Expert Consultation on ICT for Water Management

Brussels, 31/01/2013

1. Introduction

In the European Union over the last thirty years there has been observed an ever-increasing number of droughts, with increasing intensity. Between 1976 and 2006, the number of regions and populations affected by droughts has increased by roughly 20%. One of the worst droughts occurred in 2003 and affected more than 100 million people across one third of EU territory. The term 'water stress' is applied when annual water resources are below 1,700 m3 per capita; the term 'water shortage' applies when the annual water resources drop below 1,000 m3 per capita. To date, at least 11% of the European population and 17% of EU territory have experienced water scarcity-related problems. At a global level, water stress affects a significant proportion of the population. The most highly populated areas affected are: Asia – India and China; Africa - North and South Africa and the Arabian Peninsula; the Americas - the United States and Mexico[1].

It is expected that in 2040, according to a conservative estimate of the UN, the world population has grown by 1B people. Hence, it is quite likely that in 2040 an additional 100 Megacities will exist[2]. As an essential substance for nature, city, industry and humans, the economies of 2040 depend heavily on optimal management of water resources. Being an essential resource for almost all production processes in 2040, water management has grown into a major political issue (R. Meier, A3.8).

The Guidance Document n°24 "River Basin Management in a Changing Climate of the Common Implementation Strategy for the Water Framework Directive (200/60/EC)[3] identifies five building blocks of the recommend approach for the preparation of the adaptive measures: (1) how to handle available scientific knowledge and uncertainties about climate change; (2) how to develop strategies that build adaptive capacity for managing climate risks; (3) how to integrate adaptive management within key steps of River Basin Management Plan (RBMP) of the WFD; and how to address the specific challenges of managing future (4) flood risk and (5) water scarcity. River basin management, including flood and drought risk management will face a need for delivery of the second and third RBMP cycles (from 2015 until 2027). This will require a combined approach that balances action on monitoring and understanding climate driven impacts, with implementing no regret actions to improve resilience and ensuring that long life-time investments are climate resilient.

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[1] BIPE, Public water supply and sanitation services in France. Economic, social and environmental data. Fifth edition March 2012 (http://www.fp2e.org/userfiles/files/publication/etudes/Etude%20FP2E-BIPE%202012_VA.pdf)

[2] Cities foster economic and social activities that benefit from growing scales and scopes, attracting ever more people. www.mckinsey.com/insights/mgi/research/urbanization/urban_world

[3] http://www.inbo-news.org/IMG/pdf/Guidance_Document_Climate_Change_EN-2.pdf

The role of the Information and Communication Technologies (ICT) in supporting water resources management is widely recognised by the scientific community and water business professionals. A number of the on-going or already completed R&D Projects partially funded by the European Commission under FP7 ICT programme, Competiveness and Innovation Framework Programme (CIP), Entrepreneurship and Innovation Programme (EIP), EUREKA projects or national projects is the best confirmation of the latter assertion.

Water industry is also evolving. Serious discussions were initiated between authorities and traditional water utility operators for enlargement of their domain of competences, traditionally limited to water distribution, to include biodiversity and reduction of the GHG in their services[4].

However the situation of the current ICT models and tools used by the water industry assessed recently by the on-going PSP initiative **@qua** Thematic Network (A3.9 - A3.11) clearly indicates a number of limitations of implemented stand-alone applications and lack of an integrated approach, which would allow dealing with all categories of data without any redundancy. These documents will be completed in June 2013 by additional documents related to the level of sharing, guidelines for use of existing solutions and specifications of the R&D programme.

2. Purpose of the Consultation

The purpose of the present consultation was to discuss research needs and priorities in the domain of ICT for water resources management, which could be addressed in the perspective of the calls for proposals of the forthcoming Horizon 2020.

In fact, it is expected that the management of the water resources as a part of the FP7 objectives of the ICT *Challenge 6: ICT for a lower carbon economy*, which concentrates on the development of ICT to achieve substantial efficiency gains in the distribution and use of key resources such as energy and water, as well as application of ICT to decarbonise transport and make it safer, will be also reflected in the future ICT activities of the Horizon 2020.

The Consultation also explored the need for priority actions to be launched by DG for Communications Networks, Content and Technology (DG CONNECT) in the context of the broader interest which has been built up to increase efficiency in water management and foster EC investment in research and innovation for Horizon 2020.

3. Approach to the Consultation

The methodology of the consultation was based on the following four step approach:

- Preparation of the EC Initial Position Statement (Annex 1) containing survey questions and organization in Brussels on 31st of January 2013 of the panel

[4] Le Monde (4/03/2013), L'appétit des opérateurs privés. Les entreprises investissent le marché de la protection de l'eau.

discussion session of selected experts from the ongoing FP7 R&D Project activities in the domain of the ICT applications to water management problems;

- Submission by the invited panel written contributions to the consultation report (presentations and positions with respect to the survey questions);

- Based on the received feedback and analysis of the available documents from ongoing initiatives **@qua** Thematic Network and WssTP preparation of the draft Consultation Report including a tentative road map;

- Internal discussions within DG CONNECT and preparation of the final version of the Consultation Report.

This report summarises the main issues raised in this consultation which could constitute the basis for possible future activities on this field, to be launched by DG CONNECT.

The consultation involved 13 participants, experts from industry, academia and water-related associations. Most of them are involved in the on-going actions under FP7 programme. The list of participants is included in the Annex 2 to this report, while hyperlinks to the contributions of the experts are provided in the Annex 3.

