D.T.1.1.1. REPORT ON NATIONAL CONSULTATIONS ON WATER SUPPLY SAFETY MECHANISMS - ITALY

Lead Institution	PP10 – Civil Protection Department
Reviewer/s	Nicolas Guyennon (LP)
Lead Author/s	Andrea Duro (PP10)
Date last release	30-10-2020

This project is supported by the Interreg ADRION Programme, funded under the European Regional Development Fund and IPA II fund.

Contributors – name and surname	Institution
Emanuele Romano	LP - National Research Council of Italy
Nicolas Guyennon	LP - National Research Council of Italy
Anna Bruna Petrangeli	LP - National Research Council of Italy
Raffaele Giordano	LP - National Research Council of Italy
Alessandro Pagano	LP - National Research Council of Italy
Ivan Portoghese	LP - National Research Council of Italy
Roberto Pizzi	PP10 – Italian Civil Protection Department
Andrea Duro	PP10 – Italian Civil Protection Department
Emanuela Campione	PP10 – Italian Civil Protection Department
Tania Tellini	Utilitalia
Marco Gatta	Utilitalia

Contents

List of figures

List of tables

1. Introduction

The water sector in Italy is characterized by significant geographical differences among regions, due to climate, orography, hydrology and hydrology, industrial and agriculture development. Also considering the only ADRION Italian regions, significant differences can be found, being those regions located all over the Ionic and Adriatic Italy side, from the North (Friuli Venezia-Giulia) to the South (Sicily).

Water cycle

As far as the entire Italian territory concerns, long term average volumes of the annual continental water cycle are reported in figure 1 (source: Eurostat [1]).

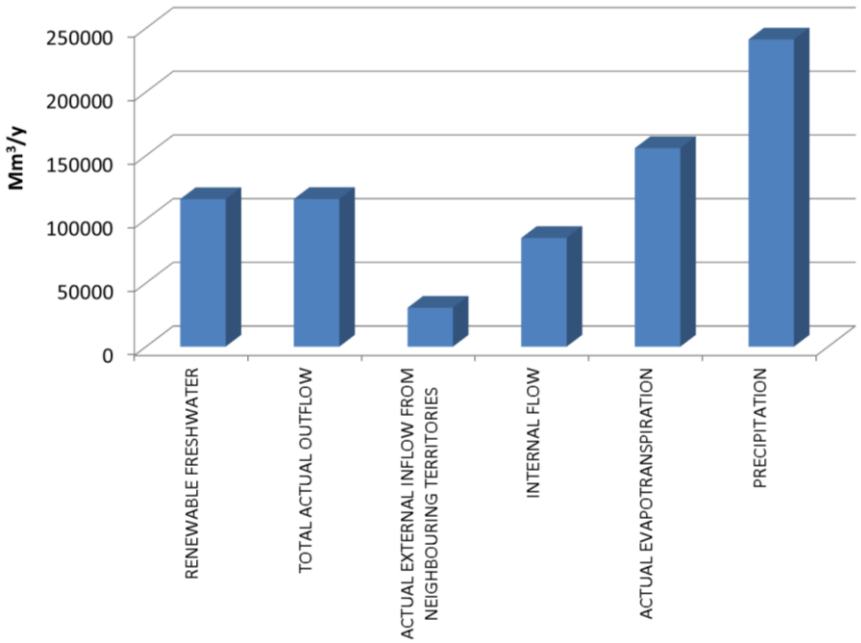

Figure 1 - Long term average volumes of the annual continental water cycle over Italy. Source: EUROSTAT (https://ec.europa.eu/eurostat/web/environment/water).

Water uses

Withdrawals for different sectors are reported in figure 2 (upper panel), whereas consumptions are reported on the lower panel. Civil uses represent approximately 28% of the entire withdrawals and 20% of the consumption. Irrigation is the main term (roughly 50%). It is worth stressing that data reported on figure 2 are at national scale. Such a distribution significantly varies through Italian regions (although irrigation is predominant everywhere).

