Inner Closed Pipe Water Transport Pumping Solar photovoltaic Powered
Solar Wat Mov

1. Excellence

1.1Objectives

- Design and test a more sustainable and efficient stepped transport system for large amounts of water, reducing the current cost of pumped reused water to re-include it in the productive system. *Aim: comparison with equivalent infrastructure cost, 75000m^3/day*
- Provide a high hydric depleted area of regenerated water at least 10 km (300 meters slope) from the ending tract of the sedimentary basin. *Aim: stepped power design and construction*
- Development of a **systemic solution** from local government (coordinator beneficiary) to promote, by revised policies, the use of reused water and reduce the pressure on natural water sources (protecting it), in order to replace the water need of "pristine" water with reused water.
- Estimate the cost of the "no-reaction", in future scenarios of overdrawn of the regional water resources, on social, environmental, agricultural and industrial patterns response.

1.2 Relation to the work programme

This project meets the requirements for the Topic **CIRC-02-2016-2017: Water in the context of the circular economy** in the frame of the **Call - Industry 2020 in the Circular Economy**.

After the adequate treatments, water may be reinjected to the productive system. However, focusing on an applicative and realistic approach, in most of cases, water can´t really follow a "circular economy" path due to the topological and distances limitations of the location of the waste water treatment plants and the costs of large water volume's transport. This project offers a bottleneck avoiding approach to the transport and inclusion of regenerated or desalinated water sources in circular economy.

Through this new systemic integrated solution, the government of the Valencian Region aims to **reinforce European productive sectors** (industrial and agricultural) enabling the transport of pre-treated water to former or new locations where this water may be re-used. This new approach includes the construction of an eco-designed (***Green Public Procurement considerations***) physical structure for solar empowered submerged inner pipe water pumping, combined with a social organization action, that is addressed to lead the public and private sector to work together to offer new potential location's end point. This proposal considers the contributions of water reuse to boost economic sustainable growth, enabling the re-industrialization of Europe by increasing the competitiveness of economical activities, enhancing water availability and keeping the price of this key resource in reasonable levels. This approach will directly provide a support to *position Europe´s industry as a front runner in moving to a circular economy and society*. The large water volume's movement of is one of the proposed action in the ***Communication "Addressing the challenge of water scarcity and droughts"*** however, this communication also says that water transfers can *have serious implications* (and policy concerns) *"for the functioning of freshwater ecosystems in a river basin and negative impact on the ecological status of water bodies increasing the risk of entry of invasive alien species on vulnerable land and water ecosystems"*. The approach carried by this proposal strongly reduces the pressure on water bodies and freshwater ecosystems implementing the policy priorities 2, 3, 4, 5, 6, 8 of the **7th Environment Action Programme (EAP)**.

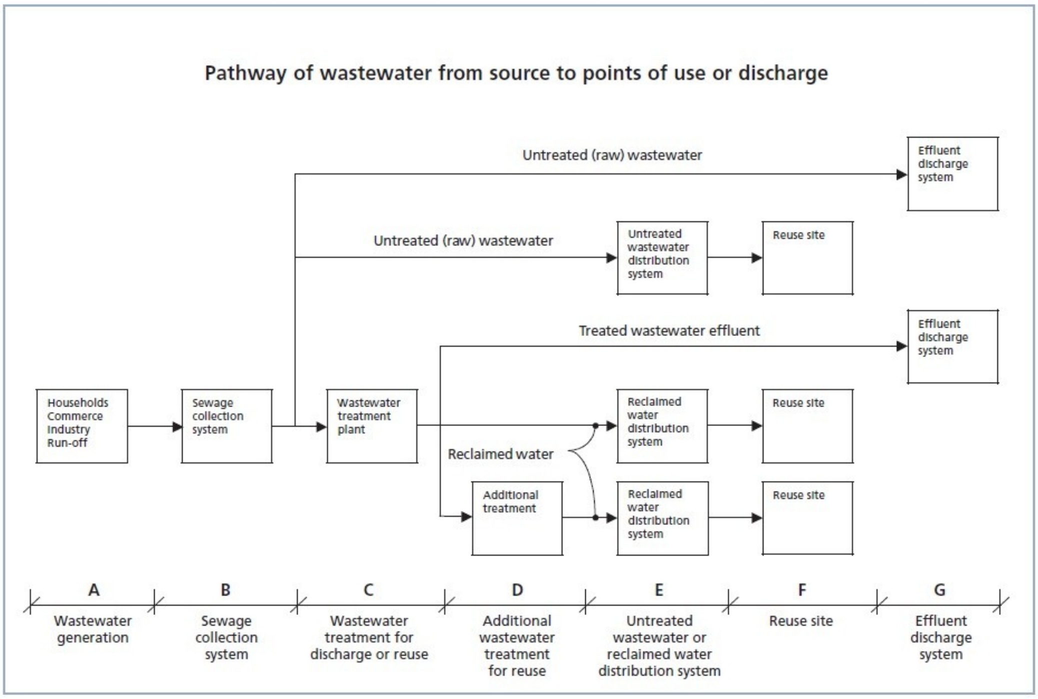
The success of this project will enable the Valencian Government (responsible of water management) to complete the circularity of water value chain and fight against water scarcity increasing the resilience of the productive sectors during the droughts periods (an environmental and social risk that occurs very often in this area). Moreover, this model will provide a large amount of data and co-created knowledge that will be shared and exploited through the Data Management Plan (DMP) specially developed for this proposal. As a consequence of the project, the partnership is interested into apply for an Innovation Deal to overcome the perceived regulatory barriers related to the exploitation of this technology. *Responsible Research and Innovation*, as a cross-cutting issue in the Horizon2020 programme, has been considered along the development of the project.