4. Expression of panel participant positions

A round-table discussion focused on the identification of possible new R&D ideas and themes to be specified in future calls relevant to the ICT applications in the water management domain of the future Horizon 2020. It is worth mentioning the on-going FP7 initiatives such as Smart Grids, which concern mostly urban water however for the Horizon 2020 the role of the DG CONNECT in the conducting of R&D and demonstration activities related to ICT applications to water management needs to be clearly focused on interoperability.

Given the three initially identified general objectives:

a) substantial consumer water and energy saving,

b) peak-period reduction of water and energy distribution loads,

c) reduction of Greenhouse Gas (GHG) emissions

and the following potential ICT domains under consideration :

- standards and interoperability through dedicated information systems for water management

  - ontologies, semantic interoperability (including georeferenced information)

  - business process modeling and architectures

- dedicated applications for water management and GHG emissions

    - suppliers (assets management, work management tools, real-time modeling and decision support)

    - customers and consumers (industry, utilities, agriculture, public)

    - tools for Life Cycle Assessment (LCA) of ICT equipment, networks and services for the reduction of GHG

- prospective technologies

    - sensors (smart water grids, standards and recommendations from W3C and OGC, European Water Platform WssTP SoA, June 2012)

    - communication and frequencies (tv white spaces network (tvwsn, IEEE 802.11af Draft Standard), wi-fi, li-fi …

the invited experts were asked to express their assessment of the following four survey questions:

- what is the return of experience from completed and ongoing R&D projects (successes and failures) ?,

- what are the identified scientific and technological barriers and challenges ?,

- what are the gaps to be addressed ?,

- what is the degree of urgency for prioritizing ?.

The following issues were highlighted in the discussion:

3.1 On the evolution of the water industry and representativeness of the initial objectives

(i) The principles of the water industry have been stable for centuries but it is clear that the current trends are leading to dramatic changes. Even if the visible effects are at different levels according to the various regions of the world, the components of the changes are the same everywhere:

- overall decrease of water consumption, and consequently weakening of the traditional economic model based on volumes sold to customers;
- increase of water reuse, and even of cascading uses;
- notion of "circular economy of water" - major change compared to the traditional "open cycle" management of water
  extension of the responsibility of water utilities to the management of the "large" cycle;
- integration of smart water management in future green / smart cities / buildings;
- water - energy nexus;

- increase of public awareness of the major role of asset management, i.e. of the overall cost of infrastructures in the cost of water.

These foreseen evolutions need to be taken into account in the design of future ICT tools for Water Resources management.

(ii) The term "Smart Grid" is currently used in the context of energy, especially to explain how ICT tools could help the real-time integration of disseminated micro energy sources (solar, biomass, etc.) in a national/regional energy grid, and how ICT could provide tools to the subtle balance between production and consumption of a physical phenomenon which is not easy to store. In a natural way, the concept of "Smart Grid" was extended to water domain, but the comparison is not so simple. Why ? Because, fundamentally water and (electrical) energy are flows of completely different natures. In addition in the water resources domain the term of "water consumption" needs to be consider in the wider sense of water cycle, which includes also return flows from industrial, agricultural or domestic distribution networks. While it is no so difficult to decide in real-time if it is possible to connect locally-produced power (e.g. by solar panels or micro-turbines) (what requires check if the frequency and tension of the produced current are within the specified boundaries of the grid) connection of, for example drinking water distribution systems is much more complicated and requires careful verification of water quality (which is not so easy in real-time) and increases the cost due to energy consumption necessary for pumping. In addition, the time steps of both domains are completely different : in a power grid you have to react in milliseconds, while in water networks it is a question of minutes (or even tens of minutes), because water is a heavy material, with an appreciable inertia, and which can be stored easily. For all these reasons, the "model" of Energy Smart Grid cannot be easily translated to the domain of water management.

(iii) For these reasons mentioned under (I) and (ii) to the initial three general objectives there is a real need to add an additional objective related to setting up the conceptual foundations for a water information system, which will be technology neutral and sufficiently open to guarantee both the interoperability of different water cycle sub-domains and future evolution of stakeholder business processes.

3.2 On the return of experience from completed and on-going ICT R&D project in the water domain

(i) Some panellists identify three ways in which the target goals presented in the Consultation meeting could be addressed through:

a) infrastructure investments in the water network distribution systems,
b) improved coordination,
c) behavioural change.

These measures have different time scales and associated costs. Infrastructure improvements are very costly and require long-term investments. With the

current economic crisis situation in Europe, there is a reduced ability to finance infrastructure improvements. However, given the small number of actors involved in water regulation and distribution[5], if they could better coordinate their activities, results would be seen immediately and therefore any tool that helps to improve this can provide direct benefits. Improvement of coordination among these stakeholders (and others depending on a spatial scale) may lead to substantial water savings. Behaviour change requires time, but due to the very large amount of water consumers has a very large potential. **Consequently, research lines could be mainly focused in the expected impacts, to the second and third approaches.**

While the EC believes that 40% water savings could be achieved from technological improvements[6],, this value is the sum of a series of different actions. **Based on water resources management experience, it can be roughly estimated that improving coordination among actors could lead to water savings between 5 and 8%**, with smart metering providing an additional 8 to 10%. The remaining savings would need to come from long-term infrastructure improvements, economic incentives, policies and land use changes. It should be noted that these water savings are accompanied by energy and cost savings since managing, moving and treating water requires a lot of energy and is expensive, as well as environmental benefits.