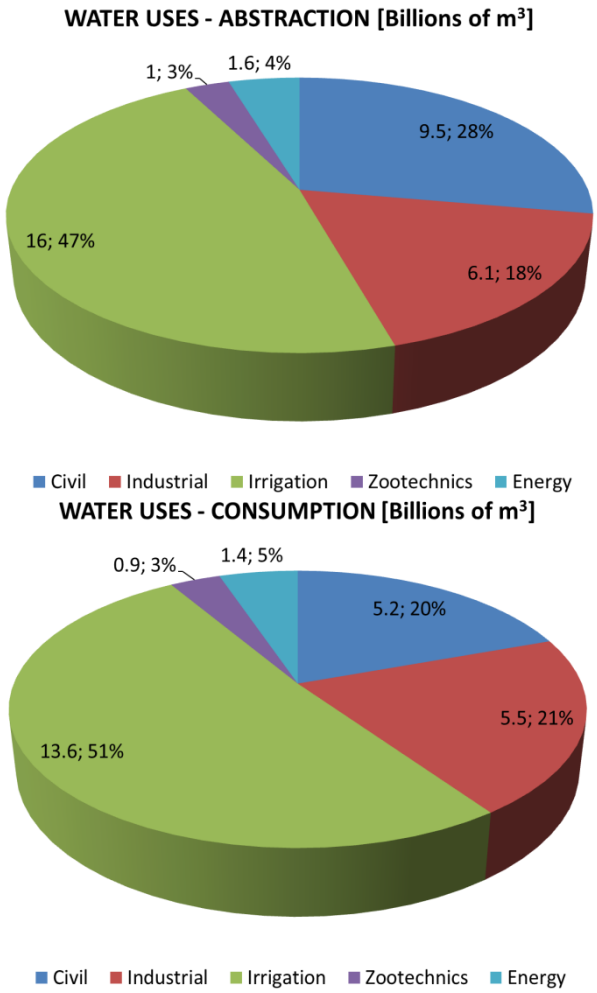

Figure 2 - Withdrawals (in Billions of m3 ; % of total) (upper panel) and consumption (lower panel) for different water uses (source: ISTAT. year: 2012).

Water resources for civil uses

Focusing only on the civil use, the relative percentage of exploited water resources (spring, well, river, surface reservoir (natural or artificial), sea water) are reported in figure 3. Different panels refer to different geographic areas: entire Italy (upper left), Adrion Italian regions (upper right), Adrion Italian regions, Lombardia and Trentino Alto-Adige excluded (lower left), Emilia-Romagna region (lower right).

The choice of reporting also data of the ADRION Italia regions excluding Lombardia and Trentino Alto-Adige is due to the strong "weight" that mainly the Lombardia region has on the totals. The Emilia-Romagna region has been reported as the Italian pilot sites (the Ridracoli water supply system) belongs to this region.

In general, groundwater exploited through wells are the main water resources (approximately 50%), together with springs (about 30% both at national and at ADRION aggregation scale). It is worth noting that the percentage of waters from surface streams, which at national and ADRION scale represents roughly 5%, in the Emilia-Romagna region increases to 22%. Therefore, the use of treatment plants for drinking water is fundamental for water management in that region.

