pham Tuyet MAI**<br>Le Viet SON |
| | | Review and analyses the scenarios produced in previous projects | 5-10 | |
| | | Development of new climate-change scenario for the Red-Thai Binh River Basin based on downscaling of the regional climate change scenario (IPCC-2007 or UNDP-2007). | 10-17 | |
| | | Scenario Building Report (D6.1) | 17 | |
| II.5 | **7** | **Designing alternatives and estimating the effects** | **7-32** | **POLIMI Francesca PIANOSI** |
| | | Selection of a subset of the indicators defined in WP4 | 17-20 | |
| | | Formulation of a *Design Problem*, i.e. a multi-objective Mathematical Programming (or Optimal Control) problem | 7-31 | |

| | | | | |
|---|---|---|---|---|
| | | Simulation of the system subject to each of the previously identified alternatives (e.g. via Markov or Monte Carlo simulation) under a given evaluation scenario (provided by WP6) | 26-31 | Quach Thi XUAN |
| | | Designing Alternatives and Estimating the Effects Report (D7.1) | 32 | |
| **II.6** | **8** | **Evaluation, Negotiations and Mitigation** | **20-34** | **IWARP Nguyen Van Tuan**<br><br>Pham Thanh Tu |
| | | Associating each indicator with a dimensionless 'value': the indicator measures the physical (or economic) effect produced by a given alternative, the 'value' expresses the satisfaction associated to that effect. | 20-33 | |
| | | Evaluating Report (D8.1) | 33 | |
| | | Carrying out negotiations among the stakeholders, in collaboration with WP2, in order to identify the alternative | 27-34 | |
| | | Negotiation Report (D8.2) | 34 | |
| **III**<br>III.1<br>III.2 | **9** | **Setting up and Testing** | **30-36** | **IWARP Le Hung NAM**<br><br>Le Viet Son |
| | | Setting up Red_Twole/P at IWARP | 30-32 | |
| | | Implementation of the best compromise policy obtained at the end of the negotiation process into Red_Twole/M module. | 32-35 | |
| | | Testing Red_Twole to IWARP (D9.1) | 33-36 | |
| **IV**<br>IV.1<br>IV.2<br>IV.3 | **10** | **Capacity building** | **1-36** | **POLIMI Andrea Castelletti**<br><br>Nguyen Van TUAN |
| | | Two PhD (3-years) scholarships at the Politecnico di Milano | 1-36 | |
| | | Three MSc (2-years) scholarships at the Politecnico di Milano | 12-36 | |
| | | Staff members of Vietnamese institutes will be invited in Italy, to participate to some phases of IMRR development to grasp the system optimization methodology and technology that will be applied in the Red-Thai Binh River Basin. | 1-36 | |
| | | Dissemination | 12-36 | |
| | | Final workshop (D10.1) | 36 | |

*Table 4-2 Project Deliverables*

| Deliv. No. | Deliverable name | WP No. | Delivery month |
|---|---|---|---|
| D1.1 | Project public web site and intranet | 1 | 3 |
| D1.2 | Final Report | 1 | 36 |
| D3.1 | Reconnaissance Report | 3 | 11 |
| D4.1 | Defining Actions Report | 4 | 6 |
| D4.2 | Defining Criteria and Indicators Report | 4 | 17 |
| D5.1 | Identifying the Model Report | 5 | 17 |
| D6.1 | Scenarios building Report | 6 | 17 |
| D7.1 | Designing alternatives and estimating the effects Report | 7 | 32 |
| D8.1 | Evaluation Report | 8 | 33 |
| D8.2 | Negotiations Report | 8 | 34 |
| D9.1 | Red_Twole delivered to IWARP | 9 | 36 |
| D10.1 | Final Workshop | 10 | 36 |

*Table 4-3 Project milestones*

| Milestone No. | Milestone name | Expected date | Means of verification |
|---|---|---|---|
| M0 | Kick-off | 1 | Kick-off meeting: first basin + coordination meeting. |
| M1 | Reconnaissance and definition of actions | 12 | Web server on line; System and components identified; Data Collection planned and started; Actions identified; Identification of criteria, indicators, models and scenarios undertaken but not completed; Scoping phase on suitable algorithms for Designing alternatives and estimating the effects; Second Basin and Coordination Meetings completed. |
| M2 | Model Identification and Scenario Building | 24 | Criteria and Indicators defined, models identified and scenario building carried out; Designing alternatives, estimating the effects and evaluation phase undertaken but not completed; Third Basin and Coordination Meetings completed. |
| M3 | Evaluation & Complexion | 36 | Alternatives designed; effects estimated; evaluation conducted; stakeholders' ranking available; negotiations rounds completed. Fourth Basin and Coordination Meeting completed; implementation completed. All reports-deliverables completed. |

# 5 Management Structure

DEI-POLIMI will act as the coordinator of IMRR. It has considerable experience in managing national and international projects.

The major tasks of project management are:

- Maintaining an efficient communication flow between the partners to guarantee a common information basis.
- Coordination and maintenance of the project web site and related communication tools.
- Coordination and synchronization of the Work Packages to meet the milestones.
- Risk management.
- Preparation and coordination of Project Meetings, etc.
- Document tracking; preparation of period technical reports; collecting and preparing the administrative and financial reports; coordination of the deliverables.
- Liaison of IMRR consortium with the MAE office.
- Management of the overall legal, administrative and financial aspects of the consortium.
- These tasks will be developed with the assistance of two boards, the Project Board (PB) and the Project Steering Committee (PSC).

## 5.1 Project Coordinator

The Project Coordinator is Professor Rodolfo Soncini-Sessa of DEI-Polimi. Dr Quach Thi XUAN of IWARP, who has recently received a PhD from DEI-Polimi under his supervision, will act as his assistant project coordinator in order to enhance the communication and integration between DEI-Polimi and IWARP activities.

## 5.2 Project Board (PB)

The overall project management is based on regular e-meeting of the PB, which is constituted of the Project Coordinator and the Director of IWARP. The PB will have responsibility for:

- ensuring the adherence to the project timetable;
- setting the scientific priorities, within the existing objectives and budget framework;
- setting the guidelines of the risk management analysis;
- defining the dissemination strategy for the project outcomes;
- establishing common operational procedures to be followed by the partners for carrying out their activities;
- defining the proper tools and “infrastructure” for assuring links between the two teams.

Decision will be based on unanimous agreement whenever possible; in case of unsolvable dispute, the opinion of Project Coordinator prevails.

