



WatERP

Water Enhanced Resource Planning
“Where water supply meets demand”

GA number: 318603

WP 6: WatERP Open Management Platform
D6.5: User Manual and Technical Integration Manual

V1.0 02/09/2015

www.waterp-fp7.eu

Document Information

Project Number	318603	Acronym	WatERP
Full title	Water Enhanced Resource Planning “Where water supply meets demand”		
Project URL	http://www.waterp-fp7.eu		
Project officer	Grazyna Wojcieszko		

Deliverable	Number	6.5	Title	User Manual and Technical Integration Manual
Work Package	Number	6	Title	WatERP Open Management Platform

Date of delivery	Contractual	35	Actual	36
Nature	Prototype <input type="checkbox"/> Report <input type="checkbox"/> Dissemination <input type="checkbox"/> Other <input checked="" type="checkbox"/>			
Dissemination Level	Public <input checked="" type="checkbox"/> Consortium <input type="checkbox"/>			

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Abstract (for dissemination)	<p>The Open Management Platform (OMP) is a web-based application that integrates in near real-time information and knowledge, inferred from the various parts of the water supply distribution chain, to support decision making from water sources to users, such as evaluating water supply and demand (including forecasting), coordinating water abstractions and uses, optimizing treatment and distribution efficiency, minimizing water losses and energy consumption, ultimately improving the matching between water supplies and demand.</p> <p>This deliverable contains the OMP’s user manual for water experts including each decision process available in the whole WatERP platform. Furthermore, ICT technical information is depicted, as guide for OMP deployment and maintenance.</p>
Key words	Open Management Platform; User Manual; Technical Manual; Deployment; Integration; Dashboard; Maintenance; OMP user

Glossary of terms

ACA- Agència Catalana de l'Aigua (Catalan Water Agency)

BI- Business Intelligence

CBR- Cases-Based Reasoning

DBMS- Data Base Management System

DMS- Demand Management System

DSS- Decision Support System

DX.Y- Deliverable X.Y

FAQ- Frequently Asked Questions

FOI- Feature Of Interest

GIS- Geographic Information System

ICT- Information and communications technology

IDE- Integrated development environment

JEE- Java platform, Enterprise Edition

JDK- Java Development Kit

JRE- Java Runtime Environment

JSON- Java Script Object Notation

MAS- Multi-Agent System

OGC- Open Geospatial Consortium

OMP- Open Management Platform

OS- Operating System

O&M- Observations and Measurements

RBR- Rules-Based Reasoning

REST/RESTful- REpresentational State Transfer

SOA-MAS- Service Oriented Architecture - Multi-Agent System

SQL- Structured Query Language

SWKA- StadtWerke Karlsruhe GmbH

URI- Uniform Resource Identifier

URL- Uniform Resource Locator

WAR- Web Application Archive

WDMS- Water Demand Management System

WFS- Web Feature Service

WMO- World Meteorological Organization

WMS- Web Map Service

Executive Summary

Deliverable 6.5 (D6.5) describes the interactions between the user and the OMP from two points of view (i) as the application user and (ii) as the technical administrator. The OMP represents the visual environment of the whole WatERP system. Thus, to check the complete WatERP a proper behaviour of the OMP is mandatory. This deliverable aims to be a complete guide for the installation and maintenance of the OMP and also a user guide to allow any new user to be able to interact with the system.

The present document is organized in four sections; the first one sets the scope of the deliverable, which mainly contains the user manual for water experts and the technical manual for ICT staff.

Section 2 is the water managers' user manual to manage the whole water supply distribution chain, and it is written with that intention. Thereby, the style of this section differs from the rest of the WatERP documentation in order to be used in the future as a product's user manual. The section is built based on the previous WP6 deliverables and mainly in the "OMP Design" sections of them, in these sections the visual interface and functional design of the OMP have been designed incrementally. Of course should be needed to customize the OMP in an operational environment, and consequently, some changes and adaptations should be done in the contents, but this section is a complete guide for a final user manual.

Section 3 depicts the ICT technical guide, which is useful to understand how to deploy and maintain the OMP platform for the technical staff. This section assumes that the user has an empty server, only with Operating System installed. Therefore, it describes the entire step by step configuration that is needed to run the OMP and presents the external software required. Also, it is described the configuration needed to integrate the rest of the WatERP's building blocks.

Finally, Section 4 summarizes conclusions. This deliverable consists of the user manual and technical integration guide; thus, it contains gratitude to the partners which had work actively in the visual and functional design and deployment of the OMP.

In order to understand this document, the following deliverables should be read:

Number	Title	Description
D6.4	Open Management Platform 3 rd prototype	The Open Management Platform (OMP) represents the user interface to enable the entire water supply distribution chain to be managed from a holistic point of view. At this point, after the third vertical integration, the development is finished. Thus this deliverable is focused on the performance of the system since it is a fundamental task to have a marketable product. Also the evolution of the development methodology is studied in order

Number	Title	Description
		to make a final report that allows the improvement of the methodology to be ready to use in next projects.
D.7.6.3	OMP Feedback	<p>This deliverable depicts the progress on the user interface design, design validation and usability validation performed in the Open Management Platform. The validation is focused on the feedback provided from pilots.</p> <p>It mostly involves the description of the evaluation and validation actions carried out during the period between D7.6.2 (month 26) and D7.6.3 (month 35); during this period, the most significant project milestone is the Third Vertical Integration (MS6) which is the final milestone in the OMP development. Thus it is important to note that only the most problematic issues found during the Third Heuristic Validation were solved. And most of the results are considered like the way to transform the OMP, which is a prototype, to a real marketable product.</p>

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1. Introduction

As it is described in **D6.4, Section 1 “Introduction”** this deliverable is focused on the description of the functionalities and dashboards implemented after the Third Vertical Integration milestone. This document summarizes the behavior of the system and how the user has to interact with it. Thus, it aims to be a complete user and technical manual. To achieve that objective the feedback of the pilots’ water managers and the deployment in the operational environments have been really important.

This deliverable has to be considered a complete user guide for the OMP, so it is written based on the user-experience of the pilots. The sections and the way that the information is structured in the OMP user-guide have been decided based on the FAQ asked by the different users involved in the OMP validations, hence, the document’s structure is significantly different of the rest of D6.x deliverables.

The technical integration manual is an installation and configuration guide, describing from the very first step how to run the OMP in an empty server. The configurations needed to integrate the OMP with the rest of the WatERP’s building blocks are also described. The information to summarize the main steps and to write this manual has been gathered during the WatERP deployment in the pilots’ operational environments. The whole WatERP platform was integrated in the pilot’s facilities; hence, the feedback obtained has been essential to write the ICT technical part of this deliverable.

2. User manual

The OMP is a web generic platform for any kind of water manager and it is based on the recommendations of World Meteorological Organization for the water sector (World Meteorological Organization, 2008 and World Meteorological Organization, 2009). Hence, the main objective is to have a common framework for all water actors and/or facilities. Furthermore, the OMP provides interoperability mechanism to facilitate the rest of WatERP modules to integrate its information into a visualization environment.

This section contains the description of the visualization environment, beginning with the different parts in which the OMP is divided according to the perspective of the user interface and includes the functionalities exposed to enable the water resource manager to perform operational management tasks.

Basically, the OMP is a visual environment focused on the decision-making performed by the water resources managers, experts and regulators that are involved in the decisional processes with different perspectives. The OMP consists of two different environments: one for the common tasks to all decision processes, and another that incorporates into the OMP's visualization all the specific information provided by the rest of the WatERP's modules (DSS and DMS). The OMP is the front-end environment where the water management and decisional process starts depending on the water actor involved.

The structure of the platform is divided in pieces or groups; each of them has a specific purpose and allows the water manager to analyze the water supply chain from a different perspective. The perspectives differ from each other in the detail of the information (from business intelligence dashboards to complex time series) and in the point of view (from schemas to cartography).

The whole pieces structure is depicted in the picture below:

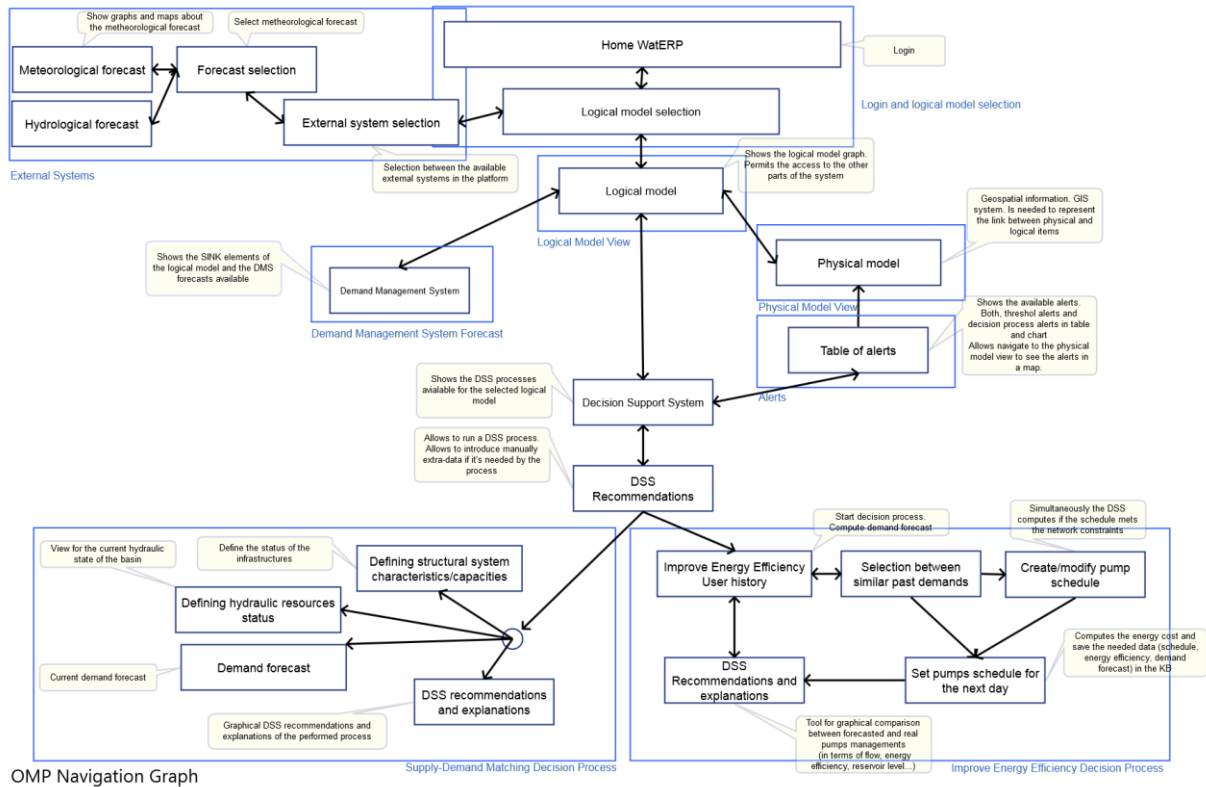


Figure 1 "OMP Navigation Graph"

Each box presented in Figure 1 "OMP Navigation Graph" is implemented as a screen or a collection of screens (for example a main screen and pop-ups) that performs a concrete operation of the OMP functional requirements. Each box represents a piece of the knowledge that a water manager needs in order to perform an analysis and make decisions in the water supply distribution cycle. A brief explanation of each box is done in the following table:

OMP group	Description
Login and logical model selection	A water manager is recognized by the OMP and select a logical model to set up the hydrological scenario
Logical Model	The logical model is shown and the water manager is allowed to analyze the scenario from a logical perspective (the ontological information and the data related is contained in each part of every logical model).
Physical Model	The physical model (geographic information system) is shown and the water manager is allowed to analyze the scenario from a physical perspective.
External Systems	The water manager is allowed to access at information provided by different external systems needed for the selected scenario and linked to the platform, for

	instance meteorological forecasts.
Alerts	Alerts produced by the DSS or by threshold exceeding.
Demand Management System Forecast	Compute and analyze DMS results.
DSS: Supply-Demand Matching Process	The water manager is allowed to configure and customize the Supply-Demand Matching decision process. Also, the decisions and recommendations dashboard is available.
DSS: Improve Energy Efficiency	The water manager is allowed to configure, customize and run the Improve Energy Efficiency decision process, particularly in the way of pumping systems management. Also, the decisions and recommendations dashboard is available.

Table 2 "OMP groups description"

In the following sections, the groups that conforms the OMP will be detailed from two perspectives: the operational (what to do?) and the technical (how to do it?).

2.1 OMP Common Parts

This section represents the common and general functionalities in all the decision processes that are considered to be necessary for water managers in any part of the water supply distribution chain, reinforcing human interaction inside natural water paths and consequently improving water management.

The OMP distinguishes two ways for representing the information: the logical model and the physical model. The logical model view is the main visualization environment used to define the problem in a schematic way and to present recommendations and explanations. The physical model visualization environment is a graphical representation used to define the geographic envelopment and to know the real environment in which the events occur.

The OMP is focused in the water supply distribution chain decision processes, in other words, it is necessary to perform the selection of a concrete decision before accessing the different building blocks of the platform. This selection is done in two steps:

1. By selecting the role of the platform user. The role of the user represents the grants that the user has in the platform, within these permissions a water manager is allowed to visualize data, visualize dashboards, manage decision processes and so on. These grants for a role are described in section "2.1.2 Login" of the present document.

2. And then by selecting the particular logical model that is going to be managed or by configuring a new one (use case under management). This action sets the hydrological scenario and the decision processes available in this scenario.

Once the particular use case (or scenario) is chosen, the OMP will show to the water manager the blocks, tools and dashboards that the water manager needs to manage the concrete water supply chain defined in the use case, providing the data, information and knowledge related to the decision-making process associated. These blocks, tools and dashboards are the building blocks of the OMP, and are integrated into the WatERP system throughout the SOA-MAS architecture to obtain information, recommendations, predictions, alerts, forecasts, etc.

The main OMP building blocks are the following:

- The decision support system (DSS)

To define the reasoning across the decision process: how to perform them, the temporal and geographical scales, the information needed from external systems and to interact with other building blocks such as the demand management systems and the artificial intelligence or computation algorithms in order to make decisions.

- The ontological instantiation of the logical model

The logical model allows the water manager to define human interaction inside water natural paths and to represent the changes derived from these human decisions (altered water cycle) in order to facilitate the decision-making process. As consequence of the ontological instantiation, the logical model will represent the entities and the related data where the decisions are going to be made.

- The physical model information

There might be some cases where the water manager would need to see the geographical scale of the use case analyzed. In those cases, a physical model view of the problem is necessary to correlate the logical model elements to reality, as well as to see the extension in the field of possible decisions. For instance, if the OMP throws an alarm about a sensor, the water manager might like to see the exact emplacement of this sensor in the basin, in order to analyze the potential consequences of this alarm. This could not be analysed as deeply in the logical model abstraction as in the physical model.

- One or more demand management systems

It allows obtaining forecasted demand in the SINK entities -as was defined in **D1.2 “Generic functional model for water supply and usage data” section 3 “Proposed Functional Model”**- to be able to assess recommendations proposed or to make decisions in a future time frame. It is possible to have more than one DMS per decision process, each one of them could provide different demand forecasts

based on different algorithms or estimation methods, therefore, is up to the water manager to choose the one which better fits his/her needs.

- External systems data/information/knowledge

It might be possible that additional information not taken into account in WatERP modules would be necessary to make decisions; therefore WatERP SOA-MAS framework provides an interoperable way to add other systems to the platform, allowing them to be shown in the OMP and be used in any decision process.

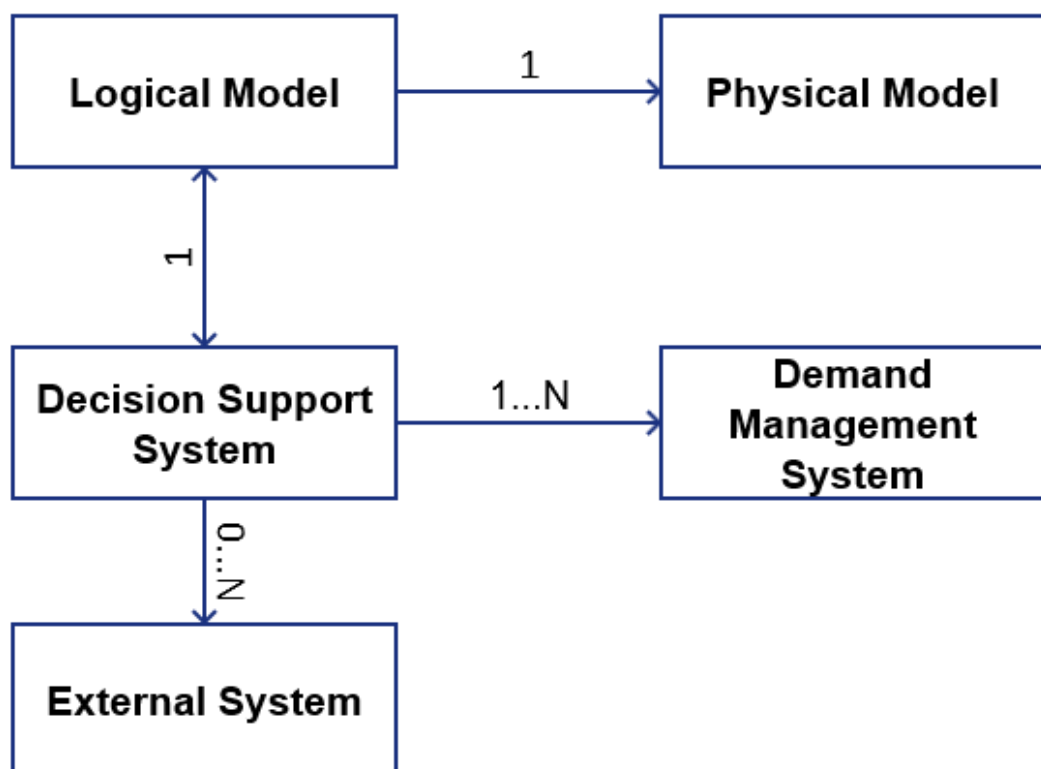


Figure 2 "OMP Building Blocks schema"

In the Figure 2 "OMP Building Blocks schema" the main building blocks involved in the WatERP framework (and consequently in the OMP) are represented. The DSS and the logical model are strongly linked; this means that the water resources of the logical models must correspond to the decisions made in the DSS; and vice versa: the decisions made in the DSS must always correspond to a water resource. In addition, a physical model is linked to the logical model with the geographical elements necessary to obtain all the necessary information on the water resources. Besides, the DSS is linked with one or more DMS to obtain demand forecasts and it can be linked to none or several external systems to obtain any other information needed to make correct decisions.

The OMP allows the water manager to manage all these blocks and integrate them in a common interface.

The following sections describe in more detail the different blocks identified: (i) login; (ii) logical and physical models; (iii) external systems; (iv) demand management system and (v) decision processes.

2.1.1 OMP Main menu

All the OMP functionalities are accessed through the OMP main menu. This is a menu bar that always appears in the upper-right part of the screen except in the login process. Once the OMP recognizes a user as a water manager for a particular logical model, the menu shows only the available functions for the user. The menu consists of a set of main menu buttons, each one can also be expanded to allow access to sub-components of the building block. The Figure 3 "DMS sub-components" depicts the sub-menu of the DMS main menu button.

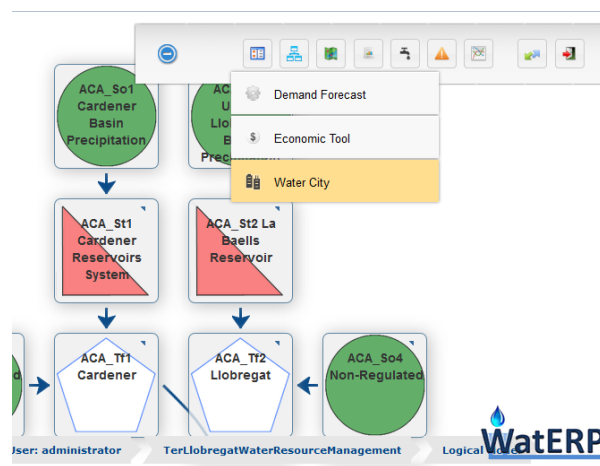






Figure 3 "DMS sub-components"

The table Table 3 "OMP menu contents" depicts each main menu button and the associated functionality or accessible building block.

Icon	Description
	Choose button: allows selection between different logical models if the current user can manage more than one.
	Logical model button: shows the logical model for the current scenario.
	Physical model button: shows the physical model for the current scenario.
	Decision Support System button: depending on the logical model selected, this button will show a different sub-menu to start or continue with the decision process.






	Business Intelligence Platform button: selecting this button the OMP will show the business intelligence platform.
	Alerts button: selecting this button the OMP will show the alerts screen.
	Demand Management System button: this button allows access a sub menu to go to the demand forecast screen, the Water City platform administration or to the demand management instruments application.
	External Systems: this button will show a different sub-menu depending on the external systems available.
	Exit button: this button performs a platform log-out.

Table 3 "OMP menu contents"

2.1.2 Login

Once the user accesses to the platform base URL in a web browser, the login screen is shown. This screen permits identifying the water manager and, depending on the water manager roles, the OMP offers the associated logical models. Also it is possible to select the user interface desired language from available ones. Furthermore, the role is also associated with necessary permissions to interact in the visualization platform.

Basically there are four different roles for a water manager in the OMP:

1. The **Visualization Role**, which allows to visualize models, dashboards and alerts and to query for time series and attributes. This role should be granted for example to executive managers, who only needs managerial information to be up date with the real time management;
2. The **Information Role**, which allows to change the behavior of the system. This role should be granted to operational managers, in other words, executors of the decisions; and
3. The **Expert Water Manager Role**, which allows creating and configuring scenarios, to parameterize and to validate the decisions and recommendations provided by the system. This role should be granted to the water manager itself, who has a global knowledge of the systems and its requirements.
4. And a fourth role that is not a water manager is needed to customize and manage the OMP from administrative point of view, the **Administrator Role**. The platform administrator role is needed to maintain, configure and customize all the general parameters of the OMP such as visualization, database connection or any other feature not included in the water manager attributions.

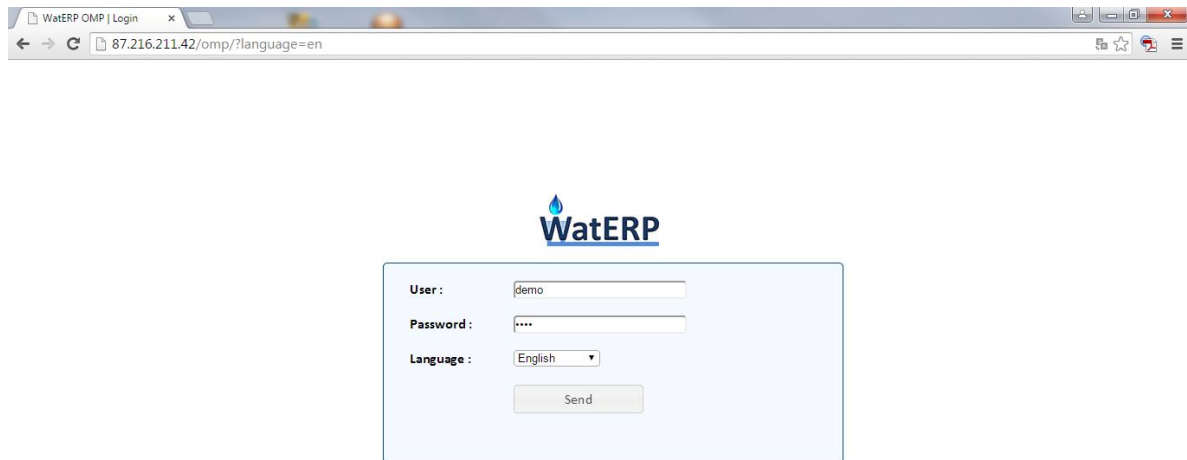


Figure 4 "Water manager login screen"

The same water manager can have different roles for different logical models and consequently, for different decision process or scenarios. Thus, after to introduce login and password, and only if the credentials are correct, the OMP will allow the water manager to select a logical model to complete the login process and assign the user a role in the platform.