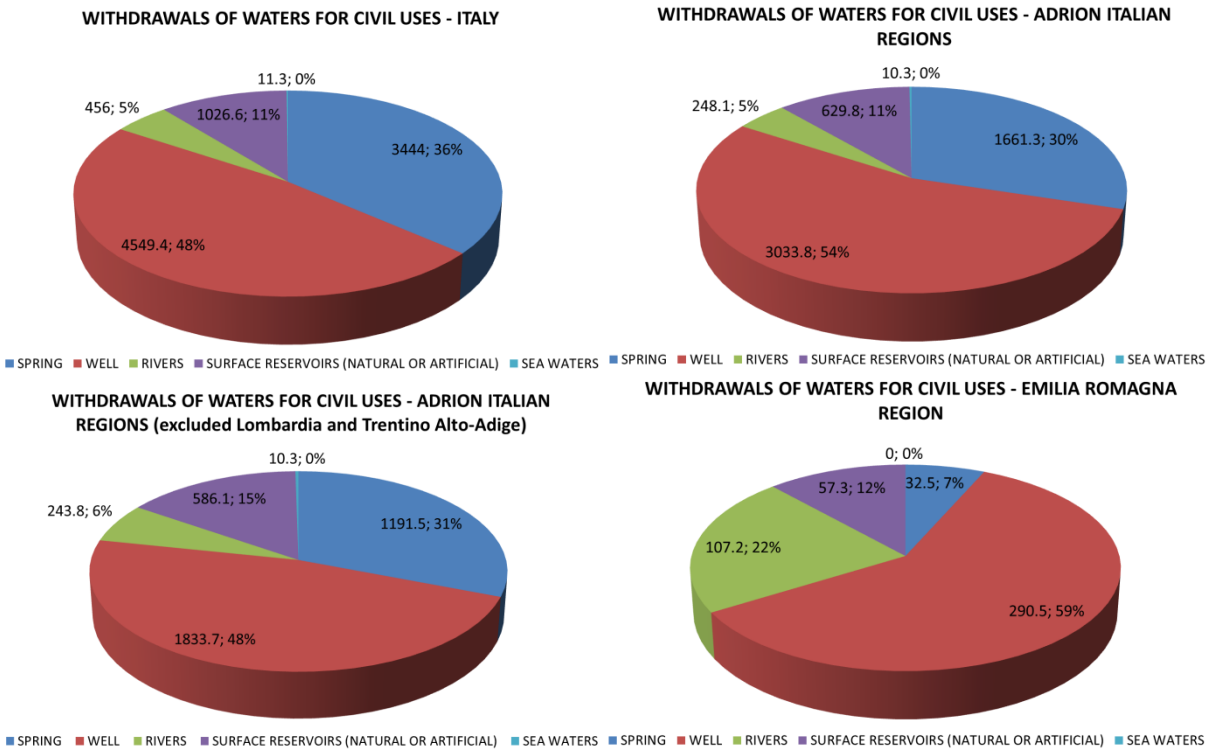

Figure 3 - Relative percentage of exploited water resources in Italy, ADRION Italian regions (included/excluded Lombardia and Trentino Alto-Adige region, and Emilia-Romagna region. (source: ISTAT [2]. Year: 2015).

Water Utilities

Concerning the management of waters intended for civil use, in Italy approximately 2000 water utilities are operating. This number encompasses all sectors of the integrated water cycle (abstraction, distribution, sewage, treatment). It is possible to distinguish between large and small water utilities, the latter referring to a different regulatory legislation, the so called "gestione in economia". Generally speaking, small water utilities are public administrations managing their own water supply systems at the municipality level.

In figure 4 the total number of large and small water utilities for the different sectors is reported. It is worth noting that considering the absolute values, the majority of water utilities in all sectors are small sized, although their number is slowly decreasing, as shown in table 1 presenting data referred to 2012 and 2015 (source: ISTAT). It is important to point out that these figures show the total number of water utilities, whatever the managed volumes, and mainly indicate fragmentation in the distribution, rather than relative importance.