With the future participation of the responsible organization of the implementation of **RIS3**, there is already planned a consecutive application for **other funds of interest** that will support the implementation of the project as the Structural and Investment Funds (ESIF), the **European Regional Development Fund (ERDF)** and the Programme **Urban Innovative Actions** (**UIA).** Moreover, to ensure the replication at an European level, is as well considered the application for some **Interreg sub-programmes** and the **LIFE Programme** where environmental concerns are relevant. Also with the aim of ensure the replicability and transferability of the project, there is expected to collaborate with the related **European Technology Platforms** (**WssTP**; **PhotoVoltaic ETPIPP**; **SMARTGRIDS**; **Zep** and the **ETP-ALICE**) and the **Knowledge and Innovation Communities** (**EIT Climate-KIC**; **EIT Inno-Energy**; **EIT Raw Materials**).

1.3 Concept and Methodology

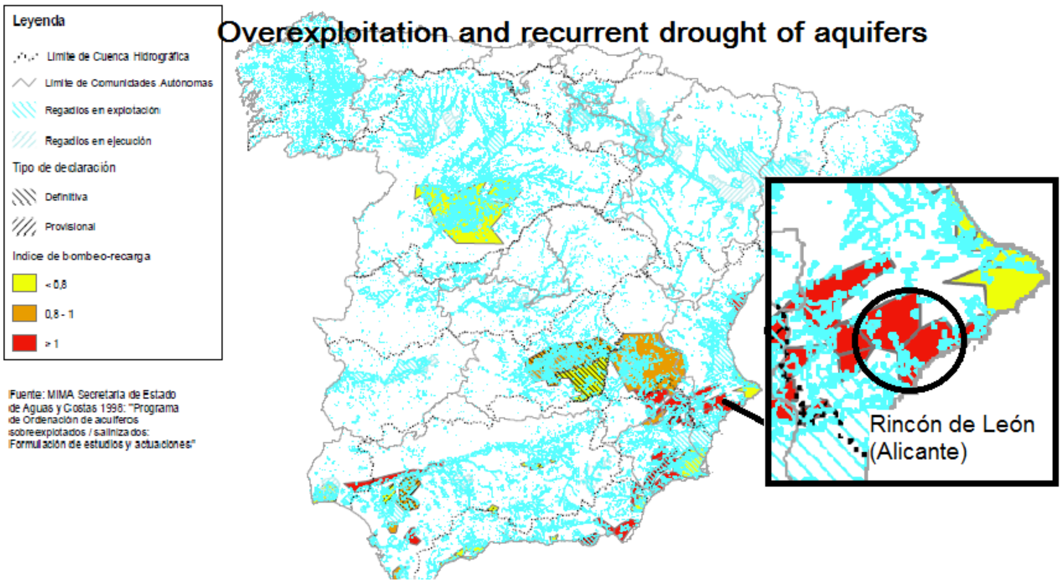
1.3.1 Concept

Lookig at the distances between the waste water generation (an overview of water reclamation technologies is available in Deliverable D19 of the EU-funded AQUAREC project -Hochstrat et al., 2006-). or collection and the reuse site, one may assert that the energy costs of the integration in circular economy of this resource, will be a serious bottleneck. One of major reasons through the world for reuse of water may not be an appropriate solution is there are many situations where reuse would not be cost-effective due to the distance between offer and demand. Major investments may be needed to link treatment plants to consumers dismissing the relative distribution of costs and benefits.



