PROJECT FINAL REPORT

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Name of the scientific representative of the project's co-ordinator[1], Title and Organisation:

Antonio Linares Sáez

Head Business Development Department

Abengoa Water S.L

Tel: +34 954936031

Fax: +34955413373

E-mail: antonio.linares@water.abengoa.com

Project website[2] address: http://www.said-project.eu/

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

a. Final publishable summary report

– **An executive summary (not exceeding 1 page).**

SAID project aims to involve the final users and the SMEs in order to improve the production and deployment of more smart water management systems in Europe. The project has focused in the deployment and evaluation of a complex demonstrator, composed by several heterogeneous and innovative DSSs in the same river basin. This demonstrator, in the south of Spain, represents many similar basins in Europe, and is it based on cutting-edge DSS technologies in four areas: flood control, quality of water, energy production and energy consumption. It has been carried out by water management authorities, companies operating water infrastructures, SMEs that produce DSS and research centers with proved knowledge in techniques and technologies for real-time data monitoring, environmental modelling, simulation and optimization of the water related elements.

The activities of SAID were shared among the partners and divided into five work packages (WPs):

Work package 1 (Specification of demonstration plans and adaptation of DSSs) focuses on the specification of the demonstration plans of SAID project that guide the demonstration activities that were carried out in work package 2. In addition, WP-1 includes the specification of requirements of the three different Decision Support Systems (DSSs) considered in the project (flood, water quality and energy production) and the specification of the monitoring network, which requires an in depth study of the demonstrator river basin to determine the suitable sensors and communication technology.

Work package 2 (Deployment and evaluation of demonstrator) has its main focus in deploying all the components of the demonstrator, such as sensors and communication elements for the new SAID monitoring network in the demo site, as well as software modules corresponding to DSSs in the control centre. Furthermore, in WP2 the demonstrator is evaluated, validated and calibrated in all its aspects, the operation of the monitoring network deployed in the demo site, as well as the suitable running and graphical tools of each isolated DSS and the integrated tool developed in WP3. To this aim, technological partners have received feedback and conclusions of the use of the tools by final users and dam managers, comparing with the previous ways of managing the river basin.

The work in WP3 is about the development of an integration platform as well as the construction of a new Integrated DSS combining characteristics of DSSs of more specific domains (e.g. flood control, water quality, energy management) which now become components in the new system. The original DSSs, based on different technologies and OSs, have been extended so that they can communicate in the proposed framework which relies on services to address software composition.

The final users (e.g. river basin managers) can access the Integrated DSS by means of a centralized Web application (Web portal) that includes intuitive maps, dashboards and charts where the data calculated by DSSs components or obtained from external sensor networks is shown. It also allows the users run simulations (in flood and ordinary conditions) in order to estimate an early basin response that can help making better decisions. WP3 also addresses the development of a set of complementary graphical tools to modify the models behind the DSSs and their configurations. In this regard, three applications, which are further explained in the pages below, have been developed: DamMod, ModBasin and PolicyMod. Also DamCoord deals with the different dams in the river basin.

- **A summary description of project context and objectives (not exceeding 4 pages**).

The aims of WP1 are: 1) to specify the monitoring network deployed within the SAID (sensors and communication technologies) and 2) the requirements of the three different DSSs (flood, water quality and energy production). In WP1, technical partners have produced a first version of each DSS that fitted with the initial requirements. In addition, this work package established how to carry out the demonstration activities of the project during WP2.

The objectives per task are the following:

- Definition the requirements to produce innovative DSSs and the demonstration plans for each DSS. To this end, it was studied the main characteristics of the basin and how it was initially managed. In this way, the project identified aspect that could be improved.

- Design and deployment of a monitoring network that improve the quality and quantity of data obtained from the pre-existing sensor networks (Hidrosur, SAICA, and EMASA networks). The partners analysed the environmental characteristics of the basin to determine which sensors are more suitable to meter the required parameters and evaluated the locations where new sensors should deploy, considering aspects such as power supply for the devices or availability of the communications networks.

- Adaptation of the DSS for flood management to the demonstrator basin. This DSS comprises two independent modules, Hydroview for river basin simulations, and BeDam for dam management simulation and optimization.

- Design and development of a DSS for water quality management for the demonstrator river basin.

- Adaptation of the energy management DSS (EM-DSS) to the Guadalhorce river basin.

WP1 objectives have been fulfilled without mayor incidents.

The aim of WP2 is to deploy all the components of the demonstrator, both hardware (monitoring network) and software (DSS tools) components, and to evaluate how these new tools can improve the management of a whole river basin, using real-time data when available and historic data. Tools are running by the final users of the public water authority. Moreover, demonstration activities have carried out throughout the project. The WP evaluates, validates and calibrates new versions of the tools provided by WP3.

The objectives per task are:

- Installation of the monitoring and communication systems. SAID monitoring network has been deployed after identifying the locations of the sensors and communication elements, taking into account the demonstration plan, the physical constrains and the current installation of the other systems.

- Installation of the software modules in the control centre. First versions of the isolated DSSs have been installed in the platform and local and remote access to the platform has been implemented according to the user profiles considered.

- Implementation of the demonstrator activities. New versions of the DSSs have been developed and evaluated by final users, who have given their feedback and conclusions of the use of the tools to the technical partners. Policy brief has been produced at the end of the project.

- Validation of the platform for integrating DSSs. Integrated tool of DSSs and the DSS for coordinated dam management have been validated.

- Calibration and enhancing of DSSs. Demonstrator deployed in the demo site has been calibrated and software aspects of the DSSs have been improved from the feedback of the final users.

The objectives of the WP-2 have been satisfactorily fulfilled and both, monitoring and communication networks work properly. Furthermore, isolated DSSs has been calibrated and validated and the specifications of the integrated tool have been produced.

In general, enabling individual DSSs to collectively conduct a simulation is a challenging task due to the inherent differences in the DSSs design and in how they are used in their respective disciplines. These dissimilarities vary from implementation issues (programming languages, interfaces and OSs) to conceptualization (spatial and/or temporal discretization in models) and operation factors. WP3 develops the main innovations related to the integration of existing DSSs in order to facilitate the construction of more complex systems that reuse existing technology. The high-level Integrated DSS enables decision makers to simulate the impact of more complex and realistic decisions that cross the boundaries of isolated/individual DSSs.

The objectives pursued in WP3 can be summarized as follows:

- Specification and development of a platform for the combination of existing DSSs based on standard integration means, such as web services. The web service paradigm is particularly effective when interconnecting DSSs developed in different technologies (Java/.Net) and OSs (Windows/Linux) as is the case in SAID project.

- Integration from user's standpoint. This entails the identification and characterization of new data and control flows that require the coordinated execution of the DSS components to reach unified results of special interest to river basin managers.

- Adaptation of existing DSSs to the integration platform. Each DSS module must implement a set of interfaces expected by the integration framework. Interfaces are the key to reusability as they abstract the implementation and enable the interconnection of other DSS instances.

- Specification and development of a web portal for the Integrated DSS. This web application presents the information of the DSSs and monitoring networks in unified screens, dashboards and maps by using common representation formats to make results easier to analyse.

- Specification and implementation of a visual modelling tool to produce diagrams of the river basin which are composed of nodes that represent basin entities (river branches, hydropower plants, reservoirs, aquifers) and that can be interconnected to build more complex models. This tool can be used to generate input data for particular target applications.

- Specification and implementation of a graphical tool that lets software technicians create new dam models which can be loaded by BeDam (a module for dam management). This tool can produce the code of the dam models automatically.

- Implementation of a tool for the definition of dam simulation policies. These policies include conditions that are periodically checked and commands to change the state (opening degree) of the dam outlets.

- Implementation of an application service to deal with the combined synthesis of manoeuvres for all the dams in the river basin. The service allows the definition of constraints on a set of dams and also on the flow at different basin locations.

- **A description of the main S&T results/foregrounds (not exceeding 25 pages),**

The results of ***WP1*** are included in deliverables D1.1-D1.7. In addition, this WP has achieved its two milestones: 1) the specification of the demonstration plans and 2) the initial version of the DSSs adapted to the demonstrator. The following list details all the scientific and technical results:

Task 1.1 Specification of the demonstration plan and requirements of DSSs

This task is led by UMA with collaboration of AW, SCI, SIM, ADD, UBI, and CMAyOT. . The partners involved studied the main characteristics of the basin and how it was initially managed to identify the aspects that could be improved.

Deliverable D1.1: Specification of demonstration plans. This deliverable contains a detailed description of the pilot area, its infrastructures (dams, channels, etc.) and presents the main characteristic of the basin management (flood, water quality and energy production). This deliverable also includes the specific of functional and non-functional requirements for each DSS, including uses cases and demonstration tests. Finally, the document includes the demonstration test for the communication infrastructure.

Task 1.2 Selection and adaptation of monitoring and communication elements

This task is led by IHP with collaboration of AW, SCI, SIM, LW and UMA. The partners involved have studied the environmental characteristics of the basin to determine which sensors were more suitable to meter the required parameters and the locations where new sensors should be deployed, considering aspects such as power supply for the devices or availability of the communications networks.

Deliverable D1.2: Technical specification of the monitoring and communication elements. This deliverable includes the specification of the sensors and communications elements. There are two relevant results associated to this document:

- Outdoor tests with radio communication at 868 MHz confirmed that our radio transmit data over 1 km with non-line-of-sight, that is, with some trees that attenuate the signal and with only simple antennas. With larger antennas we project to achieve even better results.
- Design of radio amplifier to support long-range communication.

Task 1.3 Adaptation of DSSs for flood management

This task was led by SCI with collaboration of AW, UMA, and CMAyOT.

The adaptation of Hydroview to Guadalhorce river basin consisted on:

- Adaptation of the hydrological model WiMMed to get accurate simulations of the water balance in the Guadalhorce river basin.
- Adaptation of the simulation and visualization modules of Hydroview to incorporate the hydrologic and hydrodynamics medializations of Guadalhorce river basin.
- Implementation of the new functional and non-functional requirements specified in task 1.1, e.g. access to historical and real-time data from sensor networks.

The adaptation of BeDam to Guadalhorce river basin consisted on:

- Development of the dam model of Guadalhorce-Guadalteba dam for flood management. This is a special case, since in flood management these two dams are managed as a single one.
- Design and development of simulation policies adapted to Guadalhorce-Guadalteba dam.
- Design and development of optimization policies adapted to Guadalhorce-Guadalteba dam.
- Adaptation of the simulation engine and the visualization module of BeDam to meet the functional and non-functional requirements specified in task 1.1, e.g. load a prediction or historical data as inflow hydrogram.

Deliverable D1.3: Technical specification of the DSS for flood management. This deliverable comprises a document with technical specifications of Hydroview and BeDam to take into account the requirements of the demonstrator basin. In addition, this deliverable includes a lab version of Hydroview adapted to Guadalhorce river basin, and a lab version of BeDam that includes the model of Guadalhorce-Guadalteba dams in flood scenarios.

Task 1.4 Design and construction of a DSS for water quality

This task is led by SIM with collaboration of AW and ADD. To this end, the following task issues have been addressed:

- Access mechanisms to historical and real-time data from the Hidrosur network.
- Adaptation of base form Monitor software to include in the analysis and the visualization of time series the monitoring stations of Guadalhorce river basin (Hidrosur and SAID water quality stations).
- Load of historical data for all meters and calibration of the analysis algorithms.
- Adaptation and configuration of the native GIS to the demonstrator river basin (e.g. include new aggregated indicators).

Deliverable D1.4: Technical specification of the DSS for water quality management. This deliverable includes a document with the requirements, use cases, tests, and architecture of the water quality DSS. In addition, this deliverable includes a lab version of WQ-DSS that uses an adapted version of Addition's base form Monitor to the demonstrator.

Task 1.5 Adaptation and extension of DSS for energy management

This task was led by UBI with collaboration of AW. The adaptation of the ELD consisted on:

- Definition of new georeferenced data in the ELD's application server data base.
- Definition of the statistics model to predict energy, based on past production and dam level variations, as well as past energy prices.
- Specification of data mining functions that best suits with the energy-related information available for the demonstrator basin.
- Adaptation of ELD to show new variation charts.

Deliverable D1.5: Technical specification of the DSS for energy management. This deliverable includes a document with the technical specification and a lab version of the EM-DSS adapted to the demonstrator.

In addition, two more deliverables have been produced in this work package:

Deliverable D1.6: Installation manual. This deliverable includes the guidelines to install the initial version of the three DSSs (flood, water quality and energy management).

Deliverable D1.7: Initial versions and user guides of the DSSs to deploy the demonstrator. This deliverable includes user-oriented manuals of each DSS, which describe how to use the functionality included in the initial version of these DSS. The final version of the DSSs and the manuals are part of WP2, in particular they correspond to deliverables D2.3, D2.4 and D2.5.

Furthermore, auxiliary software to access real-time and historical data from Hidrosur network has been developed. This software periodically gets data from Hidrosur database and shares data with the DSSs.

WP2 has been development from M6 to M36 and has been focused on the installation of the monitoring and communication system and the different software modules needed in the control centre in order to implement the different activities related to demonstration. Furthermore, it has been working in the calibration and enhancing of DSSs. AW is leading this work package.