## 5.3 Project Steering Committee (PSC)

The PSC will be composed of the PB members, the WP leaders (see below) and two deputies: one from MARD and one from the Cooperation Office of the Italian Embassy in Hanoi. It will be responsible for:

- supervising and controlling the research program, including control of research progress towards the milestones;
- monitoring and reporting processes and results, based on deliverables accomplished;
- performing detailed planning and co-ordination of the work, taking the responsibility for the completion and quality assurance of each WP;
- proposing corrective actions, in case of problems that might affect achievements or delay activities

and deliverables.

Decision will be based on unanimous agreement whenever possible; when necessary, a two-thirds majority will be used to determine contested issues.

## 5.4 Work Packages (WP)

The project is structured in 10 Work Packages (WP), as summarized in the Table 4-1. Each WP has a **WP Leader (WPL)**, which will:

- be responsible for the progress of tasks and activities related to her/his own WP;
- be responsible for the content and date of issue of the deliverables of her/his own WP, as defined in the project work plan;
- anticipate all significant modifications of the work plan and inform the PB for approval;
- submits to the coordinator its internal financial reports related to meetings, workshops, etc.;
- address and document internal risks which may impair the progress towards the objectives of the WP and suggest strategies to anticipate and minimize these risks whenever possible;
- monitor corrective actions;
- support the PB in all reporting activities.

In addition Table 4-1 also identifies a WP Leader Assistant (WPLA) within the IWARP staff, in order to enhance the coordination of the activities between POLIMI and the Vietnamese institute.

## 5.5 Stakeholder Group (SG)

To strength the communication with the final users a Stakeholder Group (SG) will be formed, coordinated by the WP2 (Participation) leader. This will include the representatives of major stakeholders directly involved into the project, mainly *secondary stakeholders* such as water boards, hydropower producers and farmer associations. They will be regularly informed of the project progress through the project web site and will be invited to all the Basin Meeting.

## 5.6 Communication and content management

Communication will rely mainly on electronic media (e-mail, skype and a web platform), but also on site visits and face-to-face discussions, in particular with the stakeholders.
The project web platform will consist of two components:

- Intranet: web services based on WIKI technology, which will give the participants the opportunity to discuss results and post their reports in a reserved document tracking system (maintained by WP1);
- Project web site: for disseminating information and project results. The web site will include also an on-line forum.

## 5.7 Risk management

To minimize the risk of project failure, milestones, regular internal progress reports and tasks monitoring (as described above) are foreseen. In case of necessity, the Coordinator will call for ad hoc virtual meetings of the PSC to rapidly cope the problems. The main foreseeable risk regards the lack or delay in availability of adequate data due to technical or institutional problems. In this case a series of alternative plans will be agreed between the partners and provided.

# 6 Monitoring and Evaluation

Three different Periodic Reports will be presented to MAE in order to assess the project development. Each one will consist of 2 sections, the first on technical matters, the second on administrative/financial matters. The payment from Ministry to POLIMI will be subdivided in four instalments. A first one (€ 465.003,00) in advance, a second and third ones (respectively of € 314.317,75 and € 223.742,75) at the end of the first and second years, and a final one (€ 111.457,50) at the end of the project. The payments of the second, third and forth instalments will be undertaken only after the approval by MAE of the respective periodic report. MAE in order to proceed with the payments requires receipts and appropriate documentations able to show to have spent at least 80% of the previous payments, taking into account of the co-funding of each organization. The three reports are foreseen to approximately match the schedule of Milestone M1, M2 and M3 (see Table 4-3). However the exact date might be subject to minor changes in function of the budget effectively allocated.

All Project Reports need to compare the activities and cost really undertaken with the ones planned and described in this POG. Regarding the technical section, the tables and annexes previously presented provide all the necessary information about the expected Deliverables (see Table 4-2), Milestones (see Table 4-3), and WP (see Table 4-1) planned to be undertaken or carried out each year. The Evaluation Indicators and Criteria identified in the Logical Framework will be used to evaluate the quality of the progresses and results produced. Regarding the administrative/financial section see Tables provided in the following Financial Section. It is worth noting that given the difficulty to foresee in details all the cost items in the budget some re-adjustments might be necessary within similar items (e.g. within Italian Staff (1)) under the condition that the total amount of co-financing of each organization will remain unchanged. Any relevant and major change of the POG needs to be justified and subsequently approved by MAE.

The 33,4% of each instalment will be transmitted by POLIMI to IWARP without delay, but only if all documents provided by the IWARP will be judged appropriate and complete by Project Coordinator and will be accepted by Ministry. The payments won't be allowed if the parties do not fulfil all the requirements of the Project Coordinator and/or the Ministry. Starting from the second instalment the Ministry will deduce from each instalment all the expenses of the previous year that it will judge inappropriate or not correctly proved/justified. Accordingly the amount of IWARP expenses not approved by the Ministry will be deduced from the corresponding payment to IWARP.

# PART II: Financial Section

# 7 Financial Plan

Table 7-1 describes in detail the financial plan over the three years for each item costs.