For instance, there is an urgent **need to transition towards a more water-smart society**, develop water-wise solutions and research on new ICT tools to **improve water/energy management efficiently.**

Although water savings have been achieved, these improvements are localized and uncoordinated. Each entity currently acts independently without much knowledge regarding the needs, constraints or operations of the others and information is not easily accessible. In order to achieve wide scale improvements, **there is a need for enhanced coordination, cooperation and mainly organize the knowledge around water supply actors across different scales**, in order to address both long-term water imbalances (water scarcity), and enhance resilience to drought.

Furthermore, there is a **need for increased information/knowledge sharing**. If information were shared among the various decision-makers and stakeholders, operations could be coordinated, better decisions could be made, water supplies could be prioritized according to needs and changing conditions, overall water use efficiency could be improved, and water shortages could be reduced.

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[5] Out of 70000 professional operators in the water business (WssTP,"Strengthen collaboration in research and innovation for a "water efficient Europe", Stakeholders' Event, Report, 17-18 May 2011, Brussels, Belgium) only few are involved as regulators at a country or regional levels and in water distribution at intermediary level (between storage reservoirs and network operators).In some member states (e.g. Germany) the role of an intermediate distributor doesn't exist.

[6] Dworak, T., et al. (2007): EU Water Saving potential. ENVD2/ETU/2007/0001r. Ecologic-Institute for international and European Policy. http://ec.europa.eu/environment/water/quantity/scarcity_en.htm. (ECOLOGIC 2007).

(ii) The panelists agreed that water and ICT is a field undergoing rapid evolution facilitated by a wide number of technological advances. This is impacting the status quo of many sectors including the water sector and altering how water is managed throughout the water cycle. In this context, the main recommendation consists in considering the research needs as part of a wide and holistic "pan European ICT platform" for the water cycles (including aspects of water stress in coastal zones, sustainable water management inside and around large urban areas, water in agriculture) with a clear governance. This ambitious vision will not necessarily lead to a fully integrated and consistent information system but will force each R&D funding entity or program management, instead of promoting isolated stand-alone solutions, to focus on integration of components and systems following standardized rules permitting semantic interoperability (such as ontologies).

(iii) Most water supply gravity networks have already decoupled energy from water in distribution networks, by filling the tanks at low energy costs. Smart meters and smart applications already exist, and users are already aware of their own consumption. But household water demand keeps almost inelastic. Mainly because of the lack of pricing incentives. The sustainability of the 'Real Time' requirements is of great importance. More real time data will represent more communications bandwidth and more power consumption in remote isolated sensors. Often, retrieving data once a day will be enough for managing your water systems. In addition, from pragmatic point of view robust, reliable, small and cheap sensors do not exist. New micro or nano sensors coming from R&D will be finally packed in an industrial device, with power, robust housing, communications, self-cleaning ,etc.

(iv) Contemporary EU funded research focuses on ICT for water usage control. Here the goal is the prevention of water scarcity and the research effort will yield ICT that informs and even bills users for the cost of water and its pollution. Before 2013, ICT research was focussed, amongst others, on flood prevention and mitigation. IBM, motivated by insight and the hope of new market opportunities, has conducted a study and made its conclusions public available in: *"Water – A Global Innovation Outlook (GIO) report"* [7]. The report, written as an informative text, is a most comprehensive overview of the role of ICT in the context of water. It illustrates the subjects covered in the previous paragraph with practical examples. The report makes clear that ICT for water environment is an all-encompassing subject.

3.3 On the identified scientific and technological challenges

(i) An important recent survey conducted by the WssTP initiative ("State of the art and research needs in Sensors and Monitoring", WssTP, June 2012) provides up to date list of technological challenges in this domain. Among them creation of a pan European Water ICT platform for water cycles with a clear governance is considered as of great importance and priority from the point of view of water

[7] www.ibm.com/ibm/gio/media/pdf/ibm_gio_water_report.pdf

business industrial stakeholders. In fact, the report insists on the need at the R&D level in focusing on integration of components and systems following standardized rules permitting semantic interoperability (such as ontologies) instead of promoting stand-alone solutions.

(ii) The following ICT domains are considered as the real challenges in the forthcoming period :

Open data

On December 12th, 2011, the European Commission announced its strategy on Open data, a key element of which will be the revised Public Sector Information Directive[8]. Based on a potential market value of tens of billions of euros the EC took a major step in signalling administrations to free up their data so as to stimulate innovation, transparency and quality of service. In line with the directive the following themes appear both relevant and important for the ICT domain:

- Using green open data for business development in the water industry.
- Using open source Internet of Things for uncovering new services to utilities/citizens and more specifically for real-time network control and monitoring.

Big Data

- Services enabled by technologies for the convergence with Internet of Things and Internet of Contents.
- Seamless integration of real and virtual worlds through visual analytics for Big Data in Real-Time Water Management.

In the water industry it would help in discovering consumer behavior patterns and "hidden" indicators due to the amount of information to be analyzed in real-time and not being represented by SCADAs. It would also be useful for sectors design, advanced leakage location, network resilience to problems, very short term studies of side effects (hydraulic transients, water hammer, etc.), improved DSS and energy optimization (q.p.e. ratio). Some examples about this future trend area Visual Analytics FP7 project *VisMaster* (http://www.vismaster.eu/), Live Singapore project (http://senseable.mit.edu/livesingapore/visualizations.html) or latest MIT Big Data report (http://www.technologyreview.com/magazine/2013/01/).