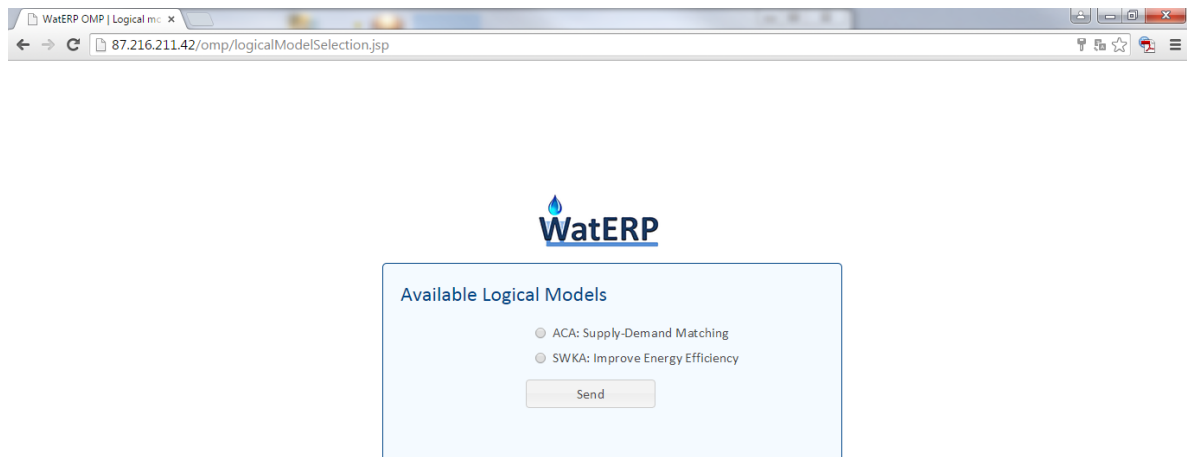


Figure 5 "Select logical model screen"

2.1.3 Logical Models

WatERP's OMP uses two different models in order to present the data to the user: (i) logical model and (ii) physical model. The logical model allows the water managers to analyze in depth the water resources (nodes) of the logical model, their composition (entities and data related), their interrelationships (arrows) and the access to the visual environment for the characteristic time series of each water resource. Instead, the physical model allows the water managers to access to the physical environment of the decision process. Below, both views are described.

The main entities of the logical models are the water resources. Each water resource can be related to any physical element of the system and this kind of relation can be of any type; thus, this link only represents that the physical and logical elements are somehow related. Furthermore, physical elements (feature of interests) are associated with the kind of measurements that can be performed and finally, with the available time series in the whole WatERP system.

Hence, the water management strategy is obtained from the knowledge that comes from the knowledge base, the DSS and DMS. The water manager enhances his/her knowledge about the studied scenario through the knowledge base, the exploitation of the direct and indirect relationships in which the water resources are involved, the physical elements, observations done, etc.

The knowledge of the DSS provides the water manager support to select a more suitable strategy based on the current state and the expected (forecasted) behavioral system state (provided by the DMS and probably by some external system).

Some of the inferred knowledge is acquired by means of time series. Thus, the characteristic time series of a water resource can be i) observed by a physical element, ii) somehow inferred from a physical element, iii) necessary to perform the decisional process but without being related to a physical element; and iv) obtained as a result of a decision making process and obtained in the scope of the water resource.

The time series should be referred to an element of the water supply chain; these elements are called Features Of Interest and represents elements with geographical position and boundaries. In a few words, a FOI is any feature that can be measured and usually (but not always) corresponds to sensors. These elements are the main information supported by the physical models, and will be depicted in the following section.

2.1.3.1 Model definition

This section presents the functional model that is being proposed for the WatERP system. Functional models are used in multiple fields of engineering in order to represent how a system behaves. In the water field a functional model is similar to a logical model where the system behavior is represented as a set of rules and decisions. Hence, logical model describes the interactions between elements

throughout water distribution chain. More in detail, this model represents the natural water cycle elements and its interaction (or conjunction) with the man-made (“human-altered”) infrastructure elements that modify the natural flows for human benefit (via channels, reservoirs, etc.).

These logical models will help discover and improve the rules of the ontology that will be developed to support the project knowledge. In the following table, some key explanations about the logical models are shown:

What is a logical model?	<p>A model is a conceptual design of the water supply system.</p> <p>A model is not geographic information, is abstract information.</p> <p>A model can support different decision processes.</p> <p>In our system, a model to support decision is called logical model.</p>
Why to use this type of modelling?	<p>To avoid the technological dependences on the classical models and modelling software.</p> <p>To support standards and non-standards, depending on the existing technology: very flexible.</p> <p>To allow the scalability of the system.</p> <p>To maximize the software reuse.</p> <p>To allow the water manager to build new logical model to support new decision processes or to change and extend the behavior of the existing decision processes.</p>

Table 4 "Key aspects of the logical models"

2.1.3.2 Need for a holistic, basin scale approach

Water resources management is extremely complex, related not only to the environment but also the numerous human activities that are carried out within this environment. Water availability and usage depend on the timing and manner of its arrival (rainfall intensity, rain or snow, duration, frequency), the physical setting of the region (climate and weather, topography, geology), the engineering structures in place, the environmental constraints (existing ecosystems), the legal regulatory context and institutional policies (Serrat-Capdevila, 2011).

Traditional approaches to water resources management have typically been based on black-box optimization models, handled by technical people and developed for very specific purposes. They do not include interactions with the end users or stakeholders involved and have not been able to include in their computations the variety of important factors that are necessary for decision makers, or in ways that are transparent to the public.

There is consequently a need for more holistic approaches that can address the complex coupled human and physical system interactions at the basin scale. Furthermore, new holistic and integrative approaches must include multi-resolution capacity so that findings and information can be transferred and used across models and users, and should be based on an agreed-upon conceptual model of the system that will help stakeholders and decision-makers understand what are the main issues and challenges at the system level, but also for each stakeholder (Serrat-Capdevila, 2011). However, the tools must be flexible so as to be able to evolve as needs arise or based on feedback obtained from prior decision-making findings. Rather than developing and using them once, decision support systems offer greater benefits when they are dynamically changed over time, as a working tool that can be modified over time as policies or modifications in the engineered system layer (canals, pipes, wells, dams, water allocations, changes in use efficiencies, changes in land use cover, etc.) occur, as well as in response to new or modified understanding of how the system works.

2.1.3.3 Logical model building

As mentioned in the beginning of this section, functional models provide the necessary mechanism to discover and know how a system behaves. This functional model will be represented in its logical form for the water systems in the early beginning of the project. As already mentioned, functional models (in water field called logical models) describe the elements that comprise its specific systems (natural paths and also human altered paths). Furthermore, these models represent decisions and rules attached with specific definition of the scenarios. The representations of functional models are useful for enhancing and defining two important parts of any water system. On the one hand, the rules and behavioral description will permit define the ontological rules between concepts of the ontology and also define instance needed for ontological population. On the other hand, the functional models permit the definition of the decisional rules that could be included in the DSS which are implemented in the reasoning engines. These rules to be included thanks to functional models also represent rules and decisions done by expert users in order to adapt the normal behavior of the system to the particularities of the water system management and most usual states of the system (e.g., droughts, floods and more).

Within a water supply system, water demand originates in many different places, and water flows within water supply distribution systems are not necessarily linear. For instance, industrial users can be located in the upper portion of the watershed, but can also be situated in the lower part of the river basin in a more urban environment. Municipalities located in the upper part of the river basin can divert water to a local water treatment plant such that this water does not follow the main water supply distribution chain but rather uses a locally-operated treatment facility, or municipalities can depend upon the primary water supply distribution system. Meanwhile, water supplies can be encountered throughout the water supply distribution chain. Although the largest surface water storage systems are typically located in the upper portions of the water supply network, rainfall falls upon all parts of the river basin,

generating new water inflows throughout the system. Finally, and further complicating the flow sequence, water can be reused or recycled throughout the system.

Although water supply networks can be very complex, what is common to each step is that each water supply entity (such as a gauge station or a reservoir) has an inflow and an outflow, and these inflows and outflows are a function of supply and demand. If the proposed tool is to replicate the “expert user” process, it will need to follow a chain of decisions that will most likely require the simultaneous examination of several different entities. Each entity will have an outflow that should correspond to the demand made by a downstream entity, and an inflow which will be passed on to an upstream entity as the new demand.

While the computations in each entity will be different depending on the type of entity and its respective characteristics, and each entity will involve a different set of data variables to relate inflow to outflow, the elements involved in water supply management can be classified according to the following five categories:






Water resource category	Description
 SOURCE	Entity in which system resources are provided.
 TRANSPORT	Entity that moves resources from one place to another in the system.
 STORAGE	Entity capable of retaining resources for a period of time for later introducing them back into the system when needed.
 TRANSFORMATION	Entity that modifies the properties of resource.
 SINK	Entity in which system resources are subtracted.

Table 5 "Water resources categories in a logical model"

Even though differences can occur among entities, in general, entities within a same category will have similar characteristics and functions. These categories are presented in the following table along with the corresponding entities that can be found in a water supply distribution system and some of the associated key variables (It should be noted that the variables contained in this table are not intended to represent an exhaustive list but rather illustrate the main parameters considered in these types of water supply elements):

Category	Entities	High level variables
SOURCE	Precipitation Sea Transfer	Volume Flow Level
TRANSPORT	River or channel Distribution	Flow Level Width Slope Travel time
STORAGE	Reservoir Aquifer Tank	Volume Level Inflow Outflow Storage capacity
TRANSFORMATION	Treatment Hydropower Desalination	Flow Elevation Quality Price Other quantitative properties
SINK	Environmental use Domestic use Agricultural use Industrial use Recreational use Evaporation losses Unaccounted for water	Volume Flow Water use rate Activity level

Table 6 "Water supply management categories, entities and variables"

These water resources are linked between all and the link represents causality relations, usually will be the water flow direction but not always, as example in the following figure a very brief logical model for the Upper part of a generic basin system is depicted, this is the first loop of a cyclic process with the aim of describe all the water supply system in order to undertake two tasks (i) allow making different decisions and (ii) allow to gain knowledge about how the system works.



Figure 6 "Logical model for a generic basin system"

The aim of this section is to introduce the WatERP system and the innovative point of view in the water management field, and why is needed to change the paradigm to exploit the existing technology in

order to improve the decision-making processes and to ensure the scalability and the interoperability of the system.

A remarkable point is that WatERP is not a static system, but rather, the system allows managing any number of logical models, and each logical model allows making decisions in any number of decisions processes as required. Each expert water manager in a field can grow his systems as much as needed, and no new software or changes in the existing is needed.

2.1.3.4 Logical model screen

This screen is depicted in the Figure 7 "Logical model screen" and allows accessing and managing to the logical model selected for the water resource manager.

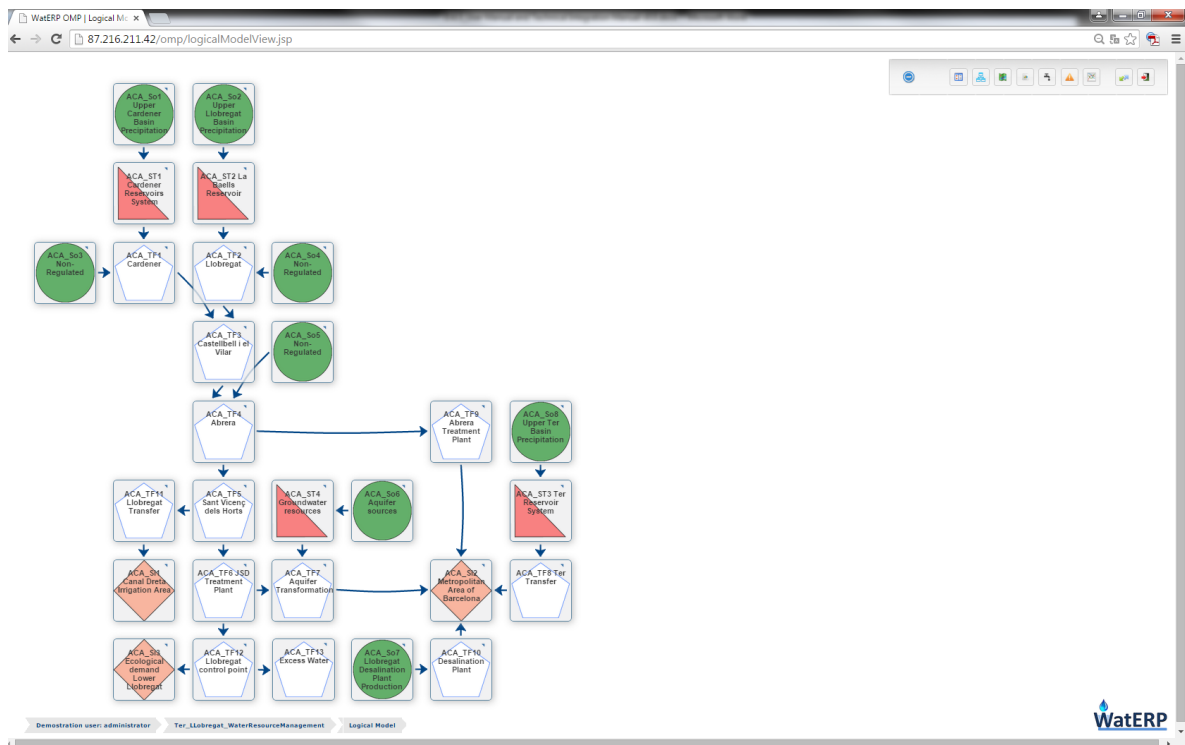


Figure 7 "Logical model screen"

The water resources elements represented in the logical model view are hot-points in the screen, to allow the water manager to access the observed time series, properties, attributes, related physical elements and past decision processes based on a contextual menu for each element. This contextual menu is created for each water resource ad-hoc according to the ontology population for every logical model. Ontology classes (as the type of water resource), the FOIs referenced and the concrete decision process are needed to be reviewed automatically so as to generate the appropriate menu for each logical model element.

The following figure depicts the popup windows that will appear when clicking on any water resource element of the previous screen. This window contains three different tabs: the FOIs tab, DSS & Alert tab and the Attributes tab.

Regarding the FOIs tab, it contains the list of FOIs that the ontology relates to the selected water resources element as well as the FOIs generated by the decision process.

The DSS & Alert tab shows a recap of all the alerts (if any) and recommendations given by the DSS.

Attribute tab is reserved for the characteristics of the selected water resource element given by the ontology.

In the example of the figure below (Figure 8 "Water resource window example"), a reservoir tank and water body are selected, and it can be seen in the FOI tab the information given by the sensor that measures the tank level. In the DSS & Alerts tab, it should show the list of generated alerts and recommendations. Finally, in the Attribute tab, characteristics such as storage capacity or maximum height should be shown.

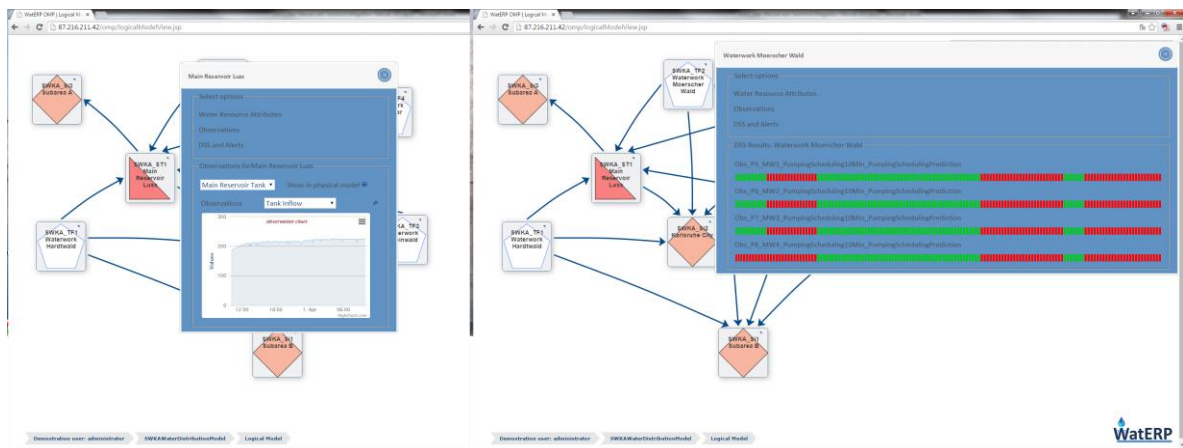


Figure 8 "Water resource window example"

2.1.4 Physical Models

The physical model consists of a Geographic Information System environment to allow the visualization of the physical elements that can be found in the altered water cycle chain (sensors of any type and other geo-located elements that are considered necessary). For each element it also allows to access the observed, calculated or inferred time series.

Logical models are formed by water resources represented by logical elements. It should be pointed out that these water resources are linked to sensors and other actual tangible elements, thus these real elements conform the physical model and are called "Features Of Interest". Even though that the

physical view is not strictly necessary to make decisions, this kind of the representation is helpful for water managers, in order to make and implement decisions.

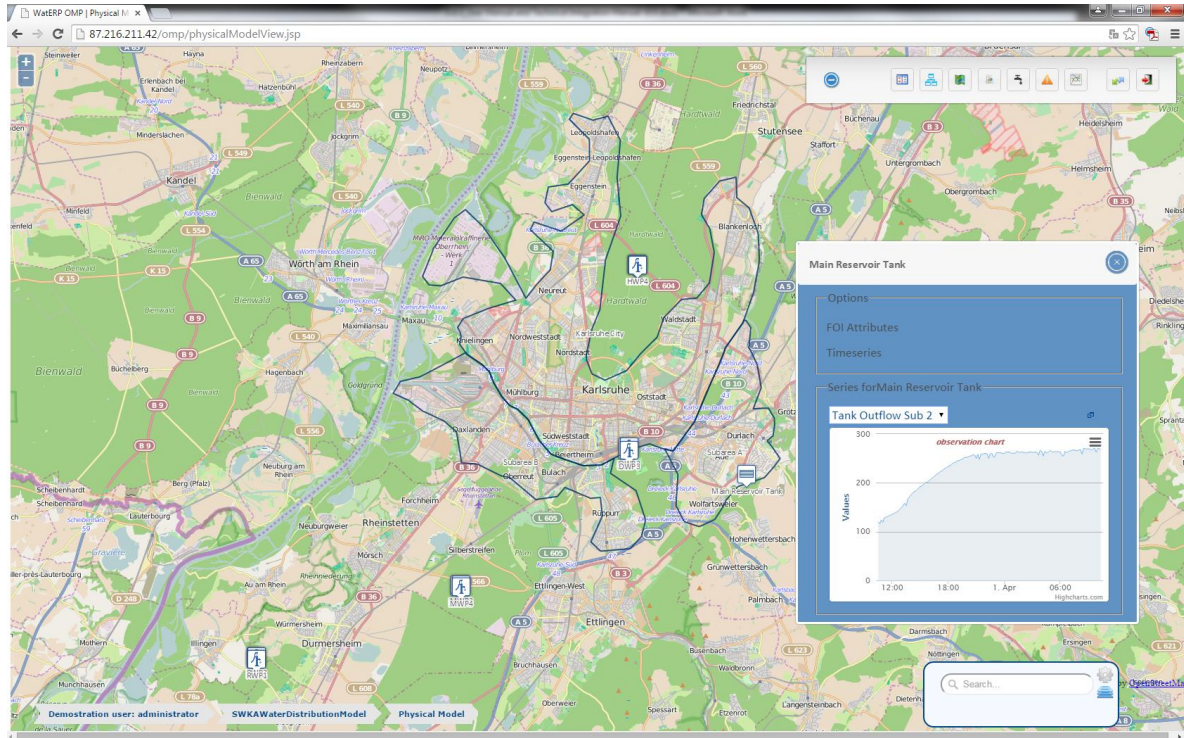


Figure 9 "Physical view"

The map navigation is as usual, so it is very intuitive for the users. Also, the FOIs are hot-points and the user can interact with them. When one FOI is selected a pop-up window will appear containing all the relevant information of the element including associated measured or calculated time series.

Furthermore, it is possible to select the base cartography from a wide collection of generic map services, as OpenStreetMaps or Google Maps.

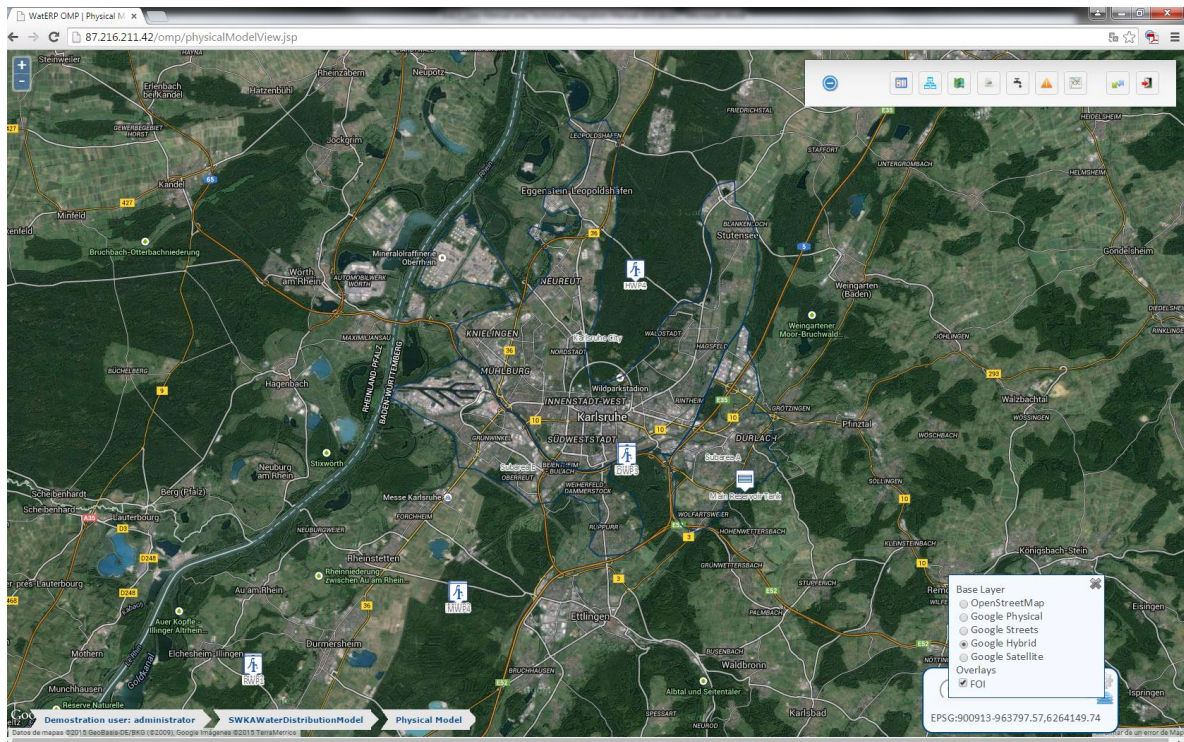


Figure 10 "Google maps hybrid base map"

Finally, the GIS platform contains clients for common web-mapping OGC services: WMS and WFS. It is possible to link with any interoperable mapping data source and add new layers to the geographic information system. This process is done by selecting the map service type (WMS or WFS) and introducing the service capabilities URL address. The process will fill the "Layers" list and allows the water manager to visualize any of the available layers in the current map.