As a result of this work package the three individual DSS were created, calibrated and enhanced in several ways furtherly detailed below. Moreover, SAID integrated tool was created allowing a more complete view that allows a more efficient exploitation of the dams. Some activities have been carried out to get the dam manager's opinion and to attend to their needs and specifications. The results of WP2 are included in deliverables D2.1-D2.5. The detailed user guide of the software tools can be found in the deliverables D2.2 (integrated management), D2.3 (flood management), D2.4 (water quality) and D2.5 (energy management). Also the final evaluation of the demonstrator plan with a comparison between the previous situation and the new one, a description of the problems found as well as solutions proposed and the evaluation can be found in the D2.1. In addition, this WP has achieved its two milestones: 3) the deployment of the demonstrator and 4) the evaluation of the platform and graphical tools.

The following list details all the scientific and technical results:

Task 2.1 Installation of the monitoring and communication system:

For the development of this task, the locations of sensors and communication elements have been identified, taking into account the needs of water managers in Guadalhorce watershed, the demonstration plan, the physical constrains and the current installations of Hidrosur system (as shown in Figures 1 and 2).

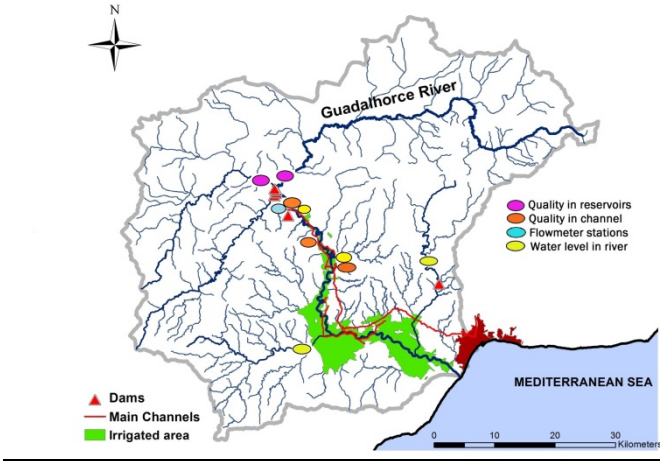


Figure 1: SAID monitoring network

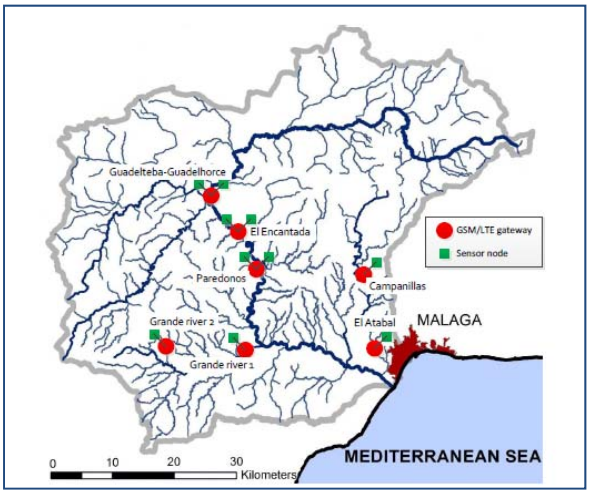


Figure 2: Network topology of the demonstrator

Moreover, the deployment of the demonstrator has been finished, carrying out different works and visits for its improvement. For the deployment of the platform of the demonstrator based in software modules, Hidrosur has been contacted for the data exchange, facilitating the data for Flood and Water Quality DSSs. Moreover, the installation of data access modules has been performed.

PROTOPYPE

With the support of CMAyOT, who has achieved convenient agreements within the local and regional authorities sphere to locate net sensors and devices in public infrastructures in appropriate conditions of security, power supply and accessibility, the installation of the monitoring and communication networks has been performed, as well as the installation of the "Water Quality DSS", including new infrastructures and facilities required for it, in order to provide security against vandalism and/or electricity supply.

It has been chosen to install 3 stations in reservoirs but only in two of them, since only Guadalhorce and Guadalteba reservoirs have salinity problems. There are two stations in Guadalhorce reservoir, where an aquifer discharges water of high salt concentration into the tail of the reservoir. For this reason, and given the considerable depth of the reservoir, which a significant stratification as a consequence, and which causes the distribution of salt along the water column, has chosen to install in this reservoir a floating profiler, which performs measurements of temperature, pH, redox potential, conductivity and dissolved oxygen throughout the water column daily. Moreover, in the tail of the reservoir a station that measures the conductivity at this point has been installed in order to monitor the aquifer discharges. On the other hand, in the Guadalteba reservoir also a salt concentration distribution in depth is presented. Saline contribution in this reservoir is due to the communication between Guadalhorce and Guadalteba reservoirs at a certain level, in which saline water passes from Guadalhorce to Guadalteba. In the case of Conde del Guadalhorce reservoir water it is not saline, so it was decided not to install any quality station in this reservoir.

In the case of the quality stations in channel, 3 stations have been installed in the Main Channel. The first one downstream La Encantada reservoir; the second one at the bifurcation of Paredones, where the main channel is divided into two; and the third one downstream, in the Main Channel of the Left Bank.

Finally, three monitoring stations of the river level were installed, one in Grande River to control the water contributions of this river as a preventive measure in flood control, one downstream of La Encantada reservoir, with the aim of monitoring environmental flow regime in Guadalhorce River, and another one in Campanillas River, upstream Casasola dam, to control inflows to this reservoir, as a preventive measure in flood control.

Water-resistant boxes were designed and developed for IHP nodes based on In-lab test with different hardware platforms. Integrated IHP nodes with environmental sensors and carried out in-lab tests with IHP nodes and environmental sensors has been implemented. Besides, IHP nodes and Gateways were installed to communicate the sensor measures to the control centre, performing the necessary tests to ensure this communication. Electronic components (radio transceiver, development kits, cables, adapter, antennas, boards, modules) for deploying the demonstrator has been provided and installed in the demo area. Although the deployment of the demonstrator has been finished in the first period, in the second period some new equipment has been installed as enhancements of the demonstrator (see Task 2.5), i.e. the battery sensors and indicators to track the sensors battery capacity levels has been adding to the SAID system.

Task 2.2. Installation of the software modules in the control centre.

A server infrastructure for installation and use of DSSs have been configured and provided. This server provides enough computational power for various DSSs to be simultaneously executed.

Moreover, the software necessary to periodically download real-time data of Hidrosur and weather forecasts, both used to feed the DSSs, has been developed. Besides, the platform for local and remote access to the three DSSs was designed. The architecture of the platform has a close relation with the user profiles. For this reason, a document to describe the platform and define the user profiles has been prepared. This document is included in the Deliverable D1.1.

Hydroview was installed on this server as well as the isolate DSSs. The laboratory version of the dam management module (result of the previous WP) was installed in the platform. The DSS for

Energy Management was successfully deployed in the virtual infrastructure. Dam data is being successfully imported into the energy DSS that is able to read it, analyse it and display important information to the final user. The DSS for Water Quality in the control centre was installed. This lays the foundation for water quality decision support exploitation as reliable and flexible data infrastructure is in place, receiving and analysing water quality data in real time and producing base indicators.

Task 2.3 Implementation of the demonstration activities.

In order to perform the implementation of demonstration activities the comparison of data from SAID network, Hidrosur data, historical data and data from dam managers has been done. To allow the accessing of data for dam managers in order that they were able to give their feedback, an access to software tools has been facilitated, besides of participate in the data access of the software tools to the new monitoring network.

To validate SAID network's data, a comparison was carried out between the SAID monitoring network and the daily samples that the dam managers used to take. All data from SAID network are compared, data from both reservoir, from channels and from rivers. Moreover, this data have been analysed for calibration of instruments. As previously mentioned, the sensors have improved the quality of real-time data because previously dam managers had to collect samples for obtaining data daily and not in real-time. Therefore, dam managers started using data from the SAID network. It has been improved the quality of real-time data with sensors at different heights. These sensors have a high initial cost but it is compensated in medium terms because of the elevated cost of manually collected samples and their analysis.

Furthermore, the demonstration plan for each DSS (flood management, water quality and energy management) has been carried out exhaustively through tests oriented to check the DSS operation tools. In addition, monthly internal reports by meetings and emails were produced to provide feedback to the technological partners performing a process of continuous improvements of the tools.

On the other hand, the SAID network sensor maintenance (sensor cleaning and batteries changes) with the periodicity required (almost every month) has been carrying out. These tasks allow get many final conclusions about the definition, installation and maintenance of the monitoring and communication network and the permanent validation of the SAID sensor data.

- Flood Management DSS

Regarding the flood management tool developed, it consists of two differentiated modules: a river basin tool (Hydroview) and a dam management tool (BeDam). The river basin tool is a GIS-based decision support system (DSS) for integrated simulation of river basins in flood episodes. It exploits a combination of simulation models: WiMMed, a physically based distributed hydrological model and Guadalfortran, a one-dimensional hydrodynamic code. The models consume historical and forecast data series (e.g. climate data) to anticipate the river basin response. Dam releases are considered and their effects integrated in the downstream simulation. The dam management tool supports dam manager decisions in flood episodes using 1) simulation of management policies and 2) synthesis of manoeuvres for dam management.

All the data collected during the demonstration activities is offered as established in clause 29 of the grant agreement. The policy brief can be found in the deliverables corresponding to this WP (D2.3).

- Energy Management DSS

Regarding the energy management area, all the information contained in the historical record was included in the energy DSS: the hourly production in Guadalhorce-Guadalteba hydroelectrical base on the outflow through the power station, real energy price historical variation, deployed sensor variation on the registered dams and operation protocol of the hydroelectric power plant.

- Water Quality DSS

The DSS for water quality management is a web application with two main managers for measured data visualization and analysis. The Meter manager module displays all the available meters and their measured information, using tools to navigate in the data timeline. The Zones manager module distributes meter information per basin, offering a simplified overview of the full system measured quality parameters.

It is created the systems “Guadalhorce” and “DMA”, to track the multi-depth quality parameters of the Guadalhorce reservoir and the herbicides value across the region respectively. Additionally, it was included some user experience improvements, to display and compare different depths for the Guadalhorce reservoir quality parameters. The criteria used to evaluate the water quality are the following: urban supply, irrigation, bathing and ecological risk factor (Zebra mussels). To quantify these criteria the following parameters were selected for their measurement: Dissolved oxygen, pH, Conductivity at 20ºC, temperature, salinity and different herbicides in the mentioned risk zones.

Task 2.4 Validation of the platform for integrating DSSs

The objective of this task is the validation of the integration platform of the three previously mentioned DSS (water quality, flood and energy management). Final-users partners have produced reports for enhancing the tool and a preliminary version of the Integrated DSS user interface was presented to dam managers, including Guadalhorce dam manager but also managers of other dam systems in Málaga (La Viñuela dam, La Concepción dam), in order to get their opinions regarding functionalities and data visualization. In these conclusions dam managers pointed out the positive impacts of the integrated tool, such as the centralization of a big quantity of data which are really useful for dam exploitation and urban and irrigation supplies. Furthermore, the quality of the real time information is high, which has a really positive impact in the daily management of the water resources since dam staff do not need to take manual measurements to control water quality, which implies save human resources in the short time and save of economic resources in the mean and long time. Furthermore, SAID integrated tool is useful and easy to use, and also does not only include the basin contributing to the reservoirs, but also the area downstream the dams, considering the flood plain in the low stretch of the river.

On the other hand, in SAID final event and workshop, the integrated tool has been validated, concluding that smart management has been demonstrated by the European innovation project SAID in the Guadalhorce basin. It allowed optimizing dam operation with decision support systems taking into account the behavior of the whole river basin. The solution achieved is providing recommendations for dam operation to limit flood risk, optimize hydroelectricity generation, and ensure the quality of water necessary for irrigation, domestic water supply and the environment.

The system is also providing additional services highlighted during the discussions held at SAID workshop organized during the Euro-INBO 2016. It can be used for training new dam operators, thanks to its simulation capabilities based on historical situations and past manoeuvres. It also aggregates real-time information into maps and indicators on the quality status of water resources that is very useful for all water users. Finally, the solutions are fully operational and can be easily customized to other river basin world-wide, different set of dams, any water quality classification systems, different water uses, etc.

Furthermore, the integration services provided were tested before incorporating them into the integrated DSS in order to check if they behaved as expected from the consumer's viewpoint. These tests mainly consisted in calling the operations with different combinations of input parameters using a REST client, and then analyzing the responses. In some cases, the tests allowed to redefine the interface for a better integration in the final system. Moreover, the evaluation of the integrated platform was also tested using the dam inflows calculated by the integrated DSS to simulate and optimize scenarios with higher dam levels. The results of the integrated DSS can be found and extensively detailed in the deliverable D2.2, Final version of the integrated management system.

Moreover, an auxiliary tool for modelling dams (DamMod) has been used to generate the model of Conde del Guadalhorce dam. In addition, this tool was used to model La Concepción dam, which is located in a different river basin. DamMod automatically produces three simulation policies (MEV, Optimum discharge, and Current State) for each new dam. BeDam was also used to run different simulations for the new dam models. Besides, the auxiliary tool for defining simulations policies (PolicyMod) was used to generate a model to manage La Concepción dam. The model of La Concepción dam and its simulation policy was included in a demo version of BeDam to simulate the management using different inflow hydrographs.

Task 2.5 Calibration and enhancing of DSSs

The objectives of this task include activities of testing software modules of the DSSs produced in WP3 and also improve the tools according to the monthly reports provided by the final users. Once all the modules were created and modified the integration tool was developed. Also, the integration monitoring and communication infrastructure had to be improved.

