MARSOL

Demonstrating Managed Aquifer Recharge as a Solution to Water Scarcity and Drought

Market Assessment

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Author(s)	Eleonora Annunziata, Chiara Pellegrini, Francesco Rizzi, Rudy Rossetto (SSSA)
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EXECUTIVE SUMMARY

Deliverable D8.3 of the EU-funded MARSOL project refers to the outcomes of the project's Task 8.6 "Potential market exploitation of the developed prototype". The analysis has been carried out from the water utilities standpoint by using data and information collected through literature review and semi-structured interviews. In particular, the analysis involved thirteen water utilities from three countries of Mediterranean area (Italy, Spain and Israel) and identified the following internal and external factors affecting market potential of Serchio MARSOL solution within water utilities:

Internal factors

- Some water utilities are testing some innovative monitoring systems to improve and simplify their monitoring activities, and integrate them into their daily routines.
- Water utilities recognize the importance to prevent emergencies regarding water security in order to manage and exploit lessons learnt.
- More innovative water utilities are able to identify emerging and feasible technologies for monitoring quantity and quality of water.
- The size of organization and consequently the availability of economic resources are crucial factors in the identification and implementation of investments regarding monitoring systems.
- Very often medium and large water utilities need to strengthen existing competences, whereas small water utilities need to integrate and gain external competences.

External factors

- Regulation very often imposes administrative, technical and budget constraints and a lot of bureaucracy on water utilities, but it is not able to identify possible risks and related control measures regarding MAR systems.
- Water utilities are encouraged by international, national and local institutions to arrange and implement monitoring frameworks for guaranteeing water security.
- The existence of a strong relationship and influence between water utilities and (local) public authorities (because of water utility's ownership) is another constraint for the development of innovative solutions and technologies with water utilities.

- External funding opportunities occasionally support the implementation of innovative solutions and new technologies, but they should be used more efficiently to develop innovative solutions that can actually address water utilities' needs and improve their performances.
- Hydro-geological contexts influence the implementation of monitoring systems. Hence, water utilities will not invest in monitoring systems in areas, where based on their experience, with low level of risks.

Therefore, exploiting the market potential of Serchio MARSOL solution requires the development of tailored-made automated monitoring systems associated with multi-level strategy that involve all stakeholders within water sector to remove non-technical barriers and local tensions.

1. INTRODUCTION

The purpose of this report is to assess the potential market exploitation of Decision Support System (DSS) developed at Serchio MARSOL site by taking into account several existing influencing factors such as stakeholders, their competences, etc. according to a systemic approach.

The analysis was carried out from the water utilities standpoint and aimed to understand how they can contribute to the market exploitation of Serchio MARSOL solution. In particular, the analysis identified internal and external factors that influence water utilities' willingness to become implementers of innovative solutions in monitoring systems and particularly automated continuous monitoring system within Managed Aquifer Recharge (MAR) scheme, such as Serchio MARSOL solution. In order to show an overarching vision of existing influencing factors within water utilities, this market assessment has used several sources of data and information.

The identification of influencing factors can provide recommendations for fostering public authorities, water utilities and technology providers to cooperate on the development and implementation of innovative monitoring systems that can increase water security, water quality and efficiency of water supply. Therefore, this market analysis not only assesses the, but also recognizes possible improvements to strengthen market potential of the developed solution.

2. METHODOLOGY

The analysis of potential market exploitation of the DSS developed in Serchio MARSOL site used integrated data and information collected by carrying out literature review and semi-structured interviews with water utilities. The analysis assessed the market potential through a SWOT analysis that identified water utilities' influencing factors in the possible implementation of innovative solutions in monitoring systems and particularly automated continuous monitoring system within MAR scheme, such as Serchio MARSOL solution.

The literature review collected information and data from scientific papers, reports and other sources in order to describe market conditions, characteristics and key players in European water industry.

The semi-structured interviews[1] were carried out with technical and/or R&D managers within eight water utilities from three countries of Mediterranean area (Italy, Spain and Israel) that were identified, with the support of technical MARSOL partners, as interesting for their different level of maturity in the implementation of monitoring system within MAR schemes. Table 1 summarises some general information about interviewed water utilities. We adopted a semi-structured interview schedule that focused on factual information gathering, while giving respondents an opportunity to develop conversation about point which their judged particularly important. The list of questions was structured into five sections: 1) Reasons for the (potential) adoption of an automated monitoring system of water within MAR scheme; 2) Internal existing and needed competences for the (potential) adoption of an automated monitoring system of water within MAR scheme; 3) External events that (can) influence the adoption of an automated monitoring system of water within MAR scheme; 4) External actors that (can) influence the adoption of an automated monitoring system of water within MAR scheme; 5) Strategy for the adoption of an automated monitoring system of water within MAR scheme. The interviews were conducted by telephone between July and September 2016.