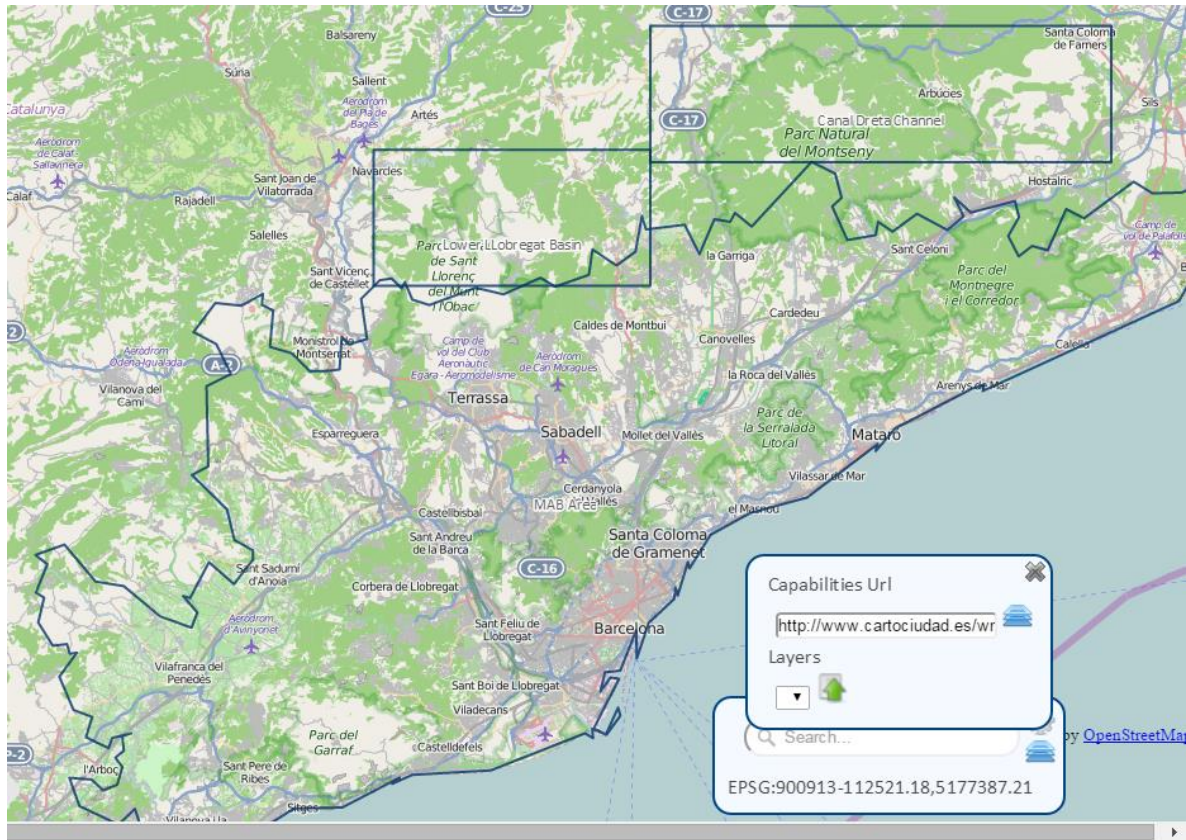


Figure 11 "Adding external interoperable web mapping services"

2.1.5 External Systems

The available external systems list will appear automatically under the "External System" button of the main menu. Actually there are two external systems available: the meteorological forecast and the hydrological forecast. And each of them offers different services.

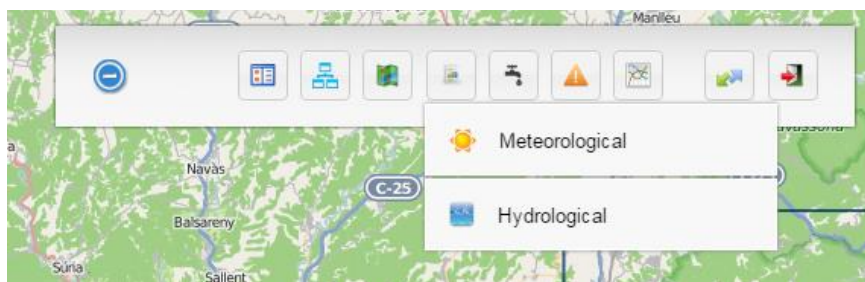


Figure 12 "External systems menu"

The meteorological external systems offer two different services: precipitation forecast and temperature forecast. Clicking in the Meteorological button the OMP will show both services to the water manager: "Precipitation" and "Temperature".

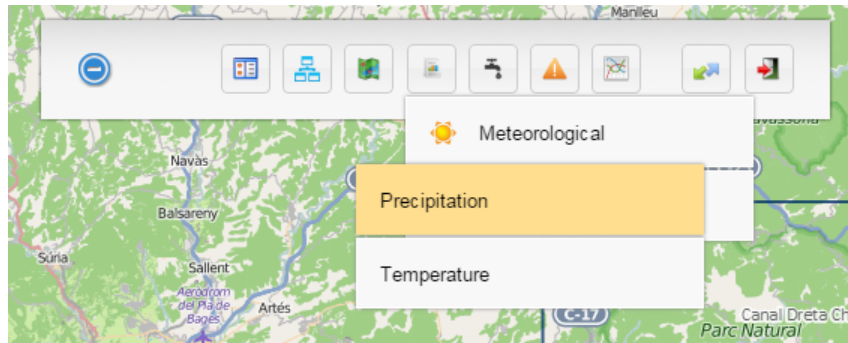


Figure 13 "Meteorological forecast external systems services"

Selecting each of them, the OMP will change the visual environment control to the services exposed by the external systems. The precipitation and temperature forecasts show weather maps (by default) and numerical time series (by clicking in a Feature Of Interest).

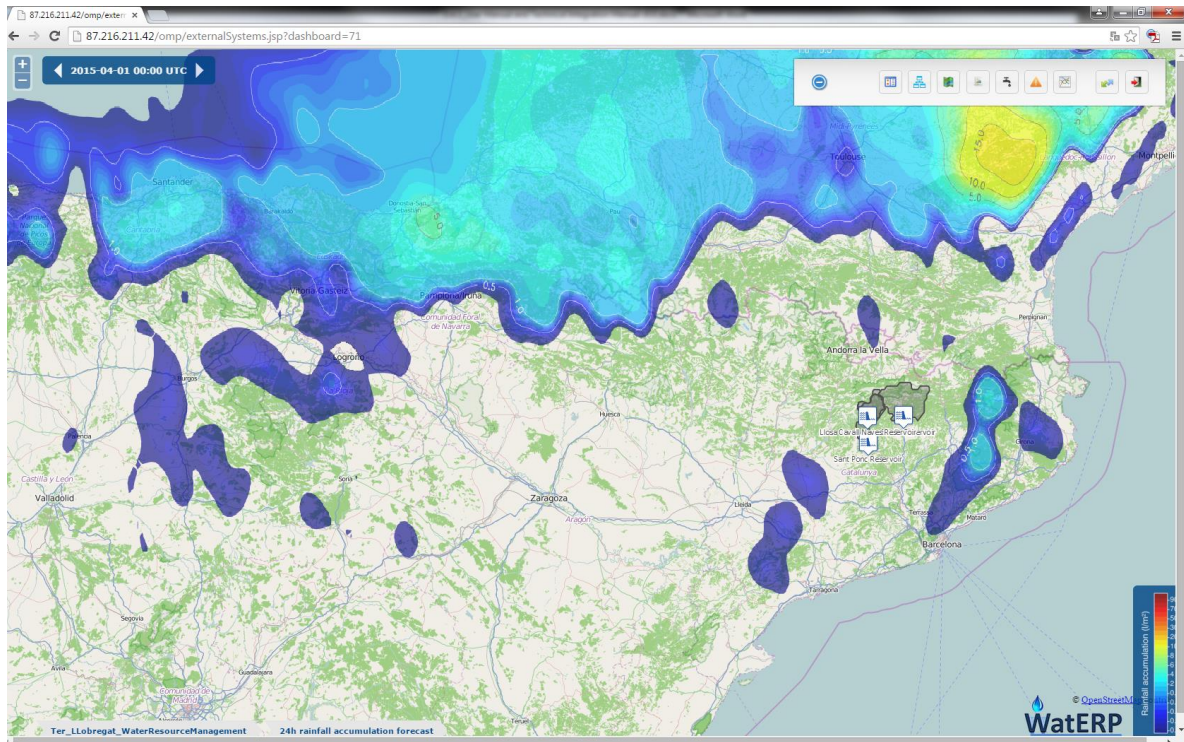


Figure 14 "Meteorological forecast external systems"

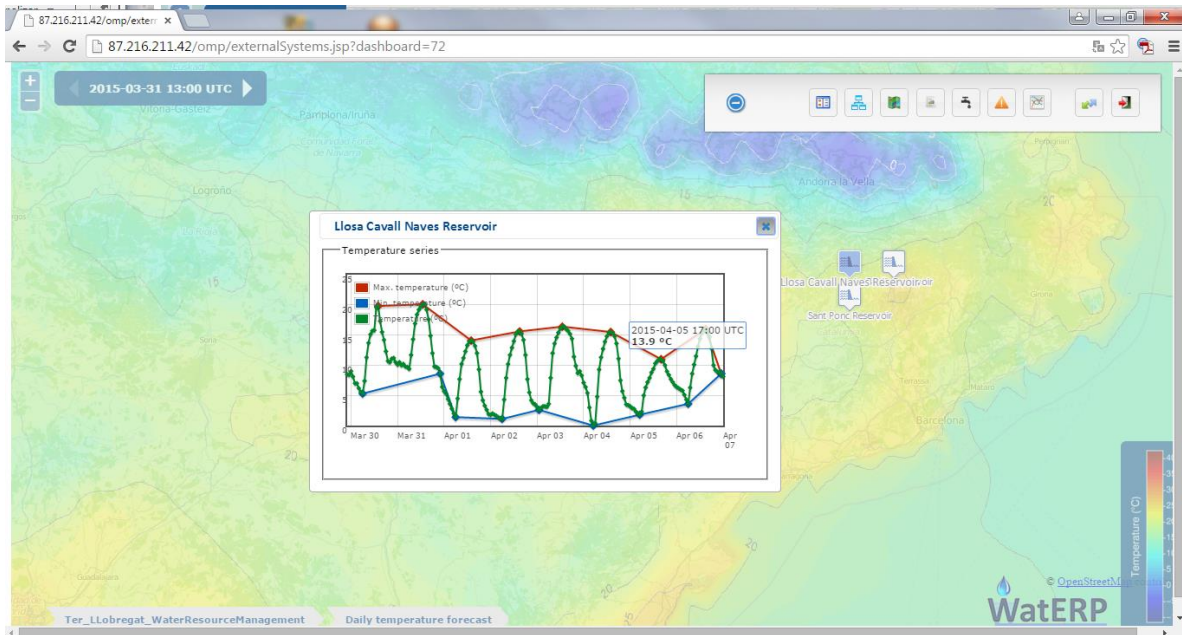


Figure 15 "Temperature forecast numeric values"

The hydrological external systems act exactly as the meteorological. There are two services, long-term and short-term hydrological forecasts, and both provide flow numerical predictions in different time scopes.

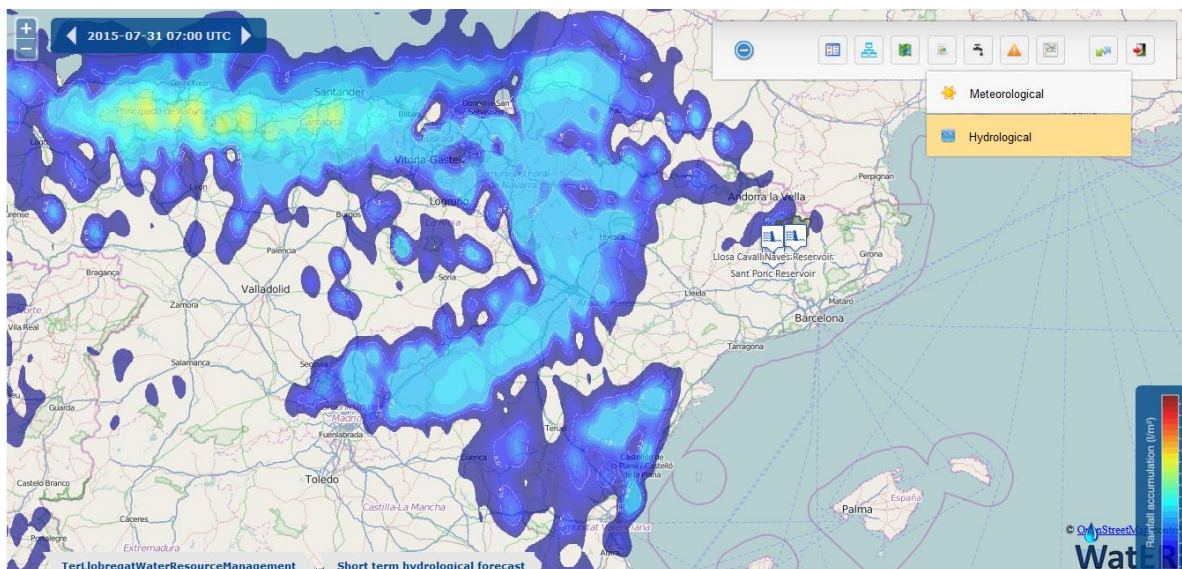


Figure 16 "Short-term hydrological forecast"

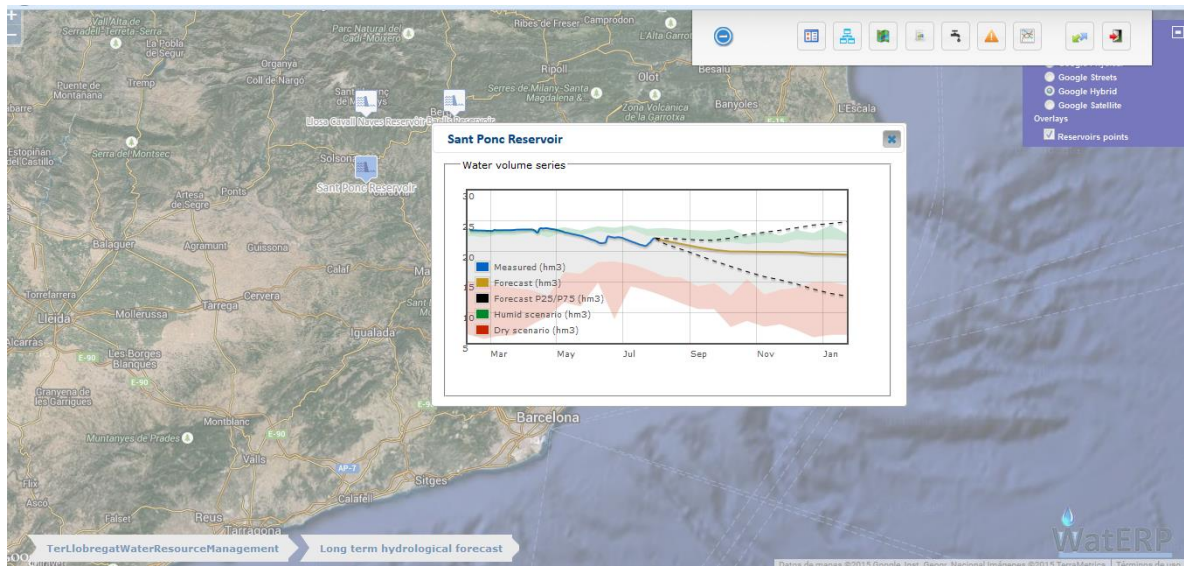


Figure 17 "Long-term hydrological forecast"

2.1.6 Demand Management System Forecast

The demand management forecast is accessed through the main menu, and represented by the tap icon. By selecting the DMS, the OMP will request for the last demand forecast for the current logical model and will show it both in numerical and graphical manners.

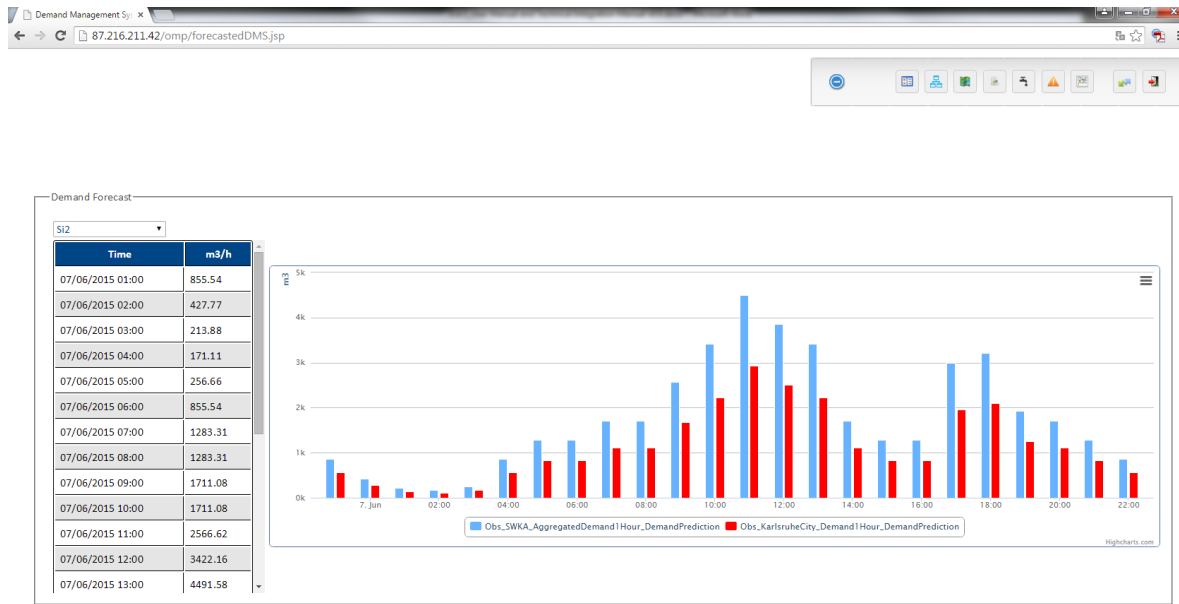


Figure 18 "DMS demand forecast screen"

The screen allows the water manager to view the accumulated demand and the particular demand for each of the SINK water resources available in the current logical model. Also, it is possible to compare all demands graphically.

2.1.7 Demand Management Instruments

The demand management instruments allows the water expert to communicate with the "Tools For Economic Instruments" defined in **D5.3 "Tools for economic instruments"** and detailed in the consortium internal document "*Discussion document on End User Interface for Economic Tool*" of Water Demand Management System (WDMS) by ICCS.

Demand Management Instruments are a collection of dashboards which can be accessed by the WDMS button in the main menu.

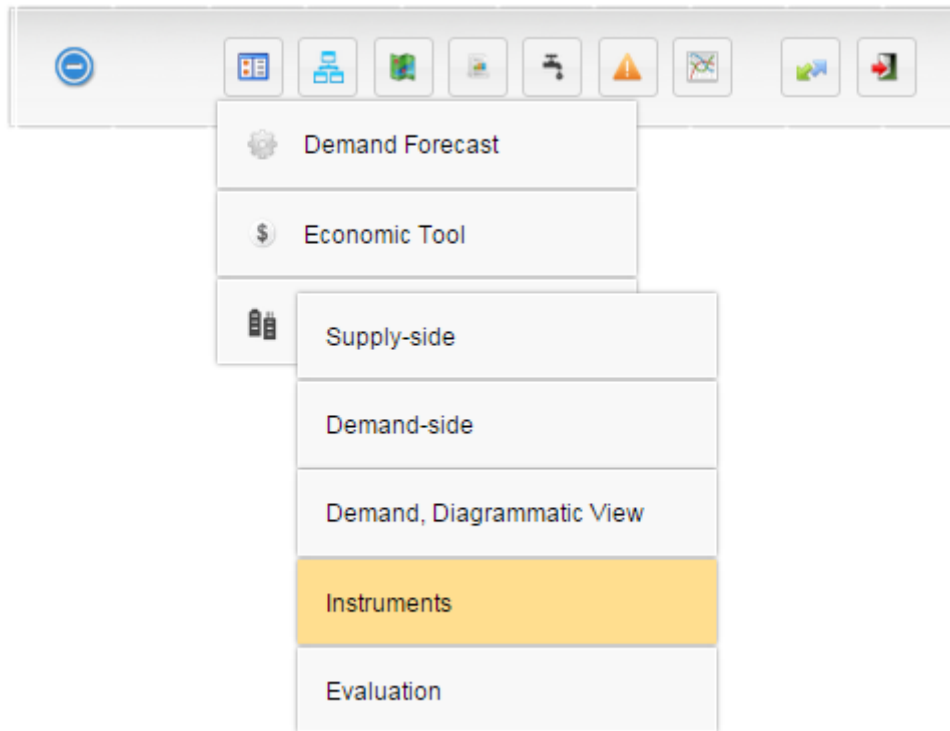


Figure 19: "Menu Demand Management Instruments"

This tool is composed by five dashboards each of them emphasizes a different view about the information involved in the Demand Management Instruments. The needed dashboards are defined in the second prototype of the OMP: deliverable **D6.4, section 3.2.4 "User Story: Demand Management System"**.

2.1.7.1 Supply-Side Dashboard

This dashboard contains all water system actors, their attributes and relations. It has a Diagrammatic Network View with the Bulk water suppliers, the Utilities water suppliers, consumers and clusters (sinks) and the interrelations between them.

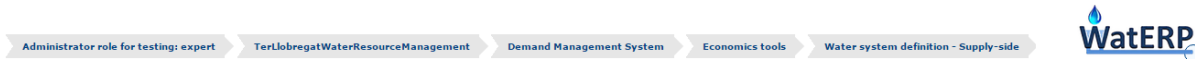
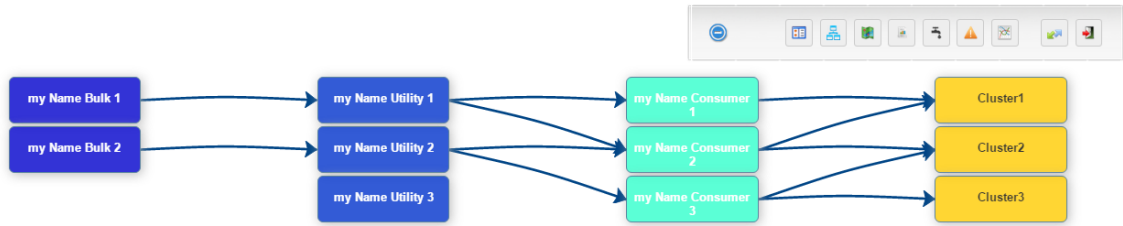


Figure 20: "Supply-Side Dashboard"

If the user clicks on an element of the graph a pop-up window with the properties of the selected element is shown.

