Horizon 2020
Programme

WIDEST

Water Innovation through Dissemination Exploitation of Smart Technologies

GA number: 642423

WP 1: ICT for Water Observatory (IWO)

D1.1: Report with IWO definition and implementation

V1.5 20/07/2015

http://www.widest.eu/

Document Information

Project Number	642423	**Acronym**	WIDEST
Full title	Water Innovation through Dissemination Exploitation of Smart Technologies		
Project URL	**http://www.widest.eu**		
Project officer	Erik Pentimalli		

Deliverable	**Number**	1.1	**Title**	Report with IWO definition and implementation
Work Package	**Number**	1	**Title**	ICT for Water Observatory (IWO)

Date of delivery	**Contractual**	6	**Actual**	6
Nature	Prototype ☐ Report X Dissemination ☐ Other ☐			
Dissemination Level	Public X Consortium ☐			

Responsible Author	Gabriel Anzaldi	**Email**	gabriel.anzaldi@eurecat.org
Partner	Eurecat (BDigital)	**Phone**	+34 93 553 45 40

Abstract (for dissemination)	This report focuses on the definition and implementation of the ICT for Water Observatory (IWO). The IWO defines a methodology to collect, analyse and publish in a knowledge base resources from relevant sources of information related to ICT for Water technologies. This report includes the objectives, methodologies, functionalities and structure the IWO is going to offer and support, conforming the inputs of the literature reviews and commercial developments and technology trends analysis.
Key words	ICT for Water Observatory, Observatory, Trends, Technologies, Water sector

Version Log				
Issue Date	**Version**	**Author**	**Partner**	**Change**
15/07/2015	1.0	Xavier Domingo	Eurecat	First version
17/07/2015	1.1	Gabriel Anzaldi	Eurecat	Corrections and improvements
20/07/2015	1.2	Xavier Domingo	Eurecat	Corrections and improvements iteration
21/07/2015	1.3	Javier Haro	CETaqua	Corrections and improvements
24/07/2015	1.4	Lian Guey	UNS	New classification added, corrections and improvements.
30/07/2015	1.5	Xavier Domingo	Eurecat	Format and revision iteration.

List of Acronyms

BP Business Process

CMS Content Management System

D1.2 Report in Smart Water Community Group monitoring

D1.3 Reports containing Literature reviews 1st release

D1.4 Reports containing Literature reviews 2nd release

D1.5 Reports containing Literature reviews 3rd release

D1.6 Reports containing Analysis of Commercial developments and technology trends 1st release

D1.7 Reports containing Analysis of Commercial developments and technology trends 2nd release

D1.8 Reports containing Analysis of Commercial developments and technology trends 3rd release

EIP European Innovation Partnership

EU European Union

H2020 Horizon 2020 EU Framework Programme for Research and Innovation

ICT Information and Communication Technologies.

IT Information Technology

IWA International Water Association

IWO ICT for Water Observatory

OSF Open Semantic Framework

SME Small and Medium-sized Enterprises

SPARQL SPARQL Protocol and RDF Query Language

TRL Technology Readiness Level

WP1 ICT for Water Observatory (IWO)

WP2 Topical Roadmaps

WP3 Overall Roadmap

WP4 ICT for Water management technologies portfolio

WP5 Dissemination and communication channels

WssTP Water Supply and Sanitation Technology Platform

Executive Summary

This report is part of WIDEST (www.widest.eu), a H2020 funded project – Coordination and Support Action (Ref. Number 642423). Deliverable "D1.1 Report with IWO definition and implementation" focuses on the definition and implementation of the ICT for Water Observatory (IWO). This includes the objectives, methodologies, functionalities and structure the IWO is going to offer and support.

The IWO will need to collect information from very heterogeneous sources, hence a methodology to select sources and filter resources is needed. Collection, classification, analysis and reporting of the selected resources has to be supported by that methodology too. This report includes that information management methodology. However, although this is a first methodology definition which will be taken as the basis of that work, it is opened for future changes, adaptations and modifications to better fit and support the IWO goals accomplishment.

All the information collected in previous steps, will have to be adequately published, structured and made accessible to the public. With that aim, a web based solution will be used to support it. This report, includes the requirements the website should support, together with a study of existing tools and sites, and a schedule to put it in production, according and synchronized with the first literature and market analysis results (D1.3 and D1.6), and taking in consideration the publishing necessities of roadmaps (WP2 and WP3), and technologies portfolio (WP4). The rest of general WIDEST information, is considered to be included in main website.

To understand this document the following deliverables have to be read.

Number	Title	Description
None		

Table of contents

Table of figures

Table of tables

1. Introduction

The role of ICT in contributing to the “Smart Technologies EIP Priority” (European Comission, 2015) is widely recognised by the scientific community and water business professionals. Despite relevant progress and innovation achieved in this field, several barriers hinder the implementation of Smart Water Technologies. Current lack of knowledge of EU water research and innovation results on industry, policy makers, and citizens, is slowing down the widespread application of solutions that can leverage the development of the urban systems and infrastructures of tomorrow.

This scenario shows that achieving water-related challenges cannot progress with the sole contribution of research. In this sense, the IWO, aligned with WIDEST project vision, has the objective of promoting the dissemination and exploitation of ICT for Water related information and become an aggregator of existing private/public technology, innovation and research advances and trends. All this information will be collected, analysed and classified thanks to the efforts focused on conducting literature reviews of relevant academic and commercial references; establishing common frameworks such as standards and guidelines; producing the three topical roadmaps and the overall roadmap; and producing a portfolio of effective ICT for water management technologies.

The main goal is to make citizen take benefit of all EU funded activities, but also take benefit of existing technologies in industry, academy or any other source. However, the water sector includes several actors and stakeholders with different necessities and interests, hence the IWO must provide concrete and relevant information to each one of them, making the observatory much more effective and focused.

This report, in which the IWO will be defined is divided in five chapters:

1. **Chapter 1. Introduction** makes an introduction to this report and presents the rest of the chapters.
2. **Chapter 2. ICT for Water Observatory Methodology.** This chapter describes more concretely what this observatory aims to be, defining its concrete goals, functionalities and internal structure. In addition, the methodology to collect and classify information is presented, including the selection and filtering of relevant sources of information.
3. **Chapter 3. ICT for Water Observatory knowledge base** defines which the functional requirements of the proposed knowledge base are, together with desired functionalities it should support. After the requirements definition, it will analyse existing tools and websites candidates to be used to support the IWO.
4. **Chapter 4. The IWO after end of WIDEST project** will propose the actions and possibilities to keep on updating and maintaining the IWO knowledge base.
5. **Chapter 5. Conclusions and future work** will synthetize conclusions and remark future work and recommendations to be done during WIDEST project.

2. ICT for Water Observatory Methodology

As stated in the description of action of WIDEST project, the main goal of WP1, in which the IWO is defined and implemented, is to increase the knowledge about ICT for Water including best practices, technologies, issues and stakeholders. The IWO takes a primary role in that goal achievement, as the IWO will be the main support to collect, analyse, classify and make that information available.

2.1 Objectives and responsibilities

The main objectives and responsibilities of the IWO can be summarized in:

- **Conduct formal background research**, such as through reading published journal papers, books, conference abstracts and posters, reviewing experiences from other fields and its sources, review reported results from other related projects, etc.
- **Conduct informal research**, such as through coordinating and attending events, conversations with stakeholders, working with the Advisory Board, exploring and using online resources, etc.
- **Keep abreast of emerging issues**.
- **Make all that information available to public at large.**

Figure 1 ICT for Water Observatory objectives and responsibilities

Therefore, these activities will provide a critical input during the whole project lifecycle to WP2, WP3, WP4 and WP5 by providing an updated picture of the ICT for Water technological trends, existing solutions and scientific results, and get feedback from them through a two-way exchange of information

and knowledge. Derived from this, a general underlying objective is to define the operations of the IWO setting the base for the execution of the rest of the tasks in WP1. Next section depicts that operations.

2.2 Operations

In order to accomplish the objectives presented in the previous section, the IWO must take care of a set of responsibilities. That responsibilities can translated to concrete operations the IWO must perform. These operations are:

- Define the **scope of the IWO**.
- Define the **structure of the IWO contents**.
- Select **relevant sources of information** to be included in the IWO operation.
- Define the **process** that will be used **for gathering, analysing and reporting activities**.