Augmented reality for water

- Service for utilities, municipalities and citizens through smart phones apps. It could help to reduce O&M costs (discovery of pipes, location of leaks, faults, etc.) and have a pedagogical use for citizens.

[8] http://ec.europa.eu/information_society/policy/psi/docs/pdfs/directive_proposal/2012/en.pdf

Crowdsourcing

- Integral data exploitation for bidirectional communication. Service for utilities, municipalities with special focus on citizens to monitor water resources and networks. Similar trend was identified by the EPA (US Environmental Protection Agency) as priority in forest, parks and gardens monitoring.

Real-time

- Real-time data collection and connection to utility services through standardized communication protocols and interfaces.
- Improve real-time understanding and control strategies on water.
- Multi-parameter real-time monitoring (discharge, precipitation, quality) for networks where current technologies are not viable (due to necessary civil works).
- Anywhere real-time monitoring for small networks and plants not able to invest in big licenses or infrastructure (mobile, multi-platform, Internet based).

Trans-sector communication

- Create a utility communications network to share among different stakeholders (electricity, water, gas, heat, other) one single network: electricity, telecomm, wired solutions, municipal network.

Asset Management

- Trans-sector dynamic asset management that integrates major players: Water, Gas, Oil, and Electricity. Use of other industrial asset management know-how and predictive maintenance expertise.
- Establish communication among expert groups in different industries to introduce, for example, the predictive maintenance experience in gas and the asset management knowledge of electrical companies in water. The aim is to gain experience from other business with a more mature know-how.
- Advanced asset inspection for automatic fault detection and localization (for instance using robotic inspection devices) linked with proper DSS tools for operation management.

Interoperability

-Interoperability and easy plug & play of services and data including semantic interoperability

-Software as a Service. Modular services easy adaptable and optimized to any type of customer, from small size and less technological networks to bigger and highly sensorized networks.

- Connection to external services, even those not related to water to improve models, alarms management and event detection.

Smart cities connection

- Being aligned and integrated with smart cities evolution.
- Gaming technology for citizen interaction and models improvement.

- New services to citizens. Decision Support Systems and capital plans linked to water/energy and able to offer adaptive billing strategies and optimized consumption patterns to end users.

Events management

- Improvement in early events detection and early warning systems for water, also linked to other sectors' assets data/alarms (electricity, gas, oil, hydro-meteorological).
- Cross-management of data of any source (Big Data, OPEX, CAPEX, O&M, etc.) to improve events detection (leaks, faults) and early response to it.

Security in water networks

- Cyber security for water. Protection of sensitive data and infrastructure to deal with future threatens (e.g. Stuxnet PLC virus).
- Unattended systems for continuous measurement (real-time?) of microbiological, hydrocarbons and emerging contaminants.

(iii) The panelists stressed the importance of the integrated approach coupling water and energy into a mutually dependent system. The competition between water and energy needs represents a critical business, security, and environmental issue, but has not yet received the attention that it merits. Energy production consumes significant amounts of water; providing water, in turn, consumes energy. In a world where water scarcity is a major and growing challenge, meeting future energy needs depends on water availability – and meeting water needs depends on wise energy policy decisions[9].

(iv) At the same time the panelist have not considered the prospective communication opportunities as a key element of the ICT contribution to the programme objectives. In fact, there was a general agreement that the water utility operators select reliable and cost-effective communication networks ready for operational use. It is very unlikely that industrial water partners will be willing to share the risk of research and will be ready to be involved even in the demonstration part of an innovation programme just for a purpose of testing of the new technologies of communication.

3.4 On the gaps to be addressed

The following (unordered) list of gaps was identified and considered as essential in the preparation of the future ICT advances in the water resources management domain:

(i) Interoperability tools for water industry, based on shared models of the Business Processes:

[9] D.Glassman et al.,The Water-Energy Nexus, World Policy Papers, The World Policy Institute, March 2011.

- Ontologies, i.e. shared definitions of concepts, necessary condition for semantic interoperability;
- Library of services, based on the analysis of BPs' invariants;
- Orchestration (possibly auto-configurating) based on BPs' flows.

(ii) Means to handle more real-time data (at network, business process, and analytical level) resulting out of more sensors and meters in the field;

(iii) Standardization (use of IP based technologies) for communication right up to the field devices

- Enabler for scalable composition of services hosted in the cloud
- Enabler for an Internet-of-things ;

(iv) Security and intrusion detection (relevant with more devices being Internet enabled) ;

(v) Energy and spectrum aware communications (to reduce GHG footprint of ICT) ;

(vi) Given the level of uncertainty in the existing GHG footprint evaluation models ICT can bring a substantial improvement of the validated methodologies and modeling capacity;

In addition ICT may bring potentially a substantial economy of GHG in the following sectors :

a. Urban development
- limitation of GHG emissions through a better modelling of the modification of an urban area form;

b. Transport
- Limitation of professional trips (visio, virtual rooms, remote work, virtual site visits,…)
- Optimisation of the transportation means
    1. Improvement of information for passengers (interoperability of existing services of renting cars, bikes, car sharing, joint trips, road traffic, etc …)
    2. optimisation of engines functionality and performance (reduction of fuel consumption as a function of meteo conditions, reliefs, traffic jams …)

c. Residential/tertiairy
- Optimisation of construction/rehabilitation works of buildings through thermic fluxes dynamic simulation;
- Optimisation of a domestic use of energy
    1. heating, lights, specific electric use (Smart house)
    2. development of a part-time use of domestic equipment

(vii) Support for vertical data driven services for water (also transport) in the following domains :
- control and automation

- Water quality management
- Waste water management
- Decision support

(viii) Pricing incentives for saving water and energy, and 'smart' appliances

(ix) Need for information scalability (as sensors grow and became smarter, new sources of information and knowledge rise)

(x) Proven ICT solutions for implementing continuous, effective and efficient directive reporting (Water Framework Directive, Urban Waste Water Treatement Directive, etc.) through EU.