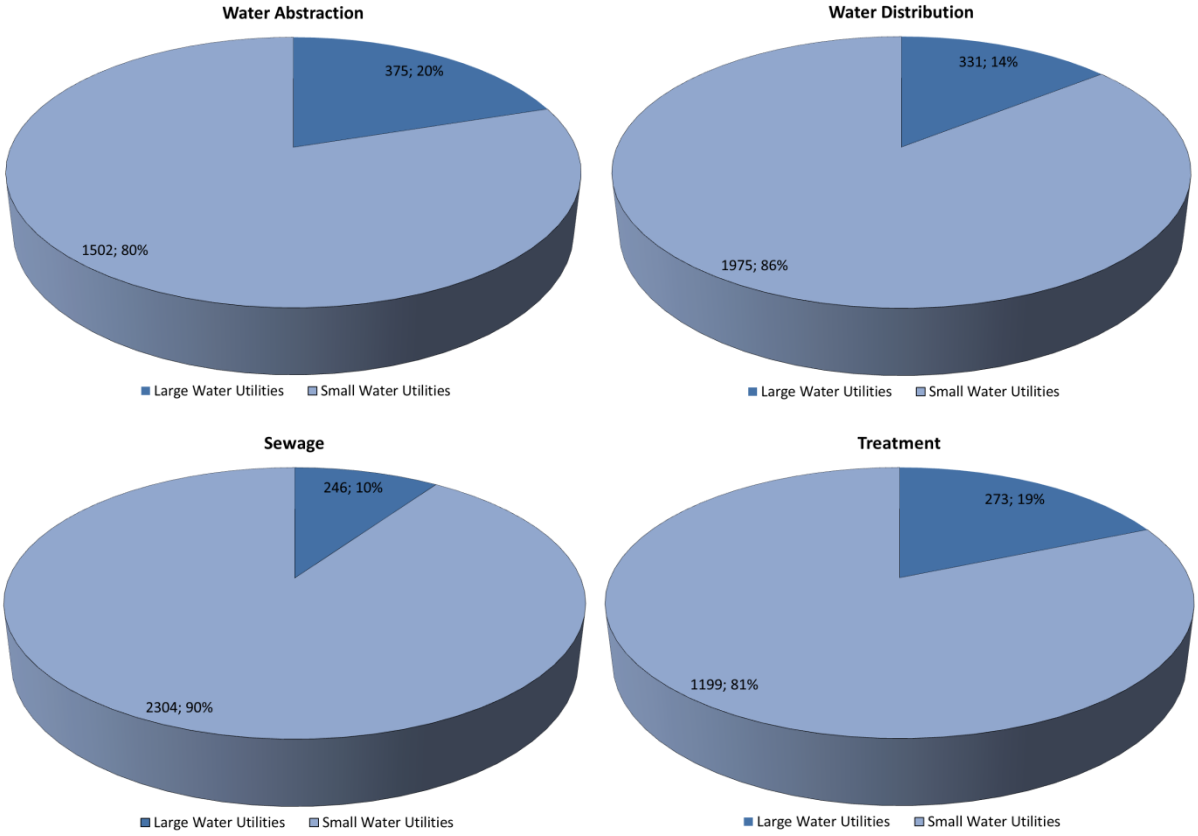

Figure 4 - Total number of large and small water utilities for the different sectors. Source: ISTAT [2]. Year. 2015

	2012			2015		
	Large Water Utilities	Small Water Utilities	Tot	Large Water Utilities	Small Water Utilities	Tot
Water Abstraction	394	1.537	1.931	375	1.502	1.877
Water Distribution	349	2.065	2.414	331	1.975	2.306
Sewage	259	2.539	2.798	246	2.304	2.550
Treatment	328	1.046	1.374	273	1.199	1.472
Total	544	2.617	3.161	486	2.371	2.857

Table 1 - Total number of large and small water utilities for the different sectors. Source: Istat [2]

Analyzing the managed volumes (instead of the number of water utilities), the map in figure 5 clearly shows that almost all Italian water for civil uses are managed by large water utilities . Significant exceptions are located in mountain areas (Valle d'Aosta and Trentino Alto-Adige) and in Southern Italy (Calabria and Sicilia).