*Table 7-1 Financial Plan*

| Code | Costs Items | Unit | Unit price | 1° year | | 2° year | | 3° year | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Q.ty | Amount | Q.ty | Amount | Q.ty | Amount | Q.ty | Amount |
| | | | | | | | | | | | |
| **1** | **Italian staff costs** | | | | | | | | | | |
| **1.1** | Full professor | Man-month | € 13,000.00 | 3 | € 39,000.00 | 2 | € 26,000.00 | 4 | € 52,000.00 | 9 | € 117,000.00 |
| **1.2** | Researcher | Man-month | € 4,000.00 | 4 | € 16,000.00 | 4 | € 16,000.00 | 5 | € 20,000.00 | 13 | € 52,000.00 |
| **1.3** | Research assistant (Assegnista) | Man-month | € 2,217.00 | 36 | € 79,812.00 | 36 | € 79,812.00 | 30 | € 66,510.00 | 102 | € 226,134.00 |
| **1.4** | PhD Student | Man-month | € 1,578.00 | 3 | € 4,734.00 | 4 | € 6,312.00 | 4 | € 6,312.00 | 11 | € 17,358.00 |
| | ***Total 1*** | | | ***43*** | ***€ 139,546.00*** | ***46*** | ***€ 128,124.00*** | ***39*** | ***€ 144,822.00*** | ***124*** | ***€ 412,492.00*** |
| | | | | | | | | | | | |
| **2** | **Other costs** | | | | | | | | | | |
| **2.1** | Attend conference/workshop for PhD students | | | | | | | | | | |
| **2.1.1** | Travel tickets | Ticket (rtn) | € 800.00 | 0 | € 0.00 | 3 | € 2,400.00 | 5 | € 4,000.00 | 8 | € 6,400.00 |
| **2.1.2** | Accommodation + Per diem | day | € 125.00 | 0 | € 0.00 | 9 | € 1,125.00 | 15 | € 1,875.00 | 24 | € 3,000.00 |
| **2.1.3** | Fee registration | conference | € 450.00 | 0 | € 0.00 | 3 | € 1,350.00 | 5 | € 2,250.00 | 8 | € 3,600.00 |
| | ***Total 2.1*** | | | | ***€ 0.00*** | | ***€ 4,875.00*** | | ***€ 8,125.00*** | | ***€ 13,000.00*** |
| **2.2** | **Consultants** | | | | | | | | | | |
| **2.2.1** | software architecture and development | Man-day | € 250.00 | 215 | € 53,750.00 | 200 | € 50,000.00 | 90 | € 22,500.00 | 505 | € 126,250.00 |
| **2.2.2** | project management | Man-day | € 300.00 | 92 | € 27,600.00 | 92 | € 27,600.00 | 92 | € 27,600.00 | 276 | € 82,800.00 |
| **2.2.3** | website, GIS and data | Man-day | € 250.00 | 130 | € 32,500.00 | 78 | € 19,500.00 | 80 | € 10,000.00 | 288 | € 62,000.00 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | analysis | | | | | | | | | | |
| **2.2.4** | auditor | Forfait | € 3,000.00 | 1 | € 3,000.00 | 1 | € 3,000.00 | 1 | € 11,000.00 | 3 | € 17,000.00 |
| | ***Total 2.2*** | | | | ***€ 116,850.00*** | | ***€ 100,100.00*** | | ***€ 71,100.00*** | | ***€ 288,050.00*** |
| **2.3** | **Vietnamese staff** | | | | | | | | | | |
| **2.3.1** | Senior staff | Man-month | € 1,500.00 | 10 | € 15,000.00 | 10 | € 15,000.00 | 11 | € 16,500.00 | 31 | € 46,500.00 |
| **2.3.2** | Senior staff | Man-month | € 1,250.00 | 12 | € 15,000.00 | 10 | € 12,500.00 | 11 | € 13,750.00 | 33 | € 41,250.00 |
| **2.3.3** | Junior staff | Man-month | € 900.00 | 30 | € 27,000.00 | 28 | € 25,200.00 | 30 | € 27,000.00 | 88 | € 79,200.00 |
| **2.3.4** | Junior staff | Man-month | € 700.00 | 45 | € 31,500.00 | 35 | € 24,500.00 | 33 | € 23,100.00 | 113 | € 79,100.00 |
| **2.3.5** | Post-doc | Man-month | € 1,000.00 | 12 | € 12,000.00 | 12 | € 12,000.00 | 12 | € 12,000.00 | 36 | € 36,000.00 |
| | ***Total 2.3*** | | | ***109*** | ***€ 100,500.00*** | ***95*** | ***€ 89,200.00*** | ***97*** | ***€ 92,350.00*** | | ***€ 282,050.00*** |
| **2.4** | ***Meetings/Workshops*** | | | | ***€ 10,000.00*** | | ***€ 10,000.00*** | | ***€ 10,000.00*** | | ***€ 30,000.00*** |
| **2.5** | **Scholarship in Italy** | | | | | | | | | | |
| **2.5.1** | PhD (2 for 3 year) | Man-3year | € 61,674.00 | 2 | € 123,348.00 | | € 0.00 | | € 0.00 | 2 | € 123,348.00 |
| **2.5.2** | Master (3 for 2 year) | | | | | | | | | | |
| | Tuition | Man-year | € 3,317.00 | 3 | € 9,951.00 | 3 | € 9,951.00 | 0 | € 0.00 | 6 | € 19,902.00 |
| | Insurance + Tax | Man-year | € 360.00 | 3 | € 1,080.00 | 3 | € 1,080.00 | 0 | € 0.00 | 6 | € 2,160.00 |
| | Accommodation | Man-year | € 6,450.00 | 3 | € 19,350.00 | 3 | € 19,350.00 | 0 | € 0.00 | 6 | € 38,700.00 |
| | ***Total 2.5*** | | | | ***€ 153,729.00*** | | ***€ 30,381.00*** | | ***€ 0.00*** | | ***€ 184,110.00*** |
| **2.6** | **Equipment and Computation Services** | | | | | | | | | | |
| **2.6.1** | Italian staff and PhD equipment | | | | | | | | | | |
| | lap-top | unit | € 1,800.00 | 3 | € 5,400.00 | 0 | € 0.00 | 0 | € 0.00 | 3 | € 5,400.00 |
| | Server (physical or cloud) | unit | € 4,000.00 | 1 | € 4,000.00 | 0 | € 0.00 | 0 | € 0.00 | 1 | € 4,000.00 |
| **2.6.2** | Vietnamese equipment | | | | | | | | | | |
| | lap-top | unit | € 1,200.00 | 12 | € 14,400.00 | 0 | € 0.00 | 0 | € 0.00 | 12 | € 14,400.00 |
| | Server (physical or cloud) | unit | € 6,000.00 | 1 | € 6,000.00 | 0 | € 0.00 | 0 | € 0.00 | 1 | € 6,000.00 |
| | Monitoring Instruments and Tools | | | | € 12,000.00 | | € 8,000.00 | | € 8,000.00 | | € 28,000.00 |
| | ***Total 2.6*** | | | | ***€ 41,800.00*** | | ***€ 8,000.00*** | | ***€ 8,000.00*** | | ***€ 57,800.00*** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2.7** | ***Financial resource (operating costs)*** | | | | ***€ 25,000.00*** | | ***€ 25,000.00*** | | ***€ 30,000.00*** | | ***€ 80,000.00*** |
| **2.8** | Travels | | | | | | | | | | |
| **2.8.1** | Italian people in Viet Nam | | | | | | | | | | |
| | Travel tickets (rtn) | ticket | € 2,000.00 | 8 | € 16,000.00 | 4 | € 8,000.00 | 4 | € 8,000.00 | 16 | € 32,000.00 |
| | Accommodation and per-diem | day | € 125.00 | 80 | € 10,000.00 | 40 | € 5,000.00 | 40 | € 5,000.00 | 160 | € 20,000.00 |
| **2.8.2** | Vietnamese people in Italy | | | | | | | | | | |
| | Travel tickets (rtn) | ticket | € 2,000.00 | 2 | € 4,000.00 | 3 | € 6,000.00 | 4 | € 8,000.00 | 9 | € 18,000.00 |
| | Accommodation and per-diem | day | € 125.00 | 36 | € 4,500.00 | 60 | € 7,500.00 | 80 | € 10,000.00 | 176 | € 22,000.00 |
| **2.8.3** | PhD students travels | | | | | | | | | | |
| | Tickets | ticket | € 2,000.00 | 0 | € 0.00 | 2 | € 4,000.00 | 2 | € 4,000.00 | 4 | € 8,000.00 |
| | ***Total 2.8*** | | | | ***€ 34,500.00*** | | ***€ 30,500.00*** | | ***€ 35,000.00*** | | ***€ 100,000.00*** |
| | | | | | | | | | | | |
| | **Sub-Total 2** | | | | **€ 482,379.00** | | **€ 298,056.00** | | **€ 254,575.00** | | **€ 1,035,010.00** |
| | | | | | | | | | | | |
| | **General Sub-Total (1+2)** | | | | **€ 621,925.00** | | **€ 426,180.00** | | **€ 399,397.00** | | **€ 1,447,502.00** |
| | | | | | | | | | | | |
| **2.9** | Overheads | | | | € 62,190.30 | | € 42,618.00 | | € 39,939.70 | | € 144,748.00 |
| | ***General Total*** | | | | ***€ 684,115.30*** | | ***€ 468,798.00*** | | ***€ 439,336.70*** | | ***€ 1,592,250.00*** |
| | ***Provided by DGCS (max 70%)*** | | | | ***€ 478,880.71*** | | ***€ 328,158.60*** | | ***€ 307,535.69*** | | ***€ 1,114,575.00*** |
| | % for year | | | | 70% | | 70% | | 70% | | |