2.1.7.2 Demand-Side Dashboard

This dashboard is a map with the clusters polygons drawn inside. The clusters have a pop-up window with their relevant information.

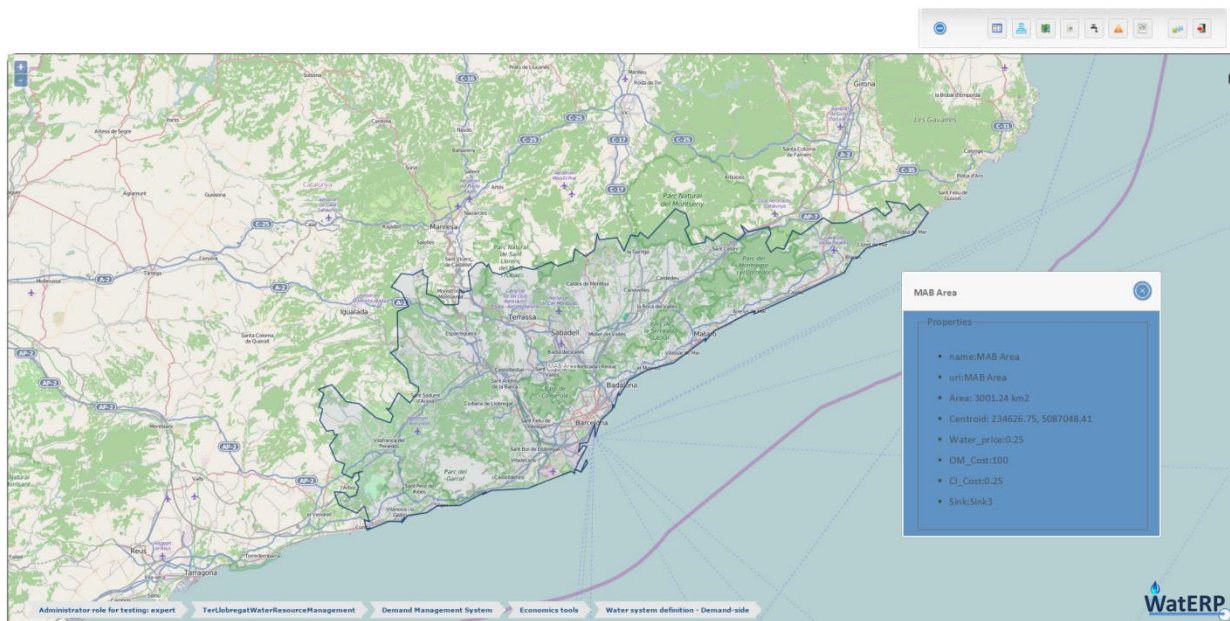


Figure 21: "Demand-Side Dashboard"

2.1.7.3 Demand Diagrammatic View Dashboard

This dashboard contains the complete structure of each cluster, an individual cluster has to be selected and the diagram of “User Classes”, “Activities” and “Appliances” will appear. This is the non-geographical view of the entities, thus it is a complementary view to the Demand-Side dashboard.

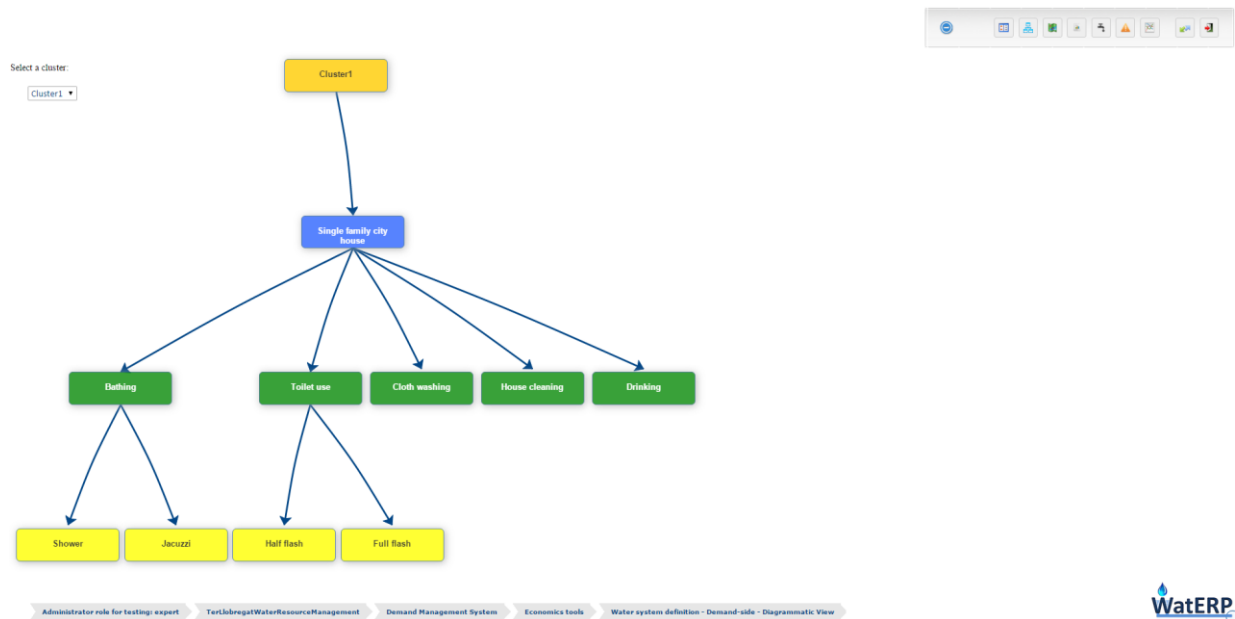


Figure 22: "Demand Diagrammatic View Dashboard"

Once a cluster (SINK) is selected a diagram appears with: the user classes (blue boxes) that the SINK has. Referenced to the user classes appears the activities (green boxes), and in the same way, the appliances (yellow boxes) referred to the activities.

If the user clicks on an element of the graph a pop-up window with the properties of the selected element is shown.

2.1.7.4 Instruments Dashboard

This dashboard allows the user to change the demand system behaviour by applying the selected economic instruments with the defined values.

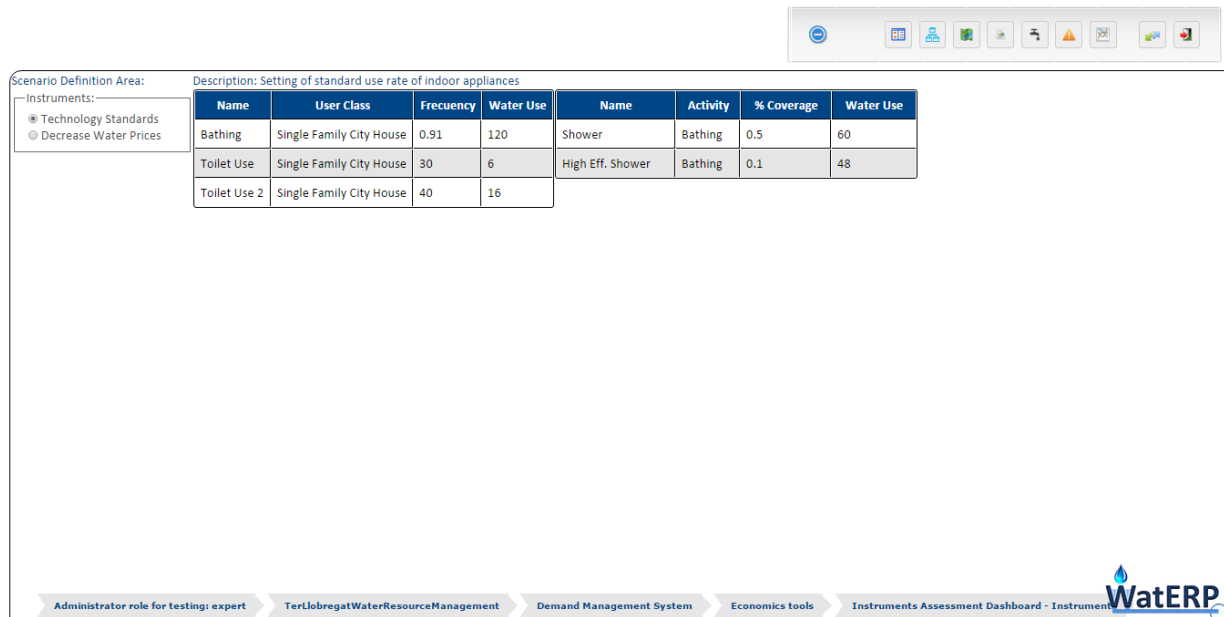


Figure 23: "Instruments Dashboard"

2.1.7.5 Evaluation Dashboard

This dashboard contains the assessment of the differences between the water system baseline and the scenario built by the baseline modified with instruments. The results are indicators for expressing the impacts of applying the instruments: water saving potential, affordability of water services and financial sustainability on water services provision.

This dashboard shows all the results of the instruments application. On the top of the screen a diagram shows the flows, both financial and water; the user can query the flows-parameters by clicking on the arrows.

The bottom part of the dashboard contains the charts with the indicators values: water saving potential indicators, affordability indicators and cost recovery.

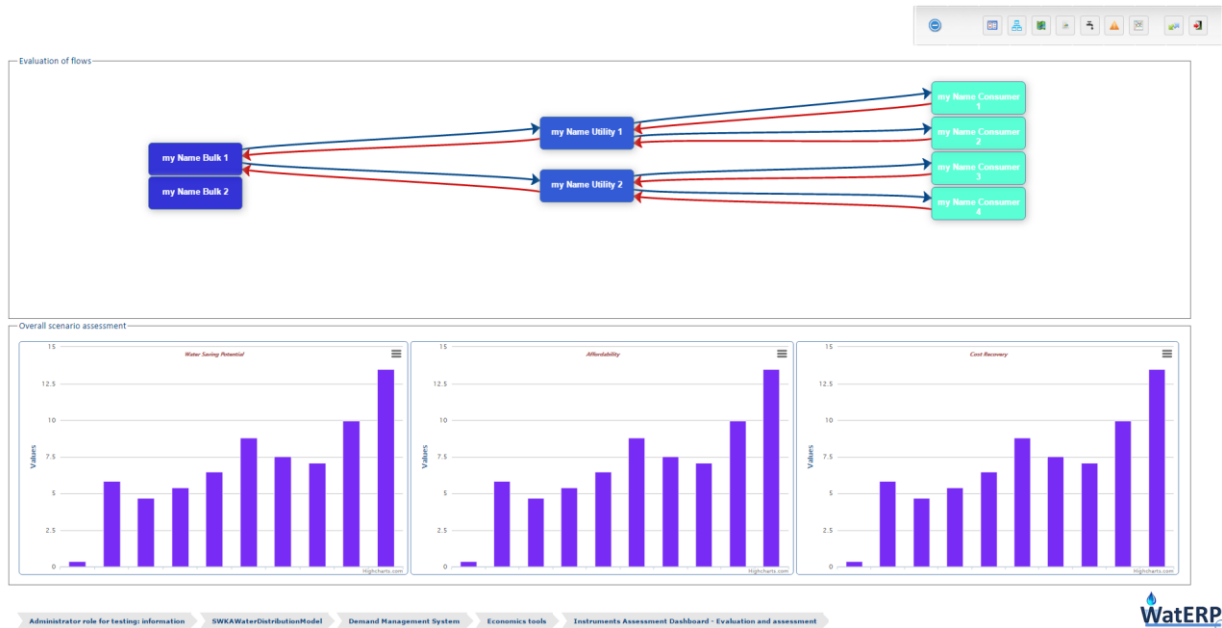


Figure 24: "Evaluation Dashboard"

Water Saving Potential Indicator: This chart will contain the whole water system saving potential indicator and the individual water saving potential for each consumer (not for bulk suppliers and water utilities), all in hm³/year.

Affordability Indicators: The affordability indicators are applied only to the consumers. There are two affordability indicators which will be shown alternatively in the user interface. The annual expenditure of consumers for water service, expressed as a change from the baseline case. The chart will contain the payment for water services at the baseline state, the payment of consumer after applying the instruments and the difference between them.

Cost Recovery Indicators: The cost recovery indicators are applied to the bulk suppliers and the water utilities, for each of them the chart will have a bar with the changes in annual expenditures of consumers.

2.1.8 WaterCity configuration

WaterCity is an independent tool which aims at promoting engagement and enhancing user participation in residential water conservation activities by employing persuasive strategies and triggering social motivation. The uses and implementation of WaterCity is deeply defined in deliverable **D5.4 "Social web-based tools for awareness raising towards demand management"**.

The OMP link with the WaterCity tool deals only about the configuration of the parameters that the WaterCity needs to run. To access to the WaterCity configuration tool the user has to select the indicated menu on the WDMS button.

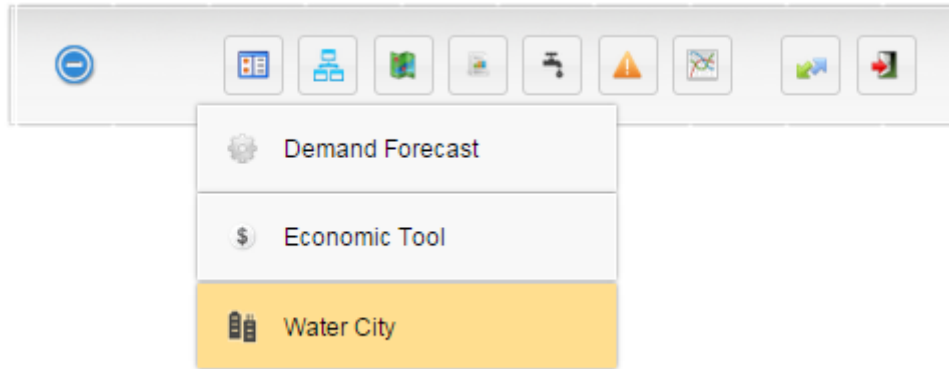


Figure 25: "WaterCity access"

So the water expert through the OMP is able to set the values for the needed parameters and also to reset the parameter values. When the user click the "Update" or "Reset" buttons the information is sent to a Web Service in the WaterCity to be used inside the tool.

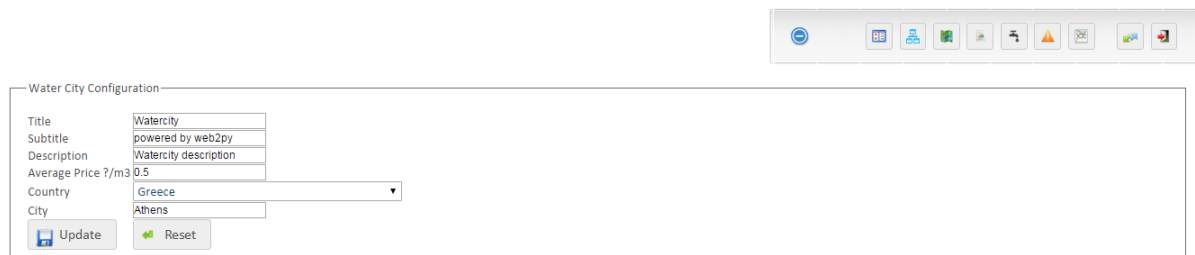


Figure 26: "WaterCity Configuration Dashboard"

2.1.9 Alerts

This dashboard is designed to show threshold alerts to the user. The threshold alerts are the classical hydrological alerts (the exceedance of a minimum or maximum threshold), which are based on information gathered by a sensor and that the water manager should be somehow alerted about. The first step is to request to the MAS these observations which have associated thresholds, and then when the user select an observation a chart with the real time values gathered for that observation is shown

with the threshold values defined. This is the more efficient manner to give that information to the water expert.

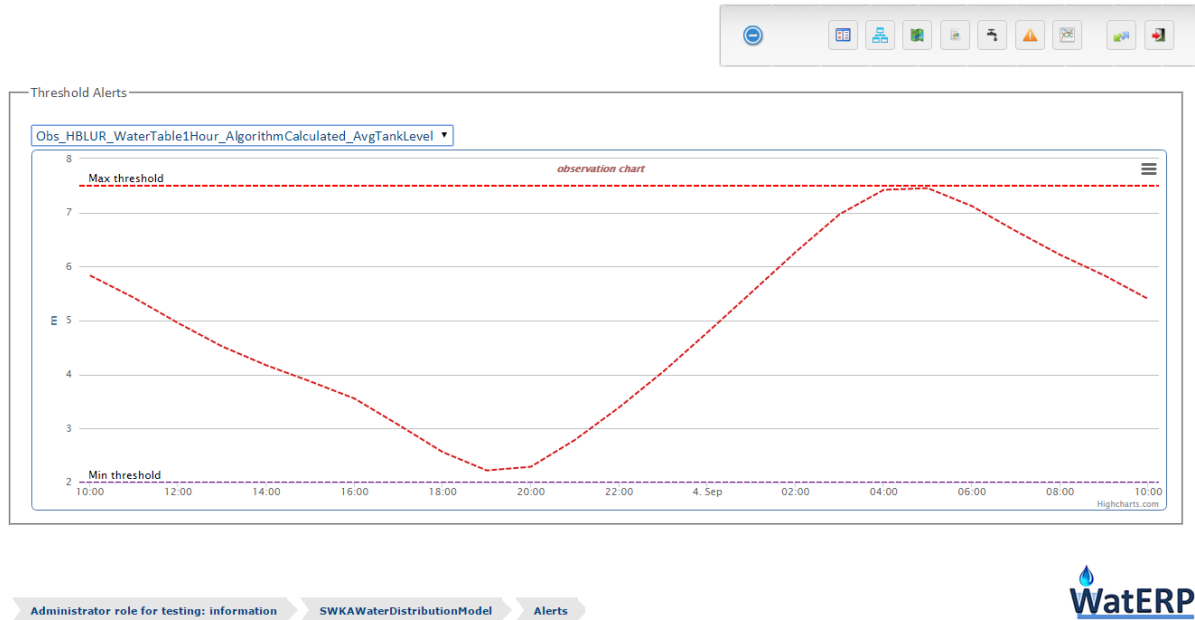


Figure 27: "Alerts Dashboard"

2.1.10 Business Intelligence Platform

Business Intelligence Platform is the tool designed to help the pilots to learn and understand their business, as any BI platform is commonly defined. The BI platform is composed by six different frames; each user is able to choose the information to show in any of the frames. With the first access to the BI platform, the user is advised to establish a default configuration. When the user clicks on the "Edit" button then he/she is able to set the desired configuration to the six different frames. For each frame the application needs: i) a chart name; ii) if the chart is enabled or not; iii) the observation to draw (belongs to a water resource and a feature of interest); iv) the chart pattern to draw; v) more observations to draw in the same frame (by clicking the green cross).

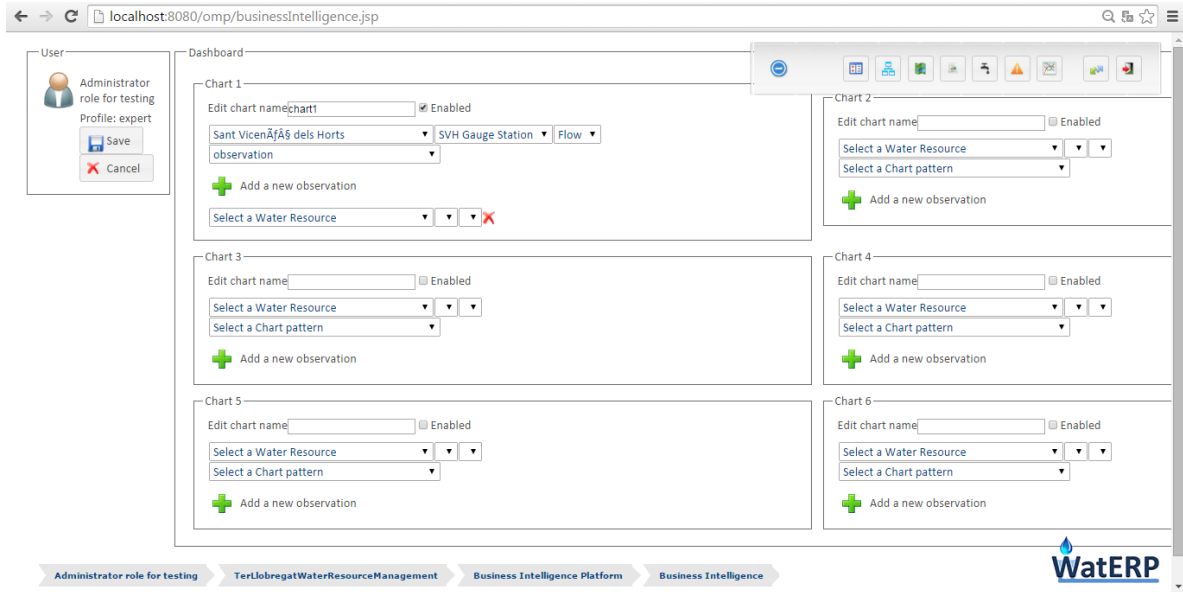


Figure 28: "Edit window for BI Platform"

To finish the edit the user has to click the "Save" button and the window will be reloaded with the customized data.

As OMP is only a prototype, the user is responsible to select a valid chart pattern for the desired observations. So if the link could not be established the observation will not be drawn, and this is a very common mistake.



Figure 29: "BI Platform"

2.2 Supply-Demand Matching decision process

The aim of the “Supply-Demand Matching Decision Process” is to provide recommendations about how to best allocate the available water resources among the various water users, by optimizing the resources, given the limited water supplies. Therefore, by prioritizing water to be abstracted from each source to satisfy the different demand, water will be saved by just improving the management of the supply chain.

2.2.1 Methodology

Given the essence of this decision process, it is needed that the DSS runs daily in order to obtain new recommendations with the new data provided (demand forecasted and observations). So the OMP daily makes a request to the process defined to execute de Supply-Demand DSS with the current selected infrastructure-parameters. After the execution the OMP is able to provide to the water manager all the information about the current state of the elements of the water supply chain and the recommendations given.

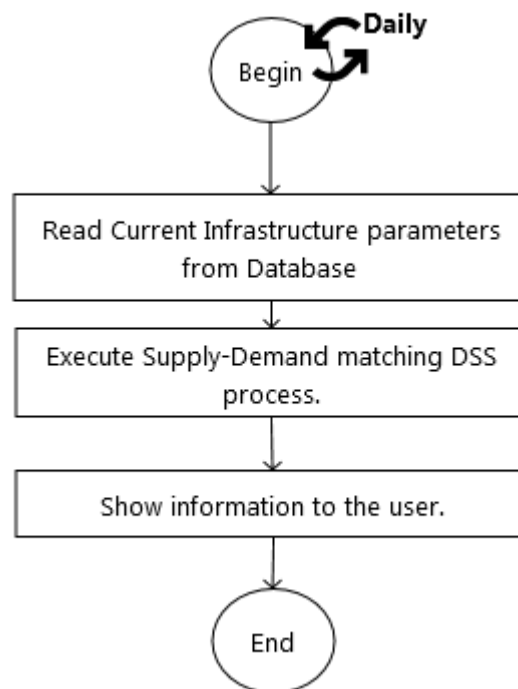


Figure 30: "Supply-Demand matching DSS flow diagram"

2.2.2 User interface

The different dashboards taking part on this DSS do not have a defined order. Most of them are the tools defined to give to the user the information generated after the today's DSS execution. The best

way to show all the DSS result to the water expert are deeply detailed in **D6.2, section 2.3.1 “Decision Processes: Supply-Demand Matching”**.