Tasks for analysed field samples for calibration of instruments with the real-time data that is currently available have been performed. On the other hand, the software modules have been set to the requirements of managers, as well as the DSSs interfaces have been improved.

The communication network has been improved through the implementation of low-power GSM gateway. The platform service that collects data from the gateways (via IHP server) was extended in two ways. Firstly, to support the addition of new gateways as well as changing the existing ones, as a result of some field equipment replacements carried out in this period.

Secondly, to integrate new variables, such as node battery levels, whose values need to be gathered and written to the shared XML files. Battery values can be received separately using a different request from the rest of node measurements. Moreover long-range communication tests were carried out in the demo locations by testing the signal from a potential location (Bobastro) to install the long-range communication instrument that will receive the signal from most of SAID sensor locations.

Software agents for data processing have been developed. Data is updated in near real time using XML file system access on the server, – the communication issues have been dealt with and file format processing is working. Data gathering and data processing software agents have been developed and adapted to SAID's infrastructure. The approach has been to:

- Analyse and process historical data records; this has been available in the project's IT infrastructure since the first deployment;
- Receive and process near real-time data from over 450 metered time series / parameters from the Hidrosur network. This first step was taken as a test for a large scale processing of the sensor network. The test had run, with excellent performance and results, on the "production" servers inside the project's IT infrastructure.
- The "sensor_data" information source has been processed and is working fine on the development servers; it is available on production servers.
- More accurate reservoir and soil properties data have been included in the DSSs tools as required by final-users partners, as well as start of the mode to update the current river basin state with real time data and the presentation of profiler data at different depths.

- Flood Management DSS

The enhancement of the dam management module focused on the definition of new dam models and their associated simulation and management policy models for flood and ordinary management. The definition of models for ordinary management required the use of new parameters in the dam model, such as a parameter that represented the scheduling of the staff. Ordinary models for Conde del Guadalhorce, Guadalhorce and Guadalteba dams were developed assuming that the level in both dams is under the separation wall. The spillway opening manoeuvres, which is normally opened two-by-two to avoid degradation of discharge channels have been incorporated in the discharge policy models of BeDam.

The dam management module of the DSS for flood management was enhanced through the graphical interface and its internal modules, mainly by correcting bugs. The dam management module of the DSS for flood management for Conde del Guadalhorce have been enhanced and introduced management policies models. In addition, the models of the dams (Guadalhorce-Guadalteba and Conde del Guadalhorce) and the different simulation policies (Optimum, MEV and Maneuvers) were calibrated. Calibration process is based on the analysis of flood episodes.

In the last months of the project, the two versions of dam management module were enhanced; that is, the desktop applications (BeDam) and the web service (BeDamService). It has been worked on the calibration of the DSS for dam management (BeDam) and new features in dam modes have been included, such as alerts when the results reach predefined values, maximum and minimum values valid for the dam parameters, or new curves such as the accumulated volume.

Auxiliary tools for dam modelling (DamMod) and simulation policy modelling (PolicyMod) were also enhanced (the graphical interface and the models produced). In addition, the models for the coordinated management of dams were also calibrated, which were used in DamCoord.

As for the basin management module of the DSS for flood management (FM-DSS)**, a** new "view" function has been implemented in the tool in order to let users display and analyse import data for any desired time period, regardless of the state of the simulation models. Users can now switch between "view" and "simulation" modes, and are no longer forced to run simulations, which are time-consuming and require dam outflows to be set, if they just want to inspect monitored hydro-meteorological data of arbitrary time intervals.

Data that belong to each mode are managed separately and don't interfere with each other. Hydroview was extended to manage simulated reservoir volume variables. Users can establish an initial volume for each reservoir before running their simulations. The calculated volume at the end of the episode becomes the initial volume of the next chained simulation. Furthermore, simulated reservoir volume can be selected by users to be displayed on a chart, like any other variable.

A new version of the hydrological model, including more accurate reservoir data and improved river basin descriptions in terms of branches and control points, has been installed and configured in the tool to enable more realistic simulations. Furthermore, the hydrological model (WiMMed) included in the basin management module of the DSS for flood management has been calibrated, in order to obtain more accurate results as inputs to the DSS, such as the series of inflows to the reservoirs.

A new FTP server has been installed and configured that allowed final-user to download data produced by the gateway/sensor network deployed in SAID. In this way, a better exploitation of the basin can be carried out due to up-to-date water quality measurements. In order to provide better real-time response by accessing the sensor network data using either the DSS applications or the FTP, the platform service supplying the XML data was modified to use shorter periods of file creation and higher data refreshing rates, thereby reducing the delay the final consumers would experience.

- Energy Management DSS

Regarding the enhancements on the DSS for Energy management (EM-DSS), activities of monitoring the EM-DSS's (Decision Support System for Energy Management) have been performed and data to detect erratic implementations have been collected as well as the calculation metrics in order to see if the provided results were correct. Moreover, analysis and enhancement of the data prediction algorithms both on performance and data quality were held.

A new dam has been added to EM-DSS's monitored data collection to allow users to study data collected from multiple sensors deployed in multiple dams. Also, a new variation reports to the EM-DSS has been also added so that users were able to study the variation of all variables associated with the registered devices for a given period of time. A schedule report endpoint and a graphical user interface have been implemented to compare real vs forecasted features.

Some bug fixing on EM-DSS's data polling mechanism was performed as well as an improvement of EM-DSS's forecasting mechanisms based on past metrics. Based on state of the art regression technics, a system that can detect the best dataset range and algorithm to be used in a predetermined period of time was developed. Using Linear Regression, SVR and decision tree regression, the system tries to best estimate the energy price in a given period of time.

Moreover, a integration with an external service providing energy prices variation has been implemented, EM-DSS is connected to ESIOS's REST API retrieving the real variation of energy

prices, and the improvement of production schedule reporting information. Users are now able to study the evolution of what was previously predicted and compare it with real dam usage.

- Water Quality Management DSS

With respect to the enhancements on the DSS for Water Quality management (WQ-DSS), the improvements are as follows:

- Zebra mussel water quality control feature:

Parameters that affect Zebra mussel propagation have been narrowed down to those critical to their bloom capability, alongside their range values, and were included in the DSS. As stated above, this assessment is now possible along the entire water column. When water conditions regarding turbidity, pH, temperature, water velocity and salinity are gathered for potential Zebra mussel blooms, the WQ-DSS will prompt an alert, and actions such as the disinfection of the water channel leading to the desalination plant of El Altabal or the CMAyOT inspection ROV deployment might be undertaken. This feature was developed considering the integration of the Water Quality DSS with the other DSS and the SAID's final product.

- Salinity dilution automation feature:

After assessing the dams' operational management procedures and discussing it with the demonstrator end-user, a salinity estimation routine was automated and based upon real time data inputs from the SAID monitoring network, supporting the decision about the most suitable water mix from the different reservoirs to accomplish specific water salinity thresholds on the water provided for different users. This procedure can adequately manage water salinity within a 24-hour spam for all its purposes (being irrigation the main concern), which matches the operational needs of the system and allowed to test and assess the capability of the DSS to receive and process different sources of data and deliver useful information to support decisions. The integration of the mentioned routine made clear that the DSS is capable of integrate new and different models and calculation routines in its decision supporting scheme (as the initially foreseen model or new tools to address specific water quality issues), which will be especially relevant for further developments and/or for customisation to different river basins.

The systems "Guadalhorce" and "DMA" to track the multi-depth quality parameters of the Guadalhorce reservoir and the herbicides value across the region respectively have been created. This operation of organization required the creation of new zones and meters for the new systems, plus the indicator's configuration and the shape files for each system.

The shape files from the other systems were also tweaked to better outline the basin, reservoirs and rivers, improving the illustration of the metered areas. Additionally, some user experience improvements were included to display and compare different depths for the Guadalhorce reservoir quality parameters.

Furthermore, as water discharges are usually carried out by the hydro-electrical power plants, an optimization procedure has been articulated with the energy DSS.

- Integration DSS

The main improvements deployed in the SAID integration platform are:

- The installation and configuration of a new FTP server that allows to download data produced by the gateway/sensor network deployed in SAID. This monitoring data allows a better exploitation of the basin due to up-to-date water quality measurements.

- In order to provide better real-time response by accessing the sensor network data using either the DSS applications or the FTP, the platform service supplying the XML data has been modified to use shorter periods of file creation and higher data refreshing rates, thereby reducing the delay the final consumers could experience.

- The platform service that collects data from the gateways (via IHP server) has been extended in two ways. First, to support the addition of new gateways as well as changes in the existing ones, as result of some field equipment replacements carried out in this period. Second, to integrate new variables, such as node battery levels, whose values need to be gathered and written to the shared XML files. Battery values can be received separate (different request) from the rest of node measurements.

- The maintenance of the SAID platform (SCI partner) where the DSS are running, giving support to new users (e.g. advisory board members), monitoring the services and databases and creating new VM replicas as needed is constant.

A description of ***WP3*** results, classified by task, is provided below:

Task 3.1 Integration of DSSs:

The Integrated DSS, a complete simulation and decision-support environment built reusing existing DSSs (flood control, water quality, energy management) has been produced in this task.

The Integrated DSS can be accessed through a centralizing web application (web portal) that allows concurrent users to analyse SAID data generated in real-time, and to run simulations that estimate the river basin response for the next few hours/days. To achieve that goal, the system is built on top of a service oriented platform which uses REST technology for the efficient communication of DSS cores implemented in different technologies and running on separate computer nodes. The REST approach enables efficient machine-to-machine interactions based on standard Web technology.

The pre-existing DSSs have been extended to export two groups of functions.

- Introspection: oriented to retrieving DSS configuration data relating to a specific deployment and target basin. For instance, a function could return descriptions of sensors or stations (with their supplied variables), modelled dams, model control points, etc.
- Simulation: for calling DSS functionality that produces simulation results. For instance, time series of water level, reservoir outflow, energy production, etc., can be returned as ordered arrays of timestamp-value pairs.

The exchanged values (input parameters and results) are encoded in the JavaScript Object Notation (JSON), an independent text format which is fast and easy to understand.

In order to anticipate the river basin response under diverse conditions, two operation scenarios have been specified. They both use climate forecasts as inputs to a model that computes the reservoir input hydrograph and the downstream flow for the next hours/days:

- The flood scenario refers to episodes of intense rainfall when high flow peaks are expected to reach the reservoirs, possibly causing the need to release more water in the hours that precede the highest simulated inflow. The priority is to protect the citizens and the dam infrastructure.
- The ordinary scenario is meant to meet the demand of water in the regular operation where, to maximize the performance, water quality and energy optimization concerns need to be taken into consideration. For example, consumers expect a range of salinity for different water uses such as irrigation, bathing and consumption. Simultaneously, hydropower plants should raise the profits by generating more power when electricity prices are high.

In order to run a predictive simulation in the Integrated DSS, that is, a simulation to obtain an early river basin response, the user is only required to set a few parameters and objectives related to the scenarios of above. All the low-level actions, such as accessing external servers to gather input data or coordinating the different simulation routines, are automatic. Moreover, the system is up-to-date all the time. In this regard, new data series are automatically imported (when required) and the river basin model is run periodically to have an updated basin state.

The application is concurrent, that is, multiple users can inspect SAID data at the same time, and can run concurrent processes to assess their simulation hypotheses without interfering with each other. In addition, the system is intuitive and easy to use, and does not require installing additional plug-ins or applications on client side: a standard web browser is enough.

The “front-end” of the Integrated DSS presents information of several DSSs and sensor networks on unified maps, tables and graphs. Values are represented in a common format in spite of their original structure. This way the users are not forced to switch from one interface to another continuously, as is the case when separate tools are used.

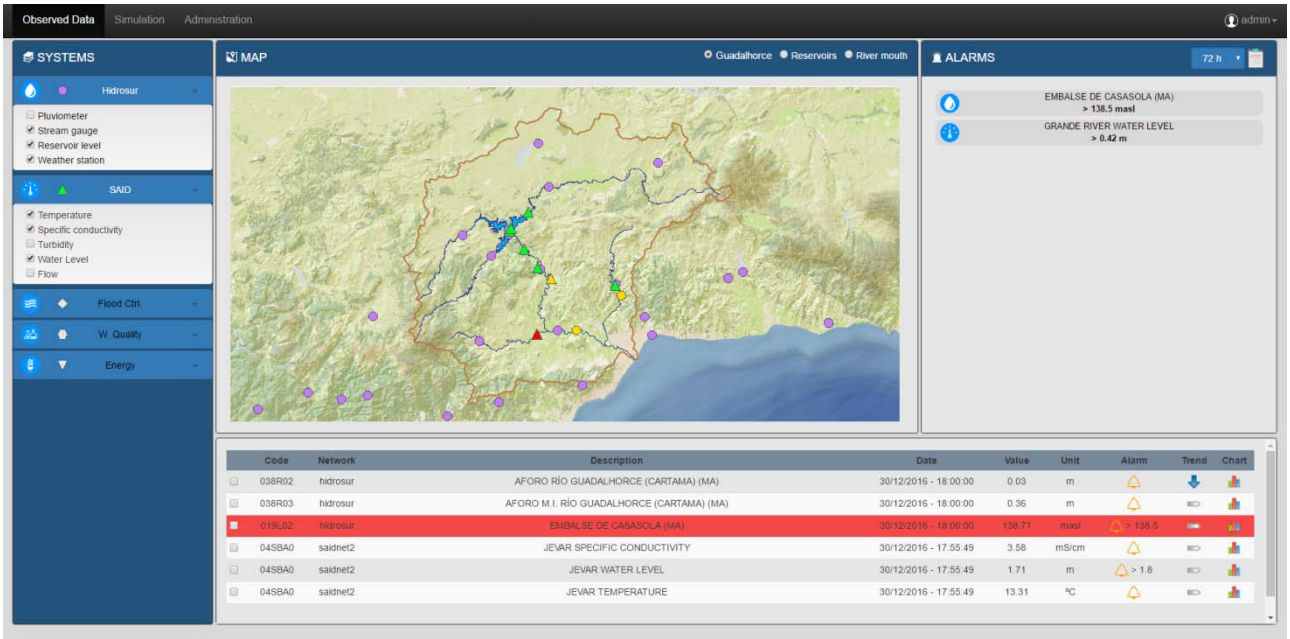


Figure 3 Detail of the "Observed data" page

The web portal consists of two main modules: observed data, for the visualization of historical and real-time information, and simulation, for the execution of predictive simulations aimed to calculate the next basin state.