- ***Cost Item 1 – Italian Staff Costs***: the POLIMI staff includes Professors, structured researchers, PostDocs and PhD students.

- ***Cost Item 2.1 – Attend conference/workshop for PhD students***: PhD students will attend international conferences during their training period. Considering the variety of countries where conferences can be organized and the varying conference fees in the budget we have used averaged costs.

- ***Cost Item 2.2 – Consultants***: the project will hire some external experts selected by their CV and experience. The cost for external consultants and for the project audit has been calculated based on previous project experiences carried out by POLIMI at national and international level, and we have taken into account as much as possible inflation and the variability of job market. The professional expertise provided will be formalized by suitable collaboration contracts.

    - 2.2.1: This cost item covers the development of the graphic interface of Red_Twole/M and general support setting up Red-Twole environment. It concerns also possible support in the development of specific modelling modules about aspect of the system that requires extra efforts. Senior experience in the specific modelling required will be asked as a requirement to the consultant.
    - 2.2.2: This cost item covers the cost for the project management and coordination. The consultant must prove long-term experience coordinating projects on similar topics related with water resources.
    - 2.2.3: This costs items covers the development of the website and possible data and GIS processing. The Consultant must have experience in web-site development, possibly with experience on web-GIS interface development and geographical data processing. Alternatively the two tasks (web-site development and GIS processing) might be carried out by independent consultants, but integration of the outputs must be guaranteed by the project coordination.
    - 2.2.4: Project audit will be carried out by an external organization with long-term experience in project assessment.

- ***Cost Item 2.3 – Vietnamese staff:*** this cost item refers to the whole contribution provided by Vietnamese personnel coherently with the development of project activities and the experience and expertise of the Vietnamese staff. This item includes also the man months for monitoring activities, translation of reports and web pages in Vietnamese, communication and dissemination costs.

- ***Cost Item 2.4 – Meetings/Workshops:*** this cost item will support a number of activities to disseminate the project outputs. Again the cost represents an average estimation of the expense the Vietnamese organization will have to face to rent rooms, provide buffets, print flyers etc

- ***Cost Item 2.5 – Scholarships in Italy:*** PhD scholarships (n.2) are calculated on the base of the XXVII cycle at the POLIMI PhD school (2011). Master costs (n.3) are calculated on the base of the current Master fees at POLIMI (2011).

- ***Cost Item 2.6 – Equipment :*** the Italian staff will buy three laptops to assign to researchers and PhD students involved in the project. About the Vietnamese equipment we foresee to buy 12 laptops for students and the IWARP personnel. Two Serves between the Vietnamese and Italian staff are foreseen to host the web site, to store data and to run computations required by the Red_Twole software during the project development and its future use by IWARP. The costs are assessed in order to cover either the expenses of buying (physically) the severs or alternatively of renting them

(cloud computing). The choice will be driven by technical evaluation and the best conditions offered by the market at the moment of the task execution.

A certain amount of expense (2.6.2) has been foreseen to buy monitoring tools and instruments. The type of equipment needed will be in relation of the missing information we will decide to acquire (WP3), the type of modelling approach that will be undertaken for each component of the system (WP4 and WP5) and the resource available in term of man-months for field survey. It is not possible at the moment to produce a detailed plan however this resource will be especially used to provide novel datasets to support novel modelling developments on components of the system which might require extra-efforts. The equipments acquired will belong to IWARP after the end of the project.

- ***Cost Item 2.7 – Financial resource (operating costs):*** this cost item includes the functioning cost of IWARP, assessed by the Vietnamese organization itself. This cost is about the 28% of the expense foreseen for the Vietnamese staff.

- ***Cost Item 2.8 – Travels:*** the cost item includes the travelling expenses for the Italian and Vietnamese staff. A total of 16 trips over the three years for the Italian staff, 9 trips for the Vietnamese staff in the second and third year, and 4 trips for PhD students in the second and third year of the project.

- ***Cost Item 2.9 – Overheads (max 10% of General Sub-Total):*** the overheads are appointed by MAE at the 10% of the General Subtotal.

# 8 Financing

The maximum budget allowed by the Project is € 1.592.250,00. The Italian Ministry funds € 1.114.575,00 , POLIMI co-funds within its activity for an amount of € 309.002,00 and IWARP for an amount of €168.673,00 . The total budget for IWARP is € 541.212,00 and for POLIMI is € 1.051.038,00. Table 7-1 shows the Financing and project costs in detail for each organization and each cost item.