The SWOT analysis[2] used data and information from literature review and semi-structured interviews in order to identify the key internal and external factors seen as important to assess potential market exploitation of DSS in Serchio MARSOL site. Internal factors consist in the strengths and weaknesses present in the water utilities as possible implementers of Serchio MARSOL solution. External factors concern the opportunities and threats presented by the environment external to the water utilities. Each factor was described to depict its operation. Moreover, it was provided a "context"

[1] Bernard, H. Research Methods in Cultural Anthropology. Newbury Park, CA: Sage Publications, 1988.
[2] Hill, T. & R. Westbrook, SWOT Analysis: It's Time for a Product Recall, in Long Range Planning, vol. 30, nº 1, 1997, pp. 46–52.

section to justify and clarify the identification of each factor and related implications for the improvement of market potential of the DSS developed in Serchio MARSOL site through the description of significant water utilities' experiences.

Table 1 – General information about interviewed water utilities

Name of company	**Country**	**Size**	**R&D activities**	**Persons Interviewed**
Water utility 1 (WU 1)	Israel	Large	Yes	R&D manager Technical manager
Water utility 2 (WU 2)	Italy	Large	Yes	Technical manager
Water utility 3 (WU 3)	Italy	Large	Yes/No	Technical manager
Water utility 4 (WU 4)	Italy	Small	No	Technical manager
Water utility 5 (WU 5)	Italy	Large	Yes	R&D manager Technical manager
Water utility 6 (WU 6)	Italy	Medium	Yes	R&D manager Technical manager
Water utility 7 (WU 7)	Italy	Small	No	Technical manager
Water utility 8 (WU 8)	Spain	Small	Yes	Technical manager
Water utility 9 (WU 9)	Italy	Medium	Yes/No	Technical manager
Water utility 10 (WU 10)	Italy	Medium	No	Technical manager
Water utility 11 (WU 11)	Italy	Medium	Yes/No	Technical manager
Water utility 12 (WU 12)	Spain	Small	Yes	Technical manager
Water utility 13 (WU 13)	Spain	Small	No	Technical manager

3. MARKET ANALYSIS

3.1 Description of Serchio MARSOL solution

The Serchio MARSOL site has hosted the development of a water quality monitoring system to demonstrate and assess the feasibility and benefits of managed induced river bank filtration versus unmanaged one. This monitoring system merges a Decision Support System (DSS) based on remote data acquisition and transmission and GIS physically-based fully distributed numerical modelling to continuously monitor and manage well fields, reducing also human operated activities. It consists of 6 piezometers and a Wireless Sensor Network (WSN) to monitor the performance of river bank filtration both in terms of quantity and in terms of quality.

The developed monitoring system is an automated continuous monitoring system, which could support water utilities to guarantee the quality and quantity of water recharged through a Managed Aquifer Recharge scheme, in particular an induced riverbank filtration. The system is able to inform water managers about the system performance and reaching limits of infiltration rates against MEF or water quality indices.

3.2 Monitoring activities for MAR schemes

The analysis of the regulatory framework conducted in MARSOL Deliverable D17.1 "Legislative Framework Review and Analysis"[3] shows that MAR schemes and related monitoring activities are poorly or fragmentally regulated across Europe. Generally, the responsibility for monitoring MAR schemes is assigned to both the operator/beneficiary of the permit/authorisation and the relevant national, regional or local authority, who grants the permit/authorization. Obviously, there are differences between the EU Member States because of the specific provisions that each of them has adopted. Baseline and operational monitoring are the most common types applied to MAR schemes. However, it should be noted that European regulations do not mention to the adoption of specific monitoring systems. Moreover, the most of surveyed Member States3 (e.g. Austria, Spain, Cyprus, Slovak Republic and Romania) do not define *ad hoc* procedures for emergency or incident management of water infrastructures. Italy has recently approved a Ministerial Decree n. 100/2016 that provides criteria for implementing and monitoring MAR schemes. In particular, it defines ex ante and ex post

[3]MARSOL Deliverable 17.1 has examined the legal frameworks governing or applicable to MAR schemes in 12 EU Member States, namely: The United Kingdom, France, Italy, Germany, Spain, Belgium, Slovakia, Romania, Cyprus, Austria, Portugal and Malta.

monitoring activities for MAR schemes in order to guarantee the assessment of benefits associated with MAR scheme, in term of quantity and quality of water.

3.3 Challenges for water utilities industry

In recent years the water utilities industry is facing a growing number of problems due to water scarcity and stress, environmental degradation affecting water quality and climate change[4,5]. These problems are complex because they ask a new role for water utilities in the process for developing innovative solutions and particularly ICT for water management sector[6]. This role consists in the implementation of new technologies, such as new smart metering technologies, but also the adoption of related supporting measures, such as new partnerships, new business models and new forms of water governance[7,8]. Accordingly, water utilities not only implement themselves innovations but can also stimulate and support technological innovations[9].

In this context, the development of ICT for water management sector requires great efforts from water utilities in order to tackle some challenges associated with these technologies. These challenges concern an effective use and management of large amounts of data from smart water technologies, the development of standards in the water domain, increasing knowledge about consumers and their water users, and reducing their skepticism towards modern smart technology[10]. Therefore, water utilities should overtake their traditional "hydraulic logic", which is characterized by the exploitation of water resource to foster economic growth, centralized system of large-scale dams and a dominant engineering culture[11], through the adoption of a holistic approach on water assets that integrates engineered and natural water infrastructures[12].