3.5 On the degree of urgency for prioritizing

There is a consensual agreement of the Consultation panel members on a necessity of a high level R&D action related to specifications of a technology independent and open reference model of the water resources information system. The first step (2014-2015) would consist in find new solutions to achieve interoperability between existing systems and develop new connectivity standards. In the next stages (beyond 2015) would consist in a development of new tools and models to achieve a better water efficiency and management, which will stick to standardisation rules introduced with a reference model. The agreed level of prioritizing follows the necessary progress in time logic : high, average and low priority. The action duration in time is classified in three time scales : short, average and long term. While preparing a roadmap it is however also necessary to take into account the interdependence between the actions, such that appropriate progress is achieved before launching a new action with a relevant priority.

It is essential that the high priority is assigned to a high level action allowing conceptualisation and design an open reference model integrating all components of a wide thematic domain of water resource management. The objective would consist in financing a project comparable to the role played in the domain of information systems for citizen protection and security issues, and disaster and emergency management operations by the FP6 – ORCHESTRA[10]. The Reference Model of Orchestra Architecture (RM-OA), one of the major deliverables of this project is being considered as a foundation laid for a majority of R&D development activities in the domain of ICT for crisis and risk management systems. ORCHESTRA not only delivered technical results such as the RM-OA plus developed services and applications, but also brought together and consolidated the risk management community. This was done by integrating the results and recommendations of previous and on-going European and national R&D cofounded projects and initiatives, in which the project brought the capacity of harmonising the technical underpinning of risk management in Europe and outside. A similar ambition is expressed by the water stakeholders represented in the consultation panel and by the members of the on-going PSP/ICT **@qua** Thematic Network (A3.13).

In more detailed manner, the following three levels of priorities emerge:

[10] http://www.eu-orchestra.org/

(i) High Priority (2014-2015)

Two main sectors can host a major innovative action (s):

- Business Process Modeling towards Enterprise Architecture: Water Business Information System (WatBis)
- Ontologies towards semantic interoperability

Laying foundations of the WatBIS can be considered as a harmonisation action, i.e. it can start from existing Target Information Systems (TIS) already designed in several water companies, updates these concepts, shares and disseminates to the whole water sector. This action may include also specifications of tools and methods for evolution towards SOA, and possibly building up of a shared library of business web services knowing the fact that usable (non water-specific) standards already exist (e.g. Open Geospatial Consortium's - OGC™).

Building Ontologies can be structured around two directions:

- Integration and dissemination of existing ontologies about sensors and measurements (mainly standards and recommendations from W3C and OGC), such as OGC™ Sensor Web Enablement (SWE), or W3C's Semantic Sensor Network ontology (SSN), or OGC's WaterML and Sensor Observation Service (SOS) ;
- Development of water-specific Ontologies, mainly "Asset Descriptions" and "Works & Interventions" , etc. identified by @qua TN.

These actions are not R&D strictly speaking, but represent demonstrative dimension and extension of existing notions and concepts and should have a short-term time scale.

The same High Priority is assigned also to two perspective thematics:

- Energy peak load shedding using water utilities and services (this R&D action already launched in several labs in Europe will require however a careful definition of detailed objectives in order to avoid overlapping effects) ;
- Definition of methods and ICT solutions for optimal solutions in the water–energy mix (R&D action).

However these two thematics can be addressed as middle term actions, once the fundamental actions on Water Business Information System (WatBis) and ontologies were sufficiently advanced.

(ii) Average Priority (2016-2018)

This can consist in a series of R&D and Demonstration actions launched on the basis of the advances of high level actions described in (i). For the identified areas of water business processes the targeted sectors are:

ASSET MANAGEMENT

- Asset Management Tool enhancements towards compliance with Business Processes (mainly about the notion of "performance of a system of assets according to a set of rules of the game")
- Improvement of Asset Management Decision Making Tools

WORK MANAGEMENT

The objective is to achieve Work Management Tools enhancements towards compliance with Business Processes. This action includes improvement of mobile tools for field workers (WeCo - Wearable Computers - , Ambient Intelligence and communicating devices, such as "smart" valve key or metal detector).

REAL TIME MODELING & DECISION MAKING

This objective addresses all domains like networks, plants and environment motoring. Several ICT solutions exist on the market but those approaches are still very partial (e.g. Takadu / SWAN) and don't match the overall expectations of the water utilities. Significant improvements will only appear with a consistent and long R&D effort. Two operational levels are requested from the used models: from event detection to complete diagnostic. All types of models (deterministic, stochastic, probabilistic and mixed/combined) could be implemented in order to support the decision process and ensure performance.

These actions can be settled as middle and long-term actions.