*Table 8-1 Financing scheme*

| | | ***Financing*** | | | | ***Cost*** | |
|---|---|---|---|---|---|---|---|
| **Code** | **Costs Items** | **POLIMI** | **IWARP** | **MAE** | **TOTAL** | **POLIMI** | **IWARP** |
| | | | | | | | |
| 1 | ***Italian staff costs*** | € 177,002.00 | € 0.00 | € 235,490.00 | € 412,492.00 | € 412,492.00 | € 0.00 |
| 2 | ***Other costs*** | | | | | | |
| 2.1 | *Attend conference/workshop for PhD students* | € 0.00 | € 0.00 | € 13,000.00 | € 13,000.00 | € 13,000.00 | € 0.00 |
| 2.2 | *Consultants* | € 8,652.00 | € 0.00 | € 279,398.00 | € 288,050.00 | € 288,050.00 | € 0.00 |
| 2.3 | *Vietnamese staff* | € 0.00 | € 147,673.00 | € 134,377.00 | € 282,050.00 | € 0.00 | € 282,050.00 |
| 2.4 | *Meetings/Workshops* | € 0.00 | € 10,000.00 | € 20,000.00 | € 30,000.00 | € 0.00 | € 30,000.00 |
| 2.5 | *Scholarship in Italy* | | | | | | |
| 2.5.1 | PhD (2 for 3 year) | € 123,348.00 | € 0.00 | € 0.00 | € 123,348.00 | € 123,348.00 | € 0.00 |
| 2.5.2 | Master (3 for 2 year) | € 0.00 | € 0.00 | € 60,762.00 | € 60,762.00 | € 0.00 | € 60,762.00 |
| 2.6 | *Equipment* | | | | | | |
| 2.6.1 | Italian staff and PhD equipment | € 0.00 | € 0.00 | € 9,400.00 | € 9,400.00 | € 9,400.00 | € 0.00 |
| 2.6.2 | Vietnamese equipment | € 0.00 | € 0.00 | € 48,400.00 | € 48,400.00 | € 0.00 | € 48,400.00 |
| 2.7 | *Financial resource (operating costs)* | € 0.00 | € 11,000.00 | € 69,000.00 | € 80,000.00 | € 0.00 | € 80,000.00 |
| 2.8 | *Travels* | | | | | | |
| 2.8.1 | Italian people in Viet | € 0.00 | € 0.00 | € 52,000.00 | € 52,000.00 | € 52,000.00 | € 0.00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nam | | | | | | |
| 2.8.2 | Vietnamese people in Italy | € 0.00 | € 0.00 | € 40,000.00 | € 40,000.00 | € 0.00 | € 40,000.00 |
| 2.8.3 | PhD students travels | € 0.00 | € 0.00 | € 8,000.00 | € 8,000.00 | € 8,000.00 | € 0.00 |
| 2.9 | *Overheads (max 10% of General Sub-Total)* | € 0.00 | € 0.00 | € 144,748.00 | € 144,748.00 | € 144,748.00 | € 0.00 |
| | ***Total 2*** | € 132,000.00 | € 168,673.00 | € 879,085.00 | € 1,179,758.00 | € 638,546.00 | € 541,212.00 |
| | ***General Total*** | € 309,002.00 | € 168,673.00 | € 1,114,575.00 | € 1,592,250.00 | € 1,051,038.00 | € 541,212.00 |

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## Annex A1: WORK PACKAGES DESCRIPTIONS

The present description of each WP provides a general outline of the main activities. A more detailed description of sub-activities planned and related GANTT for each WP will be provided during the development of the project on the IMRR web site. A parte of this web site will be dedicated to the project INTRANET that will be used as a platform to develop research activities and project reports based on Wiki technology.

**WP1**

| Work package title | **Project coordination** |
|---|---|
| Start date or starting event: | 1 |

**Targets**

- Maintenance of communication with the Steering Committee.
- Preparation of periodic reports.
- Maintenance and coordination of communication and information of the project web-site.
- Coordination and synchronization of the Work Packages.
- Monitoring of project progresses in close collaboration with the partners.

**Description of work**

The WP tasks are:

- Setting up of the communication structure of project web server, based on WIKI technology.
- Coordinating the communication with the Steering Committee and the project partners through various media, primarily through electronic communication.
- Monitor project progress.
- Compile periodic reports for timely transmission to the Steering Committee.
- Organize Project Meetings, synchronizing work plan, major milestones and deliverables.

**Involvement of the project personnel**:

*Staff from POLIMI*: Actively involved in all the activities. It coordinates task synchronization and support Steering Committee decisions. It designs and has the responsibility of the project web site and the intranet structure.

*Staff from IWARP*: It organizes Project Meetings, coordinates local Stakeholders and institutional representatives involvement. It translates web-site contents into Vietnamese.

**Deliverables**

- Project Web Site (Month 3 - D1.1)
- Periodic Project Progress Reports (approximately match scheduled Milestones M0, M1, M2 and M3)
- Final Report (Month 36 – D1.2)

**WP2**

| Work package title | **Participation** |
|---|---|
| Start date or starting event: | 1 |

**Targets**

- To ensure a wide representativeness of the stakeholders through on-site and web-based activities and to improve the efficiency and effectiveness of dialog of all the parties.
- Enhance efficiency of water resources management through awareness-raising amongst the parties involved in the participation processes.

**Description of work**

The main activities are:

Stakeholder Analysis: the set of *primary* and *secondary* stakeholders will be partitioned in Sectors of interests (water works, irrigation, fishing activities, hydropower generation, ecosystem and biodiversity conservation) and representative selected for each one of them.

Stakeholder involvement strategy: a context-specific strategy will be developed and a detailed Agenda established. Main issue to consider: local participative opportunities and constraints; stakeholders' mutual legitimacy; their attitude to collaborate. A proper mix of methods and tools (face-to-face and web-based ones) will be ensured.
Two levels of participation are foreseen: *Co-designing* and *Consultation*:

1. *Co-designing* will be limited to a suitable defined subset of representative of *secondary* Stakeholders that will be actively involved in the designing and evaluation of the alternatives through the planned Basin Meetings and face-to-face interviews.

2. *Consultation* concerns to provide Stakeholders with information and receive feedbacks from them: in this way the whole community can be informed and provide feedbacks on the on-going activities in order to strengthen the link between formal decision-making and local knowledge. Through this type of participation potentially even *primary* Stakeholders (such as Local community and end-users) might be reached. The consultation will be based on web-based tools and *ad hoc* events.