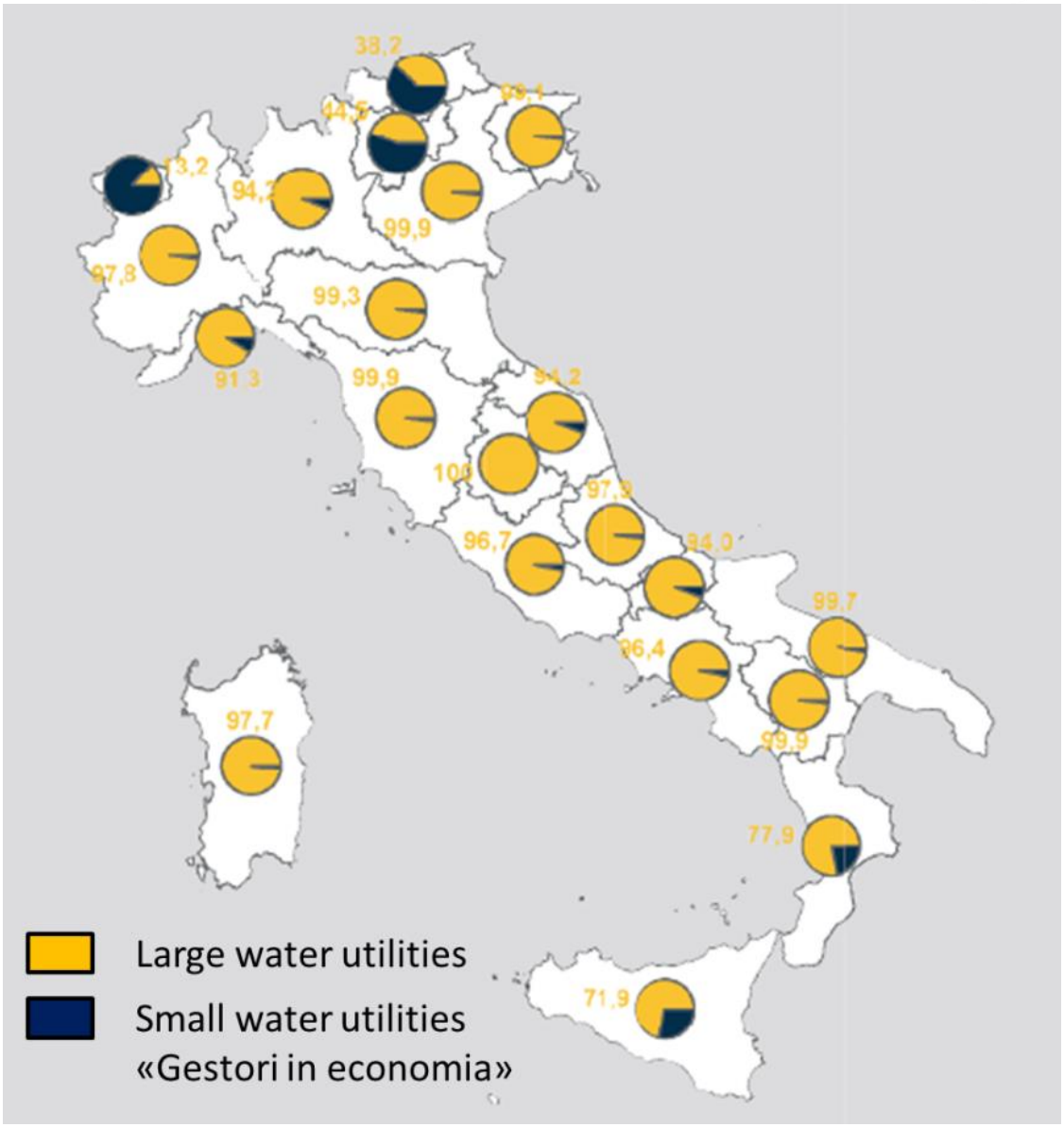

Figure 5 - Percentage of water volumes managed by large and small water utilities, aggregated by administrative region. Source: Istat [2].