[4] Fuenfschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes – Conceptual foundations from institutional theory. Research Policy 43, pp. 772-791.
[5] Ibidem 4.
[6] European Commission, 2016. Emerging Topics and Technology Roadmap for Information and Communication Technologies for Water Management. August 2016.
[7] Martins, G., Brito, A.G., Nogueira, R., Ureña, M., Fernández, D., Luque, F.J., Alcácer, C., 2013. Water resources management in southern Europe: clues for a research and innovation based regional hypercluster. Journal of Environmental Management 119, pp. 76–84.
[8] Moore, M.-L., von der Porten, S., Plummer, R., Brandes, O., Baird, J., 2014. Water policy reform and innovation: A systematic review. Environmental Science & Policy 38, pp. 263–271.
[9] European Commission, 2015. Future Brief: Innovation in the European water sector. Issue 10, February 2015.
[10] Ibidem 9.
[11] Ibidem 7.
[12] WssTP, 2016. WssTP Water Vision 2030, WssTP, Brussels.

3.4 Market conditions

The market assessment analysis considers the water utilities industry. This industry consists of all water that is collected, treated and distributed to agricultural, industrial, and residential end-users.

The global water utilities had total revenues of $761 billions in 2015, with a compound annual growth rate of 4.2% between 2011 and 2015. This is forecasted to remain steady between 2015 and 2020. The United States is the single largest country by market value globally, with Europe being the most valuable region. Europe accounts for 38.2% of the global water utilities industry value followed by United States with 28.1%. Global market consumption volume reached a total of 3126.7 billion cubic meters in 2015 with an increase of 1% between 2011 and 2015. The market's volume is expected to rise to 3280.2 billion cubic meters by the end of 2020. Agriculture is the biggest global water user because it bought 1,992.7 billion cubic meters, equivalent to 63.7% of the market's overall volume in 2015. In comparison, Industrial users had a volume of 653.2 billion cubic meters in 2015, equating to 20.9% of the market total[13].

Italy, where the Serchio MARSOL site is located, accounts for 5.8% of the value of the European water utility sector. The Italian water utilities market reached a value of $14.6 billion with a compound annual rate of change of -1.7% in the period of 2010-2014. Italian market consumption volume was 30.1 billion cubic meters in 2014. Industrial users are the largest segment of the water utilities industry in Italy, accounting for 45.2% of the industry's total volume, followed by the agriculture segment (28%). In 2019, the Italian water utilities industry is forecasted to have a value of $13.9 billion, a decrease of 4.8% since 2014[14].

Generally, competitiveness in global water utilities industry varies greatly from region to region. Often consumers only have access to one company (in the form of a regional or state monopoly) as water supplier. Therefore, competitiveness is much higher in areas where consumers have access to multiple water suppliers.

A key aspect in this sector is related to the investment in infrastructure and particularly in infrastructure upgrades. Investment in maintenance and renovation activities very often claims a large part of budgets. A recent online survey with US water utilities highlights the importance of costs associated with aging water and wastewater infrastructure[15]. The sector has to balance more and more its long-term thinking with an appropriate level of flexibility, allowing infrastructure to be responsive and adapt to a fast changing environment and innovative solutions. Unfortunately, in some countries investment in infrastructure is under-financed. Italy has decreased its investment in infrastructure by 66% in the last twenty years.

[13] MarkeLine, 2016. Global Water Utilties. London, United Kingdom.
[14] MarkeLine, 2015. Water Utilties in Italy. London, United Kingdom.
[15] Black&Veatch, 2016. Strategic directions: Water industry report.

3.5 Key players in water utilities industry

The water industry comprises a vast array of companies in charge of providing products and services related to the collection, conveyance, treatment and monitoring of water and wastewater for multiple purposes and end users[16]. At European level, the national systems that determine the structure of water utilities industry are diverse[17]. Generally, the European industry structure is usually a collection of geographically-defined monopolies, where customers are rarely able to choose their supplier[18]. In last years, many municipal utilities have been converted into private-sector companies, but the local authorities remaining as majority or sole shareholders and they are not usually in competition with the near utility[19]. Private-sector players cannot compete directly for end-user customers because companies must usually supply all customers within a geographical region[20].

Due to the nature of the product (i.e. water supply), the industry is highly regulated and the need to meet stringent hygiene standards[21]. The water industry can incentivise new entrants thanks to constant demand and an undifferentiated product. However, there are significant barriers to entry in the form of costs of infrastructure construction, engineering and water treatment facilities, extensive infrastructure requirements and high fixed costs of services associated with running pump stations, treatment facilities, reservoirs, pipelines, maintenance and wells[22]. Further factors that will further reduce new entrants are water scarcity and water pollution, both of which are emerging and severe challenges for incumbent companies. Technology and related innovative solutions may present solutions to these problems in the future[23].