Just only one dashboard “V019 Defining structural system characteristics/capacities” has an impact on the result of the DSS execution. In this dashboard the user is able to customize the different parameters defined for each infrastructure of the basin. Thus when the DSS is executed it reads these parameters as inputs for the Rule Base Reasoning machine.

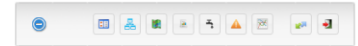
Thus the dashboards defined in the Supply-Demand matching DSS have not a defined and static order. As a quick overview: the parameters set on V019 dashboard are the inputs for the DSS and the other dashboards are the outputs.

2.2.3 Infrastructure Dashboard

This dashboard gives the possibility to change the behavior of the infrastructures of the basin if needed. The infrastructures to modify and the meaning of each parameter is defined in deliverable **D4.1, section 3.1.4.3 “ACA pilot rules and procedures”**.

The user has to define if each infrastructure configuration is working or not. If the configuration is working a period can be set, so the configuration for the selected infrastructure will only works in the selected period. Each infrastructure has a collection of characteristic parameters for which a value has to be set; these parameters represent the minimum and/or maximum flow in which the infrastructure can operate.

These configurations are stored in the OMP database and the next schedule of the DSS will read the new values and send them as inputs for the RBR machine through SOA-MAS architecture.



Defining structural system characteristics/capacities

Infrastructure: Save

Yes No

Always Select

Infrastructure	Value	Unit
ACA_S11	0	m3/sq
ACA_S12	4.7	m3/sq
ACA_S14	0.5	m3/sq
ACA_T10		
ACA_T17		
ACA_T18		
ACA_T19		
Q1F7 work min:		

Figure 31: "Infrastructures Dashboard"

2.2.4 Resources status Dashboard

This dashboard represents the current state of the storages on the basin and the current scenario (abundance, normality or scarcity) in the predefined resources: system, reservoir, Ter and aquifer.

This allows the water manager to have an overview of the entire system, allowing him/her to better understand the actual constraints of the basin regarding the management of resources.

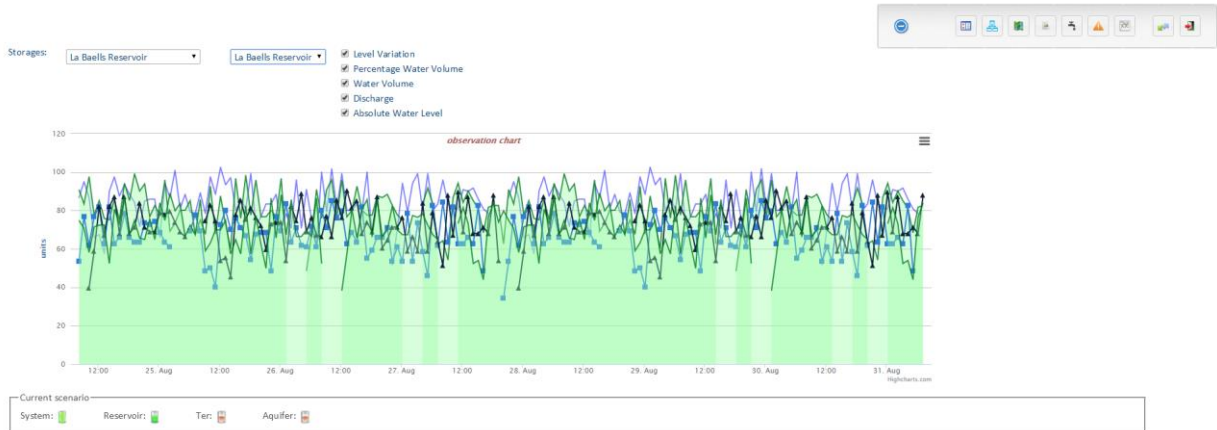


Figure 32: "Resources Status Dashboard"

2.2.5 Demand Forecast Dashboard

This is a very simple dashboard just to show the user the demand forecasted values for each sink in the temporal frames considered: today and the next two days.

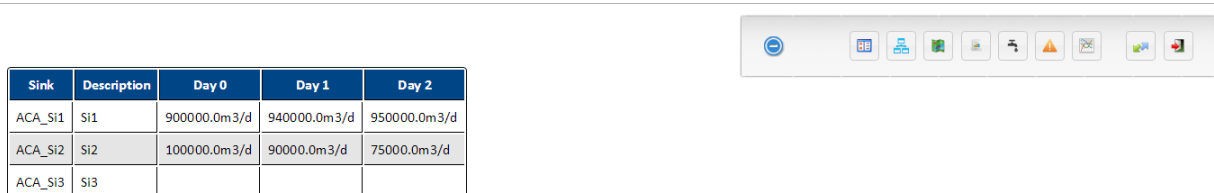


Figure 33: "Demand Forecast Dashboard"

2.2.6 Recommendations Dashboard

This is the main dashboard to show the recommendations made by the DSS for each day, the user is able to easily change the day to show the recommendations about it.

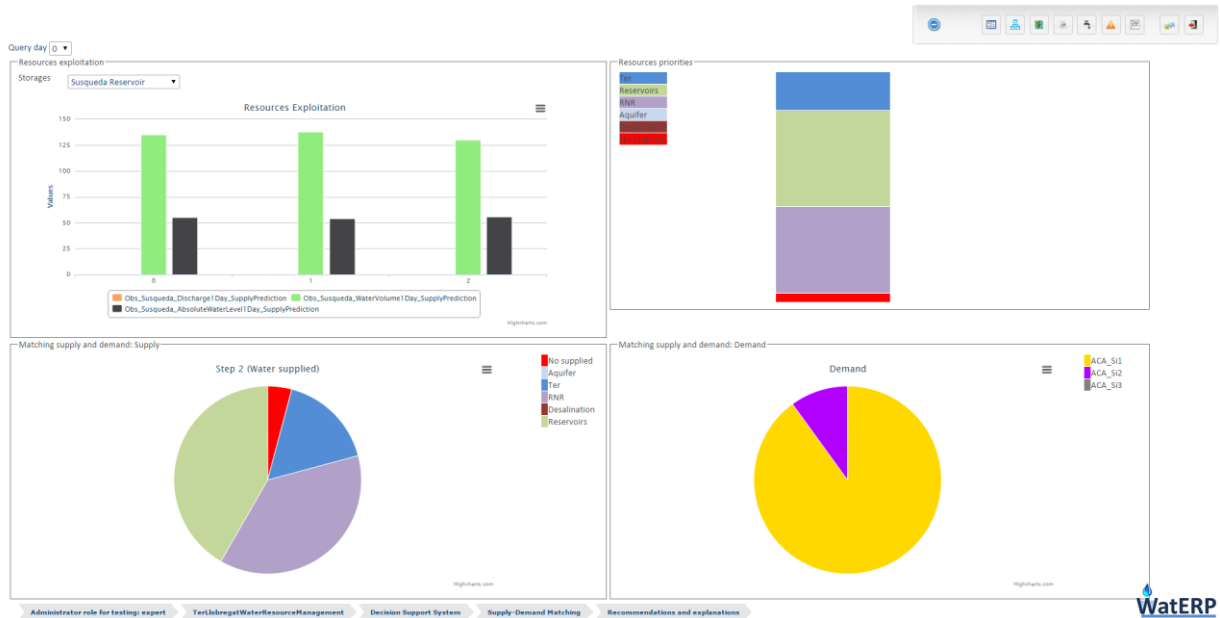


Figure 34: "Recommendations Dashboard"

As shown in the above figure the dashboard has four frames to help on the visualization for the water expert. This kind of representation attempts to summarize and tag all the information provided by the DSS output.

In the "Resources exploitation" frame, the user is able to select a storage and see its evolution during the next three days. The observations shown for the selected storage are: forecasted discharge, volume and level.

The "Resources priorities" frame gives to the user the recommendations about how the demand will be fulfilled, making a prioritization between the resources. So the resources are placed on the stack with a top-down prioritization, thus the resource on the top of stack is the first to use and so on. Each day has its own stack so this frame changes when the user selects another query day.

The frame "Matching supply and demand: Supply" shows for each resource the percentage that the amount of water supplied by this resource represents within the total water supplied. Each day has its own politic about water supplied so this frame changes when the user selects another query day.

The frame "Matching supply and demand: Demand" shows for each sink the percentage that the amount of water demanded by this sink represents within the total water demanded. Each day has its own demand so this frame changes when the user selects another query day.

2.3 Improve Energy Efficiency decision process.

The “Improve Energy Efficiency” Decision Process aim is to reduce the energy consumption of a water supply distribution network supplying all the water demanded, maintaining the service level and accomplishing the restrictions of a particular network by improving the pumping scheduling of the whole distribution system.

2.3.1 Methodology

Following, the methodology that a water manager has to adopt to perform correctly the process is described. The process is driven by the flow diagram depicted bellow (Figure 35 "Improve Energy Efficiency process flow diagram"):

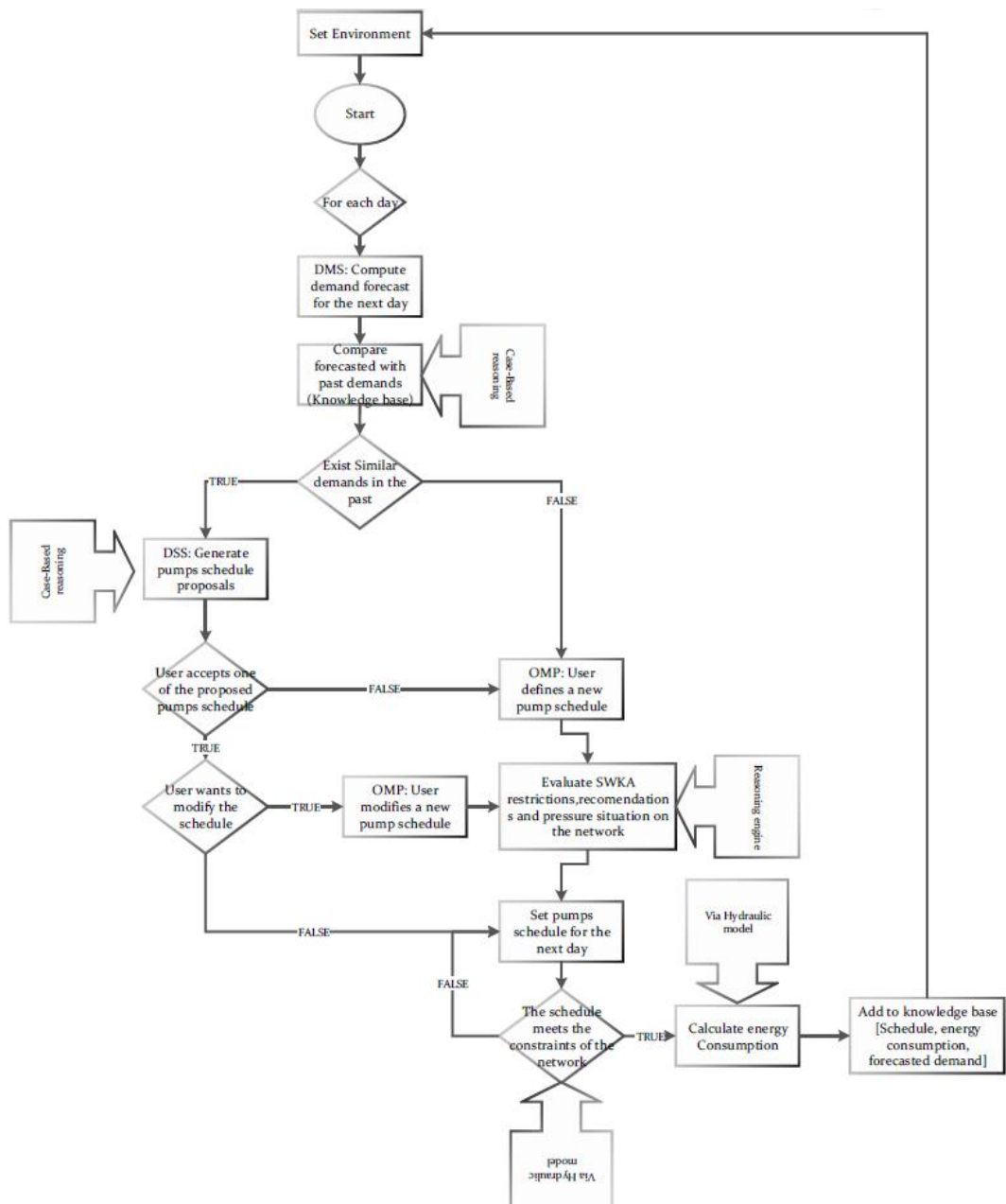


Figure 35 "Improve Energy Efficiency process flow diagram"

The decision process should be run every day due to it need to be learn and discover the optimal strategy to be followed to satisfy the demand, and manage efficiently the distribution network.

The daily process starts with the computation of the forecasted demand for the next day; the DMS should compute it and return it to the OMP and the DSS. The forecasted demand is represented in an hourly set of demand values for the next 24 hours.

With the forecasted demand, the DSS should obtain similar demands that occurred in the past, by comparing a set of features of the forecasted demand to the same set of features of all the past satisfied demands. This set of features are geometrical characteristics of the curves that represents physical elements, such as area of the curve (represents total demand supplied), peak values (maximum demanded flow in an hour), peak time (peak demand length) and other features like these. Each feature is weighted to be able to compute a value that represents how similar the two demand curves are.

With this collection of similar demands, the system is able to compute a set of recommended pumps schedules. A pumps schedule is represented in an hourly time step curve for the next 24 hours with an ON/OFF value for each ten minutes and for each pump of the supply network. If there are no similar demands in the knowledge base, the expert user should define the pump schedules for the next day. On the contrary, if there are similar demands, the DSS should to provide the expert user a recommendation about the best way to satisfy the forecasted demand from energy savings point of view. In order to do that, a process to compare the rate of similarity between the similar past demands and the forecasted demand is automatically fired, taking into account the energy cost for each past pumps schedule.

With the recommended schedule, the user has two options: either to accept and use it to satisfy the forecasted demand, or to change the proposed schedule to create a new one for the next day. In case of a new proposal, the DSS should learn how to improve the water supply taking into account the forecasting demand. This process works because demand patterns for urban water supply are repeated frequently, with very little variation between the demands supplied.

Once the user has defined the schedule for the next day; the DSS ensures that this schedule meets the supply network restrictions and constraints. These restrictions can be of different types: policies, quality of water, pressure to accomplish in certain points of the network... and should be defined by the water managers in the early steps of the WatERP system deployment. This information is computed by the DSS using a hydraulic model of the supply network to simulate the behavior of the network elements under the conditions of the proposed schedule.

If any of the constraints are not accomplished, the DSS will send an alert to the expert user, and begin a new schedule definition process. If all the restrictions are accomplished, then the DSS will compute the energy consumption of the proposed schedule (using the hydraulic model of the network) and will store in the knowledge base the new information gained: pumps schedule, demand to be satisfied and energy costs of this management to be used in the future.

2.3.2 User interface

The previous sections describes the methodology and processes needed to carry out the “Improve Energy Efficiency” Decision Processes; based on these descriptions, a visual environment is needed to support the decision making process and described in this section.

The process is driven by the navigation graph depicted in Figure 36 "Improve Energy Efficiency user interface navigation graph" with four dashboards each of one with specific purpose, three of them are part of the decision making process, while the other is for the real-time evaluation of the recommendations provided.

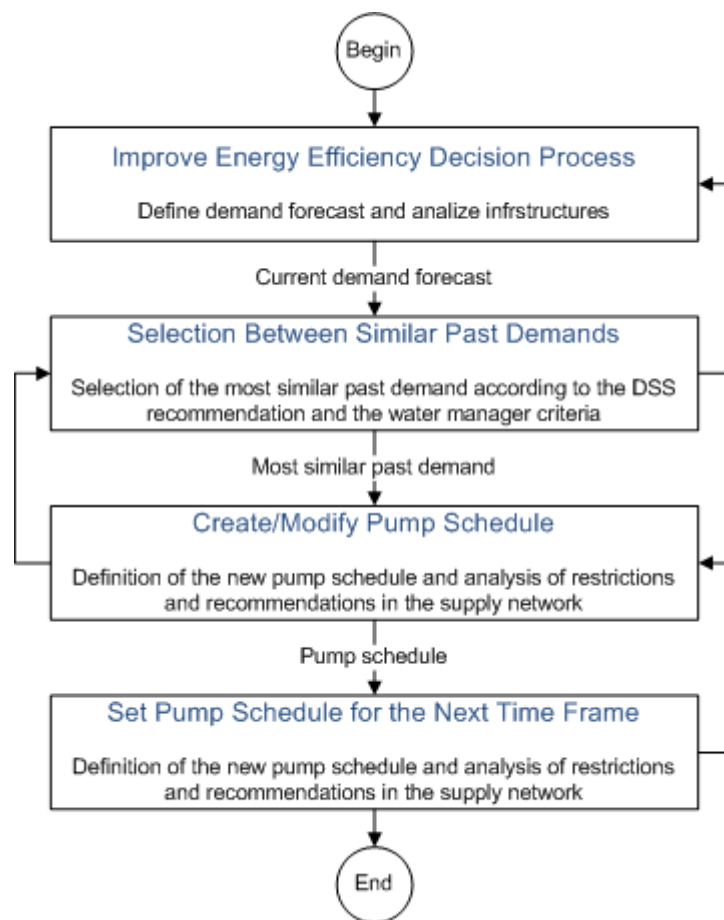


Figure 36 "Improve Energy Efficiency user interface navigation graph"

The DSS icon of the OMP main menu contains a sub menu to access each of the dashboards:

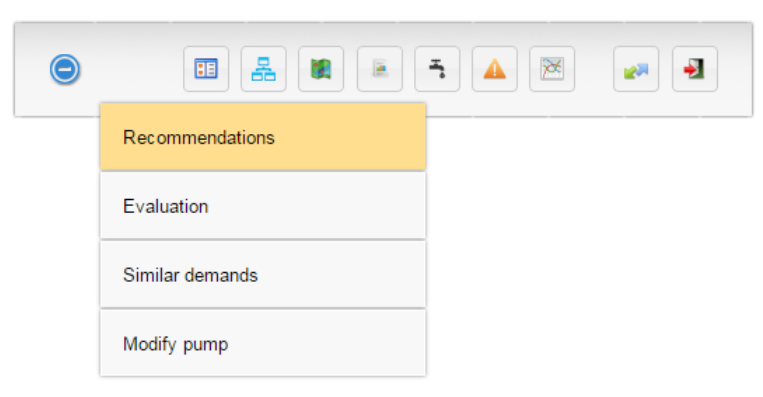


Figure 37 "Improve Energy Efficiency OMP sub menu"

At all times, the DSS sub menu adapts in order to enable only the available dashboards depending on the decision process status. For example, if the pump schedule for the next day is set, only the "Recommendations" dashboard will be available in the sub menu.

2.3.2.1 Evaluation dashboard

In this dashboard the status of the system and the available information are depicted in a graphical way.

There are two objectives; on the one hand, the assessment and selection of the demand forecast for the next day to be used in the rest of the process, on the other hand, to access to the characteristics of the water supply infrastructures.

Regarding the demand forecast, the upper frame of the view allows the water manager to select the demand forecast (requesting the available demand forecasts via the Demand Management Systems) to be used in the rest of the decision process. By selecting one of the listed demand forecasts, it opens a pop-up window with the demand chart. Currently, only one demand forecast is available, so the OMP will select this automatically and no user interaction is needed.

The infrastructures are depicted in the main frame of the view which contains tabs for any of the water resource elements that are needed to make recommendations (TRANSFORMATIONS, SINKS and STORAGES) are shown in order to facilitate the access to each water resource of the infrastructure. By selecting a concrete infrastructure a combo box will be filled with the information available for this infrastructure. In the example of the Figure 38 "Improve Energy Efficiency evaluation dashboard" the upper part contains the aggregated water demand for the complete scenario compared with the demand for a single sink. The lower frame show the water consumption in the same sink the previous day.

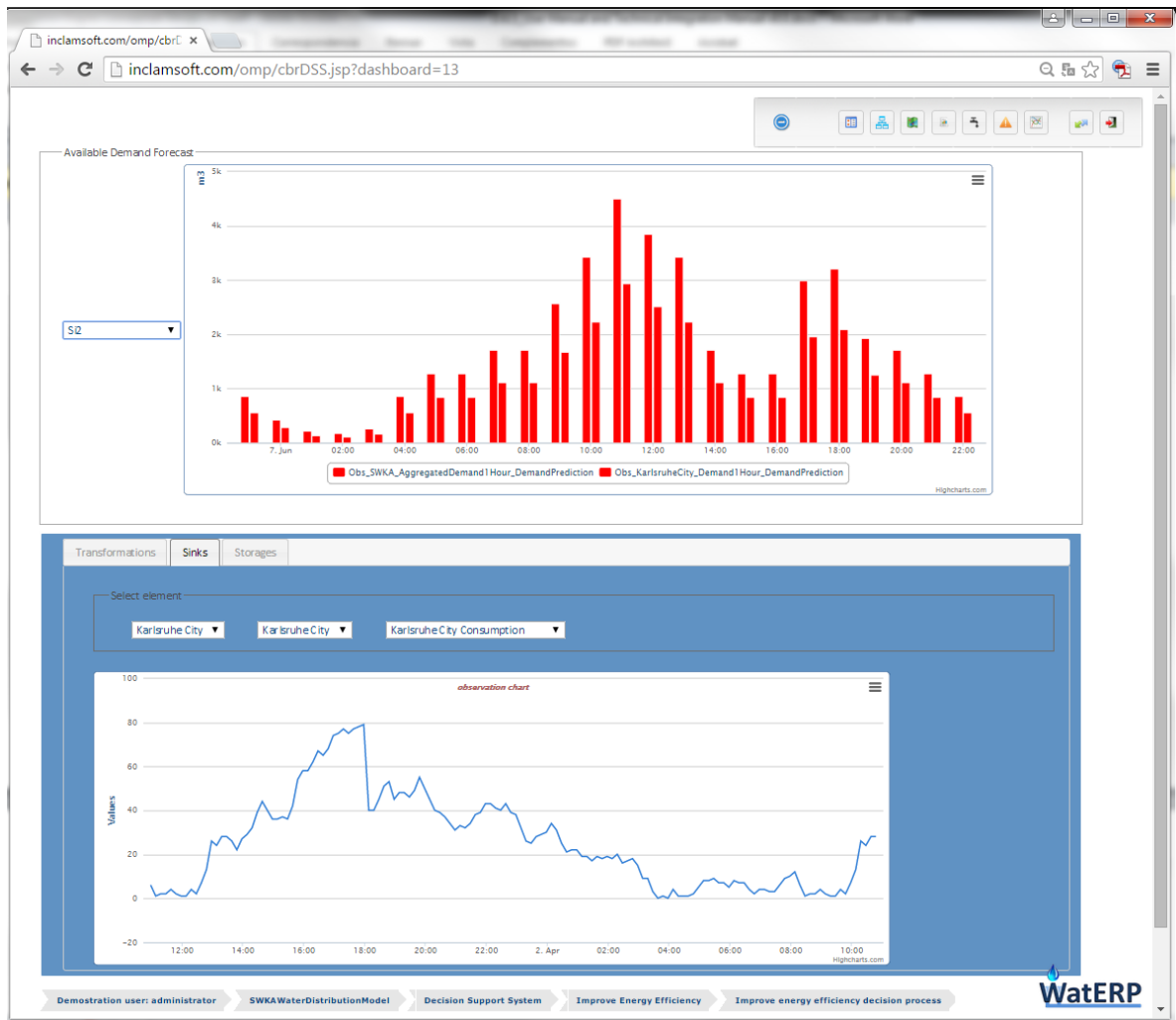


Figure 38 "Improve Energy Efficiency evaluation dashboard"

2.3.2.2 Similar demands dashboard

OMP's second view for this decision process is needed to visualize the past demands selected by the WatERP DSS as candidates to imitate their pumps management. This set of candidates is obtained automatically from the Case-Base Reasoning process, by comparing a collection of features of the demand curves and selecting the most similar to the forecasted demand calculated in the DMS. The OMP allows the water manager to analyse each of them from all viewpoints (demand supplied and pumps management), proposing the water manager the best option and allowing him/her to select another from the set of past similar demands.