The following sections will focus on defining that operations.

2.3 IWO scope definition

As one of the main objectives of WP1 is to provide an updated knowledge base to other WPs, it has been necessary to coordinate WP1 efforts with the rest of the WPs even before the activities of the other WPs had officially begun. In coordination with the WP5 Leader, the knowledge base will also be used to define the themes that are going to be implemented as part of the online courses (MOOCs) to be developed in WP5, this is currently work in progress.

As the result of this coordination actions the scope has been defined, and can be summarized in:

- **Formal background research scope**
    - **Papers** from relevant water related journals containing ICT related matters from 2010 until today will be included in the IWO operations. Open access sources will be prioritized regarding the others.
    - Water related **books** from relevant authors and publishers containing ICT related matters from 2010 until today will be included in the IWO operations.
    - Water related **abstracts and posters** from conferences including ICT related matters from 2010 until today will be included in the IWO operations.
    - Water related **reviews**, **roadmaps**, EU funded projects **outcomes** or **results**, and other types of **reports** including ICT related matters from 2010 until today will be included in the IWO operations.
- **Informal research scope**
    - All ICT for Water related **information obtained in networking sessions** in attended (or coordinated) events will be candidate to be included in IWO operations after formal/informal validation. This will also include obtained information while maintaining conversations, informal meetings or interviews with other researches, stakeholders, etc.

- ICT for Water related **information coming from the Advisory Board** will be included in the IWO operations.
- All ICT for Water related **obtained information by exploring online resources** will be included in the IWO operations after formal/informal validation. This will include exploring academic and research communities, industry providing ICT products or services to water sector, water professionals, SMEs, start-ups or customer organizations.

- **Keep abreast of emerging issues scope**
  - A list of **relevant newsletters and communities** will be done. WIDEST will subscribe to them in order to better obtain emerging technologies and issues in general in the sector. This list will be updated every 8 months.
  - The **relevant sources** determined in previous points will be **regularly checked** for new information. That list will be updated every 8 months.
  - An updated **list of events to attend** will be maintained and revised periodically. That list will be updated monthly. We will rely on the events list published by the WssTP (WssTP, 2015) and the IWA (IWA, 2015).
  - **Periodical exploration of online resources** will be also performed to check whether new sources appear and double check if previously selected ones are still valuable. This exploration must be performed at least once a month.
  - **Periodically contact with EU funded activities leaders** to obtain latest novelties from sector. In this context, projects conforming the ICT4Water will be the selected ones: EFFINET, ICeWATER, iWIDGET, UrbanWater, WatERP, DAIAD, ISS-EWATUS, sH_2, Waternomics, WISDOM, BlueSCities, FREEWAT, KINDRA, WaterInnEU and WIDEST.
  - That contact must be done at least once every six months.
- **Make all that information available to public at large**
  - A dedicated website will be used with that aim. The functional requirements and planning of this tool are described in Chapter 3 ICT for Water Observatory

More information about the relevant sources can be found in Section 2.5 Selection of the relevant sources of information.

2.4 Structure of the IWO contents

The structure of the IWO contents will define a knowledge base to be shared with other project partners, and above all, to be the basis of all information published in the IWO website.

The structure will provide several approaches of classification of the contents. That approaches come from the different ways of consulting information each one of the actors and stakeholders of the water sector do. The IWO must provide mechanisms to simplify the information querying, and with that aim, the structure will have the following approaches:

- **Research oriented approach**: This approach is based on most relevant topics that appear at conferences, journals and other scientific publications as books, roadmaps, guidelines and best practices. This approach is basically intended for academia.
- **Industry oriented approach**: This approach is aimed at the industrial sector, water professionals, SMEs and start-ups. Using their terms will foster a better technology finding and interchange, making the IWO an effective and valuable tool.
- **Citizen oriented approach**: This approach will take in consideration a classification in terms of common language used by citizen in their everyday life. That will offer an easy way to approach state of the art applied ICT technology to public at large.

The three approaches are compatible and complementary. The main idea is to be able to classify whichever resource using the three approaches, thus being able to consult it in any situation. However, it is possible that, in example, very concrete scientific research will be hardly found navigating the IWO tool using the citizen oriented approach. In fact, this is not a bad issue, but a consequence of offering the more relevant resources to each actor or stakeholder according their concrete profile. The IWO will permit changing the navigation approach, letting the user decide.

Each resource will be then classified using each approach (if desired), and tagged with a series of **keywords**. These keyword will be transversal and, of course, each resource can be classified in several leafs (if we think the classification as a tree or a taxonomy) using the same approach, as well as each resource can be linked to several keywords.

Moreover, this structure will make use of concepts and terms existing in state of the art **standards, schemas and ontologies** to semantically represent and store information, thus making the information more interoperable and reusable. WaterML 2.0 (OGC, 2015), HY_Features (OGC, 2015), CUAHSI (CUAHSI, 2015), W3C-SSN (W3C Semantic Sensor Network Incubator Group, 2011), SWEET (NASA - Jet Propulsion Laboratory, 2015) and WatERP water management ontology (WatERP Project, 2015) are examples of that. The IWO tool, if possible, is intended to include **Linked Data principles** (Linked Data community, 2015) to make knowledge accessible and exploitable in form of resources using SPARQL (W3C, 2008) queries.

Technology Readiness Level (**TRL**) will be provided for each technology and product, see Figure 2 H2020 TRL List. Similar indexes can be used to determine maturity in stakeholders or providers (founding date or similar). Finally, an attribute to determine the **type** of the resource will be added.

This structure is work in progress and each approach will have its first version in the following events:

- Research oriented approach will provide its first version coinciding with D1.3.
- Industry oriented approach will provide its first version coinciding with D1.6.
- Citizen oriented approach will provide its first version coinciding with the Industry oriented approach first version.

- Keywords, TRLs and types will have first version coinciding with Research oriented approach, and a second version coinciding with Industry and Citizen oriented approaches.

These structures are life, and will be constantly modified during the project according the necessities or findings. As an initial draft, the structure used in the EIP on Water Marketplace (EIP on Water, 2015) and the one proposed in @qua Thematic Network (@qua Thematic Network, 2015) can be checked in ANNEX 1: ICT 4 Water Marketplace Topics and ANNEX 2: ICT issues terms derived from Business Processes involved in the water cycle by @qua Thematic Network.

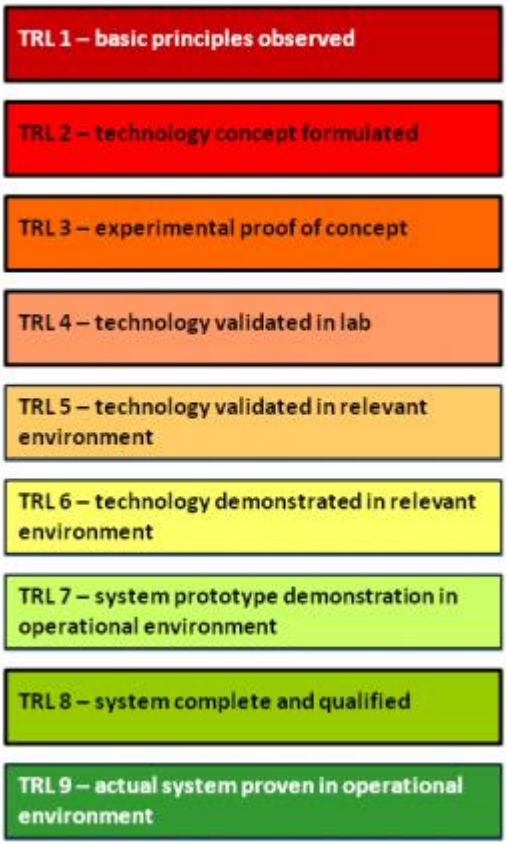

Figure 2 H2020 TRL List

2.5 Selection of the relevant sources of information

Different sources of information for scientific results, technology trends and existing products are being identified and compiled. These sources will cover all contents included in the scope of the IWO and are focused on the approaches defined in the section before. These sources are being analysed for the first time to complete D1.2, D1.3 and D1.6. After that, monitoring will start.

The definition of the sources is making use of inputs from all the technical project partners. The main results of this part of the task will be a compilation of publications, conferences, journals, products/service providers and a compilation of relevant stakeholders.