Buyers or users consist of companies and individuals purchasing water for agricultural, industrial and domestic use. In some countries (and in Italy as well) the water within a geographical region is supplied by a single (private or public) company[24]. Moreover, the expenses and complications associated with installing water infrastructure (e.g. pumps, pipes, treatment plants, etc.) as well as securing rights to water sources limit buyers' choice when deciding which water supplier to choose. So individual and company buyers can rarely choose between utility companies. On the other hand, the lack of product differentiation strengthens buyer power[25].

[16] Ibidem 17.
[17] CRIC, 2013. D1.1 – The European Water Market Analysis, Urbanwater FP7 project.
[18] Ibidem 19.
[19] Idibem 23.
[20] Idibem 19.
[21] Technopolis Group, 2013. Screening of regulatory framework. Report developed for European Commission, DG-RTD C1/. September 2013.
[22] EIP Water, 2014. EIP Water Barriers and Bottlenecks.
[23] Ibidem 12.
[24] Ibidem 19.
[25] Idibem 19.

Suppliers to the industry are mainly companies undertaking outsourced activities by water utilities companies including construction, civil engineering, laboratory services and administrative functions[26], but also software companies and equipment providers for technologies and metering[27]. Such activities are generally set under fixed term contract that can bind water utilities companies to contracts. The most influential factors strengthening supplier power are the lack of alternative services, and the importance of quality raw materials. It is vital that water utility companies provide their water to end-users almost exclusively through underground pipes constructed by third-party suppliers. The lack of differentiation between services weakens supplier power because industry players can negotiate on other factors such as price and project schedules. Supplier power is also weakened by scarce integration of suppliers' know-ledge and skills in other sectors[28].

Regulators and *regulatory agencies* define water supply policies and regulation related to the setting of tariff rules and the approval of tariff increases; setting, monitoring and enforcing norms for quality of service and environmental protection; benchmarking the performance of service providers and setting the structure of institutions responsible for service provision[29].

National *water associations* assume a consultative role and protect the interest of consumers[30].

3.6 SWOT analysis

By taking into account market conditions and key players in the water industry and information collected during semi-structured interviews, our SWOT analysis identified internal and external factors that affect the potential market exploitation of Decision Support System (DSS) in Serchio MARSOL site (Figure 1). Internal factors consist in the strengths and weaknesses internal to the water utilities possible implementers of Serchio MARSOL solution. External factors concern the opportunities and threats presented by the environment external to the water utilities.

[26] Ibidem 19
[27] Ibidem 23.
[28] Ibidem 19.
[29] Ibidem 23.
[30] Ibidem 23.

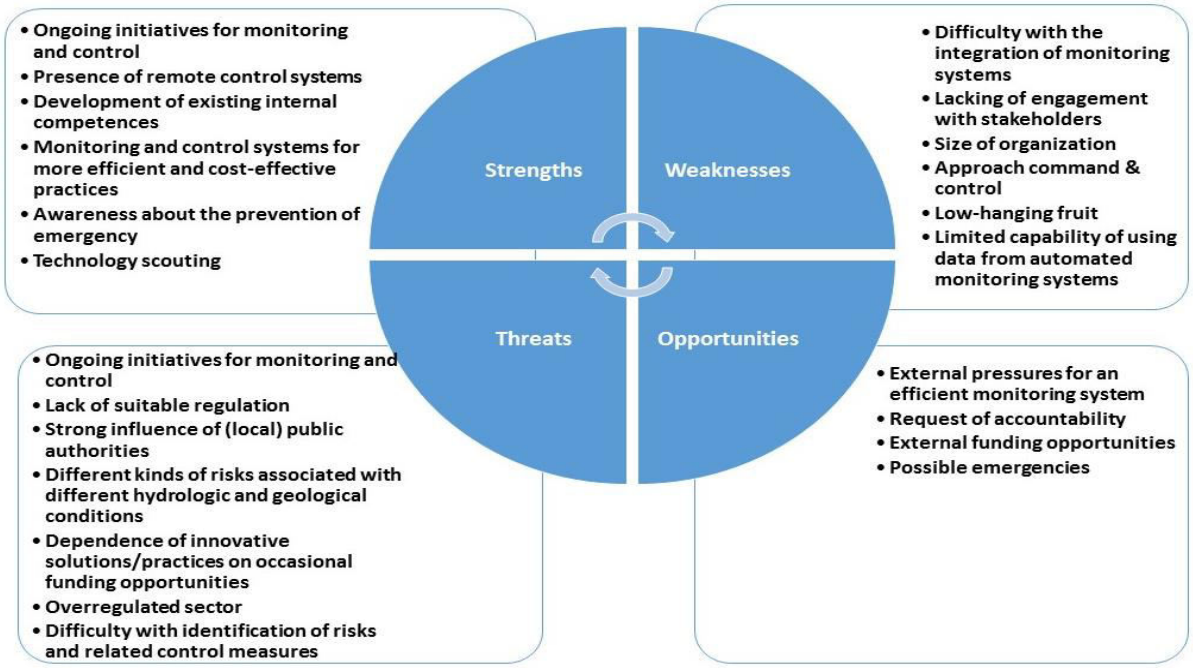

Figure 1 – SWOT analysis: identified internal and external factors affecting potential market exploitation of Serchio MARSOL solutions