Gigantic infrastructures, with enormous budgets are used for basins transfers. In the figure case of our project, the "unachieved" infrastructures raise 0,02 €/m3 the price of water. For water suppliers, benefits of reuse are largely limited to financial returns (if any), and reducing demand for freshwater may impact on overall investment in water infrastructure (Fatta et al., 2005). In the figure case of this project, the Regional Government will obtain an unnecessary infrastructure investment's reduction costs. The Water Hierarchy in the EU Water Scarcity and Droughts Policy says clearly : *"Additional water supply infrastructures should be considered as an option when other options have been exhausted, including effective water pricing policy and cost-effective alternatives"*.

The <u>core realization</u> of this project offer a different approach to reduce the loss of discharged water, giving an economical solution to water mass movement with low compared basin transfer costs in a hydric depleted region.



To reduce the regenerated or desalinated water movement costs, the stepped inner pipe solar pumping model is the proposed model in (*fig* b). In *fig* a) a proposed external pumping model prototype for tubular submerged pumps essay's facilities in controlled conditions (baseline action) will be also constructed to ensure variables innovative pumps tests.

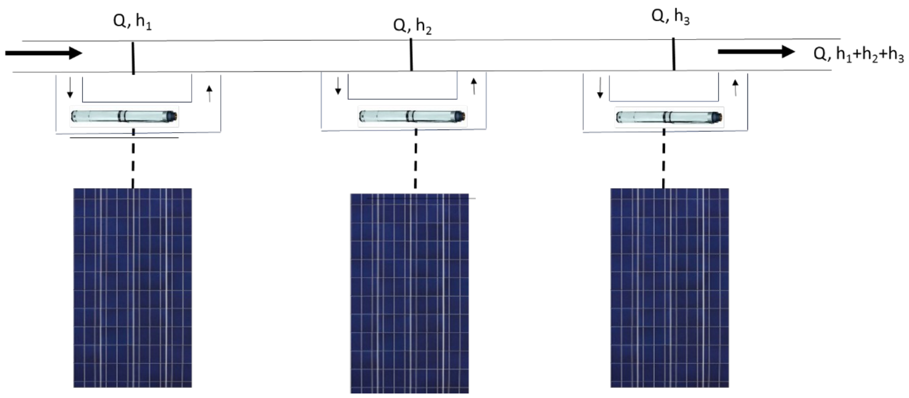


Fig a)

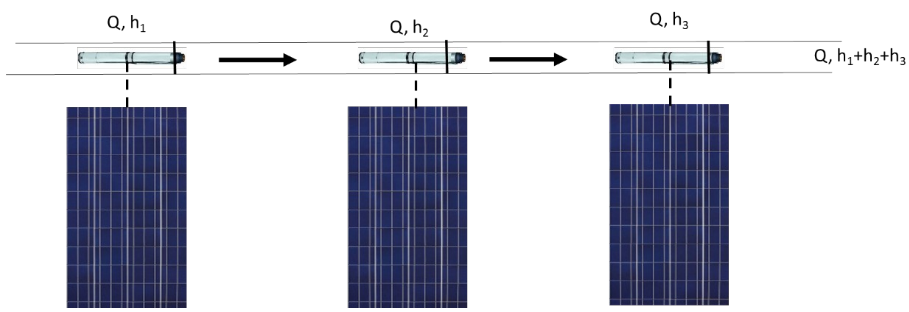
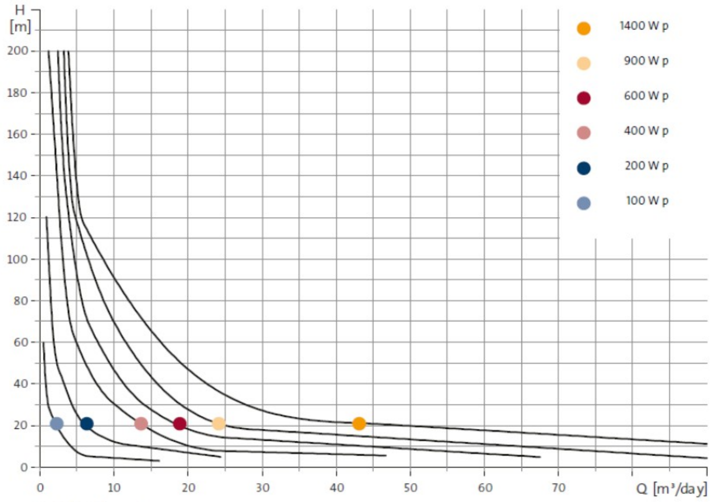