The following criteria will be used to determine the relevancy of each item:

- **Publications, conferences and journals** will take in consideration their impact factor together with scientific research publications quality indexes and general trajectory. As stated in Open Science (Open Access) policy (European Comission, 2015), science and research have always been open, but some of the processes for producing research and disseminating its results are not. The global shift towards giving free online access (open access) to the results of publicly-funded research (publications and data) has been a core strategy in the European Commission to improve knowledge circulation and thus innovation. In this context, publications following Open Access principles will be prioritised against publications which are not following them.
- **Products/service providers and relevant stakeholders** will be covered as much as possible in general. However, an indicator on maturity of each entity and product will be provided. That will help determining whether it is an emerging technology or a mature stablished one.

In a similar tempo as in previous section, that first compilation will conclude:

- Publications, conferences and journals coinciding with D1.3.
- Products/service providers and relevant stakeholders coinciding with D1.6.

2.6 Gathering, analysing and reporting process

The IWO will need to collect information from very heterogeneous sources, hence a methodology to select sources and filter resources is needed. This task is one of the more important operations the IWO performs, and closes the loop of the IWO knowledge base generation, including all previously defined sources, structures and classification methods together with TRL and other quality and maturity attributes.

The following simple steps make up the methodology:

1. **Update the relevant sources of information**.
    a. If a new source appears, add it to the list.
    b. If a source gets obsolete, remove it from the list after three iterations.
2. **Collect all relevant resources** from each validated source and determine its type.
    a. If a new type appears, add it to the list.
3. **Classify each resource** taking in consideration each approach: research, industry and citizen.
    a. If a new branch/leaf is needed in the classification tree or taxonomy, add it.
4. **Select the corresponding keywords** associated to each resource, this will indirectly semantically tag the resource.

   a. If new keywords are needed, add them and link them to the used standards, schemas and ontologies.
5. **Determine**, when possible, **the TRL of the resource and maturity of the provider** (or similar indexes depending on each case).
   a. If a new evaluating index is needed, add it and relate it with the used standards, schemas and ontologies.
6. **Add each complete defined, catalogued, tagged, and attributed resource to the IWO**.

This steps will be repeated for each resource of each relevant source of information, each time a new information collection iteration is performed. In concrete, there will be three iterations, the first one will provide D1.2, D1.3 and D1.6; the second one will provide D1.4 and D1.7; and finally, the third one will provide D1.5 and D1.8.

Moreover, this simple methodology can be used after the project ends, as long as the community or some of the partners assume the responsibility of maintaining the IWO. Although this is a first methodology definition which will be taken as the basis of that work, it is opened for future changes, adaptations and modifications to better fit and support the IWO goals accomplishment.

At the moment, this methodology is based on existing ones. In the following subsections, we will mention some of them, together with their main characteristics. In concrete, we will study existing methodologies based on systematic reviews and technology scouting. Both methodologies are embedded in the process described before.

2.6.1 Systematic Reviews

The volume of existing journals, conferences, workshops in which ICT for water related matters are exposed is in constant evolution and growing. For this reason, being able of read, analyse, critically evaluate and synthetize all the state of the art is very difficult to be performed by individuals. In this context, several studies relative to formal systematic review methodologies have appeared. These are used to produce explicitly formulated, reproducible, and up-to-date summaries of existing knowledge (Cooper, 1999), (Petticrew & Roberts, 2006).

As stated in (Dybå, Dingsøyr, & Hanssen, 2007), a systematic review is a concise summary of the best available evidence that uses explicit and rigorous methods to identify, critically appraise, and synthesize relevant studies on particular topic. Explicit inclusion and exclusion criteria specify the types of study designs, interventions, populations, and outcomes that will be included in the review. A systematic search strategy specifies the keyword strings and sources used to find relevant studies in bibliographic databases and other electronic sources. It may also be necessary to search key journals and conference proceedings by hand to identify relevant studies that are not fully indexed. The search may be bounded by dates, journals, databases, and so forth, as long as the search procedures are transparent and replicable.

Based on guidelines from the medical literature, Kitchenham presented general procedures for performing systematic reviews (Kitchenham, 2004):

1. Planning the review
    a. Identification of the need for a review
    b. Development of a review protocol
2. Conducting the review
    a. Identification of research
    b. Selection of primary studies
    c. Study quality assessment
    d. Data extraction
    e. Data synthesis
3. Reporting the review

This methodology fits perfectly the IWO needs in term of reviewing of existing ICT for water research publications.

During the planning review, the most important part is to formulate the adequate research questions to be answered. Porting this to the IWO, this will be an iterative process, in which on each iteration, the research questions will be updated depending on the ultimate advances and interests. The research questions will be based in concrete keywords and strings which will try to limit the related publications to the ones containing them. These words will be selected during the composition of D1.3, D1.4, D1.5, D1.6, D1.7 and D1.8, and are the same which will be used to semantically tag the resources. As mentioned in diverse parts of this document, this words will be constantly evolving to fit the necessities of the IWO and are determined in the second stage of the Kitchenham's methodology: Conducting the review, more concretely, in the identification of research part.

Once the research questions and keywords are determined, the search process starts. This process consists on performing queries to relevant databases to obtain related publications. After that, duplicated ones must be deleted and, in case too much databases are selected, the less relevant ones will be removed till next iterations. Thanks to that, the number of relevant publications will be reduced to a manageable quantity and, the most important part, that number will include the best publications of the best sources. Several studies determine different methods to select the best ones, one of them is the one used in (Dybå, Dingsøyr, & Hanssen, 2007), where they define four stages to perform the selection:

1. Stage 1: Identify relevant studies, search databases and conference proceedings.
2. Stage 2: Exclude studies on the basis of titles.
3. Stage 3: Exclude studies on the basis of abstracts.
4. Stage 4: Obtain primary papers and critically appraise studies.

Previous to data extraction and synthesis, Dybå, Dingsøyr, & Hanssen (Dybå, Dingsøyr, & Hanssen, 2007) use a concrete collection of questions to determine whether to include or exclude the resource. These adapted questions to our goals are:

1. Is the resource based on research (or is it merely a “lessons learned” report based on expert opinion)?
2. Is there a clear statement of the aims of the research?
3. Is there an adequate description of the context in which the research was carried out?
4. Was the research design appropriate to address the aims of the research?
5. Was the recruitment strategy appropriate to the aims of the research?
6. Was the data collected in a way that addressed the research issue?
7. Was the data analysis sufficiently rigorous?
8. Is there a clear statement of findings?
9. Is the study of value for research or practice?

Based on their quality assessment questions to determine the relevance of the resource, we have generalized the original ones, as our range of search is much wider.

At this point, only relevant resources to be analysed are collected. Finally, we extract relevant data, tag the resource and summarize it, as explained in previous sections.

2.6.2 Technology scouting

The IWO is not intended to only observe research publications, but also to be aware of existing and emerging ICT for water related technologies. In a similar way than in the previous section, we have analysed several existing methodologies. In the following lines, we summarize some of the techniques we are going to use.

Rohrbeck (Rohrbeck, Harnessing a network of experts for competitive advantage: technology scouting in the ICT industry, 2010) defines technology scouting in the ICT industry as a systematic approach by companies whereby they assign part of their staff or employ external consultants to gather information in the field of science and technology and through which they facilitate or execute technology sourcing. Technology scouting is either directed at a specific technological area or undirected, identifying relevant developments in technological white spaces. Technology scouting relies on formal and informal information sources, including the personal networks of the scouts.

The IWO perfectly fits with that definition, as it is going to perform formal and informal research, together with making use of the personal network of contacts. The contributions of technology scouting to technology foresight and management can be better understood with the Figure 3. This figure represents the two aspects of scouting: i) identification, assessment and usage of information; and ii) sourcing of technology.