3.6.1. Internal factors: Strengths

Strengths consist in capabilities, competences, resources, processes and, cultural and behavioural aspects present in water utilities that can be potential implementer of an automated water quality monitoring system similar to Serchio MARSOL solution. The analysis identified the following strengths:

- **Ongoing initiatives for monitoring and control:** Water utilities are testing pilot projects to implement different kinds of monitoring systems, not necessarily automated monitoring systems, to assess quantity and/or quality of water within their plants. These initiatives highlight the needs to search and develop solutions that support water utilities in their monitoring activities.

  Context: Especially large and medium water utilities (WU 1, WU 2, WU 5, WU 6, WU 8 and WU 11) are testing some solutions to improve their monitoring system because they want to improve their monitoring activities and internal processes. These companies test innovative monitoring systems in some pilot projects because they want to improve their monitoring activities through the adoption of more cost-effective solutions. Since water industry has strong constraints due to regulation and infrastructures, the tests help (large) water utilities to be sure about the effectiveness of their investment in monitoring systems. Moreover, WU 9 has carried out a pilot project, in cooperation with the national health institute, for monitoring the quality of water along all water supply chain.

- **Presence of remote control systems:** Water utilities have adopted remote control systems for their plants (e.g. pipelines, treatment plants, etc.), but they are considering to associate these existing systems with automated continuous monitoring and control system of quantity and quality of water.

  Context: Large and more innovative water utilities (WU 1, WU 2, WU 5 and WU 8) have remote control systems within their plants. These systems can be developed to integrate more functions such as monitoring the quantity and quality of water. Until now these systems have been focused on the assessment of plants' operation.

- **Development of existing internal competences:** Water utilities have internal technical competences able to support the implementation of monitoring systems to assess the quantity and/or quality of water, but they are willing to develop these internal competences within European projects and collaboration with other companies and universities.

  Context: All interviewed water utilities expressed the need for integrating and strengthening their internal competences in order to address new challenges associated with their industry. Water utilities cooperate with universities and other companies to address all their needs (e.g. specific sensors, improving plants' operation, etc.) by providing their infrastructure for field studies. Moreover, water utilities judged the participation in European research projects as a chance to develop their competences not only in the specific field of research project but also in other fields.

  Large and medium water utilities (WU 1, WU 2, WU 5, WP 6, WU 8 and WU 11) declared to have all internal competences for the potential implementation of monitoring systems to assess the quantity and/or quality of water.

- **Monitoring and control systems for more efficient and cost-effective practices:** Water utilities are looking for monitoring and control systems able to provide data and information that reduce maintenance, operation and personnel costs. They want to improve their decision and management process. These systems should solve some difficulties related to the characteristics of their plants and infrastructures such as location, size, etc..

  Context: All interviewed water utilities recognize that they have to overtake their traditional operational frameworks that require the support of specific technicians to assume decisions on plants' operation and maintenance. In particular, large and more innovative water utilities (WU 1, WU 2, WU 5 and WU 8) consider the development of monitoring and control systems the chance to improve their decision and management process by reducing maintenance, operation and personnel costs and solving specific issues associated with their plants and infrastructures.

- **Awareness about the prevention of emergency:** Water utilities recognize the importance to prevent emergency through suitable monitoring activities and emergency plans. On the one hand, they know that emergencies should be avoided and promptly tackle. On the other hand, they consider past emergencies that were successfully solved as a chance to develop new competences and solutions.

  Context: All water utilities identify past emergencies as triggers for the implementation of new solutions and practices in daily routines. Large water utilities (WU 1, WU 2, WU 5 and WU 8) consider the prevention as a tool to reduce costs and improve their practices. Therefore, emergencies should be avoided and promptly faced.

- **Technology scouting:** Water utilities carry out technology scouting activities through direct meeting with technology providers, trade shows, conferences, international networks and internet in order to identify emerging and feasible technologies. Moreover, water utilities try to involve all suitable actors that can integrate and strengthen their internal competences.

  Context: More innovative water utilities (WU 1, WU 2, WU 5, WU 6 and WU 8) carry out technology scouting activities in order to solve specific issues or improve their service. They choose different channels (e.g. direct meeting with technology providers, trade shows, conferences, international networks and technological platforms, and internet) to identify suitable technologies for their processes and activities. In particular, WU 1 has defined a formal three-stage process in order to select technologies that can be developed and applied in their company.

3.6.2. Internal factors: Weaknesses

Weaknesses consists in gaps in capabilities, competences and processes, internal constraints, vulnerabilities that affect water utilities that can potentially implement Serchio MARSOL solution. The analysis highlighted the following weaknesses:

- **Difficulty with the integration of monitoring systems:** Water utilities have difficulties integrating automated monitoring systems to assess quality of water into their daily routines and existing other control systems. In particular, they need a system that gives clear information to workers and technicians. In fact, automated monitoring systems should be designed in order to use sensors that provide data easy to manage and use in the arrangement and implementation of operation and maintenance activities.