The same priority is assigned also to two perspective thematics :

- Integration of ICT tools towards decentralized water services
- Methods and devices for monitoring water reuse in buildings and water cascading in cities

These actions can be settled as short and long-term actions.

(iii) Low Priority (2018-2020)

CUSTOMERS & CONSUMERS

- Relevant information regarding customers and public expectations
- Improving Water services by collecting data on consumer's behaviors.

This actions can be considered as awareness and communication actions without a major R&D effort required.

SMART WATER GRID

- Methods and solutions for Smart Water Grid Management

These actions can be settled as short , middle and long-term actions.

5. First classification of challenges

A summary of the first iteration of the classified challenges is provided in the following table:

Targeted Goal *	Proposed Action	Challenges	ICT Domains	Priority (high, average, low)
(4)	High level ontology R&D	Design and develop a reference model of water resources use related services	Ontologies, semantic interoperability, GIS, business modelling, DSS, and management tools,	high
(1)(2)	Mixed R&D and Demonstration activity	The promotion of appropriate new technologies through recommendations and demonstration of best practices contributing to significant water savings. Virtual platforms for forecasting and supporting users in the adoption of more efficient integrated water governance and management strategies.	Ontologies, semantic interoperability, GIS, business modelling, DSS, and management tools, 3D visualisation environment	high
(1)(2)	Mixed R&D and Demonstration activity	Energy peak load shedding using water utilities and services; Definition of methods and ICT solutions for optimal solutions in the water–energy mix (R&D action).	Modelling Real-time process,	high
(1)	R&D and Demonstration activity	Real time knowledge extraction through development of algorithmic models and methodologies to better assess water consumption profiles in real time for short term predictions.	Modelling Real-time process, Knowledge extraction, stream data mining.	average

(2)	Modeling and development of distributed water governance and management systems across different actors of the urban and district water systems.	Based on the knowledge generated, technology should move towards the development of distributed tools that automatically integrate each of these processes; allow scalability; establish relationships and interactions of different of knowledge & management models; assist in the distributed expert decision; and generate an effective methodology to improve the current Legislation in relation with product quality and safety.	Interoperability standards, ontologies, semantic interoperability	high
(3)	Development of Urban early warning systems for water control.	Integrated assessment based on the information related with social and environmental context; supporting evacuation plan and emergency protocols; warning of possible emergencies (emergencies prediction); and enhance inter-communication between different public authorities, actors and control points.	Semantic interoperability	average
(1) (3)	Increase the abstraction level of information	Sensor data must be obtained processed and managed using an abstraction of the information	Ontologies, Semantic Interoperability, W3C Standards (SSN-Ontology)	high
(2)	Improve quality and quality of Service assurance	Mechanisms used to interpret correctly sensor information (e.g. understand data gaps, interpret accuracy of measurements, etc). Big problem because of administration budget cuts	OGC, Sensors	average
(1) (3)	Advance in the Integration and Fusion of Data	Accessing into the information and fuse information from various context using HTTP protocol by transforming sensor-based data (ontologies) into RDF and accessing/querying it using URIs	Ontologies, Semantic Interoperability, OGC	high

(1) (3)	Sensor data registry interfaces	Based on the way of query sensor information, one of the main gaps in querying sensor data are the lost performance time.	OGC, Ontologies, Semantic Interoperability, W3C standards	high
(1) (2) (3)	Rapid development of applications	External applications should be easily incorporated into the platform.	OGC, SoA	low
(1) (2)	-improved coordination -behavioural change	Given the small number of actors involved in water regulation and distribution, if they could better coordinate their activities, results would be seen immediately and therefore any tool that helps to improve this can provide direct benefits. Behaviour change requires time, but due to the very large amount of water consumers has a very large potential. The savings would need to come from long-term economic incentives, policies and land use changes integrating energy savings.	Organisation/resource/ assets management tools	high
(1) (2) (3) (4)	- Working groups associated with the existing initiatives	- *EIP Action Groups*, in particular Water and Energy and Ecosystems Services Action Groups through one of the partners. It would be interesting to join efforts with other projects representatives and participate in Monitoring and DSS Action Group.	transversal	average

		- *Water Platforms.* Participation in strategic platforms such as @qua. Common publications and networking events with other projects to share a common view and identify barriers, gaps and challenges.		
(1) (2) (3)	Demonstration action	Explore new communication means and frequencies (tv white spaces network (tvwsn, IEEE 802.11af Draft Standard), wi-fi, li-fi) in particular in the context of need for sharing components of the smart metering infrastructure (e.g. the difference between high number of meters with low frequency vs. low number of sensors with high frequency).	Interoperability, sensors	Average /low