The Observed data page, shown in Figure 3 comprises the following components:

- Systems: the left panel contains the integrated systems (DSSs and sensor networks). They can be enabled or disabled to display/hide their information on the map. Five types of systems are currently available:
  - Hidrosur: data from CMAyOT/Hidrosur stations distributed across the river basin. They provide a wide range of hydro-meteorological data and also include information of the reservoirs, such as water level.
  - SAID: network of sensors and gateways deployed in SAID project. The sensors, that are placed at strategic locations, provide water quality and quantity data. It includes information of the profiler and sondes in Guadalhorce and Guadalteba reservoirs.
  - Flood Ctrl: simulated water flow at several river basin locations, as calculated by the hydrological models. These results are updated once a day using data of rainfall and temperature in the last 24 hours. They add valuable information where no gauges are installed.
  - W. Quality: water quality indicators related to different water uses: bathing, irrigation, urban supply and zebra mussel. Each parameter has a discrete value that indicates the suitability for each purpose by means of three different levels. They are updated using real-time data from SAID sensors.
  - Energy: energy production data of hydropower plants in the basin.
- Alarms: alarm notifications can appear on the right panel to indicate that certain variables are above or below predefined limits. Each notification includes the node as well as the activation

condition. The user can click on an alarm notification to highlight its location on the map and to access the variable that triggered the alarm. Alarms are configurable.

- Map: basin map on which the system nodes are displayed. Each system has a different shape (circle, triangle, etc.) and colour. If an alarm is activated, its corresponding node is coloured red. The map has several predefined zoom levels.
- Table of variables: when the user selects a node on the map, its variables are added to this table. Each row shows the latest value and trend of a variable, as well as its description and unique identifier. Nodes from different systems can be selected to group their variables in this table. If required, the user can configure alarms by selecting one or many rows in this table and typing a simple boolean condition.

The Simulation page includes a set of tabs for different purposes:

- Forecast: uses the same map, tables and controls as the "Observe data" page. In contrast, the forecast tab shows values estimated for the next 72 hours (our prediction time horizon). The included systems in this case are:
  - Hirlam: data series of climate forecasts (precipitation, temperature) interpolated at the same locations as the Hidrosur control stations.
  - Flood Ctrl: simulated water flow calculated by the hydrological models using Hirlam climate data. Results of water flow, reservoir inflow and volume are computed.
- Scenario: the user can enter parameters of the simulation scenarios in these tabs. When the configuration is complete, a new simulation process can be launched from here. The page has two sub-tabs:
  - Flood scenario: allows the user to edit simulation constraints on each reservoir such as maximum/minimum volume, level or total outflow. They must be satisfied throughout the flood episode.
  - Ordinary scenario: allows the definition of water quality (e.g. final salt concentration) and energy parameters (e.g. capacity, plant schedule) that are used in the optimization.
- Flood control: shows the response reproduced by the river basin and dam models. This page contains graphics of the simulated flow and the flood plains caused by the applied discharge policy (see Figure 4).
- Dam operations: the dam manoeuvres calculated in the optimization process are depicted on this page. The position of the spillways and low-level outlets over time is detailed.
- Ordinary: this tab summarizes the results of the ordinary scenario, which include the detailed hydropower plant outputs and the water distribution that fulfil the requirements (see Figure 5).

Figure 4 River basin and dam model results

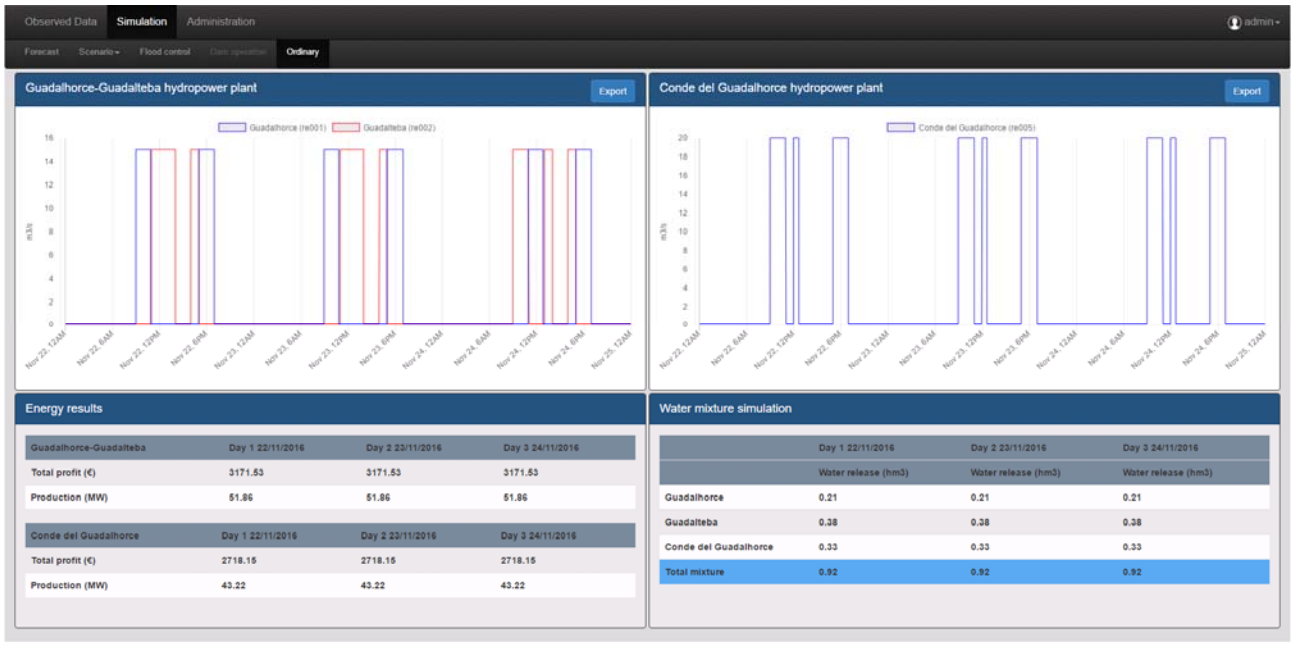


Figure 5 Results of the "Ordinary" scenario

The nodes shown on the basin map give access to all the variables of the integrated systems. To open a graph of (observed or simulated) time data series, the user selects the nodes and the desired rows of the table of variables. The graph can include any combination of data, even if the variables belong to different systems. The example in Figure 6 shows water temperature and conductivity data series. The possibility to combine practically any variables for their comparison in charts is an advantage of this integrated approach. All the plotted data series can also be exported to CSV files.

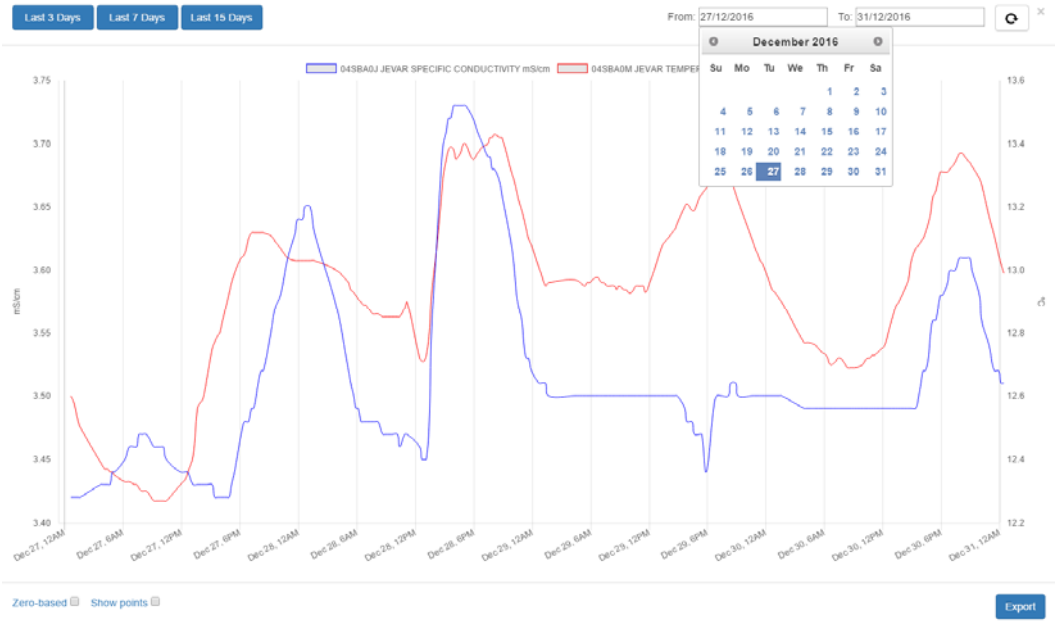


Figure 6 Example of time data series

The Integrated DSS has an administration module for the creation of application users. Each user can be assigned a different role that limits the available functions, ranging from accessing a subset of the observed data to running full simulations in flood and ordinary conditions using all the DSS cores.

Task 3.2 Development of modelling tools for final users:

Three different modelling tools, which are described below, are the results of this task.

Graphical tool for river basin modelling

Modelling a complex river basin typically requires the definition of hundreds of parameters which, in turn, depend on the used simulation tools. Sometimes the user is required to complete the modelling information editing groups of text files by hand, which is complex and error prone.

The objective of the developed graphical tool, called ModBasin, is to offer enhanced model editing capabilities to users. The tool features a visual style consisted in dragging graphical elements (nodes) from a predefined palette of components into a canvas, and connecting to each other to describe the relationships between the basin objects. Flow control nodes, river branches, reservoirs, aquifers, and hydropower plants are examples of selectable objects in ModBasin.

Each object has a set of properties that represent model parameters that can be edited by the users. In some cases, these parameters are simple strings or scalar values (e.g. hydropower plant capacity in m3/s) whereas, in others, are complex data types that are changed set with the help of custom editors which are included in the tool (e.g. reservoir height-volume-area relationship).

When the river basin model is finished, its diagram and properties can be saved to disk. The tool can also detect design errors such as duplicate identifiers or bad connections, and inform the user with a message that describes the class of error.

ModBasin is also intended for the automatic generation of files for a set of target simulation tools. One example is the network configuration file which is used to specify the river branches, reservoirs, result points, etc., in the WiMMed simulation model.

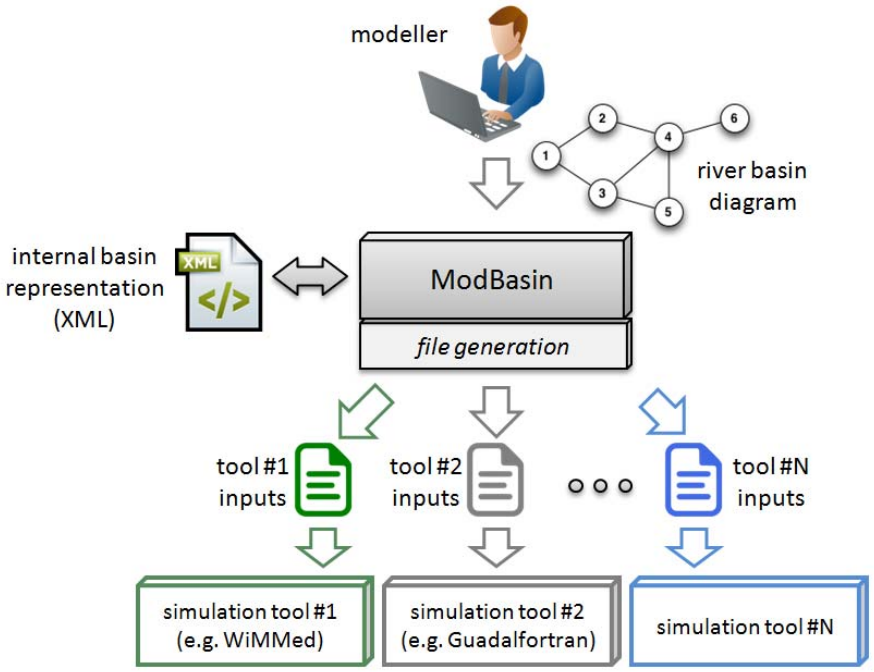


Figure 7 ModBasin inputs and outputs

The philosophy of ModBasin is summarized in Figure 7. The modeller uses the graphical interface of the tool to create a diagram (visual model) of the river basin and to set the properties of the included nodes. ModBasin stores all this information in an internal representation format based on XML. The application can convert the XML into the specific file formats required by the target simulation tools (WiMMed, Guadalfortran, etc.) as input/modelling information.