Context: A large water utility (WU 5) pointed out that the integration of automated monitoring systems to assess the quality of water should be coordinated to workers and technicians' daily routines and existing other control systems. Therefore, these monitoring systems should take into account companies and plants' characteristics in order to avoid getting more complicated companies' practices.

- **Lacking engagement with stakeholders:** Water utilities are not used to engage all stakeholders such as grassroots organizations and key individuals in local areas for improving and fostering effective management practices. This approach promotes a dialogue that can remove local tensions and trigger collaborative processes adopting.

  Context: A large water utility (WU 5) highlighted the difficulty of implementing stakeholder engagement practices in order to promote effective management practices through cooperation with grassroots organizations and key individuals in specific contexts where utilities do not have authority.

  A small water utility (WU 4) stated that it cannot tackle some issues because the company does not have authority to monitor some private wells in risk area. Therefore, the dialogue with wells' owners might prevent the pollution.

- **Size of organization:** Small water utilities very often do not have suitable competences to adopt a life cycle thinking approach in the identification and implementation of investments within their strategy.

  Context: Two small water utilities (WU 4 and WU 7) declare to have difficulty defining investments and strategy that require specific competences. In particular, they are not able to assess an investment according to a life cycle approach because of the lack of economic and human resources. Large water utilities (WU 2, WU 5 and WU 8) confirm the presence of suitable internal resources that can support long-term investments.

- **Approach command & control:** Since water industry is over-regulated, some water utilities are used to define their strategy and practices just to be in compliance with regulations. This approach jeopardizes the development of innovative solutions and life cycle thinking vision within their strategy and investments.

  Context: Small water utilities (WU 4 and WU 7) try to be in compliance with regulations when they plan investments and activities. They justify their limited development of innovative solutions and life cycle thinking approach because of strong regulatory constraints.

- **Low-hanging fruit:** Budget constraints influence water utilities in the definition and implementation of low-cost investments that are not cost-effective in the long term.

  Context: Small-medium water utilities (WU 4, WU 7, W 10, WU 11, WU 12 and WU 13) are strongly influenced by the lack of economic resources during the process for the definition and implementation of investments. Therefore, investments in automated monitoring systems that can prevent relevant risks are not taken into account or do not have priority. WU 13 has interrupted a pilot project for the implementation of a monitoring system due to budget constraints.

- **Limited capability of using data from automated monitoring systems:** Water utilities have difficulties using data provided by existing automated monitoring systems to assume efficient and effective management decisions and put them into practice.

  Context: All water utilities argue that automated monitoring systems should provide useful data for companies because they want identify some parameters that informs operation and maintenance functions about possible emergencies, issues, pollutions, etc. In the next years, one big challenge for these systems will be to identify and implement sensors that support management decisions. An easy interpretation of data from automated monitoring systems can foster the adoption of these systems.

3.6.3. External factors: Opportunities

Opportunities consist in institutional framework, partnerships, extreme events, market developments, technology development and global trends that foster water utilities in the possible implementation of automated monitoring systems of the quality of water such as Serchio MARSOL solution. The analysis identified the following opportunities:

- **External pressures for an efficient monitoring system:** International/national/local institutions foster the arrangement and implementation of a monitoring framework that is able to identify and assess parameters associated with actual water utilities' risks. This monitoring system should collect data of critical practices and activities.

  Context: Large water utilities (WU 3, WU 5 and WU 8) state the presence of increasing pressures from international/national/local institutions for the improvements of monitoring activities in the water sector. In particular, regulatory agencies foster the improvement of water security and service quality. In order to address these targets water utilities have to define or redefine their monitoring

system by taking into account innovative solutions such as automated monitoring systems. WU 8 declare that the establishment of a regional observatory of water bodies by regional authority forces, but help financially regional water utilities to implement a monitoring system.

- **Request of accountability:** Regulators very often ask water utilities to report and assess the performance of their processes and activities through an accurate monitoring system that consider all crucial parameters. This approach evaluates level of services provided by water utilities and highlight possible improvements.

  Context: Interviewed water utilities are aware that regulators are paying more attention about the performance of specific processes and activities. Accordingly, each company have to identify and implement monitoring systems to assess certain parameters. Water utilities are free to implement preferred monitoring systems by taking into account all required information.

- **External funding opportunities:** Water utilities can exploit external funding opportunities in order to develop and test innovative solutions and new technologies. Accordingly, water utilities can reduce associated risks and improve their internal capabilities.

  Context: All water utilities know the existence of external funding opportunities (and some of them have taken part into some funded projects) for developing and testing innovative solutions and new technologies. Two (more innovative) water utilities (WU 5 and WU 6) are supported by consultants in order to select more suitable funding opportunities and develop successful project proposals. WU 8 has developed a procedure to select more effective and useful project proposals for the company. A small innovative water utility (WU 12) declares that external funding opportunities has been crucial to guarantee a continuous improvement of their services and competences.