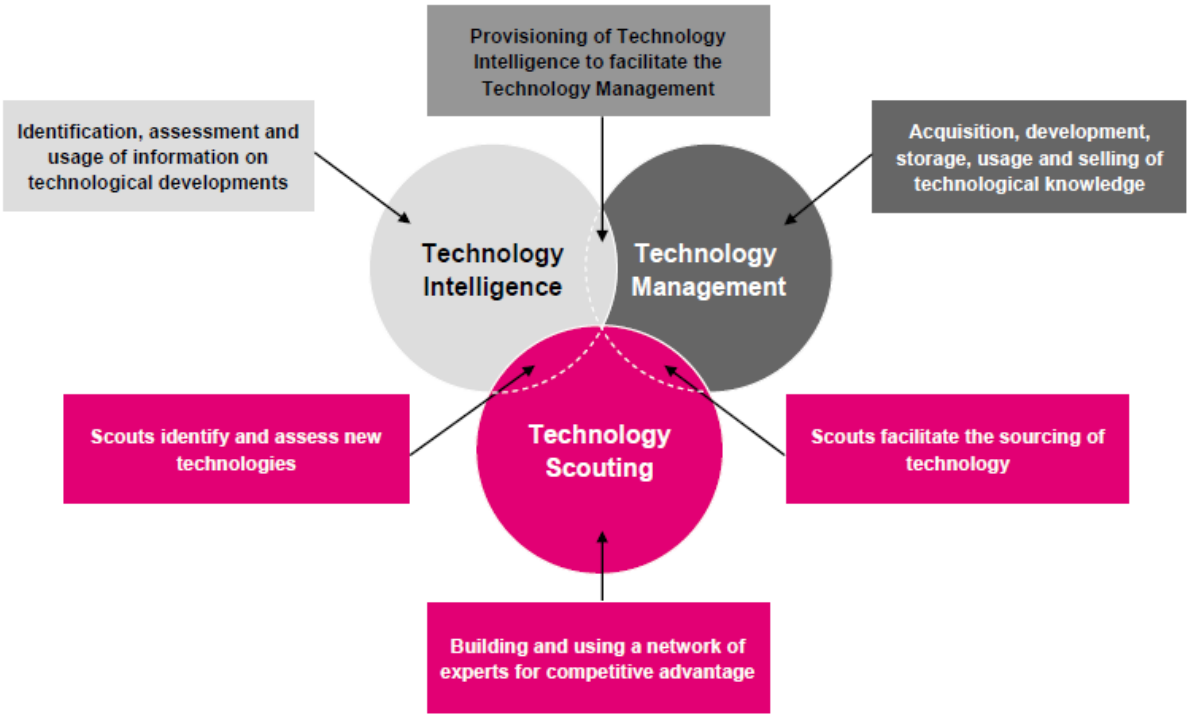

Figure 3 Contributions of technology scouting to technology foresight and management (Rohrbeck, Harnessing a network of experts for competitive advantage: technology scouting in the ICT industry, 2010)

The main goals of technology scouting include (Rohrbeck, Technology Scouting - a case study on the Deutsche Telekom Laboratories, 2007):

- Early identification of technologies, technological trends and technological shocks.
- Raising awareness of the threats and opportunities of technological development.
- Stimulation of innovation by combining the technology reports with business potential assessment.
- Facilitation of the sourcing of external technologies by reaching through the network of technology scouts to their sources of information.

With that aim, the paper describes the process to execute the technology radar. This (adapted to our-needs) process can be summarized in:

1. Identification: In this stage sources of information are accessed using, among others, the systematic review procedure defined in Systematic Reviews.
2. Selection: In this stage technologies are selected according their TRL.
3. Assessment: In this stage technologies are ranked according to two criteria: market impact and technological realization complexity.
4. Dissemination: This stage consists on clearly classify, analyse and publish in the IWO the results of the scouting process.

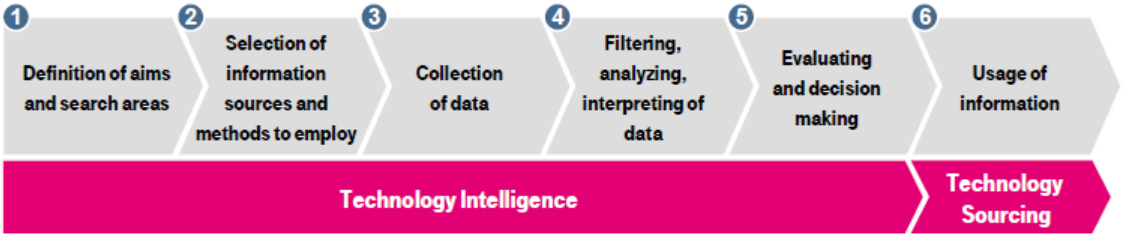

Figure 4 Technology scouting process (Rohrbeck, Harnessing a network of experts for competitive advantage: technology scouting in the ICT industry, 2010)

Figure 4 depicts the procedure as for Rohrbeck identification. In fact, Rohrbeck bases its definition in the studies done by Reger, and Ashton and Stacey (Reger, 2001), (Ashton & Stacey, 1995).

The IWO, following the simple procedure defined in Gathering, analysing and reporting process, will make use a mixture of the processes defined in Systematic Reviews and Technology scouting sections. Thanks to that, the process will be the more general possible, making use of the best techniques to search, filter, select and analyse each resource regarding its type.

3. ICT for Water Observatory knowledge base

As stated in the executive summary, all information collected in previous steps, has to be adequately structured and made accessible to the public. With that aim, a web based solution will be used to support it. This chapter includes the requirements the website should support, together with a study of existing tools and sites, and a schedule to put it in production, according and synchronized with the first literature and market analysis results (D1.3, D1.4, D1.5, D1.6, D1.7 and D1.8), and taking in consideration the publishing necessities of roadmaps (WP2 and WP3), and technologies portfolio (WP4). The rest of general WIDEST information, is considered to be included in main website.

3.1 Requirements and desired functionalities

In this section, requirements and desired functionalities will be defined. It has to be taken in consideration that WIDEST is not a development project, and there are no resources to develop a new knowledge base tool to support the project. However, several tools exist in the market, many of them open source or free to use. The following lines determine the requirements the tool should have, and the desired functionalities WIDEST would appreciate.

We can summarize the requirements in:

- **User access**: Although all information will be publically available without user registration, a private section would be very useful to manage user preferences to better provide relevant resources.
- **Categorization**: We would like to offer concrete information for each segment to better reach target interests/needs. Navigation between categories and subcategories has to be supported.
- **Searching**: The knowledge base should provide some information searching and navigation functionalities to better reach what users are expecting to find.
- **Source formats**: Multiple sources should be compatible: ontologies, databases, common document file types (PDF, DOC, DOCX…), external links to contents (it is not necessary to store everything locally)…
    - In the case this is not possible, links to source will be provided.
    - In the case of external content, periodic check for availability should be performed.
- **Service Oriented Architecture** (SOA): In order to allow other data sources embed our knowledge using web services or some similar technique/approach.

We can summarize the desired functionalities in:

- **Notifications and subscriptions** to concrete resources or categories/subcategories should be interesting. In this way, user would receive a notification each time new information is available or similar.

- **Content management**: This will be ideal to let users register the website and provide/manage information about their products, research results or similar. In that case, some validation previous to make that information available publically has to be performed.
- **Automatic categorization**: It should be very interesting to have a functionality able to, once a document in a supported text format is uploaded, the tool was able to detect some categories based on text contents, or at least, propose some of them for user validation.
- **Semantics**: We would like to use an ontology (or more than one, maybe combined with standards or schemas) to semantically tag all information. If not possible, keywords manually linked to existing standards, schemas and ontologies will be used.
- As with categorization, **automatic semantic tagging** would be appreciated.
- **Automatic gathering**: It would be great to be able to link some datasources directly to the repository. After that, user with privileges validates them following the described methodology in previous chapter.
- **Automatic data sources update**: If automatic gathering is possible, it would be great to automate the resource update process.
- **SPARQL endpoint**: to support Linked Data principles.
- **Automatic summarising**: In the concrete case of extensive text resources, it would be interesting to count with an automatic summarising functionality.

As stated before, it is very difficult for this project to achieve all these requirements and desired functionalities. However, we consider this list as an interesting start point for future evolutions of this tool, or even to inspire future observatories.

3.2 Existing solutions and portals

In order to accomplish the requirements, a classical Content Management System (CMS) could be used. A CMS is a computer application that allows publishing, editing, and modifying content, organizing, deleting as well as maintenance from a central interface. Several open source and free to use CMSs exist on the market. The most representative and extended ones are Joomla (Joomla, 2015) and Drupal (Drupal, 2015), which are presented in the following sections. In addition, some existing websites in which contribute are also analysed. These websites are: EIP on Water Marketplace (EIP on Water, 2015) and Ctrl+SWAN (EIP on Water, 2015). Finally sematic libraries for CMSs available in the market will be analysed. Selected ones are: Open Semantic Framework (Open Semantic Framework, 2015) and Apache Stanbol (The Apache Software Foundation, 2015).