ModBasin provides clear benefits in the following aspects:

- Representing the river basin as connected objects in a graph expresses the knowledge of the modeller in a very intuitive way. The used graphical notation and the compositional approach make the basin characteristics more explicit.
- By automatically generating files for target models, the final system gets easier to maintain as the necessary changes in the models can be applied by means of a high-level tool rather than editing files by hand.
- The application has great potential to evolve. For instance, more features and basin elements could be added in future versions of the tool. The file generation module could be augmented as well to support further target models and tools.

The main window of ModBasin, which contains the palette of components, the property editor, and the model design area, is depicted in Figure 8. This diagram example includes all the available basin objects in the current version of ModBasin.

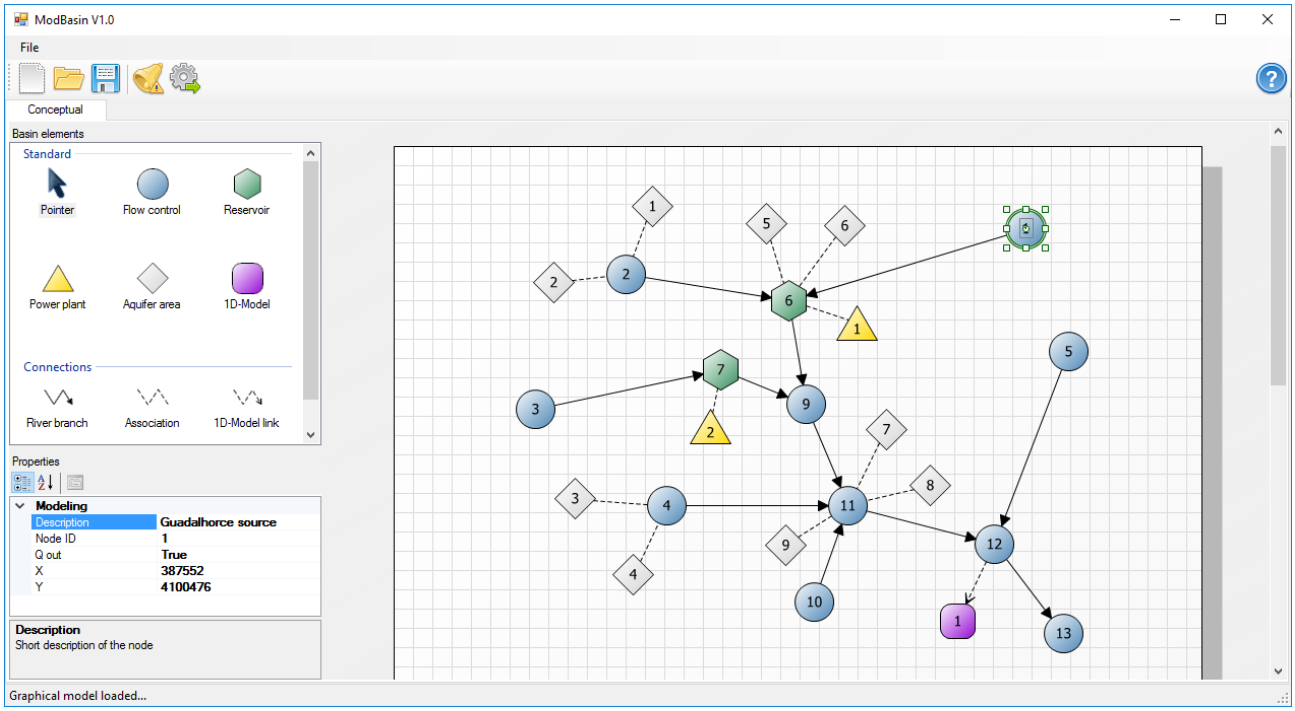


Figure 8 ModBasin model diagram

Graphical tool for dam modelling

BeDam, a module of the DSS for flood management, uses different kind of models: the dam model, the deterministic model of the management policies, and the non-deterministic model of the policy used in management mode to produce different sets of manoeuvres. All these models are described in a formal modelling language (Promela).

The aim of the graphical tool for dam modelling, called DamMod, is to support formal modelling specialized users in producing new dam models for BeDam. This tool is not only able to generate the code of a dam model, but it also allows the user to manually modify the model in order to add extra functionality, not considered in the original specification. In addition, the tool produces some default management policies.

DamMod can be used to model any dam. In particular, in the framework of SAID project, it has been used to model Conde del Guadalhorce dam for flood episodes.

The operation of DamMod can be divided into three phases. In the first phase, the user specifies the dam (name, parameters, outlets and gates, etc.). DamMod can export/import this information into a file, which is not the model code. In the second phase, the user associates the outlet descriptions with the files containing the discharge equations and DamMod generates the dam model code. The outlet equations are embedded in a predefined function in C code. In the third phase, the user associates the generated model with the non-functional files. Finally, DamMod produces an assembly that can be loaded by BeDam.

The main window of the DamMod tool is shown in Figure 9. The element types that can be included in a dam model are on the left side panel. The central area contains the controls to describe the dam elements. The following information can be specified in a dam model:

- Constants: values which are relevant in the dam description. The name of these constants can be used in the discharge equations of the outlets, and it is also interesting information for BeDam users.
- Dam parameters: variables that will evolve over time during the execution of the models. By default, all empty dams have four predefined parameters: inflow, outflow, volume and level. Parameters have associated curves which can be based on different interpolation methods, and can optionally be bound to sensors of different classes.
- Outlet types: an outlet type is a discharge element that can include several gates. All the gates will be at the same height and will use the same discharge equations. Several percentages of apertures can be defined for the gates. In addition, the user can specify the file with the C code that implements the discharge equations.

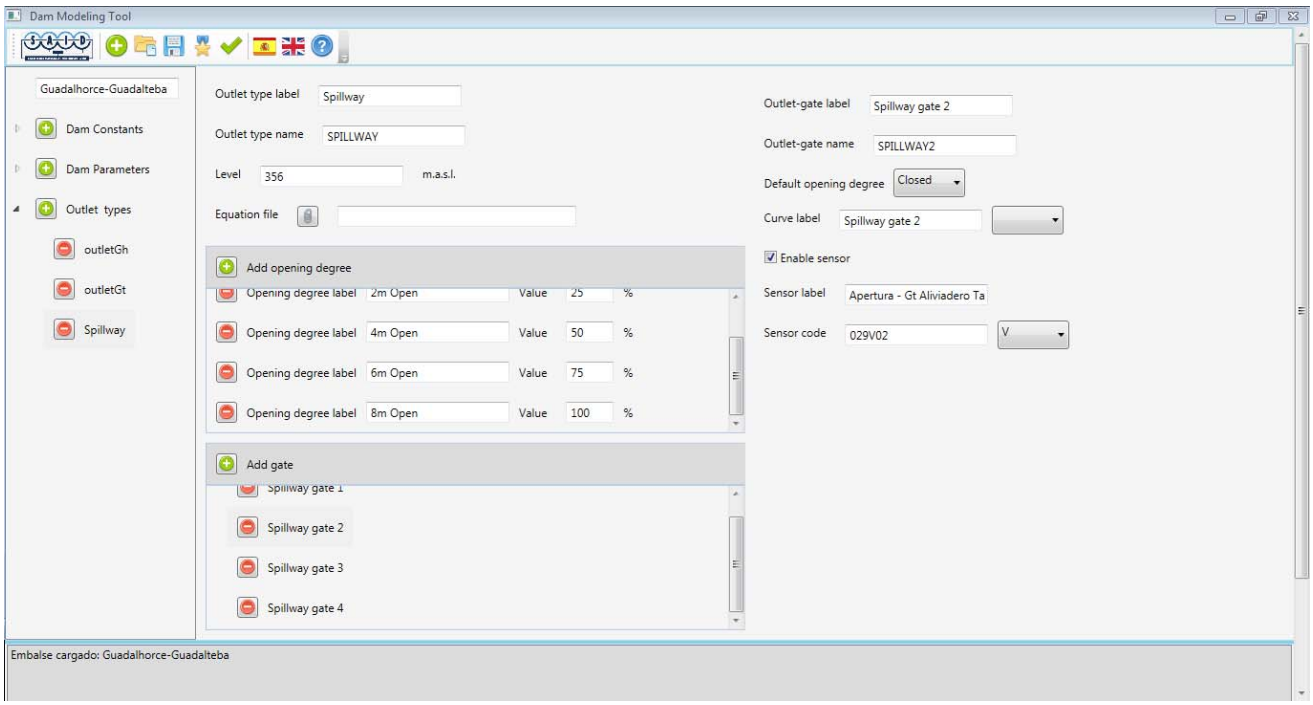


Figure 9 DamMod graphical interface

Graphical tool for dam management policies

PolicyMod is a tool to define new simulation policies for dams. The tool is part of the application suite aimed to improve the adaptability of the dam management module. PolicyMod is oriented to dam managers who want to simulate new management policies in BeDam. This tool helps the users define the management rules for the selected dam, produces the associated model, and embeds it in the BeDam assembly which contains the dam model.

Figure 10 shows the main window of the tool. The dam information panel includes the dam parameters which can be used in the management rules to define "conditions", and the outlet gates which can be used to set both "conditions" and "actions". The decision tree area is used to define the management rules as an ordered set of "decisions".

A decision is composed of "conditions" and "commands". The order of the decisions determines the order of their evaluation. In Figure 11 a decision example with 5 conditions and 2 commands is shown. A condition, in turn, defines the range of values of a dam parameter or the opening degree of a gate, and is formed by a parameter (left side), a relational symbol and a number or dam parameter (right side). It is possible to define conditions over the outlet state too. In this case, the outlet gate is the left operand, the relational symbol must be "==", and the current opening degree is the right operand. Finally, a command is defined by the name of the gate and the new opening degree.

Once the policy has been defined, generating its model and integrating it into the BeDam resources assembly is automatic and can be done simply pressing a button on the toolbar.

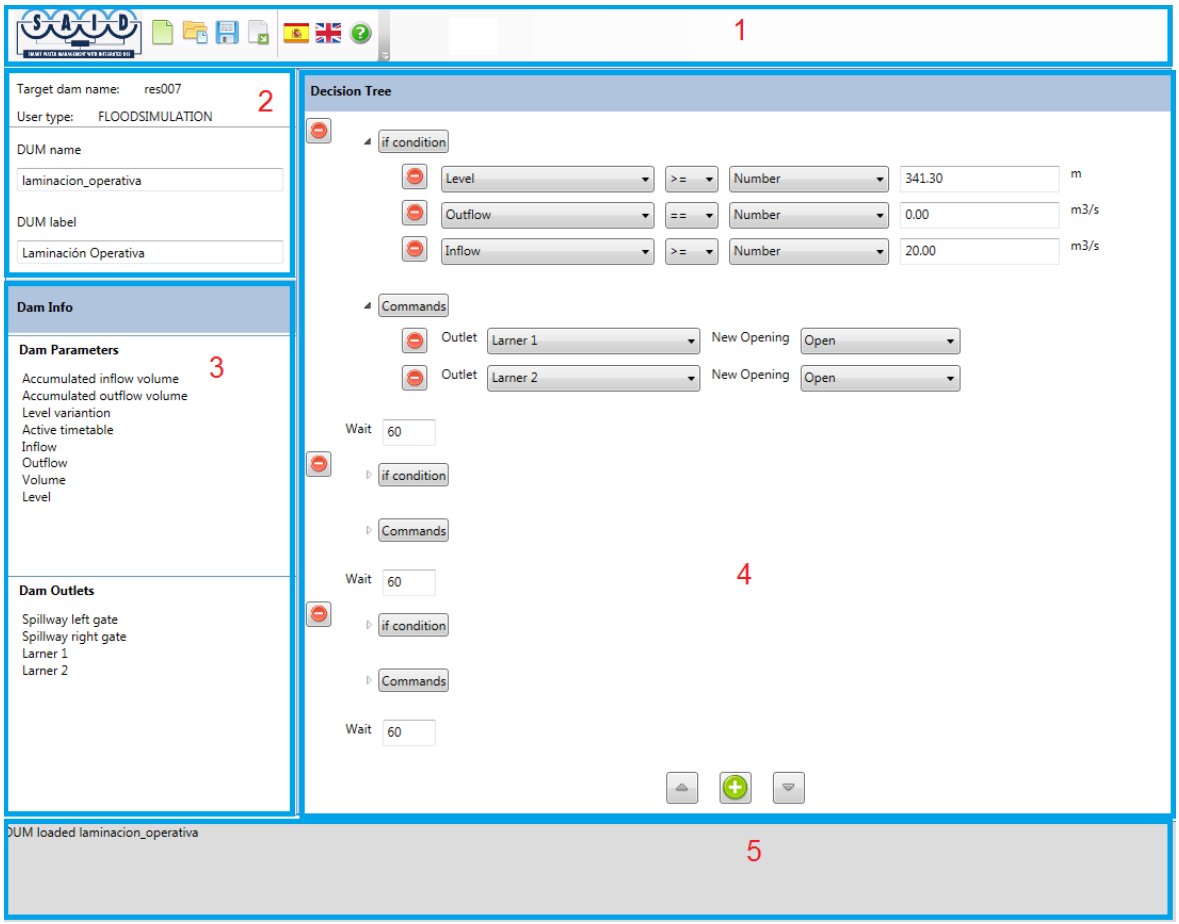


Figure 10 PolicyMod graphical interface

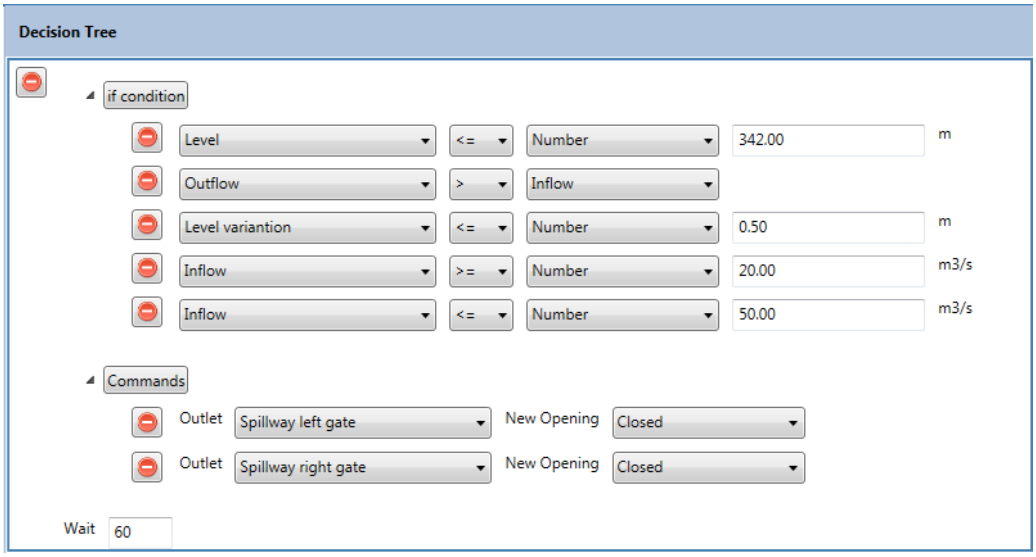


Figure 11 Decision example

Task 3.3 Using the integration platform to develop a DSS for optimizing coordinated dams