- **Possible emergencies:** Emergencies force water utilities to develop and implement innovative and effective activities and instruments for solving associated problems. Therefore, water utilities increase their knowledge and capabilities that can be used in other contexts.

  Context: The majority of water utilities (WU 1, WU 2, WU 5, WU 6, WU 8, WU 9 and WU 12) consider emergencies as the chance to develop and strengthen competences and knowledge. Then, these companies declared that after an emergency they have re-used and implemented "new" solutions, practices and capabilities in other contexts. This approach highlights company's need to maximize all employed resources.

3.6.4. External factors: Threats

Threats are represented by institutional framework, partnerships, extreme events, market developments, technology development and global trends that hinder water utilities to implement Serchio MARSOL solution. The analysis pointed out the following threats:

- **Lack of suitable regulation:** Water utilities highlight that regulation does not support the development of MAR systems and associated monitoring tools. In particular, in the past some national regulations have forbidden aquifer recharge in order to avoid controversy with users. This initial approach has influenced following regulation and accordingly water utilities' investments and strategy in water collection.

  Context: A water utility (WU 6) points out that the existing regulatory framework provides a hierarchy of areas (i.e. energy efficiency, compliance with standards for purification and sewage pipes, and water security) in whom water utilities have to make an effort to improve their performances. Therefore, monitoring activities with aquifers are not considered directly crucial by regulators. Moreover, WU 6 and WU 10 claim that the past Italian regulations have ignored aquifer recharge to avoid possible economic controversy with users.

- **Strong influence of (local) public authorities:** (Local) public authorities as water utilities' owners can cause stiffness in management practices and investments within water utilities**.** Due to their role of shareholders in some water utilities public authorities are crucial actors in the planning of relevant investments.

  Context: A large water utility (WU 2) highlights the strong relationship with local authorities in planning investments, because local authorities are main shareholders of the company and know local priorities. Another (innovative) water utility (WU 1) points out that the influence of public authorities does not support, but limit them.

- **Different kinds of risks associated with different hydrologic and geological conditions:** Water utilities assess risks associated with hydrologic and geological conditions with a high likelihood to negatively affect quality of water during water collection phase. In particular, water utilities technicians argue that surface waters are more prone to contamination and pollution and need to be monitored. Therefore, water utilities will not invest in monitoring systems in areas, where based on their experience, with low level of risks.

Context: A large innovative water utility (WU 2) identifies higher level of risk (and accordingly monitoring activities) associated with shallow aquifers.

An innovative water utility (WU 6) highlights the importance to monitor the quality of surface waters because of a higher likelihood of pollution. Therefore, the deep groundwater is not considered as a critical factor that should be monitored to avoid contamination and pollution.

Another large innovative water utility (WU 5) has adopted a water service plan in order to assess risks associated with their infrastructures and related monitoring activities. This assessment procedure will take into account different hydrologic and geological conditions where WU 5 has its plants and infrastructures.

- **Dependence of innovative solutions/practices on occasional funding opportunities:** Very often innovative solutions such as innovative monitoring systems will develop during European/national/regional projects not guarantee the continuation of projects after their end and related technology development.

  Context: Two water utilities (WU 4 and WU 6) point out the limits associated with the development of pilot projects (innovative solutions) funded by European/national/regional projects, because external funding opportunities do not guarantee the long-term operation of pilot projects. Moreover, some water utilities make their infrastructures and sites available to these pilot projects as research settings, but they do not consider these projects as a chance to satisfy their needs. According to WU 4 and WU 6, very often universities and research centers do not develop project ideas that are really useful for their company. Therefore, water utilities are not interested in investing in these innovative solutions after the end of projects.

- **Overregulated sector:** Regulators and regulatory agencies create bureaucracy and slowdown in adoption of innovative practice within water utilities. In particular, they define a hierarchy of priorities for water utilities. Therefore, each water utilities should find solutions and measures to address these priorities by taking into account administrative and budget constraints imposed by regulators and regulatory agencies.

  Context: A large (innovative) water utility (WU 1) recognizes that the water sector is highly regulated. Therefore, the company have to deal with a lot of bureaucracy that lead to inefficiencies and a waste of time. In particular, regulation limits the development of innovative solutions. Two water utilities (WU 6 and WU 10) highlight that their operation is strongly influenced by regulation.

- **Difficulty with identification of risks and related control measures:** Institutions (regulators, regulatory agencies and local public authorities) have difficulties identifying possible risks and related control measures within water sector. Sometimes local public authorities ask water utilities for supporting them in the identification of risks when new technical solutions are implemented or unexpected events happen.

  Context: A water utility (WU 6) argues that regulators and national and international regulatory agencies exercise a strong influence on company's operation but they are not able to identify actual risks associate with water collection (and managed aquifer recharge). A small but innovative water utility (WU 12) declared that the company has supported their regional water authority for monitoring a company's MAR scheme, because authority does not have skills to assess and monitoring MAR schemes.