Fig b)

Submerged pumps with anti-return streams will be installed in the longest pipe distances. These submerged pumps, fed with direct current without inverter, will have electronic systems incorporated to control the flows pumped. Photovoltaic solar power will achieve the sustainability of this model.



The SQFlex Solar performance curves are based on:

- Irradiation on a tilted surface
- Ht = 6 kWh/m² per day
- 20° tilt angle
- Ambient temperature at 30°C
- 20° northern latitude
- 120V DC

In the above figure, flow curves/head gauges of different solar pumps (Grunfodfox SQFLEX Font) are showed. A photovoltaic power system of adequate power to the receiver, generally associated to the pump, is the power provider of all steps. These TRL's 9 technologies are available.

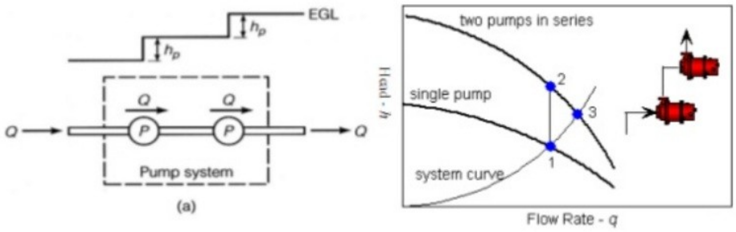
As regard as the centralized control software, it will integrate "internet of the things" for the field collection data. So, it will be transformed in or EWS or DSS surveyor system.

When new facilities are planned, it is necessary to predict the operation and maintenance costs. The inclusion of externality charges in regenerated water is very difficult because these externalities are often unperceived by society. Therefore, it will be essential to develop public awareness campaigns about the true cost and benefits of both sources of water, the comparative costs of this system versus big infrastructure investments costs, and the quantified costs of "***do nothing***". In spite of, financial instruments and mapping feasible business models, financial and non-financial values will be integrated as another essential ***core realization*** through all the project. For those reasons throughout the development of this project, an exhaustive comparative financial viability study will be achieved. However, according to the EEA DPSIR *(Driving force, Pressure, State, Impact and Water Response)* assessment framework, this project is aimed to build and calculate viability assumptions from some real technological response to water movement infrastructures.

International water association (London siege), EUWMA (from whom FENACORE, is the Spanish representative), WssTP, Zero Emission Platform, SmartGRID, PhotoVoltaics ETP's are perfects targets for transferability, replication and communication ways.