3.2.1 Joomla

Joomla (Joomla, 2015) is a CMS which enables users to build Web sites and powerful online applications. Many aspects, including its ease-of-use and extensibility, have made Joomla one of the most popular

Web site software available. Moreover, Joomla is an open source solution that is freely available to everyone.

The most important features Joomla supports are: i) Multilingual; ii) Media Manager; iii) Contact Management; iv) Smart search; v) Content Management; vi) Nested categorization; vii) Tagging; viii) Frontend editing; ix) Content versioning; x) Syndication and Newsfeed Management; xi) User Management; and xii) Web Services.

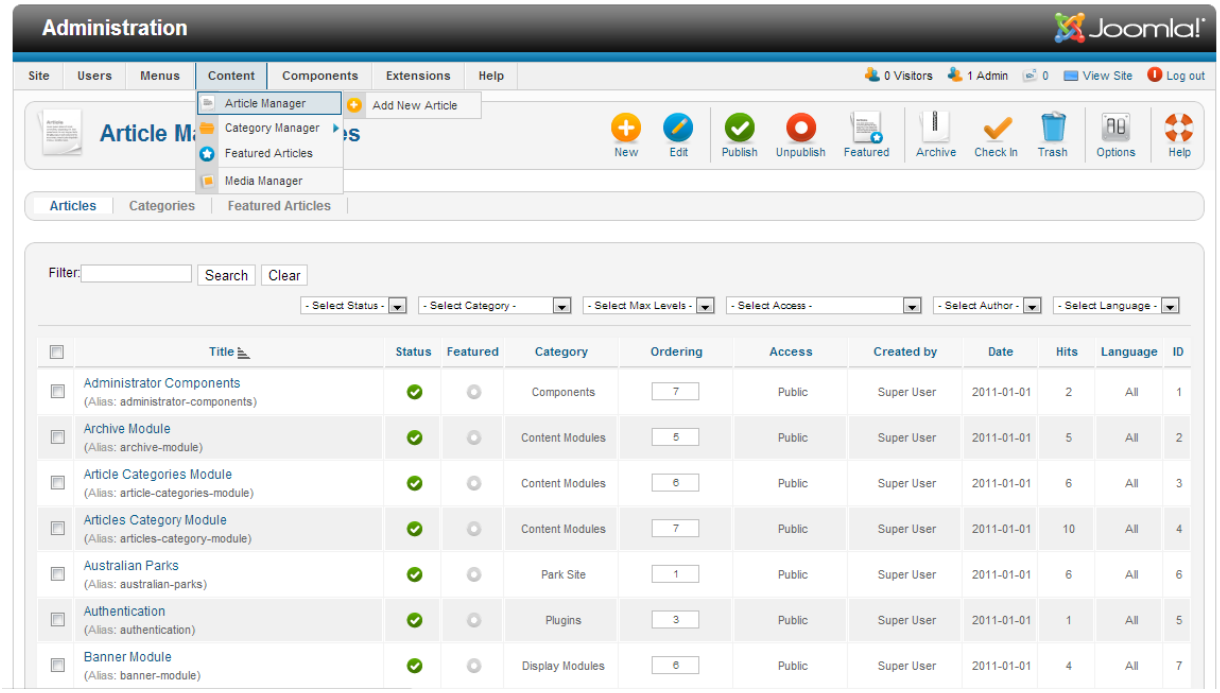

Figure 5 Joomla screenshot

As an initial summary, Joomla accomplishes requirements but lacks of semantic support by default.

3.2.2 Drupal

Similar to Joomla, Drupal is an open source content management platform powering millions of websites and applications. Drupal is a free software package that allows you to easily organize, manage and publish your content, with an endless variety of customization. The most important features Drupal support are: i) Multilingual; ii) Configuration Management; iii) Accessibility; iv) Built-in Web Services; v) Effortless Authoring; vi) Fast Theming; and vii) More Field Power.

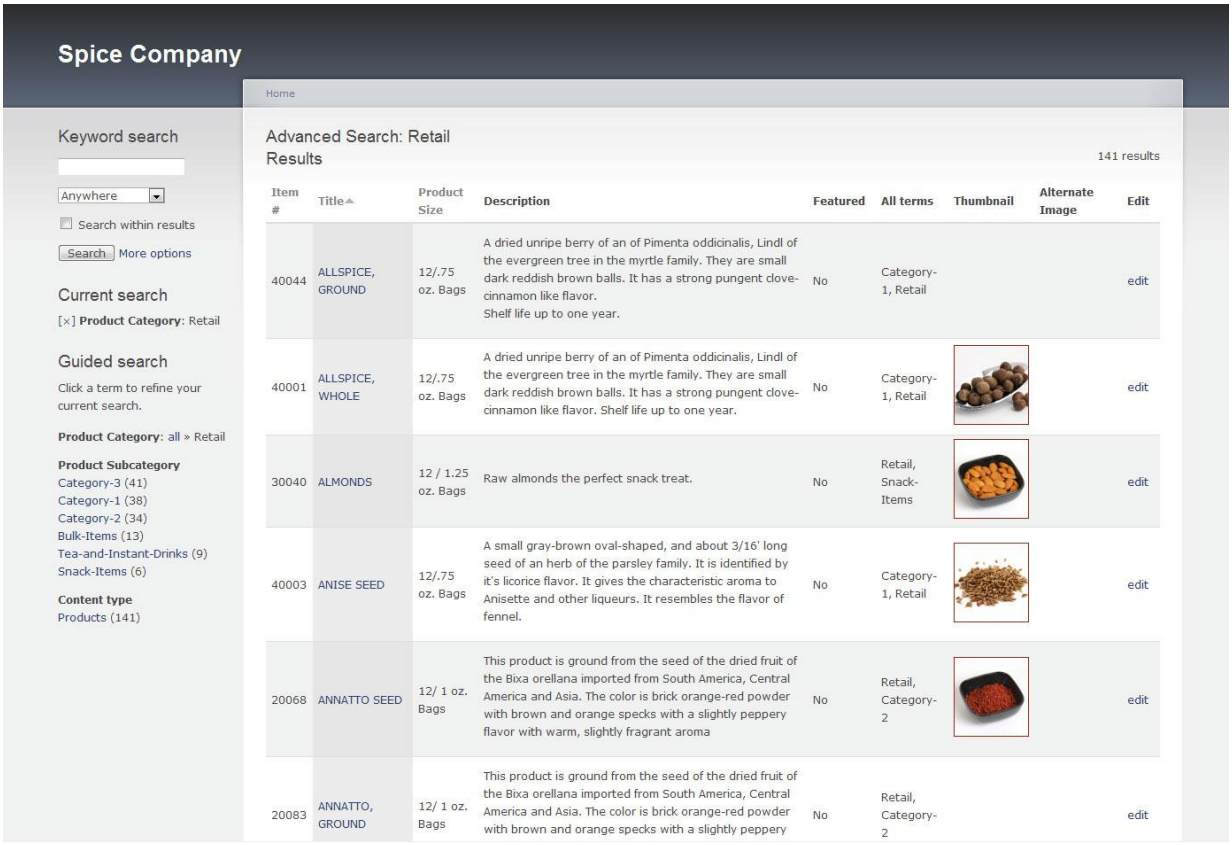

Figure 6 Drupal backend screenshot

Similar with what happens with Joomla, Drupal fully support IWO requirements, but lacks of native semantics support.

3.2.3 EIP on Water Marketplace

At the centre of the EIP on Water Marketplace (EIP on Water, 2015) is the matchmaking function, which - similar to a conventional marketplace - enables people to meet each other as well as offer their products. The EIP Water Marketplace enables users to search for colleagues of interest across the entire innovation value chain, as well as offer products and services. A water life cycle filter enables users to narrow down their search to a specific organisation, project, product or service thereby enabling them to easily look for information by region or any specific water-related topic.

And there is more than just searching on the Marketplace: users can use the news aggregator to automatically receive a comprehensive collection of recent news on water innovation, or filter news and publish it onto your desktop via RSS. A bookmarking system feature enables users to mark resources of interest and compile them into their personal information repository for later use.

In this case, the solution is provided as is. Users can register and provide and manage their assets in fancy tool. However, the tool has not support (or dedicated representation) for published materials.