3.7 Conclusion

The analysis highlights that water utilities are aware of the importance of guaranteeing the water security through the implementation of effective monitoring systems to assess quantity and/or quality of water within their plants and potentially within MAR scheme. The awareness has been fostered by several external pressures present at international, national and local level. Moreover, water utilities recognize the importance to prevent emergencies in order to manage and exploit lessons learnt. For this reason, above all medium and large water utilities test some innovative monitoring systems in order to improve and simplify their monitoring activities, and integrate them in their daily routines. These efforts are strictly related to the level of innovation and diffusion of ICT technologies within water utilities. In fact, large water utilities equipped with remote control systems within their plants are more available to associate these existing systems with automated continuous monitoring and control system of quantity and quality of water.

The effective integration of these systems relies on their ability to provide useful data about possible emergencies, issues, pollutions, etc. and support decision process within water utility's daily arrangement and implementation of operation and maintenance activities. Therefore, these monitoring systems should be adapted to water utility's needs.

Moreover, the implementation of these monitoring systems should take into account the level of water utilities' competences. Even though water utilities are aware of the importance of strengthening and integrating their internal competences thanks to European projects and collaboration with other companies and universities, water utilities' differences require the development of diversified measures to increase water utilities' knowledge and skills. Very often medium and large water utilities need to

strengthen existing competences, whereas small water utilities need to integrate and gain external competences.

The presence of suitable internal competences also supports technology scouting activities within more innovative water utilities in order to identify emerging and feasible technologies for monitoring quantity and quality of water. The existence of internal competences and knowledge about best available technologies triggers a virtuous circle for improving R&D and operational activities within more innovative water utilities.

The size of organization and consequently the availability of economic resources represent crucial factors in the identification and implementation of investments within their strategy, but also in the operation and management activities. When the planning of investments is influenced by the scarcity of economic resources, water utilities risk implementing low-cost investments that are not cost-effective for guaranteeing water security in the long term. Furthermore, daily routines exclude some fundamental activities such as monitoring, if they are not forced by regulation and a risky hydro-geological context, because water utilities do not adopt a life-cycle approach. Therefore, water utilities try to exploit external and occasional funding opportunities in order to develop and test innovative solutions and new technologies by reducing economic and operational risks. The availability of these external funds should be used more efficiently in order to support water utilities in the development of innovative solutions that can actually address their needs and improve their performances.

The analysis points out the inadequacy of regulation as another crucial aspect related to the development of MAR schemes and innovative monitoring systems of quantity and quality of water. Very often regulation imposed administrative, technical and budget constraints and a lot of bureaucracy on water utilities. Moreover, it is not able to support small and less innovative companies in the identification of possible risks and related control measures that can strengthen water security.

The strong relationship and influence between water utilities and (local) public authorities because of water utility's ownership can represent very often another constraint for the development of innovative solutions with water utilities. On the other hand, innovative water utilities can dialogue with public authorities in order to offer more suitable solutions with regard to local needs.

Finally, the analysis shows that the dialogue between water utilities and stakeholders involved in the water sector (e.g. grassroots organizations, key individuals, regulator, technological providers, etc.) can foster the implementation of innovative and cost-effective solutions to improve water security. Some water utilities recognize benefits associated with this dialogue because sometimes the principal barriers to innovative solutions, such as automated continuous monitoring and control system of quantity and quality of water, are non-technical barriers because of regulation, lack of knowledge, local tensions, etc.

4. CONCLUDING REMARKS

The market analysis has assessed the potential market exploitation of Decision Support System (DSS) in Serchio MARSOL site by taking into account several existing influencing factors such as stakeholders, their competences, etc. according to a systemic approach.

The analysis has been carried out from the water utilities standpoint and tried to understand how they can contribute to the market exploitation of Serchio MARSOL solution. The analysis identifies internal and external factors that affect market potential of Serchio MARSOL solution within water utilities.

From an internal point of view, water utilities can become potential implementers of Serchio MARSOL solution, if technology providers and research centres develop tailored-made automated monitoring systems. These systems should take into account water utilities' management practices and daily routines, and in particular their technological level and competences. It is crucial that they should be designed to provide data for supporting operation and maintenance activities within water utilities, but also to be easily integrated to other ICT technologies such as remote control systems. Moreover, the implementation of these systems should be tailored-made because small and less innovative water utilities should integrate and enrich their internal competences for managing innovative monitoring systems, such as Serchio MARSOL solution.

Regarding external factors, an effective diffusion and implementation of automated monitoring systems can be fostered and facilitated by a continuous dialogue between water utilities and stakeholders (e.g. grassroots organizations, key individuals, regulator, technological providers, etc.). This dialogue can overcome some non-technical barriers and can avoid and remove local tensions hindering the implementation of innovative solutions, such as Serchio MARSOL solution.

In conclusion, the analysis provides a systemic view of influencing factors associated with the market potential of Serchio MARSOL solution. Then, exploiting its market potential requires a multi-level strategy that involves all stakeholders within the water sector.