A new Decision Support System for the coordinated management of dams in a river basin has been produced in this task. The application, called DamCoord, uses the services of the integration platform to obtain the water flow along the basin during a flood episode. DamCoord has been designed as a web service making it easier for it to be consumed by any external tools or be included in the SAID platform. This DSS, however, is experimental and its integration has been developed in parallel.

The objective of DamCoord is to provide different alternatives to manage the dams of the basin in flood episodes. Given a particular flood scenario, the DSS has to synthesize a set of manoeuvres that preserve the safety of the dams and the basin. This “safety” condition is expressed using constraints. DamCoord internally uses a model checking tool called SPIN to search the space of solutions, and Promela as a modelling language to specify the dams and management policy.

The API of DamCoord consists of two main functions: one to get the service configuration, and other to carry out the synthesis of manoeuvres.

The configuration function returns a description of all the modelled dams, including their variables and outlets, as well as a list of basin locations where flow constraints can be defined.

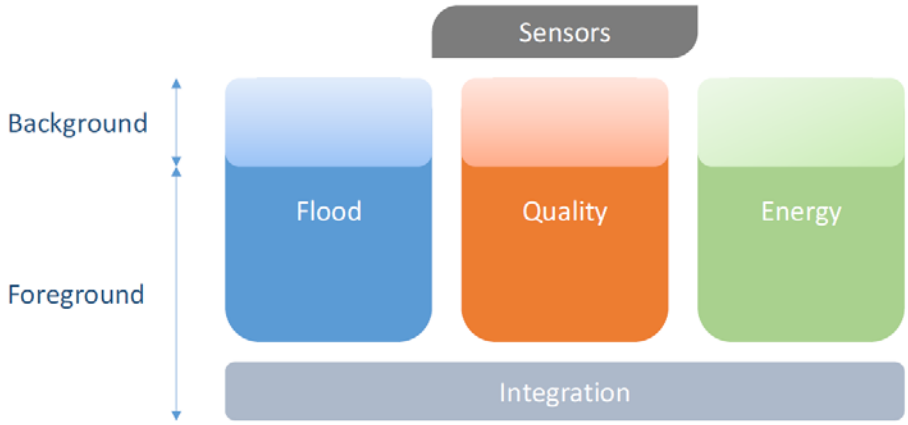
The function to calculate the coordinated manoeuvres uses the following inputs: the inflow to each reservoir (hydrographs), the constraints over any dam variables (level, outflow, ...) or basin locations (flow) and, optionally, the initial state of the reservoirs. The service returns, for each dam, the total outflow and the evolution of the outlets over time (their opening degree). If it is not possible to find a solution that satisfies all the constraints, the caller is notified.

DamCoord coordinates its execution with another service in the SAID platform (Hydroview) which is in charge of simulating a river basin model. Every time DamCoord requires the evaluation of the water flow caused by a different dam discharge, the Hydroview service is accessed.

The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results (not exceeding 10 pages).

An exploitation plan (D4.4) was developed taking into account the current situation on the area of dam managing: most of the water infrastructures in Europe are still managed by expert operators based on traditional best practices but with little support from these new smart tools.

What makes SAID different from other DSS on the market are three points: open interoperability, integrated to respond to the global needs of water management and easily configurable for any basin, which means that all the efforts are market-oriented to the integrated water resources management.



Other potential areas to exploit this knowledge could be in industrial processes, distribution and transportation networks, banking and financial asset management, emergency management and natural disasters, smart cities, mobility networks and traffic management.

Potential impact and use

· **Technological impact**

The improvement of DSS technologies greatly account for better information, based on a monitoring network, which mean a more comprehensive decision basis, providing with water quality information, which is not provided by current DSS.

Moreover, the project has developed software for managing river basins. Decision making in river basins can account for large losses in case of unforeseen phenomena, such as flooding, or poor management, for instance loss of water quality, scarcity or waste of energy. The platform allows designing DSS to be implemented in the same system and interact with each other, enhancing management utilities. The DSS shares data input and work with more complex scenarios. The project has also involved the design and building of wireless sensor networks (WSN) that are applied to monitoring applications and that require quality of service. This was not feasible with the existing

state-of the art technology and was considered to be one of the major pitfalls of WSNs. Therefore, the project results were crucial to enabling technology for wide up take on WSN technology.

· Economic impact

In economic terms, the project has implied the following savings:

- Minimize economic losses caused by severe natural phenomena and climate change.
- Optimize and reduce energetic consumption in the management of hydraulic infrastructures, such as dams.
- Improve the socio-economic balance between demand and resources.
- Reduce the exploitation cost of hydraulic facilities.
- Reduce the energetic consumption of pumping stations. The pumping stations optimization by means of advanced regulation techniques can mean a saving in energy consumption of 15%.
- Lengthen the life of pumps.
- Reducing the high investment required in current water management systems.
- Environmental impact
- Contribute to the efficient management of scarce resources (infrastructure management of water, at the level of river basins and water pipes, medium by which it is transported to the primary water supply, to agricultural and urban and industrial sector)
- Reduction of energy consumption that contributes to the global reduction of CO2 emissions.
- Impact on SMEs
- Contributing to open new markets and opportunities to industrial water sector and particularly SMEs (water processing and treatment sector, water management sector, ICT sector, wireless sensor network sector)
- Impact on policy makers
- Support the technical background of water policies by giving access to indicators provided by the DSS to policy makers.
- Impact on society and scientific community
- Better quality, more sustainable product with a more competitive price to end users
- Contributions to the scientific literature and knowledge about smart water management systems.

· Environmental impact of SAID

The implementation of a suitable and automated water quality monitoring network and its integration as a module of the DSS has accounted for a more rational allocation of water supply demands, namely for irrigation, domestic and industrial purposes.

The SAID project has approached the issue environmental impact, while maintaining a global vision, developing knowledge and technologies that contributed to the sustainability of the integral water cycle. It has contributed to the efficient management of scarce resources (infrastructure management of water, at the level of river basins and water pipes, medium by which it is transported to the primary water supply, to agricultural and urban and industrial sector), through the development of a decision support system that takes into account the use of high quality information in real time with climate prediction models.

By accomplishing the main objectives of SAID, the uses of water has been improved, in such a case allowing the availability of more water resources to supply more users, and concurrently to the generation of alternatives to natural resources (recovery of aquifers, waste water treatment and reuse, desalination) and developing more sustainable technologies in terms of energy consumption (given the constraint of available energy resources, there was a need to generate solutions to make sustainable the water and energy consumption). Moreover, the reduction of energy consumption has contributed to the global reduction of CO2 emissions.

· Impact on SMEs

The experience and know-how created by the project will concur for its future implementation in other water managing authorities. Therefore, the participant SMEs will then have the required proficiency to device analogous solutions and accordingly meet market challenges. New developments will open new markets and opportunities, particularly:

- In the industrial sector related to water processing and treatment (drinking water, waste water, water reclaim), developing technologies, processes and applications for managing the integral water cycle, in order to improve its own sustainability.
- In the water management sector, new tools for water infrastructure management and better water resource management will have an impact in the improvement of water transport and distribution in water basis, with the subsequent savings of energy and resources.
- In the ICT sector, incorporating cutting-edge technologies to the water cycle, particularly: radar measurement for real time data acquisition on water resources, weather predictions from more reliable data, which will allow for a better management of resources.
- In the Wireless Sensor Network sector, the results will be commercialized as tools for WSN design (and application in other areas).

· Impact on policy makers

Since the DSS permits extent information availability, data quality and empirical experiences that are extremely valuable to policy makers. Therefore, they will have access to data in order to implement local, national and EU regulations following the direction of the Water Framework Directive based on real indicators.

· Impact on society

Especially the water quality DSS will provide crucial information regarding domestic supply management, avoiding further difficulties or even potential public health problems. Socio-economic impacts will be:

- A more efficient hydraulic resources management. The availability, use and quality of water have been improved, both for surface and subterranean water resources. A better knowledge of the hydraulic response to adverse weather phenomena will also permit better management.
- A more efficient management of the infrastructures (e.g. reducing the effects of flooding, forecasting risks associated with water phenomena, and ensuring a normal exploitation in exceptional circumstances).
- Reduction of energy consumption in water infrastructure operations.
- Matching needs to resources and ensuring a sustainable water supply.

– For the end-users, the implementation of SAID represents a better quality, more sustainable product with a more competitive price.

· Transnational impact on the project partners

Bearing in mind the geographical origin of the partners within the EU, this allows a broader view on the transversal issues regarding water quality.

Regulation of water management, in terms of legislation, control, quality and environmental aspects, is directly related to the country's development level. From this perspective it is important that the scientific basis for producing viable solutions respond to the potential of the market. The project will offer the partners the possibility for scientific and technological relations with companies in other countries, supporting the development of the participant SMEs and the production of competitive products, as well as access to the water management market.

Main dissemination activities

During the development of SAID project, especially during the proposal submission and negotiation stage, the partners contacted with their corresponding water and environmental related Public Authorities in order to introduce the SAID project and try to obtain institutional support. During the implementation of the project these contacts have been consolidated and several meetings have been held, and during the events organized by SAID partners when these Authorities have attended.

In the framework of SAID project, a surveillance system has been established in order to find projects with similar objectives and goals. In this sense, the SAID project has identified and established links and synergies with related major water investments and projects at EU level, identifying EU funding programmes for which new partners are interested in exploring the potential of SAID technologies in new projects:

– **H2020**: call: Systemic, eco-innovative approaches for the circular economy: large-scale demonstration projects

– **Interreg Europe**: Priority axe4: Protecting the environment and promoting resource efficiency (2017)

– **Cross border cooperation in the Mediterranean**: PRIORITY B.4.1 Support sustainable initiatives aimed at finding innovative and technological solutions to increase water efficiency and encourage use of non-conventional water supply (2017).

Moreover, initiatives like RIS3 or JPI Water are also monitored to identify complementary EU funding mechanisms related to DSS priority.

The surveillance system established has also served to searching for complementary funding opportunities for future water related projects and activities coming from national and local public authorities.

- **The address of the project public website, if applicable as well as relevant contact details**.

Furthermore, project logo, diagrams or photographs illustrating and promoting the work of the project (including videos, etc…), as well as the list of all beneficiaries with the corresponding contact names can be submitted without any restriction.

b. Use and dissemination of foreground

A plan for use and dissemination of foreground (including socio-economic impact and target groups for the results of the research) shall be established at the end of the project. It should, where appropriate, be an update of the initial plan in Annex I for use and dissemination of foreground and be consistent with the report on societal implications on the use and dissemination of foreground (section 4.3 – H).