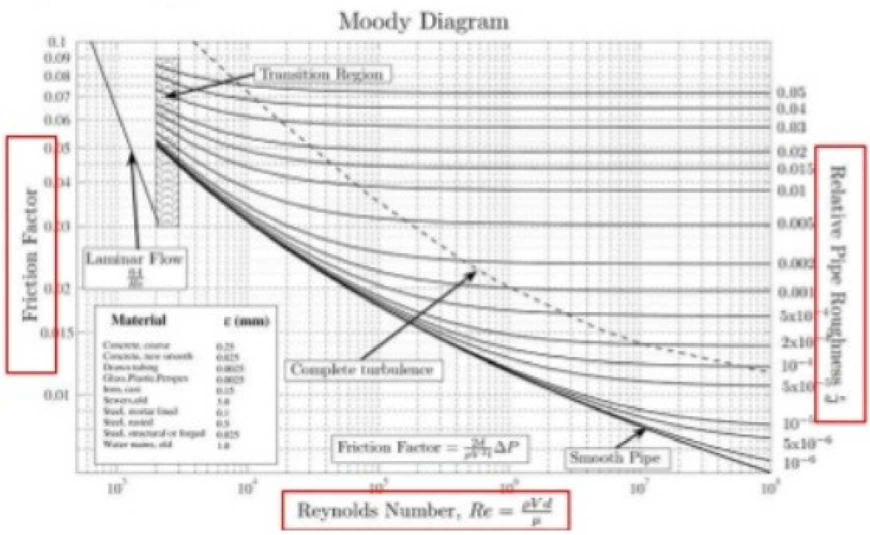
1.3.2 Methodology

The project system designs require pumps to be operated in series, in which the discharge of one pump eventually leads to the suction of another. This is often done when pipeline and component losses in the system are substantial and it is not feasible (or at least not economical) to achieve the required total head with a single pump. Additionally, series operated pumps may be used to vary the flow through a pipeline, accommodate a wide variation in pumped fluid properties, or compensate for variable downstream conditions. Some examples of systems that utilize pumps in series operation include long pipelines, steam-condensate loops, and primary-secondary chilled water systems. However, one may see boosters pumps installed in a variety of situations. To ensure that Pump a is sufficiently sized to provide the necessary pressure at the Pump a+1 suction, a set boundary pressure is used for the sizing procedure. A short run of pipe, so as not to affect the head loss in the system, is added prior to the Pump a+1 suction and is connected to a boundary pressure.



In series arrangement, each pump handles same flow rate, but the total head produced by the combination of pumps will be additive. Since each pump generates a head H corresponding to a flow Q, when connected in series, the total head developed is Ht = H1 + H2, where H1, H2 are the heads developed by the pump in series at the common flow rate Q.

The theoretical required power of the pumps leads to a simple calculation of replacement of equal grid or fossil combustible generators by photovoltaic solar power acquisition. The pumps in serie performance requirements will be fitted to avoid losses and return flows mischarge. The system will be equipped of a laminar stabilizator system. The frictional loss will be compensated by distance re-arrangement of the submerged pumps. A diagram remembering Moody is showed bellow.



The use of topological and very precise infrastructural engineering data are required. GIS will be used for integrate these data. QGIS, gvSIG or ARCGIS tools will be used.

As energy efficiency is referred, all high efficiency solar panels are admitted.

	Work Package Preview		Transversal Work Packages		
Coordination & Management	Pipe Implemention Works	WP2	Socio-economic studies	Applicability and viability studies	Experimental and Socio-Economical Models Based Legislative Proposals
	Photovoltaic Power System	WP3			
	Construction of integrated system	WP4			
	Environmental Impact Studies (water&energetic balances)	WP5			
	Knoledge and Data Exploitation (DMP)	WP6			
	Software Development	WP7			
WP1	ICT and "Internet of the Thinks Integration	WP8	WP9	WP10	WP11

1.4 Ambitions.

Born as a one more step of a chain of investment in the water sector located in this area, one of the most important aims is the integration of all the technologies referred above. This solution is an ambitious project ready to compete with big basin transfer infrastructures. This project has the unique purpose to develop a desition-making instrument for the EU by offering measurable, reliable and replicable technical data, as well as integrated socio-economic, global viability and replicability models to water transport in context of circular economy. A successful achievement of this project will offer an alternative response and substantial savings to all countries.

2. Impact: Expected Impacts

Impact 1: *significant reduction of the current water and energy consumption"*

This solar empowered transport system presented, will be able to transport all the treated water from waste water treatment plant to a high place slope up. It will lead to a high reduction of pristine water consumption (near 60%) in the place where it´s transported. At regional level, it means around 0.25% of the total water consumption.

Impact 2*: interconnectivity between the water system and other economic and social sectors*

Water is a key resource that has a prominent position in economy and society. The recirculation of water will contribute to make more sustainable economic activities allowing its continuity along the time that currently is in high risk of disappear.

Impact 1: *Increased public involvement in water management and increased citizen satisfaction with water services;*

This system will be able to be adapted to of the socio-economic context requirements, and obtain a public transparent feedback for price's fitting of the reuse water. Not only the awareness campaigns about the importance of the reused water, although included in this project, will contribute to the awareness of the public. The responsible availability increase of water in hydric depleted areas (touristic season aggravated) is the perfect target to introduce win-win strategies for the success of water reuse projects. As this system is considerably cheaper than other pre-existent solutions, it will be adaptable and applicable to transport water wherever it is needed.