In the left frame, the current demand forecast is showed in numerical values both aggregated and by sink, and the demand chart is showed in the main graph.

In the main frame, a list contains the similar past demand proposed by the DSS. Selecting one of them the main graph will show and compare the past demand with the forecasted demand.

Each list element (past demand) contains numerical and graphical representations of the demand and the related pump schedule/curve. The time series of demand curve presents a graph with the demand (main graph) and a table with time-value pairs (upper-right zone); and the pumps schedule time series (in the bottom zone, green for ON and red for OFF), along with the on-off state for each pump that has been used to supply that demand.

Bellow the past demands list, a little frame labelled as “Compare with” allows the water manager to show in the chart only the information of the current past demand or to add the information of another past demand, so as to comparing them graphically and numerically.

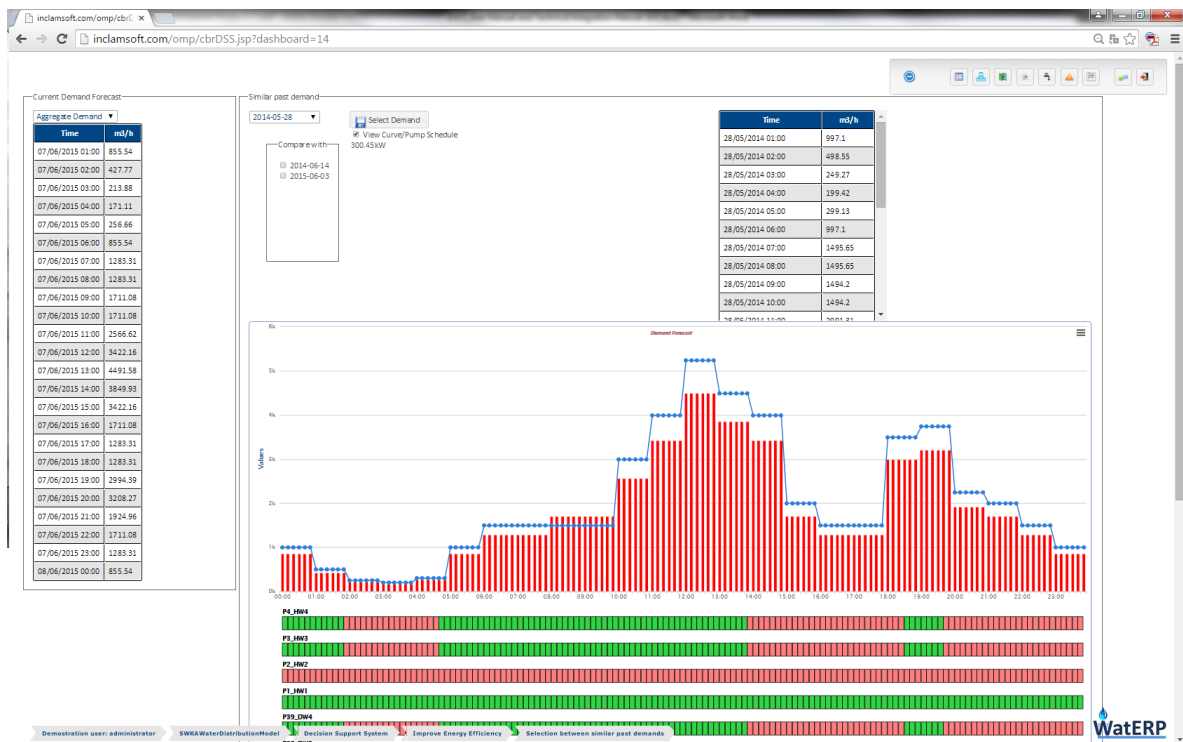


Figure 39 "Improve Energy Efficiency similar demands dashboard"

Finally, the water manager has to select one of the proposed past demands and its corresponding pumps schedule, and this selection is sent to the Modify pump dashboard.

2.3.2.3 Modify pump dashboard

Modify pump dashboard allows the expert user to modify the pumps management used in the selected past demand. This dashboard allows as well the water managers to create a new pump management from the scratch.

In the left frame, labelled as “Select Schedule”, it is possible to change the pumps group (or water work) schedule that is being visualized in each moment.

The main frame is labelled as “Current Water Work Pumps Schedule”, the water manager is able to change the status on/off of each pump in order to change the proposed pumps schedule. The schedule of the pumps is represented in the view as longitudinal bars (time scale), which is subdivided in order to represent the time step, each time step represents ten minutes. At the same time, these subdivisions (time steps) are coloured either in green or red, showing whether the pump are working or not (on/off status). By clicking on the time line the pump status will change between ON and OFF.

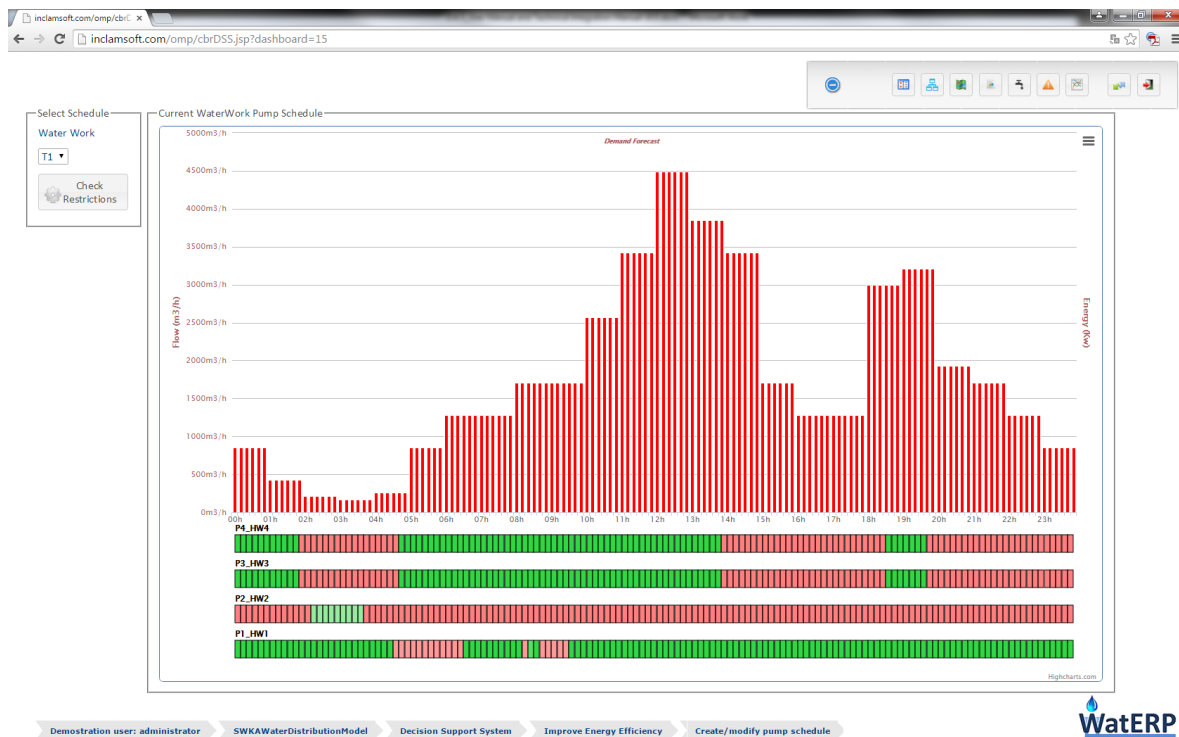


Figure 40 "Improve Energy Efficiency Modify pump dashboard. Initial status."

The main objective of this dashboard is to check whether the selected pump schedule is good enough to supply the demand from the energy efficiency point of view. In order to verify this, a collection of restrictions and recommendations have been set in the DSS. These set of rules define if the status of the supply network is the required or desired when the pumps schedule runs.

With the new or edited pumps schedule, the Reasoning Engine must then assess if all restrictions of the supply network are accomplished, and if not, alert the water manager and allow him/her to change the pumps management until all the restrictions are satisfied (it is not possible to continue the decision process if any the restrictions are not accomplished).

In order to perform these verifications, a hydraulic model of water supply distribution system is run. This model simulates as well the pumps work schedule.

The expert water manager can modify, add or remove restrictions and recommendations set of rules, in order to improve the DSS learning about the efficiency of a pump schedule to satisfy a demand.

In this dashboard, the button labelled as “Check Restrictions” makes the DSS process to check the state of all the restrictions and recommendations (accomplished or not) and the possible reasons of why a restrictions has not been met. When this button is clicked, the hydraulic models runs and the OMP show a screen waiting for the hydraulic simulation ending.

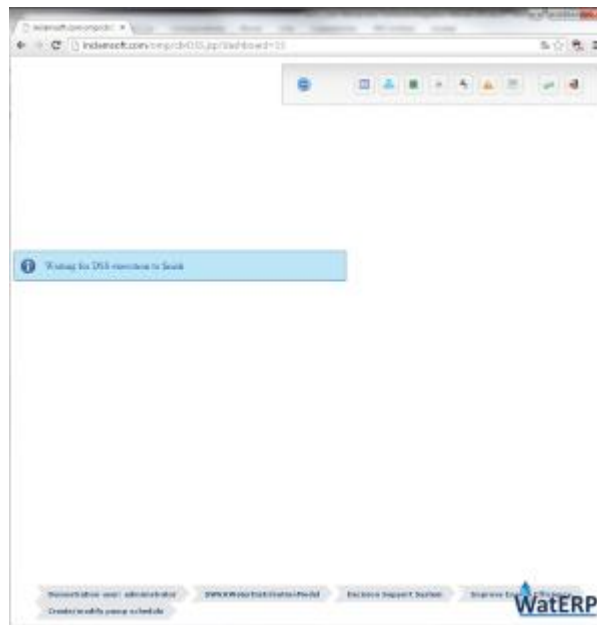


Figure 41 "Improve Energy Efficiency Modify pump dashboard. Waiting for hydraulic simulation."

Once the hydraulic model ends and the DSS performs the rules checking, the “Select schedule” frame changes in order to present the hydraulic results of the simulation and the scenario status.

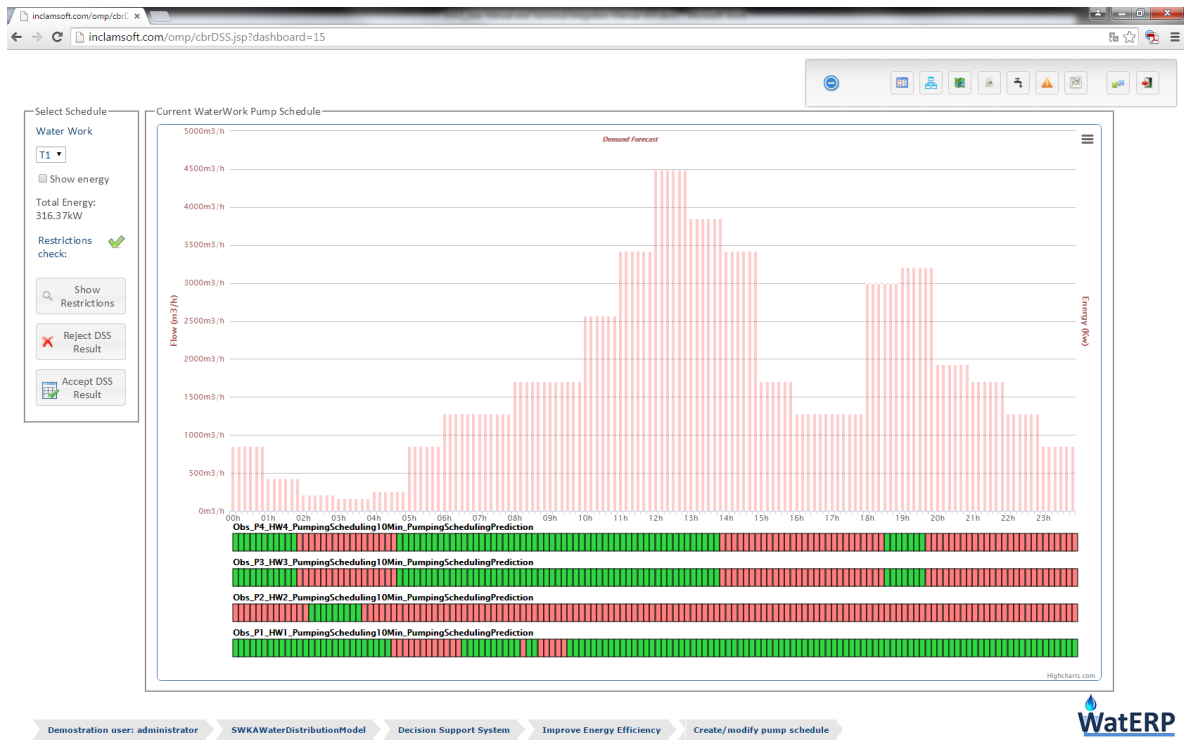


Figure 42 "Improve Energy Efficiency Modify pump dashboard. End simulation status."

DSS results are shown in a pop-up window (Figure 43 "Improve Energy Efficiency Modify pump dashboard. Restrictions and recommendations.") which includes the list of restrictions, the list of recommendations and the status of each one for the current pump schedule and demand forecast. This pop-up window is available clicking on the "Show restrictions" button.

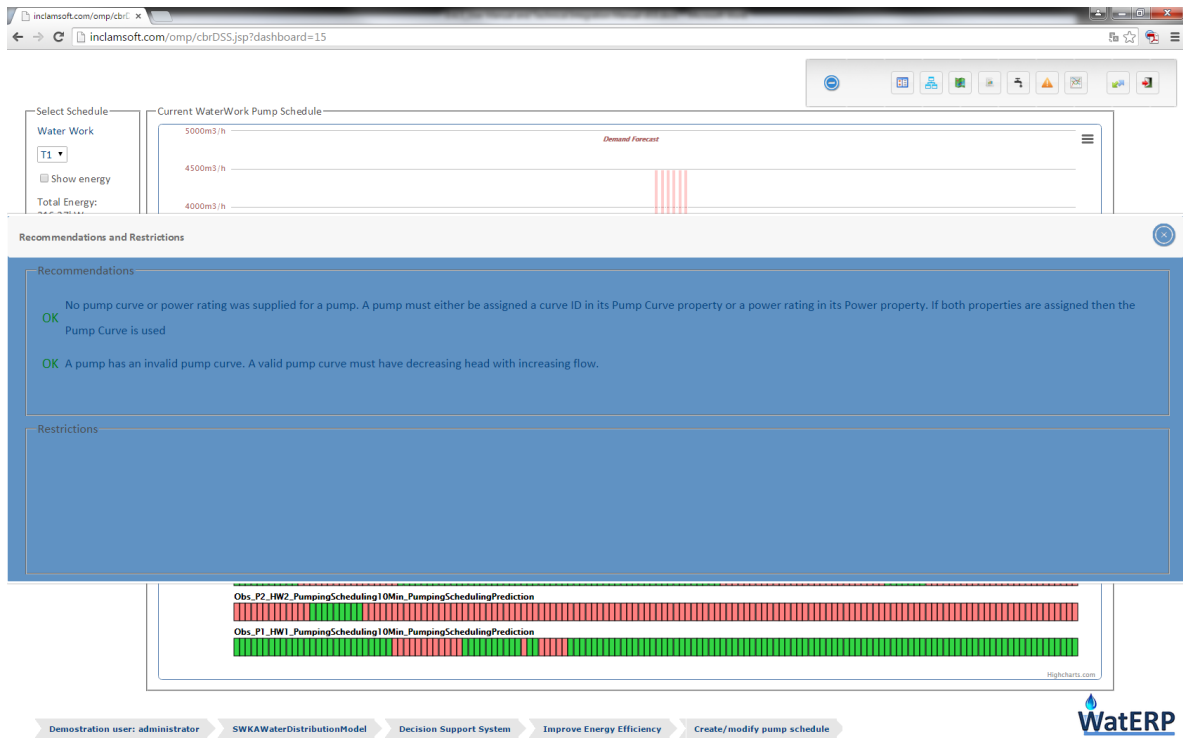


Figure 43 "Improve Energy Efficiency Modify pump dashboard. Restrictions and recommendations."

The water manager can accept the current pump schedule (button "Accept DSS results") or return to the previous dashboard to generate a new pump schedule (button "Reject DSS results"). If any restriction is not accomplished, the button "Accept DSS results" appears disabled and the water manager can only back to the previous dashboard.

By the end of the process that this dashboard implies, a pumps schedule is selected to satisfy the forecasted demand in the supply distribution network, accomplishing all restrictions and recommendations which ensure the correct status of the water system during the next day.

2.3.2.4 Recommendations dashboard

The aim of this dashboard is not to generate a pump schedule, but to evaluate in real time the pump schedule set for the current day.

Specifically, the dashboard objective is to monitor and compare the forecasted behaviour of the supply network with its real behaviour (sensors metering); as well as to compare the present management with past pumps management in order to obtain the improvement of energy efficiency.

The visualization dashboard includes predictions (forecasts) and real data to estimate errors. All the information is presented in one graph including, demand forecast, real demand, evolution of the storage level, water works efficiency, inflows, outflows, real energy behaviour and pump schedule.

The dashboard is depicted in the Figure 44 "Improve Energy Efficiency Recommendations dashboard. Real time monitoring and comparison." and consists of two frames. The upper graph contains the information that must be represented as time series both observed and predicted; the storage levels information (including thresholds), flow and energy consumption for each pump, water work and the total amount. The user can select the variables to display in the graph, through the left side of the upper frame: there are one check button for each water work and reservoir, and the desired parameter can be chosen (for instance real time and forecasted information of storage levels).

The lower part of the dashboard contains the current pump schedule, which can be filtered to show all pumps or only the pumps that compose a particular water work. This frame contains the pump schedule selected in order to allow the water manager to know which part of the infrastructure is working at any moment.

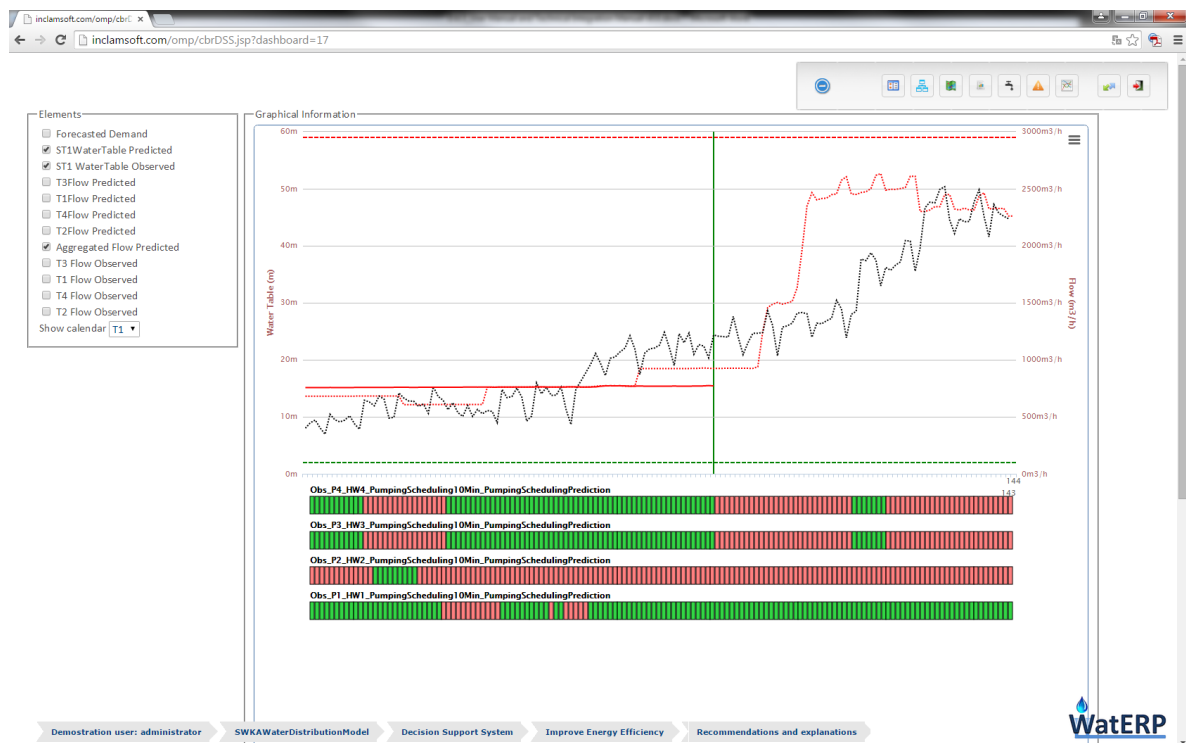


Figure 44 "Improve Energy Efficiency Recommendations dashboard. Real time monitoring and comparison."

In the example above, the water manager can see in real time the pump schedule recommended for the T1 water work, the real tank evolution, the predicted tank evolution and the predicted aggregated flow provided by the water works. Also, the vertical green line indicated the last observed value gathered.

To summarise, this dashboard allows the water manager to monitor the real behaviour of the water supply network and compare it with what it was predicted. At the same time, the user will learn from this information and it will teach the DSS how to operate in the future, detecting possible restrictions and recommendations changes in the rule-set, discovering possible mistakes that had led to select similar

past demands, finding network leaks or fixing divergences between the supply network and the hydraulic model.

3. Technical integration manual

This section could be considered as the administrator manual, just like previous section is considered the user manual. This section is purely technical and it has to be the guide for OMP installations. It will also help with the maintenance and configuration of the application. This technical point of view will provide a fundamental perspective of the OMP giving a better understanding about how this tool works.

3.1 OMP Installation

The OMP has been developed over a stack of Open Source tools, and Java is located at the bottom of this stack. For the development we are using JDK 7u17 and for the deployment JRE 7u17, so the whole solution is built over this version of Java¹.

The next cell is the composed by the Application Server (Leander, 2010) and the Data Base Management System (DBMS) (Gorman), which are the core of the needed tools. As application server we have used JBoss7.1.3, any 7.X version would be enough but for the best performance 7.1.3 is highly recommended. JBoss² (Marchioni) is the most used full JEE stack implementation server, so it's a pretty powerful and stable tool.

And as DBMS OMP uses MySql³ Server 5.6.22 (Schwartz, Zaitsev, & Tkachenko) as it is the freely version of the world's most popular open source database.

Thus at the top of the stack we found the OMP and the OMP-database deployed inside the Application Server and the DBMS respectively.