The plan should consist of:

- Section A

  This section should describe the dissemination measures, including any scientific publications relating to foreground. **Its content will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

- Section B

  This section should specify the exploitable foreground and provide the plans for exploitation. All these data can be public or confidential; the report must clearly mark non-publishable (confidential) parts that will be treated as such by the Commission. Information under Section B that is not marked as confidential **will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

Section A (public)

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[3] (if available)	Is/Will open access[4] provided to this publication?
1	River basin management with Spin	UMA	23rd. International Symposium, SPIN 2016	No 23 April 2016		Netherlands	2016		Link	Yes
2	"A DSS For Reservoirs Operation Based On The Execution Of Formal Models"	AW, UMA	INTERNATIONAL CONFERENCE ON HYDROINFORMATICS	No 11, August 2014	*City College of New York*	New York, United States	2014		Link	yes

[3] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).
[4] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

3	Multi-channel support for preamble sampling MAC protocols in sensor networks,"	IHP	22nd International Conference on Software, Telecommunications and Computer Networks (SoftCOM 2014)	No 22 , September 2014	IEEE	Croatia	2014		Link	Yes
4	Natural and human drivers of salinity in reservoirs and their implications in water supply operation through a Decision Support System	AW	European Geosciences Union General Assembly 2016	No, April 2016		Vienna Austria	2016		Link	Yes

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities[5]	Main leader	Title	Date/Period	Place	Type of audience[6]	Size of audience	Countries addressed
Conference/ Workshops/Meeting/Forums								
1	Oral presentation	AW	Jornada Técnica de la Plataforma Tecnológica Española del Agua (PTEA) – Meeting of the Spanish Water Platform	02/04/2014	Spain	Policy makers, scientific community, Industry, media	92	Spain
2	Oral presentation	AW	Water Innovation Europe 2014	24-26/06/2014	Brussels, Belgium	Scientific community (higher education, Research), Industry and Policy makers	200	European region

[5] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[6] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

3	Published an article	AW, UMA	11th International Conference on Hydroinformatics	17-21/08/2014	New York, US	Scientific community (higher education, technical Research) and Industry		World (International)
4	Organization of Conference	SEM	15th EMWIS Steering Committee	09/09/2014	Valencia, Spain	Policy makers	70	Euro-Mediterranean region
5	Presented the paper: "Multi-Channel Support for Preamble Sampling MAC Protocols in Sensor Networks"	IHP	22nd International Conference on Software, Telecommunications and Computer Networks (SoftCOM 2014)	17-19/09/2014	Split, Croatia	Scientific community (higher education, Research) and Industry		European region
6	Oral presentation	AW	EIP Water Conference	5/11/2014	Barcelona Spain	All	400	European region
7	Oral presentation	SEM	2nd Mediterranean Water Forum	25/11/2014	Murcia, Spain	Policy makers	250	Mediterranean region

8	Oral presentation	CMAyOT	X Jornadas Españolas de Presas	18-20/01/2015	Seville, Spain	Scientific community (higher education, Research) - Industry and Policy makers	400	Spain, Colombia, Peru, Dominican Republic, Bolivia, Ecuador, Germany, France, Italy & Portugal
9	Oral presentation	AW and SEMIDE	The joint WssTP-ERRIN RIS3 Workshop	25/03/2015	Brussels, Belgium	All	60	European Region
10	Oral presentation+ brochures	CMAyOT	Mesa Temática Interregional I+D+I en Agua	25/06/2015	Murcia, Spain	Policy makers	50	Spain
11	Oral presentation	AW and SEM	Water Innovation Europe 2015	24-26/06/2015	Brussels, Belgium	Scientific community (higher education, Research), Industry and Policy makers	250	European region

12	Oral presentation	AW	2nd International Conference on Hydro-meteorological Risks and Climate Change	11-13/11/2015	Cholula, Puebla, Mexico	Scientific community (higher education, Research) - Industry	500	International
13	Oral presentation	SCI	7th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K)	12/11/2015	Lisbon, Portugal	Scientific community (higher education, Research)	600	International
14	Oral presentation+ brochures	SEM	WssTP H2020 Brokerage & WGs Event	23/11/2015	Brussels , Belgium	Scientific community (higher education, Research) - Industry	250	European region
15	Brochures	UMA	PEARL European Project	12/01/2016	Marbella, Spain	Scientific community		European region
16	Oral presentation+ brochures	SEM	3rd EIP Water Conference	10/02/2016	Leeuwarden-The Netherlands	Policy makers & scientific community	250	European region

17	Brochures	AW	Smart Water Innovation Network in the city of Burgos	07/04/2016	Burgos, Spain	Supply water and water treatment companies	150	European region
18	Oral Presentation	UMA	23rd. International Symposium, SPIN 2016	7-8/04/ 2016.	Eindhoven, The Netherlands	Scientific Community	40	International
19	Oral presentation+ brochures	AW	European Geosciences Union Media at General Assembly 2016	17–22/ 04/2016	Vienna Austria	Scientific community (higher education, Research	200	European region
20	Stand	SEM	Water Innovation Europe "European solutions for a smart water society"	21-22-23/06/2016	Brussels Belgium	Scientific community (higher education, Research) - Industry	250	European region
21	Oral Presentation	UMA	XVI Jornadas sobre Programación y Lenguajes (PROLE 2016)	14-16/09/2016	Salamanca, Spain	Scientific community	30	National
22	Oral presentation	SIM	River Basin District Council of the Center Region, "Information Systems for IWRM: new approaches for old challenges Innovative approaches and tools for IWRM"	21-09-2016	Coimbra,(Portugal)	Public administration	50	National

23	Brochures	SCI	International Conference and Exhibition: HYDRO 2016, October 10-12th 2016, Montreux-Switzerland	10-12/10/2016	SWITZERLAND	Scientific community	1500	International
24	Training workshop	AW SCI UBI SIM SEM UMA	SAID workshop organized in the framework of Euro-inbo 2016	19-10- 2016,	Lourdes (France)	Scientific community (higher education, Research) - Industry	30	European region
25	Brochures	SCI AW	Empowering public procurement for innovation in the Eu water sector: Water PiPP Final Conference	9-10- 11-2016,	Zaragoza (Spain)	Scientific community (higher education, Research) - Industry	100	European region
26	Oral presentation + brochures	UBI	Private presentation for EDP Renováveis	29-11-2016	Lisbon (Portugal)	Potential client	10	Portugal
27	Oral presentation+ training materials	All partners	SAID final conference and training workshop	30- November 2016,	Malaga (Spain)	Scientific community (higher education, Research	100	Euro-Mediterranean Region

Articles/Press releases/Newsletters								
28	Article for the 11th International Conference on Hydroinformatics	AW, UMA	Article : “A DSS For Reservoirs Operation Based On The Execution Of Formal Models”	08/01/2014	New York, United States	Industry and Scientific community		International
29	E-newsletter	SEM	EMWIS Flash	(every two months starting from 31/01/2014 to 31/12/2016)	Sophia Antipolis	All	More than 30 000	Euro-Mediterranean Region
30	(Office International de l’Eau), No.25, Edition Française	SEM	Article: “L'innovation pour répondre aux défis méditerranéens sur l'eau”	02/01/2015	Sophia Antipolis	All	30 000	World (International)
31	Magazine	AW	iagua(ES):” New technologies for integrated water management,” (press release)	05/05/ 2015	Spain,	All		Spain
32	22nd International Conference on Software, Telecommunications and Computer	IHP	Article: “Multi-channel support for preamble sampling MAC protocols in sensor networks,”	19th, 2014	Split, Croatia September	Scientific community (higher education, Research		World (International)

	Networks							
33	Magazine	SEM	SAID article in ICOLD Newsletter	02/04/ 2016,	Paris, France	All		World (International)
34	Article at European Geosciences Union General Assembly 2016	AW	SAID article at EGU General Assembly	17–22 04-2016,	Vienna | Austria	Scientific community (higher education, Research) - Industry		Europe
Dissemination Materials								
35	Article	SIM	SAID article on the Portuguese Water Partnership Newsletter	08/01/2014	Portugal	All	140	
36	6-page brochure in English	SEM	SAID Brochure English	From 02/01/2015	European region	All	World (International)	
37	4 factsheets	SEM	Factsheets	17/11/2014	Sophia Antipolis,	All	World (International)	1500

38	Poster	SEM	Posters	30/06/2015	Sophia Antipolis	Scientific community, industry	World (International)	
39	6-page brochure in Spanish	SEM	SAID Brochure Spanish	02/04/2016	Sophia Antipolis	All	World (International)	2 posters
40	SAID official video in 3 languages	SEM AW	SAID Videos	28/11/2016	Sophia Antipolis	All	World (International)	500
41	Short Video for the promotion of SAID	SEM	SAID advertisement video	01/08/2016	Sophia Antipolis	All	World (International)	
42	Demonstration videos for each DSS	SEM	SAID demo videos	19/10/2016	Sophia Antipolis	All	World (International)	
43	Booklet (32 pages)	All partners	SAID Quick start guide	02/05/2016	Sophia Antipolis	All	World (International)	
44	Booklet (14pages)	SEM	SAID Results	28/11/2016	Sophia Antipolis	All	World (International)	50

Online Activities								
45	website	AW, SEM	SAID website	31/03/2014	www.said-project.eu	All	World (international)	
46	Social media	SEM	SAID Facebook page	05/01/2014	Online Social media	All	World (international)	145 Likes
47	Social media	SEMIDE	SAID LinkedIn	05/01/2015	Online Social media	All	World (international)	15 followers
48	Interview7	AW	Interview with Antonio Linares (AW)	21/02/2014	Online portal	All	Spain	
49	Web referencing on European Portal	SEM	EIP online market place	July 2015		All	Europe & International	
50	Web referencing	All partners	Links from partners websites	31/01/2014	Partners websites	All	Worldwide	

[7] http://www.iagua.es/noticias/entrevistas/14/02/21/entrevista-antonio-linares-de-abengoa-45665

51	Social media	SEM	SAID YouTube	05/01/2015	Online Social media	All	Worldwide	252

Section B (Confidential[8] or public: confidential information to be marked clearly)
Part B1

The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter.

The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

TEMPLATE B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC.					
Type of IP Rights[9]:	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant (s) (as on the application)

[8] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

[9] A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.

Part B2

Type of Exploitable Foreground[10]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[11]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
COMMERCIAL EXPLOITATION OF R&D RESULTS	A TOOL FOR THE SIMULATION AND VISUALIZATION OF THE BEHAVIOR OF A RIVER BASIN, AND FOR DAM MANAGEMENT IN FLOOD EPISODES. THE TOOL HAS SOME ADDITONAL MODULES FOR GRAPHICAL EDITING OF THE REQUIRED INFORMATION PROVIDED BY THE RIVER BASIN MANAGER			DSS for Flood control	• M72.1 - Research and experimental development on natural sciences and engineering • O84.2.4 - Public order and safety activities			Owner: Softcrits, UMA, Licencing for use: AW, CMAyOT

[19] A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.
[11] A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

Type of Exploitable Foreground[10]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[11]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
					• Wireless telecommunications activities			
COMMERCIAL EXPLOITATION OF R&D RESULTS	A TOOL FOR REAL-TIME ANALYSIS OF MEASURED WATER CONSUMPTION AND QUALITY			DSS for Water Quality	• M72.1 - Research and experimental development on natural sciences and engineering • O84.2.4 - Public order and safety activities • Wireless			Owner: ADD, SIM

Type of Exploitable Foreground[10]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[11]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
					telecommunications activities			
COMMERCIAL EXPLOITATION OF R&D RESULTS	A tool that aggregates all the data related with energy generation at a dam and allows to plan the best management strategy to assure its production objectives taking into account all the other constraints			DSS for Energy management	• M72.1 - Research and experimental development on natural sciences and engineering • O84.2.4 - Public order and safety activities • Wireless telecommunication			Owner: UBI

Type of Exploitable Foreground[10]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[11]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
					s activities			
COMMERCIAL EXPLOITATION OF R&D RESULTS	Software platform that facilitate the integration of existing and future DSSs			Integrated DSS	• F42.9.1 - Construction of water projects • O84.2.4 - Public order and safety activities			**OWNER:** Integrated DSS: SCI, UMA, SIM, ADD, UBI Integration platform & Web portal: SCI Licencing for use: AW, CMAyOT
COMMERCIAL EXPLOITATION OF R&D RESULTS	Wireless communication from SDI-12 sensors to the Internet server			Wireless sensor data gathering	• F42.9.1 - Construction of water projects • Wireless telecommunications activities			**OWNER:** IHP

In addition to the table, please provide a text to explain the exploitable foreground, in particular:

- **DSS for Flood control**

Its purpose

The set of tools in this DSS allows predicting the impact of manoeuvres on the dams in order to reduce damage due to floods. Different simulation models that consume real-time and predicted climate time series are used to reproduce the response of the river basin, which includes the calculation of the reservoir inflow and the basin state downstream. The users can establish constraints that must be satisfied by the dam discharges which are optimized by the tool. This DSS features a GIS-based graphical interface that lets the results computed across the basin area be accessed in a clear and user-friendly way.

How the foreground might be exploited, when and by whom

This DSS is designed to be used by the agencies in charge of management of the Dams in the river basin.

IPR exploitable measures taken or intended

The IPR belongs to SCI and UMA (depending on the modules), and both partners have decided to exploit the whole package together. The use for a new river basin requires adaptation to the basin, so the knowledge of both partners and potentially additional entities is required.

Potential/expected impact (quantify where possible)

The impact of this solution could be very relevant in Spain (because is one of the countries with more big dams). It is also applicable to other dams, like those in the Mediterranean area.

- **DSS for Water Quality**

Its purpose

Most countries in the European Union (and around the World) are suffering severe water stress caused by an array of negative pressures on water resources and water demands. Hence, the sustainable management of water resources is fully recognized, as it is established by the European Water Framework Directive (60/2000/EC) and other regulations. In order to fulfil its obligations and considering the complexity of water bodies control and the uncertainty on future scenarios addressed by climate changes, there is an imperative demand for the use of integrated management tools and methods, such as computerized models. The DSS for Water Quality management allows its users assess current or historical water quality information throughout the basin metering points and use this information to obtain global water quality indicators which can be used to support planning and operational decisions. The final product

presents several solutions regarding integrated watershed management. Although the demonstrator was designed for the Guadalhorce watershed, addressing its specific problems, there is an obvious potential to promote the customization and deployment of its concept to other watersheds where such kind of needs have already been identified and recognized, in straight collaboration with the involves partners (ADD and SIM).