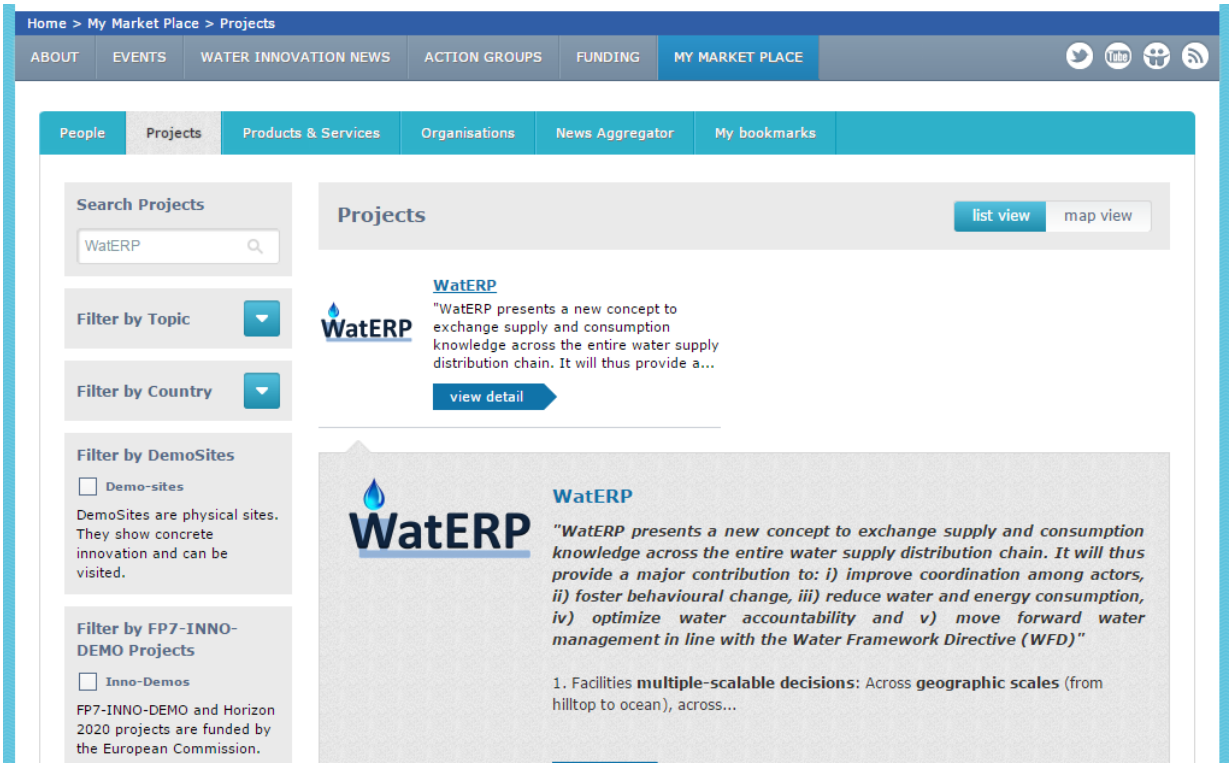

Figure 7 EIP on Water Marketplace

3.2.4 Ctrl+SWAN

Ctrl+SWAN Action Group (EIP on Water, 2015) is devoted to the further development of innovative sensor systems' technologies to be integrated and implemented in the design of an innovative approach to the water distribution networks management, with the broaden goal to introduce our concept of Smart WAter Network (SWAN) as a key subsystem of the notion of Smart City, as it has been recently recognised in the scientific and technical international community. To tackle the above mentioned issues, the action group focuses on techniques and technologies for water quality monitoring via innovative sensors and devices, in order to design and implement enlarged data models in a reliable early warning system for a more efficient water distribution network management, and extend our studies on the novel technique for designing i-DMAs compatible with hydraulic performance and optimized for water network protection.

As part of their efforts, the Action Group offers a software catalogue of products which may be candidate to be fed with WIDEST outcomes.

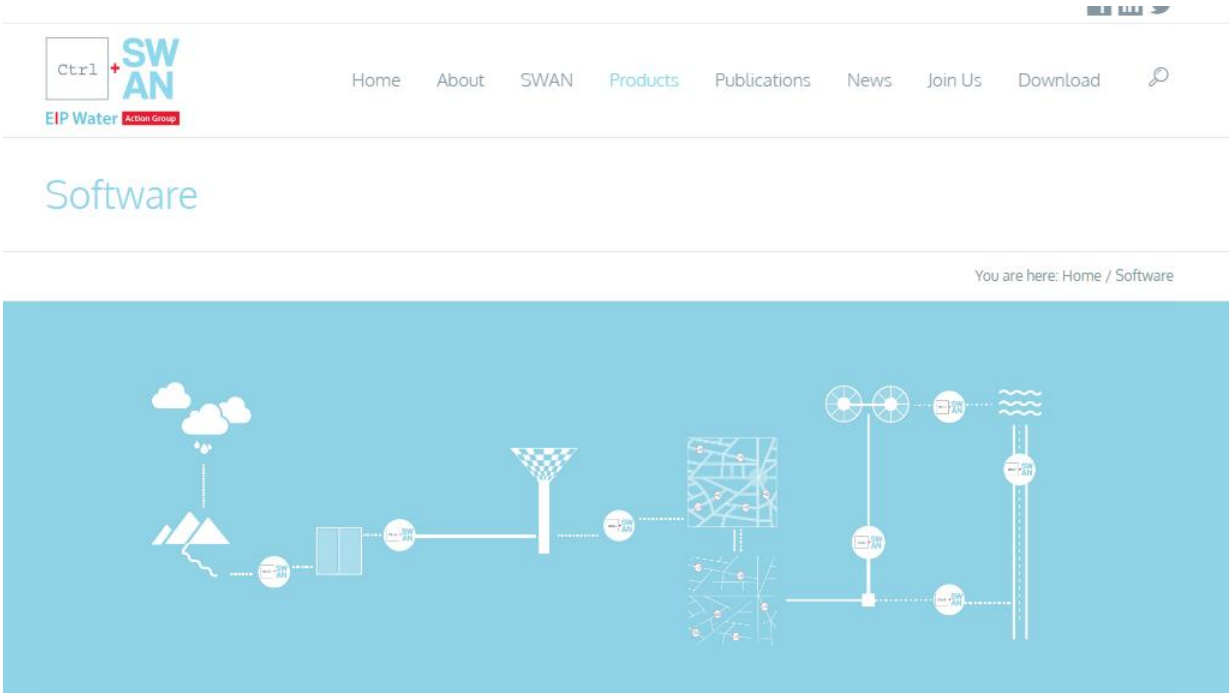

Figure 8 Ctrl+SWAN portal

3.2.5 Open Semantic Framework

The Open Semantic Framework (OSF) (Open Semantic Framework, 2015) is an integrated software stack using semantic technologies for knowledge management. It has a layered architecture that combines existing open source software with additional open source components developed specifically to provide a complete semantic technology framework.

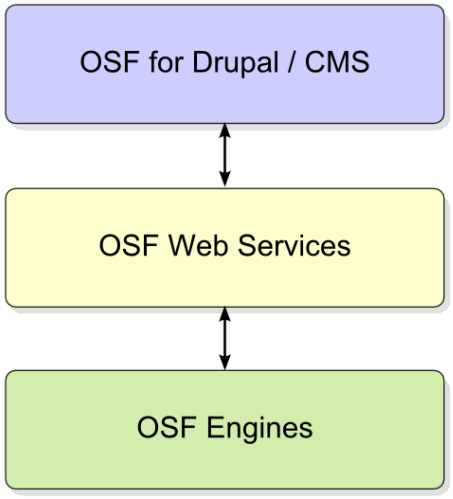

Figure 9 OSF Stack

The basic architecture of OSF is quite simple. The architecture pivots around OSF's Web services, for which there are now nearly 30 providing a wealth of functionality. This intermediate OSF Web services layer may be accessed directly via API or command line or utilities, or may be controlled and interacted with using standard content management systems (CMSs). The RESTful OSF Web services provide the uniform means to access best-of-breed data management and indexing engines. This design both: 1) abstracts away the complexity of the individual engines, while 2) enabling combined capabilities orchestrated by OSF not available from the engines alone. Full CRUD (create, read, update, delete) under user permissions and security is provided to all digital objects in the stack.