**Involvement of the project personnel**:

*Staff from IWARP*: Responsible for all the activities

*Staff from POLIMI*: Support the activities with the appropriate methodologies.

**Deliverables**

- Organize and held the four basin meeting.
- Produce a synthetic summary following each basin meeting for internal use that includes the lists of participants, their affiliate organizations, the minutes of the meetings and stated agreement. The report must include also the foreseen participants we want to reach for the next basin meeting and a description of the involvement strategy planned.

**WP3**

| Work package title | **Reconnaissance** |
|---|---|
| Start date or starting event: | 1 |

**Targets**

- Acknowledgment of the problems to be tackled in the Red-Thai Binh river system.
- Define the decision-making procedure to be adopted in the Project for both river systems
- Define the *Goal* that the planning project must pursue.
- Data collection of relevant information necessary to model the system

**Description of work**

For both Hoa Bihn-Da-Delta sub-system and Red-Thai Bihn river systems:

1. Identify:
   - the spatial and temporal boundaries of the system being considered (*scoping*);
   - the normative and institutional context of the project;
   - the data already available and the missing information;
   - the stakeholders involved and their interests;
   - the Decision Makers (DMs) involved,
   - the *Goal* of the planning project, which is derived from the DMs' strategic goals, from the stakeholders' interests and from the regulatory and planning context.
2. Data Collection:
   - to collect and process available data required by the modelling phase (WP4-6)
   - to plan and undertake possible field monitoring campaigns if relevant data are missing and if the resource available in the project allows such activities. This task might include some additional work after the 11$^{th}$ month to support the collection of planned key information (see project GANTT Table 4-4).
3. Translate the Goal into *visions* able to describe project aims of the different stakeholders' point of view.
4. Prepare and held the first Basin Meeting (together with WP2) where
   - the PIP procedure is presented and discussed and, if necessary, negotiated among all the parties;
   - the parties share all the available information, agree upon its validity and identify the need for further investigations. In other words, when necessary, even the validity and availability of the information must be negotiated.

**Involvement of the project personnel**:

*Staff from IWARP*: Actively involved in all the activities

*Staff from POLIMI*: Support the Identification and Data Collection phases providing information on constraints and needs of the modelling phase. Disseminate the PIP methodology (see Annex II).

**Deliverables**

- Reconnaissance Report (Month 11 – D3.1)
- Annex I: A list of the Stakeholders involved and their contact information.

- Annex II: A list of datasets available specifying the organizations in charge of each type of information and its supposed use within the project.
- Annex III: A list of missing information for which data collection has been planned. A synthetic description of the data collection methodologies planned must be specified.

**WP4**

| Work package title | **Conceptualization** |
|---|---|
| Start date or starting event: | 3 |

**Targets**

- Define actions for Red-Thai Binh river systems.
- Define criteria and indicators.

**Description of work**

This WP is organized in 2 main tasks:

1. The options for intervention that are supposed to achieve the Project Goals must be identified, bearing in mind the interests of the different Stakeholders. Then each intervention is broken down into one or more (*meta-*)*actions*, i.e. elementary interventions that can be fully and easily defined in the modelling environment by specifying the values of their attributes (that is, by specifying who is doing what, how and when). In this way a meta-action is transformed into an *instantiated* action. From the point of view of the regulation, only off-line design of control policies will be considered. The instantiated actions are the 'building blocks' from which the *alternatives* will be constructed in WP7.
2. WP3 defines the project goals and objectives. These objectives need to be translated in a set of mathematical indicators that can be measured and predicted for different project alternatives (see WP5 and WP7). This task identifies a hierarchy of *evaluation criteria* that reflect the characteristics of the problem and the values that are at the basis of the Stakeholders' judgments. The criteria do not have to pertain only to the Project Goal, but to all the positive and negative effects that the Stakeholders hope for or fear. In particular, criteria for sustainable development will have to be considered. Each of the criteria at the lowest level of the hierarchy (*leaf criteria*) is then associated with an *indicator*, i.e. a function of the trajectories of the variables that describe the system condition. The *indicator* must be mathematically defined by a function/functional of the modelled variables and the information needed for its calculation identified.

**Involvement of the project personnel**:

*Staff from POLIMI*: Actively involved in all the activities. It will coordinate, fed by Stakeholders inputs, the development of *meta-actions* and *indicators* in order to be suitably integrated in WP5 and WP7.

*Staff from IWARP*: It will coordinate local Stakeholders involvement and will provide to POLIMI staff suitably elaborated information of their attitude's elicitation: all the feasible interventions that Stakeholders suggest should be included among the actions and the hierarchy of evaluation criteria should be constructed following their needs.

**Deliverables**

- Defining Actions Report (Month 6 – D4.1)
- Defining Criteria and Indicators Report (Month 17 – D4.2)
- Annex I: Fact sheets (i.e. a synthetic dossier) including for each evaluation criteria identified the associated *indicators,* their mathematical equations, and the corresponding code and the source of information needed.

**WP5**

| Work package title | **Model Identification** |
|---|---|
| Start date or starting event: | 5 |

**Targets**

• Identify the model of the Red-Thai Binh river systems.

**Description of work**

The WP's objective is the development of a *model* to simulate the system behaviour, as measured by the indicators identified in WP4, under different planning alternatives. The model is supposed to be composed of several sub-models describing the different system components. Depending on the data and knowledge available, these models can take either the form of an expert or a mathematical model. The level of model complexity for each component cannot be foreseen in detail now, it will be a trade off between project objectives, data availability (see WP3), state of art on models capability, and project resource. Traditional conceptual models will be developed for existing and planned reservoirs. Statistical models will be preferably used for characterizing the main hydrological and hydraulic processes under present conditions. Conceptual hydrological models are instead required to generate climate driven projections of flow patterns throughout the basin. If the availability of data will allow it, the development of *ad hoc* models for water demand and river erosion will be developed.

It is a task of this WP to translate models into codes that will feed WP7 and WP9.

Given the participatory nature of the process, stakeholders will be involved in the model identification activity to ensure model credibility. To this end, when available, the models already run at IWARP will be also considered for integration in the Red_Twole environment.

**Involvement of the project personnel**:

*Staff from POLIMI*: Actively involved in all the activities. It will coordinate the development of the various model modules. POLIMI will be mainly concerned with the development of statistical and data-driven models.

*Staff from IWARP*: It will provide information on data and models availability. It will coordinate the involvement of the stakeholders in the model identification and take care of the development of conceptual and physically-based models.