The Italian law regulating the civil water sector, allows for different types of water managers: public administration, public companies, mixed companies under public control, mixed companies under private control and completely private. According to the data reported in figure 6 (source: Utilitatis), the vast majority of the water utilities are public or under the public control (approximately 98%)

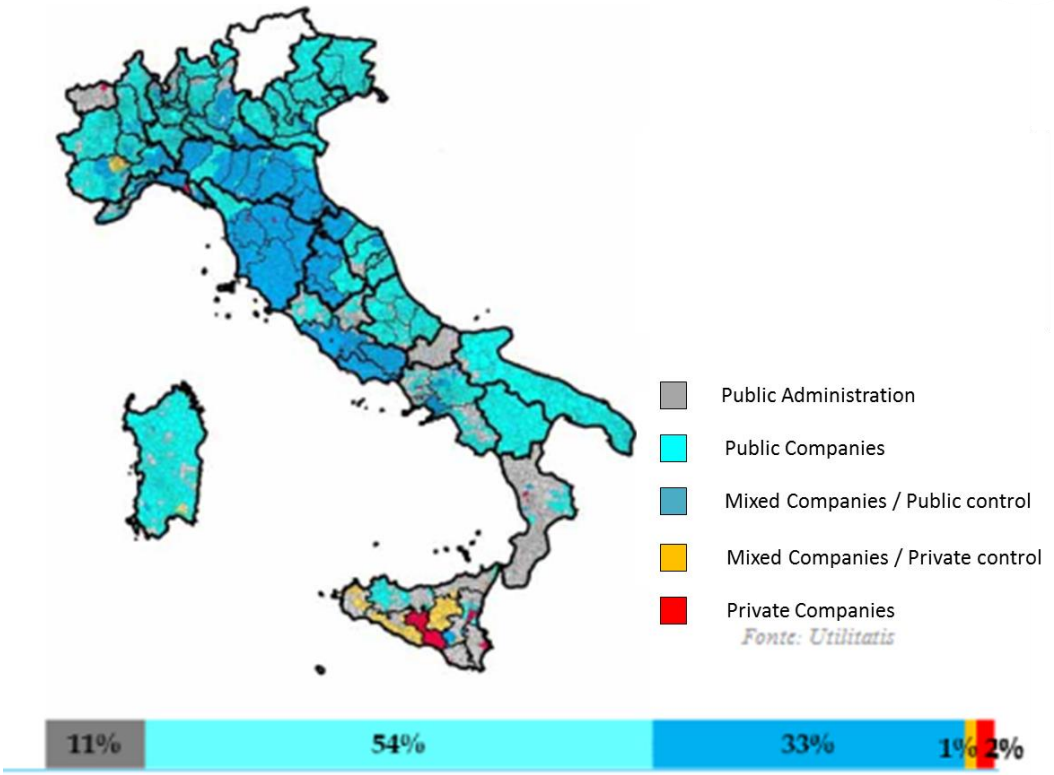

Figure 6 - Geographic distribution of different type of water utilities (source: Utilitalia [3]).

Water Losses

Considering the efficiency of the distribution system, water losses of the water supply systems for civil uses (figure 7) are in the order of 35% at both national and ADRION Italian regions aggregation scale, with a deterioration in performance from 2012 to 2015. Losses in Emilia-Romagna are lower than the Italian average.