Impact 4*: replication of new business models in other areas and replication of models for synergies between appropriate funding instruments at regional, national or European level;*

Unfortunately, if the current over exploitation or in some case *irresponsible* use of water and the consequences of climate change parameters don't change, the replicability of this project is guaranteed by the "near to come" outcomes. Moreover, an increasing number of authorities of different consideration, show at least an active concern in this issue. After the demonstration of feasibility and viability of this project boosted by the access and success of this proposal, in addition to funding instruments mentioned in the *relations to work programme*, ERDF, ECF, ESIF, and in some case ACP and some EIB funds are contemplated. After a transparent strategic independent feasibility and viability study, the Regional Government will acquire the capability to transfer and replicate the model through specific budget headings. Based on the extension of viability model developed for the reintegration of this resource as added value in circular economy, other projects, products or services will be able to use the same approach, using it as a competitiveness advantage by the inclusion of not usually contemplated but more new EU legislation compliant. The integration of infrastructure demand for reinjection of reused water adequacy will be a good example of proposed investment.

Impact 5*: creation of new markets in the short and medium term*

As above explained (WP), there is already planned to apply for some *Interreg sub-pogrammes* to ensure the replicability, transferability and the creation of new markets linked to this technology. Moreover, the presence of reused solar pumped water in the productive sectors will allow the persistance SME's primary and secondary productive sectors (economical actors like farmers) that otherwise would be forced to conclude their economic activities for water scarcity. As well, is expected to introduce this sustainable water supply as an added value to revolutionise the productive and consumption patterns.

Impact 6*: providing evidence-based knowledge that facilitate a broader transition to a circular economy in the EU;*

While European regulations and policies are highly focusing its efforts in water affairs, there is not much regulation regarding the transport of large water volumes aside from basin transfers. The co-created knowledge that the success of this project will provide a large amount of data that could foster new regulations to boost solar powered water recirculation as a available solution to water scarcity.

Impact 6*: implementing the Sustainable Development Goals (SDGs), in particular SDG 12 'Ensure sustainable consumption and production patterns' and SDG 6 'Ensure availability and sustainable management of water and sanitation for all', as well as the conclusions of the COP21 Paris Agreement15 .*

This proposal directly implement the **SDG's** "***Ensure availability and sustainable management of water and sanitation for all***" (target 6.1; 6.4; 6.6 and 6.B), "***Ensure sustainable consumption and production patterns***" (target 12.2; 12.5; 12.6 and 12.7). Besides, this project will also implement the Goal "Ensure access to affordable, reliable, sustainable and modern energy for all" (target 7.3 and indirectly 7.B), "***Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation***" (target 9.1; and indirectly 9.A), "***Take urgent action to combat climate change and its impacts***" (target 13.1 and 13.2), "***Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss***" (target 15.1; 15.3; 15.5 and 15.8).

Using solar power in the whole transportation process allows a zero CO2 emission tax, therefore is an action that is completely in line with the conclusions of *the COP21 Paris Agreement 15.*

Abstract

Water transport has presented one of the greatest challenges for all the cultures along the history. Focusing on an applicative and realistic approach, in most of cases reused water can´t really follow a "circular economy" path due to the distances from the location of the waste water treatment plants and the large water volume's transport costs. However, due to the large water volumes that are consumed for human activities, the recirculation of significant quantity of this resource, often requires the construction of great infrastructures and the use of high energy inputs. The reinjection of this *ressoure* at productive sector's end user locations, features important investments supported by administration, becoming thus, the water reutilization an expensive option. Inner pipe submerged solar powered pumps are an innovative technology that offer a cheaper sustentable approach to large water volume's transport. By building a large-scale system solar empowerd pumping to provide TWW to locations where water is scarce and droughts are very frequent, the adequacy of the will be assessed. New telemetric ICT leads to the integration of DSS software to ensure the effectivity and efficiency of a control center, allowing an EWS and rapid response. Regarding to the socioeconomic aspects, actions to assess the economic viability of these facilities will be performed, including all social agents. According to the EEA DPSIR *(Driving force, Pressure, State, Impact and Water Response)* assessment framework, this project is aimed to build and calculate viability assumptions from some real tecnological response to water mouvement infrastructures costs.