**Deliverables**

• Identifying the Model Report (Month 17 – D5.1 )
Annex I: Fact sheet (i.e. a synthetic dossier) and code for each one of the *models* developed.

**WP6**

| Work package title | **Scenario building** |
|---|---|
| Start date or starting event: | 5 |

**Targets**

- To define the simulation scenarios that will be used for designing alternatives and estimating the effects.

**Description of the work**

Both the design and evaluation of the Pareto-efficient alternatives that will be performed in WP7 require as an input a *simulation scenario* describing the temporal evolution of external forcing factors like meteorological variables (e.g. precipitation and temperature) and socio-economic drivers (e.g. water demand for civil, industrial and irrigation use).

The scope of this work package is to produce such scenario. More than one scenario can be defined to account for uncertainty in future climatic and socio-economic projections. The number and type of scenarios to be produced by the WP as well as the characterization of the associated uncertainty and the techniques used to produced them (either expert-based or model-based) will be conditional upon data availability and will be agreed upon after reviewing the state-of-the-art and outcomes from other research projects in the area. At minimum, deterministic scenarios of meteorological variables (precipitation and temperature) based on downscaling of regional climate change scenarios by IPCC-2007 or UNDP-2007, and of water demand pattern will be developed.

**Involvement of the project personnel**:

- Staff from POLIMI: provide consultancy
- Staff from IWARP: actively involved in all activities

**Deliverables**

- Scenario Building Report (Month 17 – D6.1)
  Annex I: technical description and numerical code for downscaling climate change scenarios.
  Annex II: Time-series of meteorological (precipitation and temperature) and hydrological variables under climate change. Time-series of projected water demand.

**WP7**

| Work package title | **Designing alternatives and estimating the effects** |
|---|---|
| Start date or starting event: | 7 |

**Targets**

- To select the design indicators.
- To design Pareto-efficient alternatives by optimization of the design indicators.
- To evaluate the Pareto-efficient alternatives by a set of evaluation indicators.

**Description of the work**

1. The *design indicators* that will be used for designing the Pareto efficient alternatives are defined. These are a selection and/or manipulation of the set of indicators defined in WP4. The definition of the design indicators must balance the need for reproducing the Stakeholders' interests and the requirements of the optimization methods that will be used for the alternatives design.
2. A set of *Pareto efficient alternatives* (e.g. operating policies) is designed by multi-objective optimization. Each Pareto efficient alternative represents a different trade-off between the objectives of the optimization problem. The definition of the optimization problem includes: (i) the problem objectives, that are based on the selected design indicators; and (ii) the problem constraints, i.e. the model of the system (from WP5) and (iii) the design scenario (from WP6). The solution of the problem is based on dynamic programming and/or nonlinear programming methods (e.g. Stochastic Dynamic Programming, Q-Learning, Multi-Objective Genetic Algorithm).
3. The designed Pareto efficient alternatives are evaluated by model simulation under historical and/or projected hydrological scenarios (from WP6) and their performances are synthetically measured by a set of *evaluation indicators* (from WP4).

The Design algorithms here developed compose the core of Red_Twole/P.

**Involvement of the project personnel**:

- Staff from POLIMI: actively involved in all activities

- Staff from IWARP: provide consultancy in activity 1 and 2 for the selection of the design indicators and the design and evaluation scenarios, including elicitation of Stakeholders attitude towards uncertainty and risk

**Deliverables**

- Report on Designing Alternatives and Estimating the Effects (Month 32 – D7.1).
  Annex I: Fact sheet (i.e. a synthetic dossier) and numerical code for computing the design indicators.
  Annex II: set of Pareto efficient alternatives and numerical code used for optimization.
  Annex III: time series of simulated system variables under Pareto efficient alternatives (and corresponding indicator values) and numerical code used for simulation.

**WP8**

| Work package title | **Evaluation, Negotiations and Mitigation** |
|---|---|
| Start date or starting event: | 20 |

**Targets**

- Identify the *preference structure (through value functions)* of each stakeholder.
- Identify the *reasonable alternatives* through negotiations.
- Identify the *mitigation actions.*

**Description of work**

This WP is organized in 2 main tasks:

1. Evaluation: each indicator is associated with a dimensionless 'value': the indicator measures the physical (or economic) effects produced by a given alternative, the 'value' expresses the satisfaction associated to that effect. The association is realized by defining a *partial value function* identified through interviews with the stakeholders. Once all the indicators are transformed into 'values', the overall satisfaction for an alternative is expressed by a dimensionless *index*, which is a function of the attained 'values'. Each stakeholder will define the index in its own way, thus formalizing its preference structure, and will derive its ranking of the alternatives (produced in WP7) by sorting them by decreasing values of the index.
2. Negotiations: in collaboration with WP2, negotiations are carried out among the stakeholders, in order to identify the alternative, if one exists, that is judged to be an acceptable compromise by all the stakeholders. A win–win alternative, i.e. an alternative that improves all the stakeholders' indices with respect to the Alternative Zero, would be the ideal candidate, however, such an alternative does not always exist. In a case of irresolvable conflict between the interests of different stakeholders, negotiations concludes with the identification of the set of alternatives (*reasonable alternatives*) that obtain wide *agreement* and with listing the supporting and opposing stakeholders for each of them.

   If an alternative enjoys the agreement of the majority of the stakeholders, but not all of them, it is important to explore whether the agreement can be enlarged by introducing *measures* (actions) of mitigation. In order to achieve that, new actions are identified and evaluated, which act specifically on the criteria that are of interest for the unsatisfied stakeholders.

**Involvement of the project personnel**:

- Staff from IWARP: Actively involved in all activities

- Staff from POLIMI: Support the identification of the *value functions*, the *reasonable alternatives* and the *mitigation actions* providing expertise, methodology and when available suitable elicitation tools.

**Deliverables**

- Evaluation Report (Month 29 – D8.1)
- Negotiation Report (Month 32 – D8.2)

**WP9**

| Work package title | **Setting up and testing** |
|---|---|
| Start date or starting event: | 30 |

**Targets**

- Setting up and testing Red_Twole modules

**Description of work**

This WP is organized in 3 main tasks:

1. The modelling tools and algorithms developed in WP5, WP6 and WP7 are clustered together to compose the planning module Red_TwoLe/P. IWARP staff will be instructed to use the module for any further analysis which does not involve structural changes in the system topology (e.g. adding new reservoirs or other new components).
2. The best compromise policy obtained at the end of the negotiation process will be implemented into the software module Red_Twole/M. An interface will be developed through which the relevant authority can choose the release decision given the current conditions of the reservoirs.
3. Red_Twole/P and Red_Twole/M will be tested with the threefold purpose of making the necessary model checking, training the IWARP staff to use it autonomously and evaluate the performance of the best compromise policy selected in the real operation of the existing system.