In this context, OSF is thought as an extension of Drupal, adding semantics capabilities to the popular CMS.

3.3 Apache Stanbol

Apache Stanbol (The Apache Software Foundation, 2015) is a modular set of components that provide semantic content management features. One of its core capabilities is to extract information from unstructured content, i.e. plain text. This process is called content enhancement. With content enhancement you can identify entities like persons, places, or organizations within unstructured content. Once entities are identified they can be automatically linked to open linked data sources on the web, like DBPedia. Other feasible use cases include: direct usage from web applications (e.g. for tag extraction/suggestion; or text completion in search fields), 'smart' content workflows or email routing based on extracted entities, topics, etc. Read the Apache Stanbol overview to learn more about Apache Stanbol.

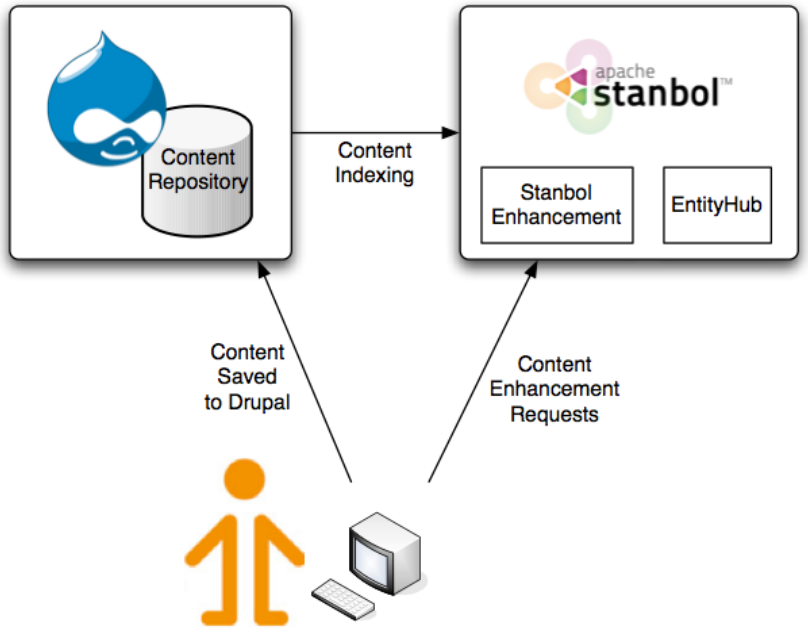

Figure 10 Drupal & Apache Stanbol architecture

In a similar way than the OSF, Apache Stanbol is thought to live in a Drupal CMS in this context, adding it with extra semantic capabilities.

3.4 Summary matrix

In the following table, the list of requirements and functionalities is crossed with every listed product.

	Joomla	Drupal	EIP on Water Marketplace	Ctrl+SWAN	Open Semantic Framework	Apache Stanbol
User access						
Categorization						
Searching						
Source formats						
Service Oriented Architecture						
Notifications and Subscriptions						
Content management						
Automatic categorization						
Semantics						
Automatic semantic tagging						
Automatic gathering						
Automatic data sources update						
SPARQL Endpoint						
Automatic summarising						

Table 1 Functionality support matrix

The green cells represent supported features, the red ones unsupported features and the yellow ones are neutral, depending on the host CMS in which that libraries are installed.

As a first conclusion, although the major lack of semantics, the use of existing tools and stablished platforms seems to be the most adequate. Synergies between existing platforms will improve project impact and will foster reuse of existing effective tools. Moreover, and according with the last EASME Water Eco-innovation meeting on 26th February concerns, we will not duplicate efforts on developing or researching something other funding activities are already doing.

3.5 Planning

Regarding the previous concepts, technologies and existing solutions, a decision has to be taken. However, this decision will be done when the D1.6 is completed. At that stage the contents of the IWO knowledge base will have an initial full version, and decisions will be more accurate to real necessities. Once the D1.6 is delivered, WIDEST will dedicate efforts to compare the different options here exposed

(or others to come), take a decision and put in production that solution. This doesn't mean developing or even deploying a CMS, it could also mean using an existing one, which is the most probable situation. The efforts can be estimated in one month for testing, deployment (if needed) and testing, and two months more to perform the initial population. Meanwhile, outcomes of D1.2, D1.3 and D1.6 will be made public in the WIDEST main website in adequate file formats to foster exploitation.

4. The IWO after end of WIDEST project

One of the more important questions to answer is: what will happen to the IWO after end of WIDEST project? This section pretends to give the vision of WIDEST project regarding this issue.

The main barrier to overcome is the maintenance of the website and its contents, as at the end of WIDEST project the website will be self-sufficient and no development efforts will be needed, this can be summarized in:

- **IT related matters**: Domain renewal and management, infrastructure management (servers, services and updates).
    - **WIDEST** partners conform a strong consortium. Therefore, there should be no problem to **find budget to pay that maintenance and externalise it**. This cost are estimated to be very low (<300€/year), depending on the final specifications and capacities of the IWO.
- **Content management**: This refers to continue maintaining and adding new relevant information to the knowledge base.
    - The first enabler of this point is that **users will be able to manage their assets**. That means that interested actors of the water sector will have the adequate permissions to create, modify and delete entries in the knowledge base.
    - Derived from previous point, who will take care of assets quality? In a same way that in previous point, WIDEST consortium should pay attention to that, **finding ways to obtain resources to maintain it**. This resources should be also dedicated to perform more contents iterations, thus making the IWO be up to date after end of WIDEST project.
    - If no ways to obtain available resources are found, it could be considered **to delegate all that functionalities and contents to an interested body or community** able to maintain it, assuring that initial philosophy and criteria is maintained.

Summarising, in both cases is a matter of resources, and in some way, of political interest of being in front of that knowledge base. WIDEST vision is to provide a powerful IWO website, making it an interest tool in which invest, thus fostering a better ICT for Water community.

5. Conclusions and future work

This report has presented the general IWO operations, including the selection of relevant sources of information, the methodology to collect, analyse and publish the available resources, the functional specification of the IWO website, an initial planning to have the IWO website in production, and finally, a vision of how the IWO website will be maintained, in terms of IT infrastructure and contents, once the end of WIDEST project is reached.

One conclusion is that, the methodology defined to collect, analyse and publish the available resources is easy to understand and put in practice. However, it will require certain domain knowledge for being able to take profit of the three classification approaches and the rest of attributes. As stated in previous chapters, this is work in progress. That means that this can change regarding the concrete or emerging necessities, and this defines one task for future work: maintain and improve the methodology and its related classification structures, lists and sources.

Related to the web tool, is has been stated that a classical CMS is an ideal tool to be the basis of the IWO. However, if possible, it would be of great help to count on some automatic procedures able to perform a first classification and summary of the resources. That would greatly improve the capacity of the IWO, making maintenance tasks much more effective and fast. However, this technology is not very mature in market, and WIDEST project has not resources bound to develop a new ICT tool. Therefore, efforts will be focused on finding the best CMS, combined with existing libraries or tools which make that operations lighter. As future work in this context, WIDEST project will explore the sector to try to find entities or bodies interested on maintaining or even invest on the website, and of course, with the restriction of maintaining its public access and philosophy.

To conclude, the public and open philosophy of the IWO website, should foster a more open community, able to interchange knowledge without quotes or restrictions. In that way, open access publications, and free to try management solutions will be prioritized against closed ones.

6. References

@qua Thematic Network. (2015, 07 26). *@qua: ICT for water efficiency.* Retrieved from http://www.a-qua.eu/

Ashton, B., & Stacey, G. (1995). Technical intelligence in business : understanding technology threats and opportunities. *International Journal of Technology Management*, (pp. 79-103).

BlueSCities. (2015, 07 15). *BlueSCitites*. Retrieved from http://www.bluescities.eu/

Ciancio, J. (2011, 11 11). *Map of Water Business Processes.* Retrieved from @qua ICT for water efficiency: http://www.a-qua.eu/jahia/webdav/site/aqua/shared/project_publications/Deliverables/Deliverable_2.1_Map_of_WBP_v3.0.pdf

Cooper, H. (1999). *Synthesizing research: a guide for literature reviews (3rd Edition).* Thousand Oaks: Sage.