¹ <http://www.java.com/>

² <http://www.jboss.org/>

³ <http://www.mysql.com/>

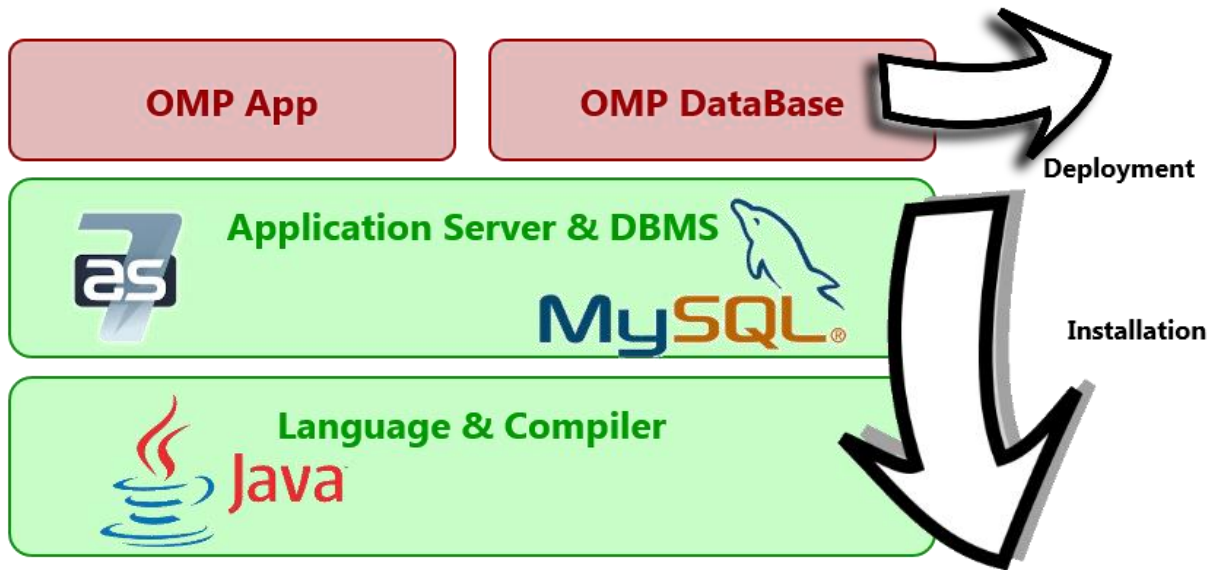


Figure 45: "OMP Software Stack"

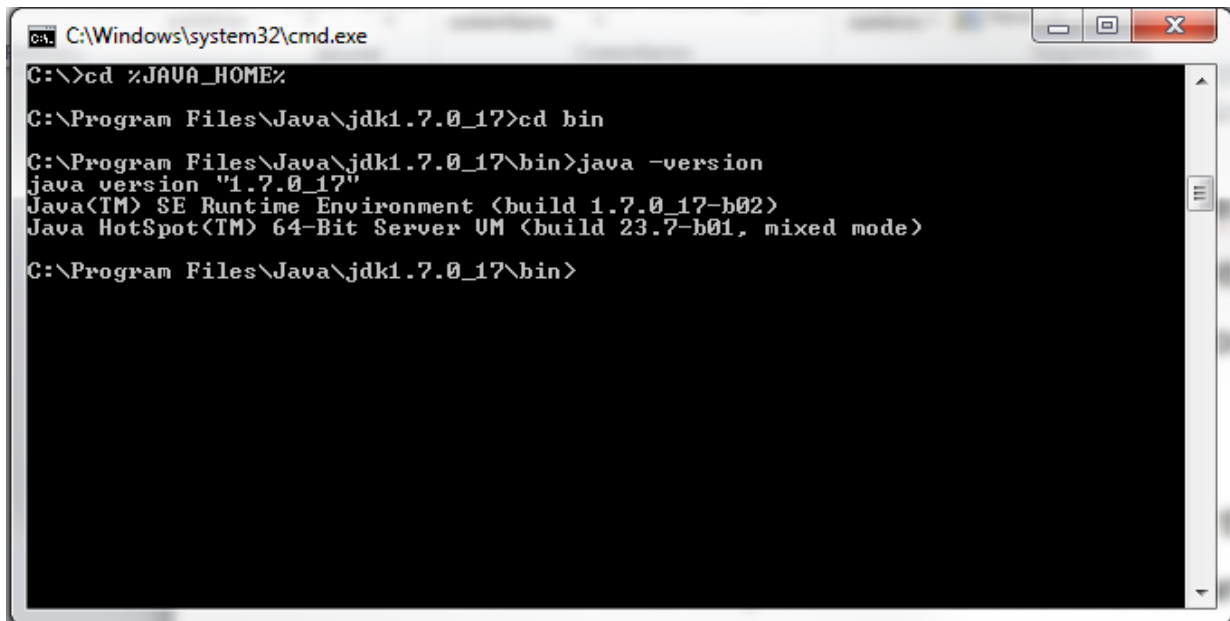
3.1.1 Installation of Software needed

Figure 45: "OMP Software Stack" depicts the list of software elements to install, most of the operating systems are allowed for this kind of elements but we have already tested with Windows8 and Ubuntu12. The different phases of the installation process are described in the following sections.

3.1.1.1 Java

First phase of the installation process is the JDK/JRE (Kurniawan) package version 7u17. It is recommended to install JRE in production environments and JDK in development environments but it is mandatory to install one of them. Depending on the Operating System of the server where the OMP is going to be installed we have some different steps to follow to complete de Java installation process, but this is a pretty simple process and a huge amount on examples are in the Web.

Once you have the JDK/JRE installed you have to set the JAVA_HOME variable and then you are able to test your installation, just executing in the prompt of your operating system the command "Java - version".



```

C:\Windows\system32\cmd.exe
C:\>cd %JAVA_HOME%
C:\Program Files\Java\jdk1.7.0_17>cd bin
C:\Program Files\Java\jdk1.7.0_17\bin>java -version
java version "1.7.0_17"
Java(TM) SE Runtime Environment (build 1.7.0_17-b02)
Java HotSpot(TM) 64-Bit Server VM (build 23.7-b01, mixed mode)
C:\Program Files\Java\jdk1.7.0_17\bin>
  
```

Figure 46: "Java Installation"

3.1.1.2 Eclipse IDE

This is the next phase of the installation process, it is not mandatory and it is only recommended for development environments to allow the programmer to modify the source code of the OMP platform. As this step is only for development purposes it is not going to be described in this deliverable.

3.1.1.3 JBoss

As described above the Application Server to use is JBoss7.1.3 (Marchioni), any 7.X version is able to be installed but is highly recommended 7.1.3. As JBoss is a complete JEE server (Jendrock, Cervera-Navarro, Evans, Gollapudi, & Haase) is also possible to use any other JEE server with the same specification but usually some problems will appear with the different library-versions used by the application servers.

To install the server the selected version has to be downloaded from the JBoss Web. The application server is usually downloaded as a compressed ZIP file so the first step is to UNZIP the file and set the JBOSS_HOME variable as defined in the operating system used. Then the JBoss has to be defined as a service, this step is pretty different depending on the operating system, and it is highly recommended to check the OS technical manuals.

To check if JBoss is correctly running then the administration console will be accessible at <http://localhost:9990> in the server machine⁴.

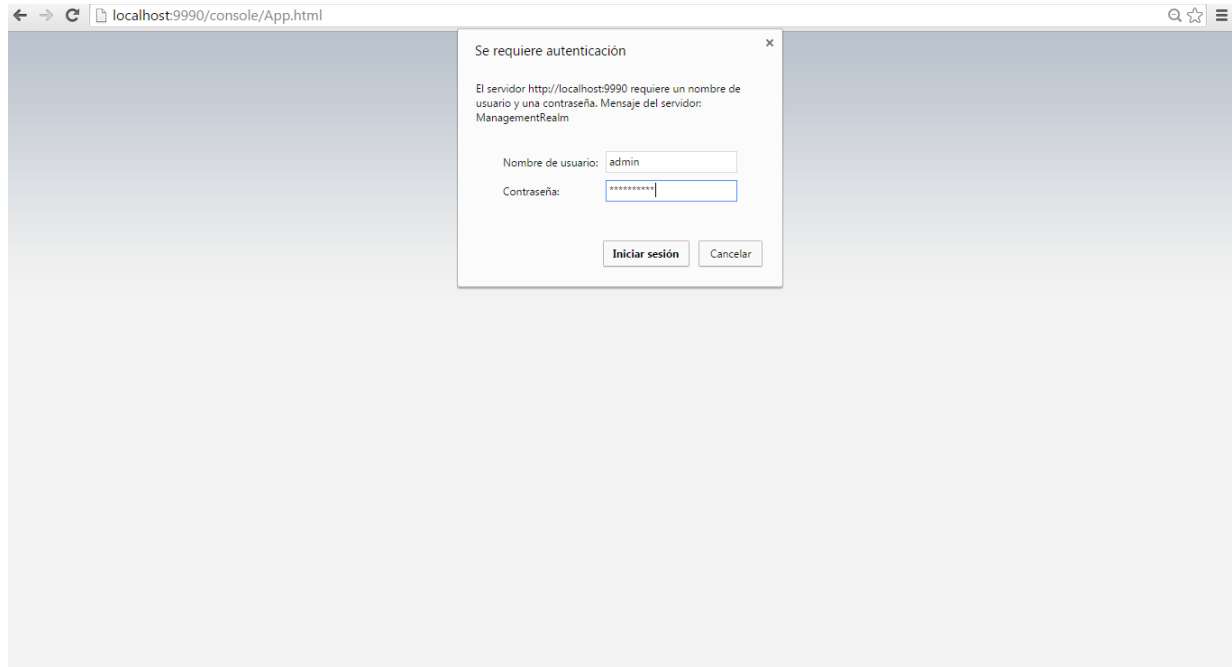


Figure 47: "JBoss Administration Console"

3.1.1.4 Mysql

The next phase is the installation of MySQL (Schwartz, Zaitsev, & Tkachenko) 5.6.22 as the selected Data Base Management System⁵. The corresponding executable package has to be downloaded from the MySQL Web, the installation of the MySQL server consists of a wizard, which is pretty simple and it has some steps to configure the mainly parameters as the root password and the MySQL server port.

⁴ https://docs.jboss.org/jbossas/6/Admin_Console_Guide/en-US/html/

⁵ <https://dev.mysql.com/doc/refman/5.0/en/installing.html>

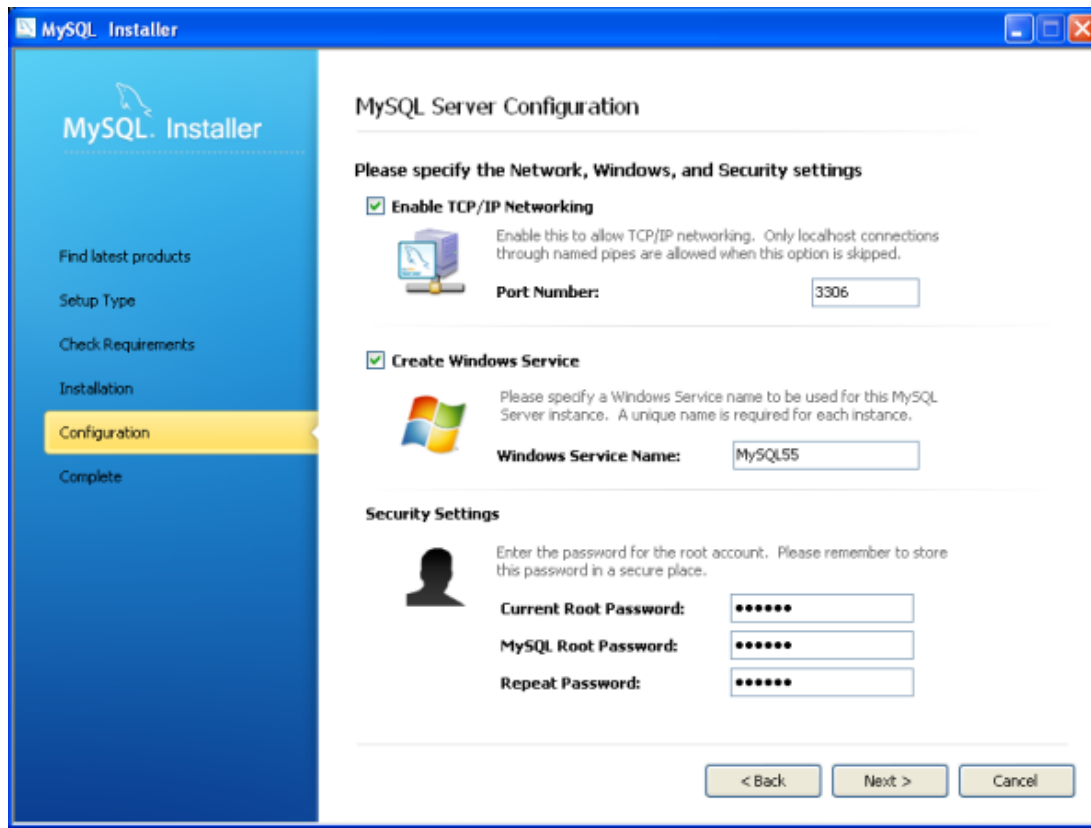


Figure 48: "MySql Server Installation"

The same installer could be used to install a MySQL client as MySQLWorkbench⁶, this is not a mandatory step but a desktop client is really useful to query the OMP database.

3.1.2 OMP Deployment

When the installation of the needed software components is finished then the OMP components can be deployed. The OMP solution is composed of two files: omp.sql and omp.war and both are mandatory to make the system run.

3.1.2.1 OMP Database Deployment

The OMP database is defined in the omp.sql file which is ready to be deployed in a MySQL server, this can be done by command line or easier with a MySQL server client. Any of these tools has an import feature to read this .sql file and to initialize the database.

⁶ <https://www.mysql.com/products/workbench/>

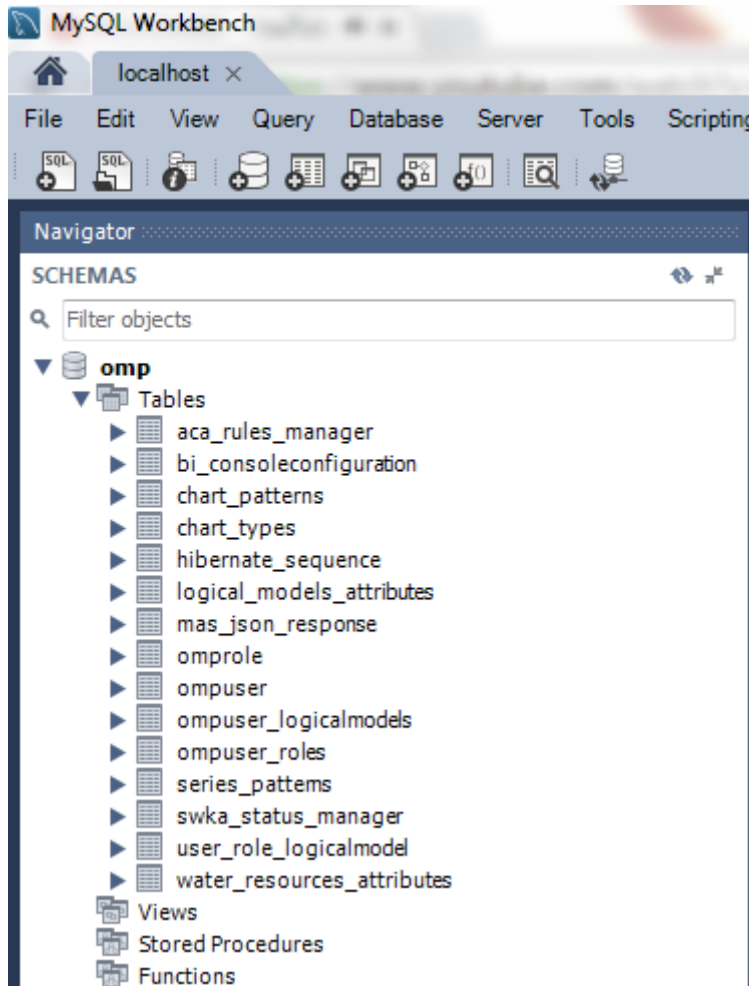


Figure 49: "OMP Database Deployment"

3.1.2.2 OMP Application Deployment

The OMP is distributed as a WAR file, ready to be deployed in a JBoss7.1.3 application server. To deploy the OMP JBoss created service has to be stopped (this is done different in each operating system). Then the omp.war file has to be copied into \$JBOSS_HOME/standalone/deployments folder, and then the JBoss service can be started.

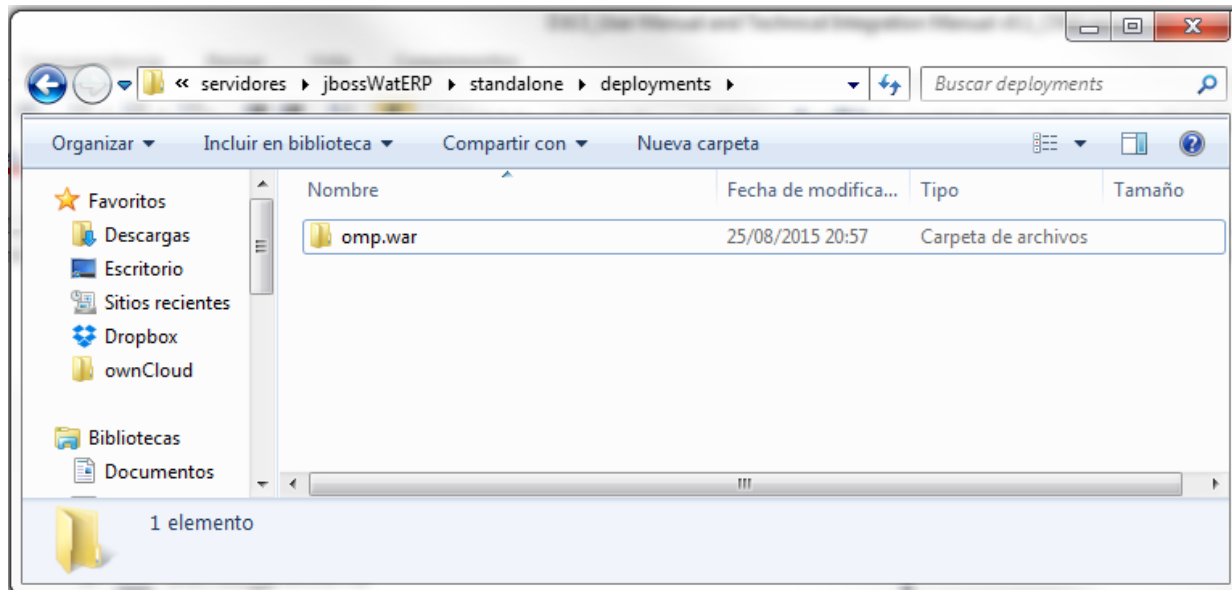


Figure 50: "OMP Application Deployment"

The log files are located in `$JBOSS_HOME/standalone/log` and if any error take place it new entry will appear in the log file. Once the OMP is correctly deployed it can be accessed by default at <http://localhost:8080/omp>.

3.2 OMP Configuration

This point aims to summarize the configurations needed by the OMP platform, this configurations has two phases: OMP connections and OMP customizations. The first phase is the configuration of the OMP connections with the OMP-database and with other systems (MAS and WaterCity). This step is mandatory and it has to be correctly configured to assure the proper behavior of the system. The second phase deals about the customization of the information as i) internationalization, ii) series patterns definition and iii) chart patterns definition. So this second step is not mandatory, it is a tool for the user to customize the OMP and to feel more comfortable with the way that information is shown.

3.2.1 OMP connections

The OMP has to establish connections with other WatERP-elements: MAS and WaterCity, and also with OMP database. Thus the configurations of these communications are essential for the proper behavior of the system.

- ➔ External connections: As connections with MAS and WaterCity are configured in the `omp.properties` file which is located inside the `OMP.war` file.

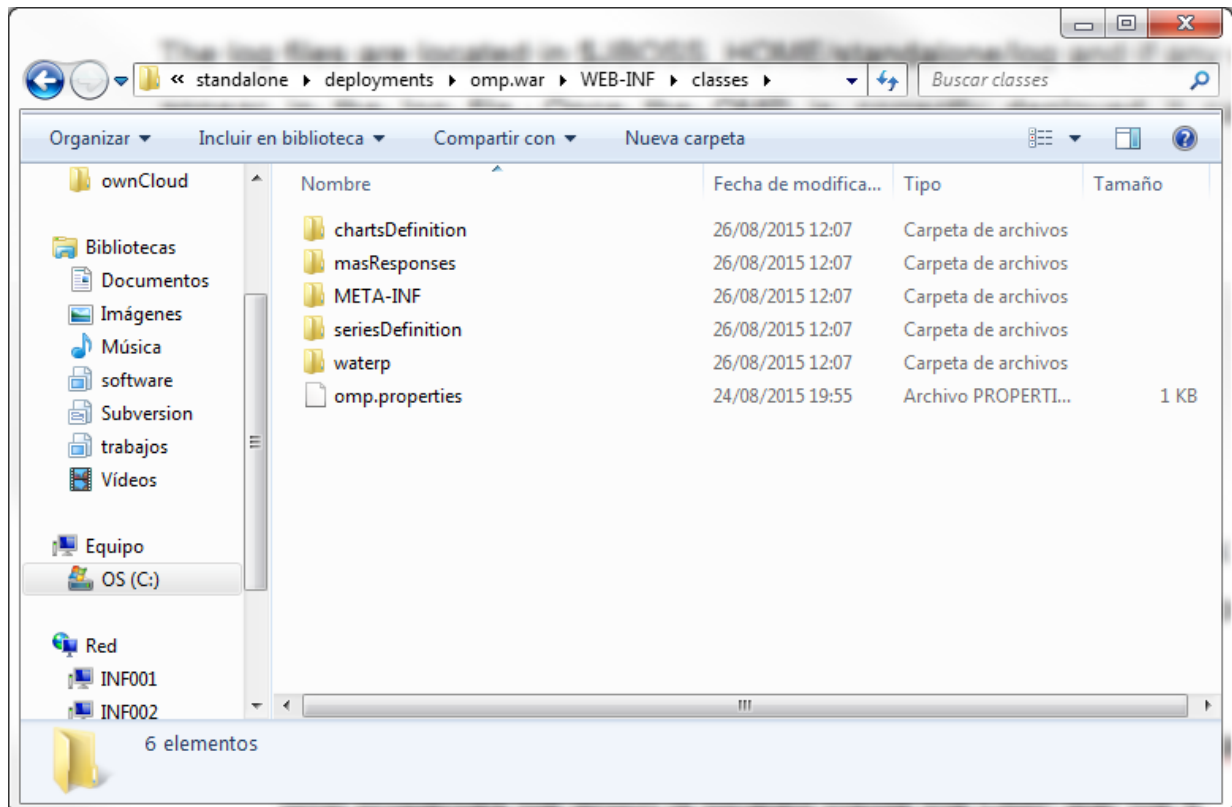


Figure 51: "omp.properties location"

In this file the URL to connect to MAS and WaterCity are defined and can be set at any time. The server must be restarted to get the new configuration.

```
MAS-URL=http://172.20.10.196:8086/mas_core-0.1/service/
WATER-CITY-URL=http://snf-542682.vm.oceanos.grnet.gr/watercity/services/call/soap
```

➔ OMP database connection: as any data source deployed in a J2EE application server the connection is defined in a `-ds` file located inside the OMP.war deployed file.