**Targeted goals :*

(1) *Substantial consumer water and energy saving,*

(2) *Peak-period reduction of water and energy distribution loads*

(3) *Reduction of GHG emissions*

(4) *Foundations, independent on other objectives*

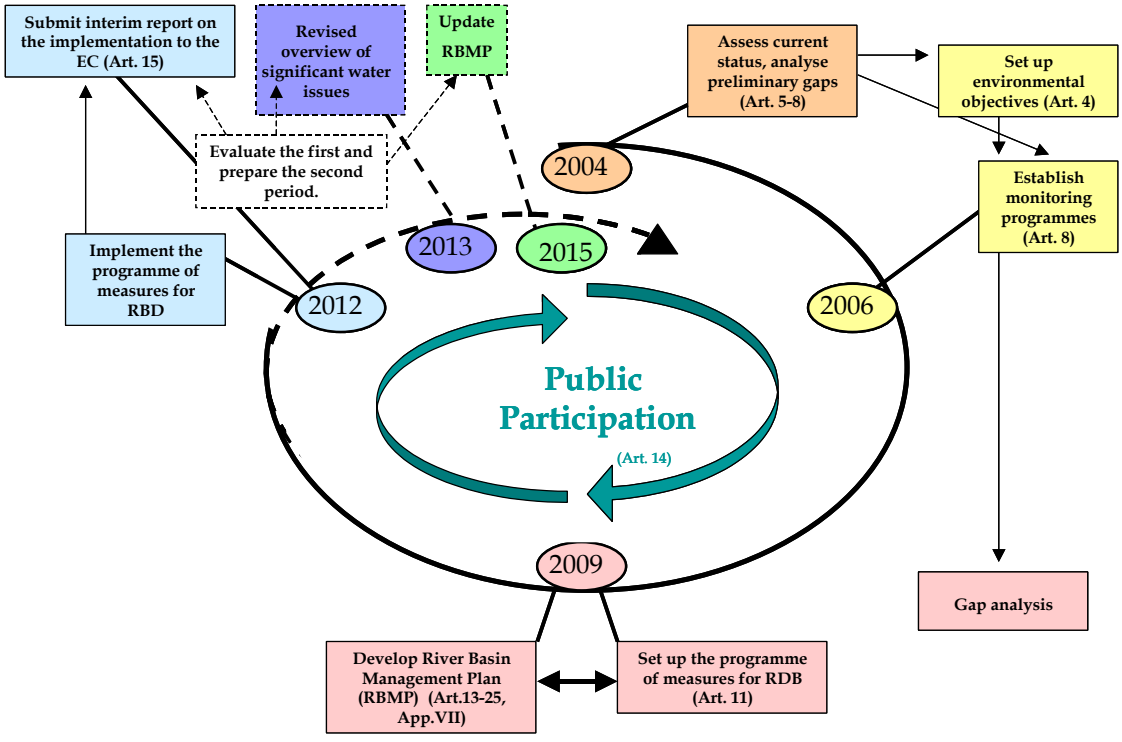
6. Tentative roadmap

In January 2013 the **@qua** Thematic Network has prepared a draft programme of innovation actions (A3.13), which can be considered as a first iteration for setting up the tentative roadmap for the R&D and demonstration projects of ICT for Water Resources Management under Horizon 2020.

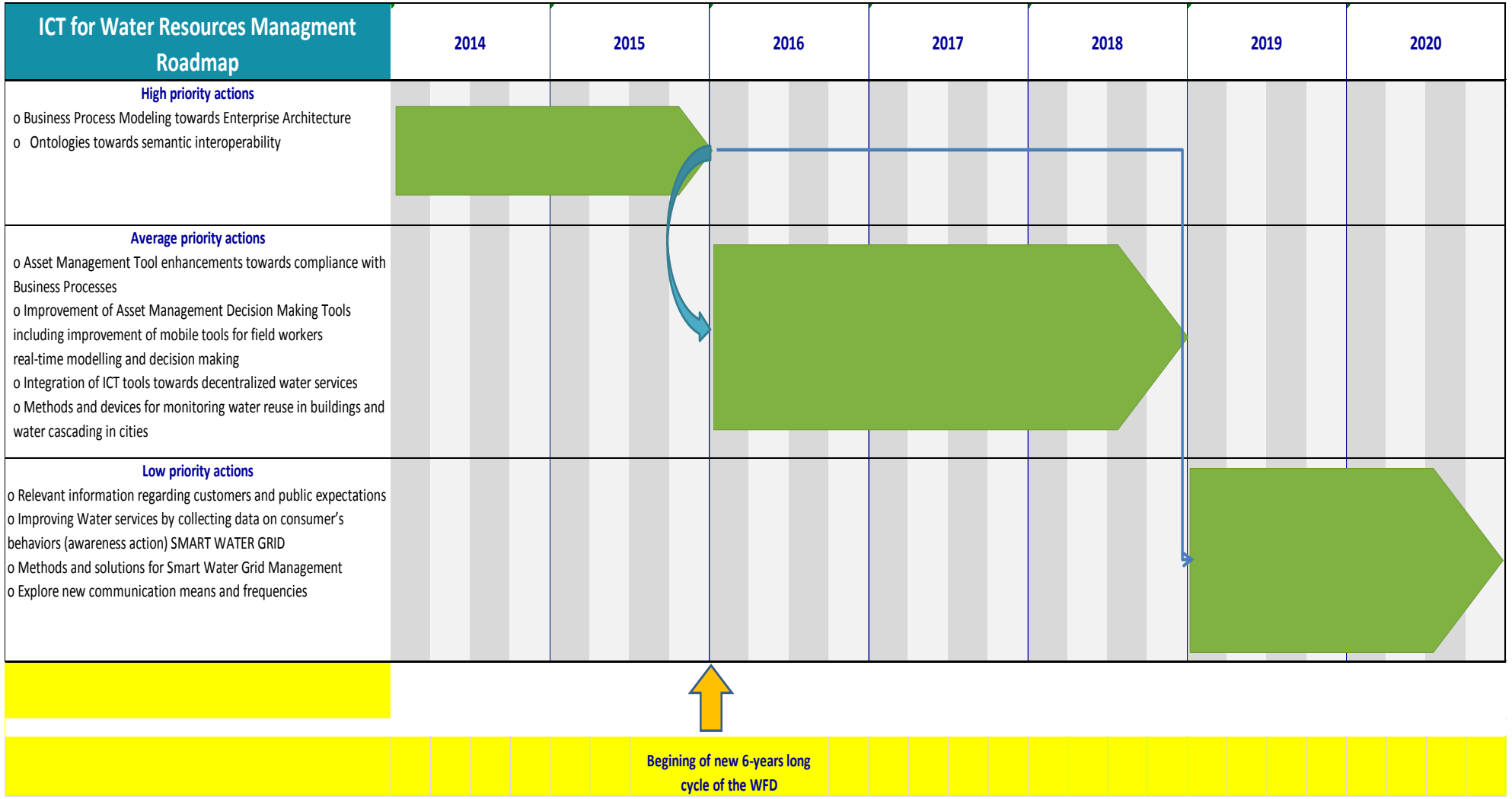
This document describes in extensive manner a series of innovation initiatives the need for which was identified and presented during the Consultation.