How the foreground might be exploited, when and by whom

The DSS for Water Quality final product presents several solutions regarding integrated watershed management. These solutions intend to enter the market providing a customized tool to manage specific watershed case scenarios. The final product achieved in the demonstrator stands as an example of the various solutions that can integrate this DSS, rendering a good overall picture of both its flexibility and convenience. The target market is mainly comprised of river basin management authorities (examples from the company working network), which will be the first commercial targets: the Portuguese Environmental Agency or its regional branches – which are the current river basins authorities in the Portuguese mainland, the Regional Directorate for Environment - which is the current river basin authority in the Azores Autonomous Region, the National Institute for Water Resources of Angola or the National Directorate for Water of Chile. Other market opportunities will be further studied with special attention being given to countries in which integrated water resources management has already been integrated in their respective legal framework and/or strategic plans. Africa and South America markets present themselves as upfront candidates. Being the potential clients almost of public nature, the investment capability will be an expected hurdle to be surpassed. That is why the establishment of a suitable “business model” for the implementation of the SAID solutions (each module by itself and the solution as a whole) is a crucial and strategic instrument for the market penetration feasibility. The offering of complementary and added-value services (as the support on finding funding sources, which are available in many countries for these type of solutions and entities) can be another strategy to implement.

IPR exploitable measures taken or intended

The relevant IPR measures were taken during the project design and within the background management. Since the tools’ source code will not be publicly available, there are no additional exploitable measures to be taken.

Further research necessary, if any

As further research to be undertaken, two courses of action may be carried on:

To optimize the solution developed for the Guadalhorce watershed by further improving and fine tuning the Water Framework Directive classification schema and monitored parameters, the monitoring network and key parameters for Zebra mussel bloom prediction model, the water quality forecasting and the salinity dilution procedures modelling, directly relating it to the dam operation routines;

Add further features to the existing DSS, promoting the integration of other water management issues and quality classifications (examples: the Blue Flag programme classifications, port authorities’ environmental management programmes, coastal monitoring

and alert systems, and other classification systems which can be represented by the DSS concept).

Both perspectives will be important assets to turn the DSS into a more suitable and relevant software for other watersheds that will allow an improvement in its market potential.

Potential/expected impact (quantify where possible)

The product quality, robustness and differentiation aspects are the crucial topics for its economic feasibility. In that context, it is important to highlight that the product at hand differentiates itself from standard software products already in the market by its customization capabilities, presenting not only data visualization capabilities but its statistical analysis and therefore presenting operational options to the decider. Its graphical interface also incorporates GIS data layers making it more comprehensive as to where in the watershed quality issues are arising.

Moreover, any particular aspect concerning water quality in the watershed can be addressed by looking into its causal factors and incorporated into the DSS. If this issues call for a new improved monitoring network, as proven by the demonstrator, the software can promptly communicate with this network, even if real time data acquisition is available. So, it is considered that the software's flexibility is its greatest asset, allowing, with a reasonable customisation process, to meet the client's and the market's needs as they arise, currently and in the future.

- **DSS for Energy management**

Its purpose

The energy management decision support system provides a unique view focused on the optimization of energy production activities of a dam. The maximization of the profit generated from energy production activities is one of the lowest priorities for dam operators despite having a considerable impact on the dam's financial health. Before considering potential generated profit, dam operators carefully study the water requirements of the population and agriculture activities as well as the impact of discharge/retain activities both in the water quality as well as in the natural ecosystem.

Only after all this factors are analysed (resulting in requirements/restrictions to the dam's operation) and taking also into consideration the dam's operation working hours, an energy production schedule is defined. Optimizing the water discharge operations that target energy production is then critical since so many restrictions are already being placed in its operation and thus fairly impact its potential profit income. Energy management decision support system was specially designed to target the optimization of energy production activities allowing dams to maximize its income.

How the foreground might be exploited, when and by whom

The DSS for energy management focuses on providing a unique view of the dam energy production activities by promoting the maximization of the generated income. This DSS was

designed and implemented targeting water authorities as well as energy managers and contractors that use dam facilities to generate electricity. The EU is the main market to explore with special focus on Spain (where the DSS was tested) as well as Portugal. These two countries are currently the main potentials for an initial exploration of this product and some contacts have already been made in Portugal.

A private meeting took place with EDP Renováveis (the main water based energy producer in Portugal) where the DSS was presented and its operation and features explained. Besides Spain and Portugal, and taking into consideration the feedback and interest perceived in SAID's dissemination activities and workshops France, Ireland and Poland markets will also be a primary target to consider in this DSS exploitation.

IPR exploitable measures taken or intended

Source code of the energy management tool is not publicly available and will remain closed. No additional measures are currently considered.

Further research necessary, if any

Presented below are the potential future steps and enhancements considered for this DSS:

- Enhance integration with energy consumption activities
- Evolve the DSS's prediction features integrating the analysis of other internal and external variables/factors
- Adapt DSS's prediction features to other countries allowing its exploitation in a wider set of markets
- Increase the independence of the energy management DSS and dam monitoring equipment allowing this DSS to be used with a wider set of equipment
- Evolve the user interface providing a more complete set of features taking into consideration feedback received or to be received in this DSS presentation

Potential/expected impact (quantify where possible)

The energy management DSS is an important tool since it provides a unique view of the dam focusing on its past, present and future profit. The maximization of the profit generated by dam activities will certainly be an important factor for the dams' maintenance and upgrade activities promoting their financial health.

- **Integrated DSS**

Its purpose

The Integrated DSS combines functionality of the three DSSs in the SAID project (flood control, water quality, energy optimization) and it provides a unified view of the basin facets to final users. This DSS has two main purposes: on the one hand, the visualization of data from the individual DSSs and monitoring networks, which is done on the same screens and charts; on the other hand, the execution of predictive simulations in flood and ordinary conditions aimed to foresee the river basin response in the next hours (forecasts). In these

simulations, the functions exported by the three DSSs (with the aid of a service-oriented platform) are invoked in a transparent way to users, for example, to calculate the water volume to be released from each reservoir, or the optimum hydropower plant outflow to fulfil the water demand. Users with different privileges can access this DSS through a Web application in a concurrent way.

How the foreground might be exploited, when and by whom

This DSS can be used by agencies that pursue a smarter and more efficient management of the river basin resources. The Integrated DSS can be exported to other river basins provided that the individual DSSs are first properly adapted to the new basin.

IPR exploitable measures taken or intended

The Integrated DSS is a composite product developed with the joint efforts of many of the SAID partners. The IPR, in this case, can be classified as follows:

- The integration platform (server side), the DSS Web application for final users, and the services to gather external data into the platform belong to Softcrits.
- The foreground part to adapt each particular DSS to the platform (client side) and to return the data required by the integration framework, belongs to the owners of each DSS.

Further research necessary, if any

Interesting future work related to this DSS is the specification and development of user-friendly tools to extend the workflows of the flood and ordinary scenarios, so that the interactions with the internal DSS components can be configured in a more flexible way (for instance, by using a visual language). This makes it easier to adapt the Integrated DSS to new environments.

Potential/expected impact (quantify where possible)

The Integrated DSS can have a great impact on river basins of Spain as well as other European countries where problems related to water supply, reservoir salinity, energy generation or flood control also need to be tackled in combination.

- **Wireless sensor data gathering**

Its purpose

The complete system for sensor data gathering gets data from SDI-12 sensors installed outdoors sends data wirelessly to the GSM gateways, and then forwards it to the Internet server. The system includes the following three components: SDI-12 interface to sensors, the GSM modem, and the Internet server:

- Sensor node with SDI-12 interface is connected to SDI-12 sensors and reads data using SDI-12 data format. After reading data, the sensor node sends it wirelessly to

another node that is connected to the GSM gateway. All nodes are operated on batteries.

- The GSM setup includes a low-power GSM modem and the sensor node. To allow low-power operation, the GSM modem is mostly switched off. The sensor node receives wirelessly sensor readings from another node, wakes the modem for a short time, only to send data to the Internet server.

- Software on the Internet server to process incoming sensor readings.

How the foreground might be exploited, when and by whom

This wireless setup can be used by agencies or companies that need to install sensors in location without any infrastructure, such as electricity or network.

IPR exploitable measures taken or intended

The Wireless sensor data gathering is mainly developed by IHP. However, further work is needed to create a product from the prototype demonstrated in the SAID project.

Further research necessary, if any

Potential/expected impact (quantify where possible)

The wireless sensor data gathering allows the use of sensors anywhere, without any infrastructure. In this way, agencies or companies can gather sensor data in new locations, leading to many new installations of sensors.

c. Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

A General Information *(completed automatically when **Grant Agreement number** is entered.*

Grant Agreement Number:	619132
Title of Project:	SmArt water management with Integrated Decision support ssystems
Name and Title of Coordinator:	Abeinsa Bussiness Development SA

B Ethics

1. Did your project undergo an Ethics Review (and/or Screening)? 1- If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'*	***0Yes 0No***
2. Please indicate whether your project involved any of the following issues (tick box) :	***No***
RESEARCH ON HUMANS	
Did the project involve children?	No
3- Did the project involve patients?	No
4- Did the project involve persons not able to give consent?	No
5- Did the project involve adult healthy volunteers?	No
6- Did the project involve Human genetic material?	No
1- Did the project involve Human biological samples?	No
Did the project involve Human data collection?	No
RESEARCH ON HUMAN EMBRYO/FOETUS	
Did the project involve Human Embryos?	No
Did the project involve Human Foetal Tissue / Cells?	No
Did the project involve Human Embryonic Stem Cells (hESCs)?	No
- Did the project on human Embryonic Stem Cells involve cells in culture?	No
- Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	No
PRIVACY	
12- Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	No
13- Did the project involve tracking the location or observation of people?	No
RESEARCH ON ANIMALS	

14- Did the project involve research on animals?	No
15- Were those animals transgenic small laboratory animals?	No
16- Were those animals transgenic farm animals?	No
17- Were those animals cloned farm animals?	No
18- Were those animals non-human primates?	No
RESEARCH INVOLVING DEVELOPING COUNTRIES	
19- Did the project involve the use of local resources (genetic, animal, plant etc)?	No
20- Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	No
DUAL USE	No
• Research having direct military use	No
21- Research having the potential for terrorist abuse	No

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	5	4
Work package leaders	11	12
Experienced researchers (i.e. PhD holders)	3	4
PhD Students	1	1
Other	6	14

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	**6**
Of which, indicate the number of men:	3

D Gender Aspects

5.	**Did you carry out specific Gender Equality Actions under the project?**	○ X	Yes No

6. Which of the following actions did you carry out and how effective were they?

		Not at all effective				Very effective
❑	Design and implement an equal opportunity policy	○	○	○	○	○
❑	Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑	Organise conferences and workshops on gender	○	○	○	○	○
❑	Actions to improve work-life balance	○	○	○	○	○
○	Other:					

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

X No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

X Yes- please specify: Open day (SAID final event)

○ No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

X Yes- please specify: SAID website

○ No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

○ Main discipline[12]: Civil engineering

○ Associated discipline**¡Error! Marcador no definido.**: Mathematics and computer sciences

○ Associated discipline**¡Error! Marcador no definido.**: Earth and related environmental sciences

G Engaging with Civil society and policy makers

11a	**Did your project engage with societal actors beyond the research community?** *(if 'No', go to Question 14)*	X ○	Yes No

[12] Insert number from list below (Frascati Manual).

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

- X No
- ○ Yes- in determining what research should be performed
- ○ Yes - in implementing the research
- ○ Yes, in communicating /disseminating / using the results of the project

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	○ Yes X No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- X Yes- in framing the research agenda
- X Yes - in implementing the research agenda
- X Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- X Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture		Energy Environment Food Safety		Information Society Research and Innovation	

13c If Yes, at which level?

Local / regional levels
- ○ National level
- ○ European level
- ○ International level

H Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	-
To how many of these is open access[13] provided?	
How many of these are published in open access journals?	
How many of these are published in open repositories?	
To how many of these is open access not provided?	
Please check all applicable reasons for not providing open access:	
❑ publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other[14]: ……	

15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*		-
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	
	Registered design	
	Other	
17. How many spin-off companies were created / are planned as a direct result of the project?		-
Indicate the approximate number of additional jobs in these companies:		

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

	Increase in employment, or		In small & medium-sized enterprises
❑	Safeguard employment, or	❑	In large companies
❑	Decrease in employment,	❑	None of the above / not relevant to the project
❑	Difficult to estimate / not possible to quantify		

[13] Open Access is defined as free of charge access for anyone via Internet.
[14] For instance: classification for security project.

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:*
Difficult to estimate / not possible to quantify	X

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes X No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

X Yes ○ No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

X	Press Release	X	Coverage in specialist press
❑	Media briefing	❑	Coverage in general (non-specialist) press
❑	TV coverage / report	X	Coverage in national press
❑	Radio coverage / report	X	Coverage in international press
X	Brochures /posters / flyers	X	Website for the general public / internet
X	DVD /Film /Multimedia	X	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

X	Language of the coordinator	X	English
X	Other language(s)		

***Question F-10*:** Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES

1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]

1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)

1.3 Chemical sciences (chemistry, other allied subjects)

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2 ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern)

6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]