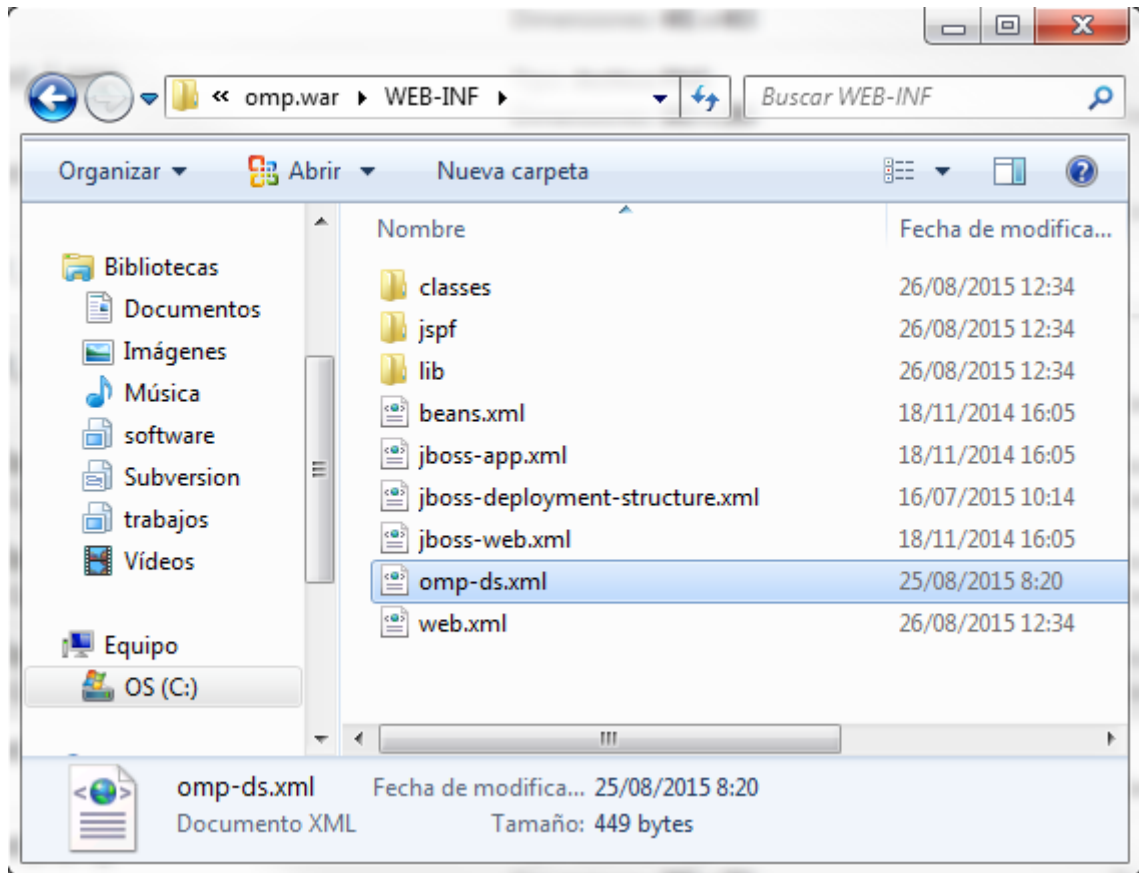


Figure 52: "omp-ds.xml location"

This file is a XML datasource deployable definition file, which has a predefined structure. There the URL and the user and password to access to the database can be modified.

```
<?xml version="1.0" encoding="UTF-8"?>
<datasources xmlns="http://www.jboss.org/ironjacamar/schema">
  <datasource jndi-name="java:/WatERP/datasources/omp" pool-name="omp_pool"
enabled="true" use-java-context="true">
  <connection-url>jdbc:mysql://192.168.232.205:3306/omp</connection-url>
  <driver>mysql</driver>
  <pool></pool>
  <security>
    <user-name>root</user-name>
    <password>*****</password>
  </security>
</datasource>
</datasources>
```

3.2.2 Internationalization⁷

The file OMP.war provided to deploy is just a compressed file that can be opened with any compressor tool inside it the language files are located in the i18n⁸ folder.

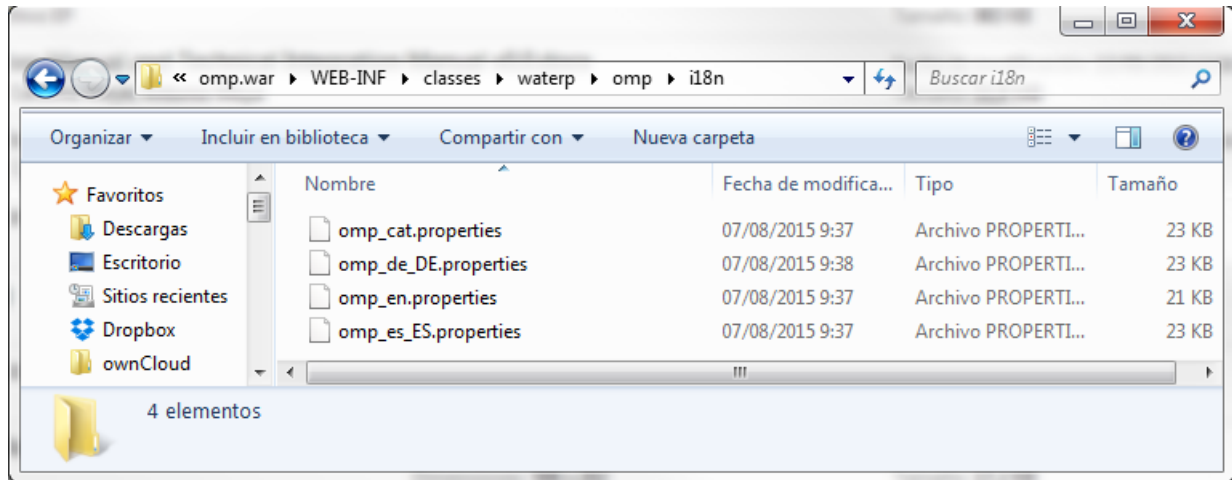


Figure 53: "Language files location"

Each one of this files are a text-file with pairs of identifier-value, so the internationalization tool works looking always for an identifier inside de language file selected by the user and then show the associated value. Thus if a new language is going to be added a new file has to be created with the correct pair-values. This file has to be named with the language identifier as "_es_ES" or "_en" and then the language will be automatically loaded inside the application. A sample of the content of these language-files is shown below.

⁷ <http://www.ccjk.com/what-is-internationalization-i18n-localization-l10n-and-globalization-g11n/>

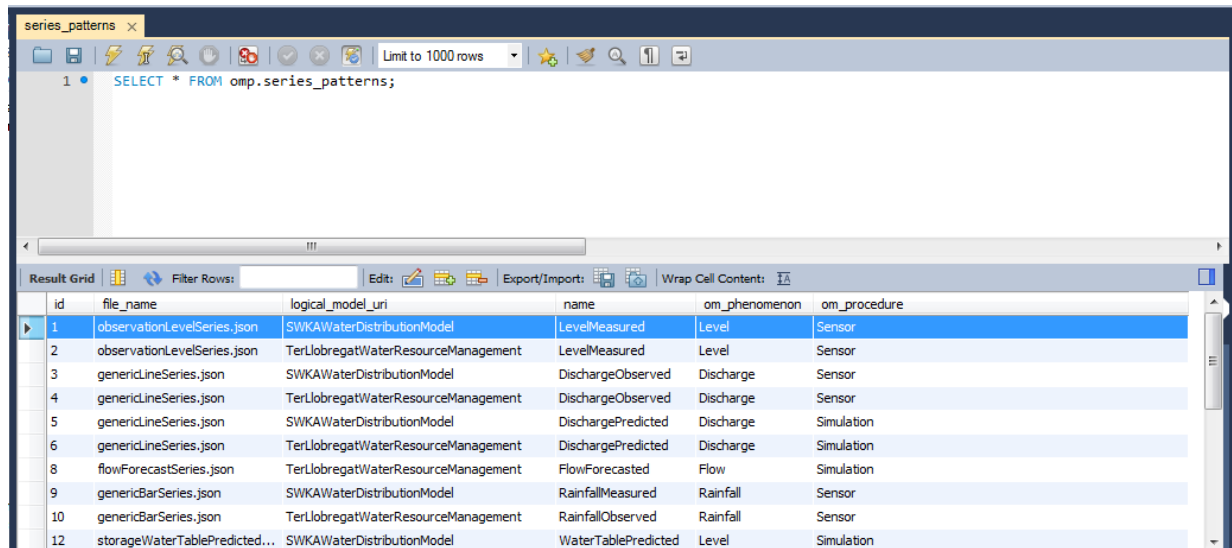
⁸ <http://i18next.com/>

```
dms.economicTool.dashboard.v030.popup.noproperties = No properties
dms.economicTool.dashboard.v030.popup.properties = Properties
dms.economicTool.dashboard.v030.title = Water system definition - Supply-side
dms.economicTool.dashboard.v031.popup.area = Area
dms.economicTool.dashboard.v031.popup.centroid = Centroid
dms.economicTool.dashboard.v031.title = Water system definition - Demand-side
dms.economicTool.dashboard.v032.combo.selectsink = Select a cluster
dms.economicTool.dashboard.v033.dashboard.scenario.description = Description
dms.economicTool.dashboard.v033.dashboard.scenario.instruments = Instruments
dms.economicTool.dashboard.v033.dashboard.scenario.text = Scenario Definition Area
dms.economicTool.dashboard.v033.title = Instruments Assessment Dashboard - Instruments
dms.economicTool.dashboard.v034.dashboard.evaluationflows = Evaluation of flows
dms.economicTool.dashboard.v034.dashboard.overallscenario = Overall scenario assessment
dms.economicTool.title = Economics tools
dms.economicTool.message.response.error = Cannot read Economic tool response
.....
```

3.2.3 Defining a series pattern

The OMP user is also able to customize the way that a time series is shown in a graph. A visualization-frame can be set for any phenomenon and procedure as defined in OGC Observation & Measurements standard conceptual model), and any logical model has its own time-series visualization settings.

In the OMP database we have a table to store this configuration: "series_patterns". Each row has the information about which JSON file has the graphical-information to draw a time series with a given logical model, phenomenon and procedure.



id	file_name	logical_model_uri	name	om_phenomenon	om_procedure
1	observationLevelSeries.json	SWKAWaterDistributionModel	LevelMeasured	Level	Sensor
2	observationLevelSeries.json	TerLobregatWaterResourceManagement	LevelMeasured	Level	Sensor
3	genericLineSeries.json	SWKAWaterDistributionModel	DischargeObserved	Discharge	Sensor
4	genericLineSeries.json	TerLobregatWaterResourceManagement	DischargeObserved	Discharge	Sensor
5	genericLineSeries.json	SWKAWaterDistributionModel	DischargePredicted	Discharge	Simulation
6	genericLineSeries.json	TerLobregatWaterResourceManagement	DischargePredicted	Discharge	Simulation
8	flowForecastSeries.json	TerLobregatWaterResourceManagement	FlowForecasted	Flow	Simulation
9	genericBarSeries.json	SWKAWaterDistributionModel	RainfallMeasured	Rainfall	Sensor
10	genericBarSeries.json	TerLobregatWaterResourceManagement	RainfallObserved	Rainfall	Sensor
12	storageWaterTablePredicted...	SWKAWaterDistributionModel	WaterTablePredicted	Level	Simulation

Figure 54: "Series-pattern table"

So when a new user login into the OMP platform then he has to select a logical model and any time-series to show in the OMP is defined by a phenomenon and a procedure. Thus OMP is always able to get the JSON-file related to the time-series to draw. An example of this kind of file is shown below.

```
{
  "type": "area",
  "color": "rgba(51, 153, 255, 1)",
  "lineWidth": 1,
  "dashStyle": "Dash",
  "fillColor": "rgba(153, 204, 255, 0.1)",
  "fillOpacity": 0.75,
  "shadow": false,
  "marker": { "enabled": false }
}
```

These files are located inside the application file OMP.war which, as has been said before, can be opened with any compressed utility.

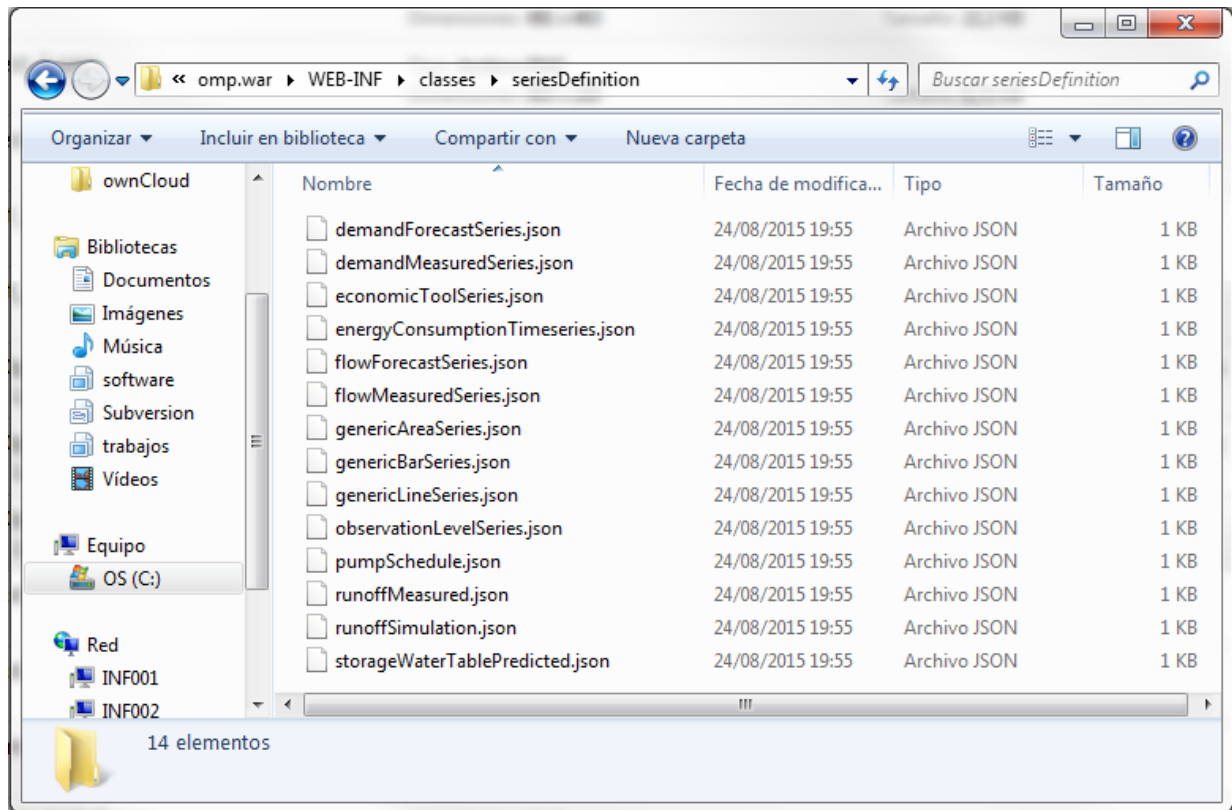
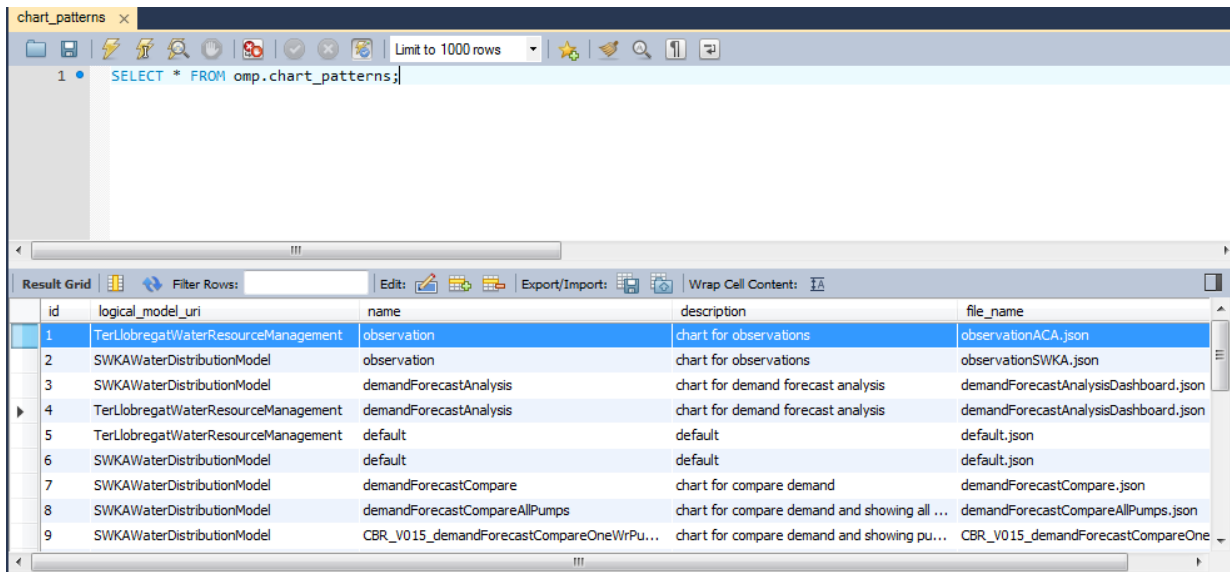


Figure 55: "Series pattern file location"

3.2.4 Defining a chart pattern

Just as with the time-series, the user is able to customize any chart in the system. In the OMP database there is a table named "chart_patterns" that stores the link between a chart identifier in a logical model and the JSON file where the graphical information of this chart is defined.



id	logical_model_uri	name	description	file_name
1	TerLlobregatWaterResourceManagement	observation	chart for observations	observationACA.json
2	SWKAWaterDistributionModel	observation	chart for observations	observationSWKA.json
3	SWKAWaterDistributionModel	demandForecastAnalysis	chart for demand forecast analysis	demandForecastAnalysisDashboard.json
4	TerLlobregatWaterResourceManagement	demandForecastAnalysis	chart for demand forecast analysis	demandForecastAnalysisDashboard.json
5	TerLlobregatWaterResourceManagement	default	default	default.json
6	SWKAWaterDistributionModel	default	default	default.json
7	SWKAWaterDistributionModel	demandForecastCompare	chart for compare demand	demandForecastCompare.json
8	SWKAWaterDistributionModel	demandForecastCompareAllPumps	chart for compare demand and showing all ...	demandForecastCompareAllPumps.json
9	SWKAWaterDistributionModel	CBR_V015_demandForecastCompareOneWrPu...	chart for compare demand and showing pu...	CBR_V015_demandForecastCompareOne...

Figure 56: "Chart_patterns table"

This JSON files are stored inside the OMP.war file and they can be added/modified or deleted just taken care of the integrity of the data stored in the configuration tables. An example of this kind of file is shown below.

```

{
  "chart": {
    "backgroundColor": "#FFFFFF",
    "borderWidth": 1,
    "borderRadius": 5,
    "zoomType": "x",
    "reflow": true
  },
  "plotOptions": {
    "series": {
      "dataLabels": {
        "format": "{y:.2f}"
      }
    }
  },
  "tooltip": {
    "shadow": false,
    "valueDecimals": 2
  },
  "legend": { "enabled": true },
  "title": null,
  "xAxis": {
    "type": "datetime",
    "title": null
  }
}

```

The chart pattern definition is a remarkable point for the customized view inside the Business Intelligence Platform. When the user is editing one of the charts the first thing to do is to select the observation to show, then the application reads from the database the JSON-file to apply for this observation depending on: the logical model selected and the phenomenon and procedure related to the selected observation. Then the user has to select the chart-pattern to apply, so the observation selected is going to be drawn in this kind of chart-pattern. This is pretty powerful tool because the user is able to customize each chart, but it also makes the user responsible of the visualization. Thus, for example, if the user selects a real-time observation and a categorized chart the application is not going to draw the selected observation inside the selected chart.

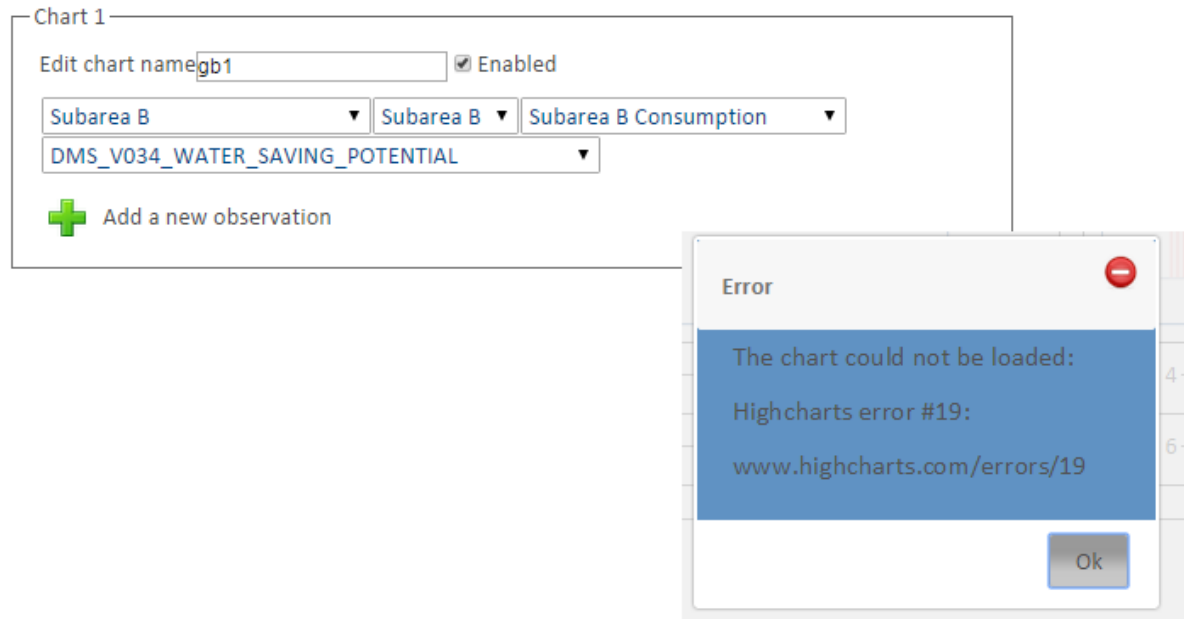


Figure 57: "Chart Pattern Error"

So to create a new chart pattern, the summarized steps to follow are:

1. Create the new file as JSON format, and copy it inside the "chartDefinition" folder in the OMP.war file deployed in the server.
2. Insert a new row in the "chart_patterns" table referring the new file and giving a name to the pattern created.
3. Check the new pattern inside the Business Intelligence Platform.

4. Conclusions

Due to the nature of the current deliverable, the main conclusion to highlight is that it can work as a complete “getting started guide” for new users. From the perspective of “user manual”, the document should be customized for each operational environment with the available building blocks of the whole WatERP system, but it is sufficiently clear and complete so as not to need important changes. From the perspective of “technical integration manual”, it is expected that any ICT user reading this deliverable will be able to install and configure the OMP to get it running from an empty Operating System.

The development methodology used during the OMP implementation (***D6.3, section 2 “OMP Software Development Methodology”***) has focused on the continuous feedback and communication between the pilots’ water managers and the ICT technical staff. This approach has been essential to gather the weakness points and FAQs of a new user using the OMP. Also the deployment and integration of the WatERP project in the facilities of the pilots has been a powerful source of information especially those related to the OMP installation and configuration. Regarding the pilots’ deployment, the relevant information gathered has been the main input for the construction of this deliverable.

5. References

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