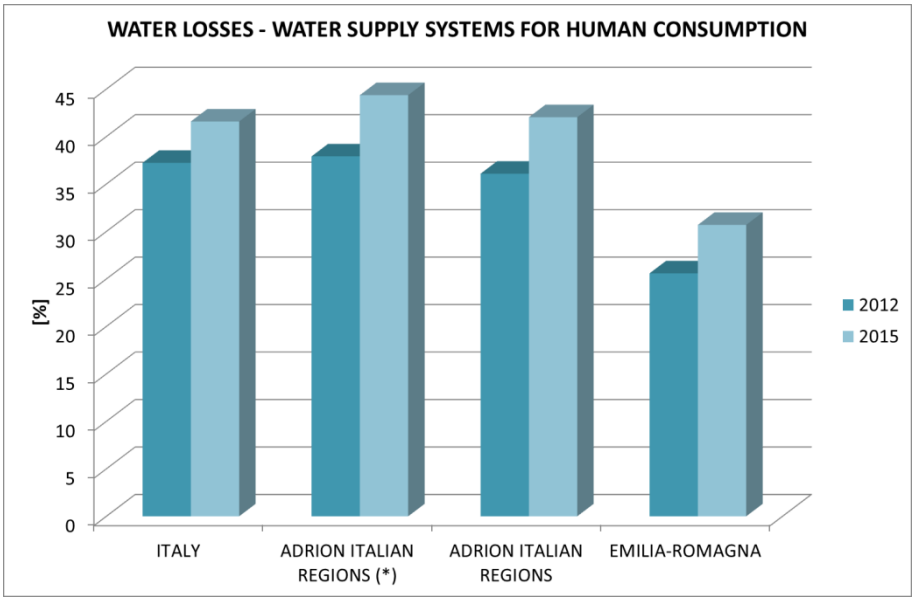

Figure 7 – Percent of water losses concerning distribution of water for human consumption for different regional aggregation in Italy. (Source: Istat - Censimento delle acque per uso civile – 2015).

Continuity of service

Considering the continuity of the service, some areas mainly of Southern Italy have supply issues (especially during prolonged periods of low precipitation such as 2017). According to ISTAT, in 2017, 11 provinces applied rationing measures (over the entire territory or part of it) to face water scarcity conditions. All these areas are located in Southern Italy, more prone to drought impacts than Northern and Central Italy).

Financing

The fare system for water intended for civil uses is based on a “full cost recovery” rate.

The water manager is not entrusted to determine the rate, but only to apply. Rate is fixed by two public authorities (Enti di Governo dell’Ambito, EGA and Autorità di Regolazione per Energia, Reti e Ambiente, ARERA), based on strict rules accounting for operating and investment costs, as well as management efficiency, quality of service, etc.

The flow chart of the Italian water management procedures is shown in figure 8

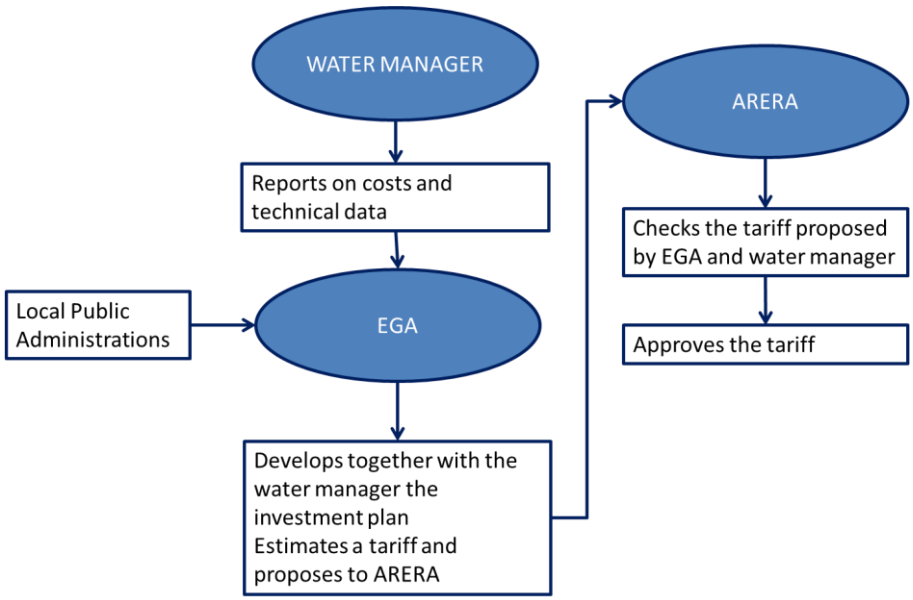

Figure 8: Flow chart of the Italian water management procedures. (source: modified after UTILITALIA [3]). ARERA stands for Autorità di Regolazione per Energia, Reti e Ambiente; EGA stands for Enti di Governo dell'Ambito.