The proposed programme is well anchored in the vision of the ongoing modification of the water industry, which is a key stakeholder in the process of wider use of ICT solutions to water management problems. With a clear synergies with WssTP it represents at the same time a real opportunity to the scientific and academia stakeholders for an acceleration of transfer of the research results to the industry.

In brief, the timeline for these actions should be organize in agreement with the institutional cycle of the implementation of the Water Frame Directive and other associated directives. In fact, by the end of 2015 it is expected the first cycle of the implementation of the WFD will be completed and the next 6-year long 2nd iteration will coincide with the duration of the Horizon 2020.



For this reason the proposed by **@qua** timeline should be corrected given the initial conditions fixed by the Commission (beginning of the Horizon 2020 is settled on January 2014).


ICT for Water Resources Managment Roadmap
2014
2015
2016
2017
2018
2019
2020
High priority actions
o Business Process Modeling towards Enterprise Architecture
o Ontologies towards semantic interoperability
Average priority actions
o Asset Management Tool enhancements towards compliance with Business Processes
o Improvement of Asset Management Decision Making Tools including improvement of mobile tools for field workers real-time modelling and decision making
o Integration of ICT tools towards decentralized water services
o Methods and devices for monitoring water reuse in buildings and water cascading in cities
Low priority actions
o Relevant information regarding customers and public expectations
o Improving Water services by collecting data on consumer's behaviors (awareness action) SMART WATER GRID
o Methods and solutions for Smart Water Grid Management
o Explore new communication means and frequencies
Begining of new 6-years long cycle of the WFD

Annexes

Annex 1 : DG CONNECT background document "ICT-Water-Consultation_Meeting_(31thJanuary2013)_initial position statement" (<<ICT-Water-Consultation_Meeting_(31thJanuary2013)_initial position statement.doc>>

Annex 2: List of Participants

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Annex 3: Expert presentations: references and links

A3.1 : Dr. Marc Erlich, Grazyna Wojcieszko "ICT-based Water Resources Management" (<<ICT and Water Management, January 31st, 2013.pdf>>)

A3.2 : Albert Rodriguez and Anrés Cisneros "UrbanWater – Horizon2020" (<<URBANWATER_Roadmap for H2020.ppt>>)

A3.3 : Dr. Parag Mogre "ICeWater: ICT solutions for efficient Water Resources Management" (<<ICeWater_Contributions_v03.pdf>>)

A3.4 : Prof. Dragan Savić "iWIDGET" (<<iWIDGET_Jan2013_Brussels.ppt>>)

A3.5 : Silvia López Martinez and Boris C.Pelletier Gómez "ICT for Water Management Consultation – EFFINET" (<<EFFINET - PPT 20130131 ICT Water Consultation Meeting Platform v2.0.ppt>>)

A3.6 : Gabriel Anzaldi "WatERP" (<<130131 WatERP Expert Consultation on ICT for Water Management_v2.0.pdf>>)

A3.7 : Prof.Robert Meijer "UrbanFlood" (<<UrbanFlood_248767 Robert Meijer H2020 roadmap consultation 31-1-2013.ppt>>)

A3.8 : Prof.Robert Meijer "Position paper ICT for Water H2020" (<<Position paper ICT for water H2020 Robert Meijer.doc>>)

A3.9 : Prof.Philippe Gourbesville "@qua - ICT for water efficiency" (<<@qua_BXL_2013_3.pdf>>)

A3.10 : @qua ICT Thematic Network , Deliverable n°2.2 "Current ICT solutions & limitations" , version 4.2, November 2012

A3.11 : @qua ICT Thematic Network, Deliverable n°2.3 "ICT gaps",version 4.2, November 2012 .

A3.12 : @qua ICT Thematic Network, Deliverable n°3.1 "Deliverable_3.1_ICTReviewOfWaterProfessionalExpectations_v4.3-2, November 2012.

A3.13 : @qua ICT Thematic Network, Deliverable n°3.4 "Draft programme of innovation actions", version 2.0, January 2013

A3.14 : @qua ICT Thematic Network, "Did you say Smart Water Grid ?", Internal document of the @qua TN, September 2012 (Dr. Jacques Boudon).

A3.15 : Pierre Sacareau "WssTP – A common vision for water innovation" (<<DGConnect-Brussels2013WssTP-SMTF-v2.pdf>>)