CUAHSI. (2015, 07 15). *CUAHSI*. Retrieved from https://www.cuahsi.org/

DAIAD. (2015, 07 15). *DAID Project*. Retrieved from http://daiad.eu/

Drupal. (2015, 07 30). *Drupal - Open Source CSM*. Retrieved from https://www.drupal.org/

Dybå, T., Dingsøyr, T., & Hanssen, G. (2007). Applying Systematic Reviews to Diverse Study Types: An Experience Report. *Proceedings - 1st International Symposium on Empirical Software Engineering and Measurement, ESEM 2007*, (pp. 225-234).

EFFINET. (2015, 07 15). *EFFINET FP7 Project*. Retrieved from http://effinet.eu/

EIP on Water. (2015, 07 15). *Ctrl+SWAN.* Retrieved from http://www.swan.technology/

EIP on Water. (2015, 07 15). *EIP on Water Marketplace.* Retrieved from http://www.eip-water.eu/my-market-place/how-it-works

European Comission. (2015, 07 15). *Open Science (Open Access) Policy.* Retrieved from http://ec.europa.eu/research/swafs/index.cfm?pg=policy&lib=science

European Comission. (2015, 07 19). *Smart technologies | EIP Water*. Retrieved from http://www.eip-water.eu/priorities/smart-technologies

FREEWAT. (2015, 07 15). *FREEWAT - Free and Open Source Software Tools for Water Resource Management*. Retrieved from http://www.freewat.eu/

ICeWater. (2015, 07 15). *ICT Solutions for efficient Water Resources Management*. Retrieved from http://www.icewater-project.eu

ICT4Water. (2015, 07 15). *ICT4Water cluster*. Retrieved from http://www.ict4water.eu/

ISS-EWATUS. (2015, 07 15). *Integrated Support System for Efficient Water Usage and Resources Management*. Retrieved from http://issewatus.eu/

IWA. (2015, 07 15). *Full list of IWA Events*. Retrieved from http://www.iwa-network.org/event/full-list-of-iwa-events

iWidget. (2015, 07 15). *iWidget Project*. Retrieved from http://www.i-widget.eu/

Joomla. (2015, 07 15). *Joomla CMS.* Retrieved from http://www.joomla.org

KINDRA. (2015, 07 15). *KINDRA Knowledge Inventory for hydrogeology research*. Retrieved from http://www.kindraproject.eu/

Kitchenham, B. (2004). Procedures for performing systematic reviews., (pp. 1-28).

Kohlmann, U., & Boudon, J. (2012, 11 27). *Current ICT Solutions.* Retrieved from @qua ICT for water efficiency: http://www.a-qua.eu/jahia/webdav/site/aqua/shared/project_publications/Deliverables/Deliverable_2.2_Current_ICT_solutions_v4.2.pdf

Linked Data community. (2015, 07 15). *Linked Data - Connect Distributed Data across the Web*. Retrieved from http://linkeddata.org/

NASA - Jet Propulsion Laboratory. (2015, 07 15). *SWEET - Semantic Web for Earth and Environmental Terminology*.

OGC. (2015, 07 25). *OGC HY Features: A common Hydrologic Feature Model.* Retrieved from https://portal.opengeospatial.org/files/?artifact_id=55157

OGC. (2015, 07 15). *OGC WaterML 2.0*. Retrieved from http://www.opengeospatial.org/standards/waterml

Open Semantic Framework. (2015, 07 20). *Open Semantic Framework*. Retrieved from http://opensemanticframework.org/

Petticrew, M., & Roberts, H. (2006). *Systematic Reviews in the Social Sciences: A Practical Guide.*

Reger, G. (2001). Technology Analysis & Strategic Management., (pp. 533-553).

Rohrbeck, R. (2007). Technology Scouting - a case study on the Deutsche Telekom Laboratories. *ISPIM-Asia Conference*, (pp. 1-14). New Delhi.

Rohrbeck, R. (2010). Harnessing a network of experts for competitive advantage: technology scouting in the ICT industry. *R&D Management 40* (pp. 169-180). Oxford: Blackwell Publishing.

smartH2O. (2015, 07 15). *The smartH2O project: A European project on water sustainability*. Retrieved from http://www.smarth2o-fp7.eu/

The Apache Software Foundation. (2015, 07 22). *Apache Stanbol*. Retrieved from https://stanbol.apache.org/

UrbanWater. (2015, 07 15). *UrbanWater FP7 Project*. Retrieved from http://urbanwater-ict.eu/

W3C. (2008, 01 15). *SPARQL Query Language for RDF*. Retrieved from http://www.w3.org/TR/rdf-sparql-query/

W3C Semantic Sensor Network Incubator Group. (2011, 06 10). *Semantic Sensor Network Ontology*. Retrieved from http://www.w3.org/2005/Incubator/ssn/wiki/SSN

Wat€rnomics. (2015, 07 15). *Wat€rnomics*. Retrieved from http://www.waternomics.eu/

WaterInnEU. (2015, 07 15). *WaterInnEU H2020*. Retrieved from http://www.waterinneu.org/

WatERP Project. (2015, 07 15). *WatERP: Where water supply meets demand*. Retrieved from http://www.waterp-fp7.eu/

WISDOM. (2015, 07 15). *WISDOM Project*. Retrieved from http://www.wisdom-project.eu/

WssTP. (2015, 07 15). *Event Calendar*. Retrieved from http://wsstp.eu/events/

ANNEX 1: ICT 4 Water Marketplace Topics

1. Natural Waters
   - 1.1. Coastal Waters
   - 1.2. Groundwater
   - 1.3. Lakes
   - 1.4. Marine Waters
   - 1.5. Rain and Precipitation
   - 1.6. Rivers
   - 1.7. Scarcity, Floods, Droughts (Extreme Events)
   - 1.8. Transitional Waters
   - 1.9. Wetlands
2. Sustainability
   - 2.1. Climate Change
   - 2.2. Ecosystem Services
   - 2.3. Limnology and Fresh Water Ecology
   - 2.4. Nutrient Removal and Recovery
3. Water Policy and Administration
   - 3.1. Financing
   - 3.2. IWRM Integrated Water Resource Management
   - 3.3. Laws and Legislation
   - 3.4. Public Private Partnerships
   - 3.5. Training and Capacity Building
   - 3.6. Water Governance
   - 3.7. Water Pricing
4. Water Services and Water Use
   - 4.1. Drinking Water Supply
   - 4.2. Fisheries and Aquaculture
   - 4.3. Industrial Water Supply
   - 4.4. Irrigation and Drainage
   - 4.5. Navigation
   - 4.6. Recycling and Reuse
   - 4.7. Wastewater (Treatment and Sewerage)
   - 4.8. Water and Energy
5. Water Technology
   - 5.1. Biological Treatment
   - 5.2. Chemical Treatment

5.3. Filtration and Separation
5.4. Hydroinformatics
5.5. Hydrology
5.6. Instrumentation, Control, Automation
5.7. Modelling
5.8. Water Chemistry

ANNEX 2: ICT issues terms derived from Business Processes involved in the water cycle by @qua Thematic Network

The list of Business Processes studied in (Ciancio, 2011) under the @qua Thematic Network were merged in the following ones to be studied in (Kohlmann & Boudon, 2012):

- BP1: Operation of Plants
- BP2: Operation of Networks
- BP3: Asset Management
- BP4: Work Management
- BP5: Geographic Information (GI)
- BP6: Measurements
- BP7: Customers
- BP8: Public Service Contract
- BP9: Transverse BPs

Where each new "merged BP" is the combination of two or more BPs treated in (Ciancio, 2011), as it is explained as follows:

- Operation of Plants
    - Drinking Water Treatment Plants
    - Wastewater Treatment Plants
- Operation of Networks
    - Drinking Water Network (including water balance in primary networks & leak detection)
    - Wastewater Network
    - Storm Water Network
    - Real-time Network Management
- Asset Management
    - Asset Management in general
    - Planning and design of new assets
    - Links between asset management and works & interventions
- Works and Intervention
    - Management of field interventions and plant maintenance
    - Electromechanical maintenance in WTP, WWTP & PS
    - Field works in general
    - Sewer Inspection
    - Sewer Cleaning
- Use and Maintenance of GI = Geographic Information

- Measurements
  - Automation & Sensors (DW, WW and ENV)
  - Advanced Metering Infrastructure or AMI (incorporating AMR & AMM)
  - Laboratories and Quality Control
- Customers
  - Billing, Customer care and communication
  - Including manual meter reading
- Public Service Contract Management
- Crisis Management