**Involvement of the project personnel**:

- Staff from IWARP: Actively involved in all activities

- Staff from POLIMI: It will provide the modules Red_Twole/P and Red_Twole/M and all the support to IWARP staff in order to make them able to use the modules autonomously

**Deliverables**

- Red_Twole delivered to IWARP (Month 36 – D9.1)

**WP10**

| Work package title | **Capacity building and dissemination** |
|---|---|
| Start date or starting event: | 1 |

**Targets**

- Build capacity in the IWARP staff actively involved in the project.
- Involve local students in the development of the project.
- Disseminate the results of the project.

**Description of work**

1 – Capacity building

- Two PhD (3-years) and three MSc (2-years) scholarships at the Politecnico di Milano will be offered to outstanding Vietnamese students with a suitable background. Both scholarship types are assigned based on a competitive evaluation.
- Staff members from Vietnamese institutes will be invited in Italy to participate in some phases of IMRR development and learn about the system optimization methodology and technology that will be applied in the Red-Thai Binh River Basin. The staff members, selected by the project Coordinator, must satisfy the criteria of being specialized in water resources, member of Vietnamese institutes, experienced in reservoir system operation in the Red-Thai Binh River Basin, capable and qualified for the training, and recommended by Vietnamese institutes.

2 – Dissemination

- The website, developed in WP1, will be regularly updated with public and downloadable documentation and data, and interactive sections concerning monitoring and evaluation of dissemination activities.
- A final workshop will be organized in Hanoi, to transfer the know-how produced by the IMRR Project to staff members of Vietnamese institutes and Vietnamese practitioners.
- The project scientific results will be published on international scientific journals and conference papers.
- The project cooperation results will be disseminated through the website, newsletter, etc.

**Involvement of the project personnel**:

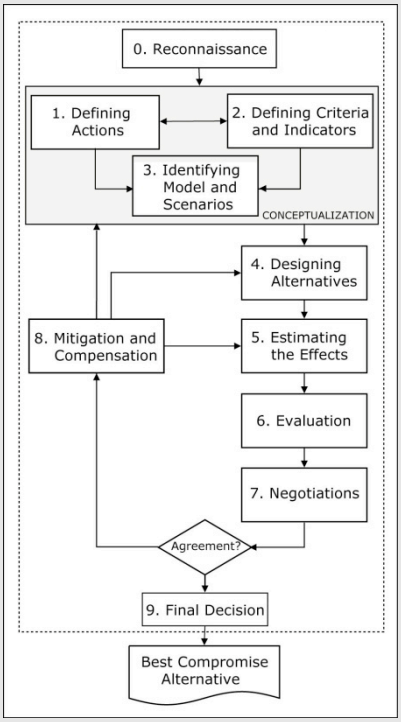
- Staff from POLIMI: actively involved in all activities

- Staff from IWARP: select suitable staff members from its instituted to be trained at POLIMI. Support and coordinate the engagement of local stakeholder for the dissemination activities.

**Deliverables**

- Final Workshop (month 36)
- At least 3 international papers

# Annex A2: THE PIP PROCEDURE




**0. Reconnaissance.** The aim of this phase is the definition of the *project goal*, the temporal and spatial boundaries of the water system, and the normative and planning context where the decision has to be implemented (scoping). All the *stakeholders* and their concerns, needs and expectations are identified, along with the available and missing information on the system. The very PIP procedure is presented and explained to the parties (DMs and stakeholders), and, if necessary, negotiated among them.

**1. Defining Actions.** The *actions* and measures that are presumed to serve the project goal are identified in strict collaboration with the parties. These may include infrastructural and normative actions as well as regulation policies for reservoirs and diversion dams. An action is said to be instantiated when the parameters through which it is easily and fully identified are specified. An *alternative* (or programme of measures) is a coordinated mix of instantiated actions.

**2. Defining Criteria and Indicators.** The project goal is translated into a hierarchy of operational *criteria* that reflects the stakeholders' viewpoint in evaluating the alternatives and the environmental and sustainability issues. The hierarchy's lower level criteria are associated to quantitative (or even qualitative) *indicators* through which the root criterion can be verified. Such indicators are functional of the trajectories of the variables describing the system condition.

**3. Identifying the Model and the Scenarios.** In order to compute the value of each indicator in correspondence with each alternative, a model of the whole system must be identified. The inputs to the model are the variables describing the alternatives and the variables specifying the *project scenarios*. The latter include the description of all the future events that are not under the control of the DMs, e.g. hydrological and demand scenarios under climate change. Models are usually mathematical ones, but, when necessary, they can also be substituted by experts.

**4. Designing the Alternatives.** The set of alternatives to be presented to the stakeholders for negotiations is designed in this phase. Firstly, all the possible combinations of the actions specified in phase 1 are considered to obtain a list of alternatives. Then, the ones that are efficient in the Pareto sense are selected for consideration, either by experts, or by solving a Multi-objective Mathematical Programming (or Optimal Control) problem.

**5. Estimating the Effects.** The effects produced by the efficient alternatives are assessed by simulating the system behaviour over a given time horizon.

**6. Evaluation.** The *value* the stakeholders attribute to an alternative, namely the satisfaction they derive from it, is not always directly proportional to the numerical value of the indicator. It is therefore necessary to translate each indicator (occasionally groups of indicators) into the actual ''value'' perceived by the stakeholders. This can be done by means of a Partial Value Function that has to be identified through interviews of the stakeholders. From these functions, a dimensionless *index* is obtained for each alternative and for each stakeholder expressing the overall satisfaction the stakeholder assigns to that alternative.

**7. Negotiations.** The above indexes are used to compare the alternatives and to guide negotiations among stakeholders. Negotiations can be carried out in many ways and terminate with the identification of a set of alternatives (*reasonable alternatives*) to which the majority of the stakeholders agree to.

**8. Mitigation and Compensation**
To improve the outcomes for the unsatisfied minority of stakeholders and broaden the consent for the attractive alternatives, mitigation and/or compensation measures are analysed. Eventually a set of reasonable alternatives, for which the consent cannot be broadened any further, is identified.

**9. Final decision**
Among the set of the reasonable alternatives the one that provides the *best compromise* is selected by the DMs.