WATER SNAPSHOT

CONTEXT FOR SERVICES			
	VALUE	**YEAR**	**SOURCE**
GDP per capita ($)	34.49	2018	WORLD BANK [4]
Population [M. inh]	60.317	2019	ISTAT
Poverty headcount [3.5$ a day % pop]	1.8	2017	WORLD BANK [4]
Local government units [municipalities]	7.904	2019	ISTAT
For which, average size [inh]	7631	2019	ISTAT
ORGANIZATION OF SERVICES			
Number of formal water service providers	1877[1]	2015	ISTAT [2]
Water services law	YES	---	See par.2.1
Single line ministry	NO	---	See par. 2.2
Regulatory agency	YES	---	See par. 2.2
Utility performance indicators publicly available	NO	---	---
Major ongoing reforms	YES		Low proposal 23 march 2018 (Daga)
FINANCING OF SERVICES			
Operating cost coverage	Tariff based on a "full cost recovery" approach		
Average residential tariff [€/m^3]	1.37	2017	UTILITALIA [3]
Average annual investment [€/cap/year]	41.3	2017	UTILITALIA [3]

Table 2 - Water snapshot

[1] Referred to the water abstraction activities. See table 1

2. Concept of water supply safety in Italy

2.1 Legislation related to water safety

For many decades, the Italian legal framework for the utilization of water resources was based on Royal Decree (RD) 1775/1933. It was issued with the aim of increasing hydroelectric use and of providing the regulation of private withdrawals (particularly for irrigation and hydropower) on the basis of a licensing system, although the activity of water resources planning by the state was lacking. In the same year, another fundamental law (RD 215/1933) regulated the responsibilities of the organizations for land reclamation (Consorzi di bonifica), which were entrusted of developing an integrated plan in the fields of soil conservation, irrigation, rural roads and rural electricity supply. A previous Act RD 523/1904 had introduced a classification of the hydraulic works along the watercourses. Five categories were identified according to the importance of the watercourse and duties of the state, of the local institutions (provinces and municipalities) or consortia of private owners in order to provide for their construction and maintenance.

The planning principle for drinking water supply was introduced by Law 129/1963, which established the drafting of the aqueduct master plan to be developed by the local offices of Ministry for Public Works. The aim was to impose constraints on water sources in order to satisfy urban water requirements as estimated for the year 2015.

During the 1970s the focus of water legislation was on water quality and environmental impacts of wastewater (Rossi and Benedini, 2020). As the principle of decentralization, established by the Italian Constitution (1947), had been implemented by means of the establishment of ordinary regions (1971), many responsibilities in water field have been transferred to the regions by DPR 8/1972 and by Law 382/1975.

Thus, Law 319/1976 (Merli Act) entrusted the regions with the preparation of water restoration plans, including sewerage and wastewater treatment plants. The Merli Act regulated the pollution control through the introduction of standard quality levels on the effluent to be discharged in water bodies, and established a service fee for sewage system and wastewater treatment, in accordance with the polluter pays principle, while establishing a penal liability for polluters.

At a later time, several decrees defined technical guidelines for water pollution control, thus acknowledging the European Directives on water quality and environ- mental protection, adopted by the European Economic Communities (created by the Treaty of Paris, 1951 and the Treaty of Roma, 1957) in the 1970s and 1980s with focus on protecting waters of anthropogenic interest (drinking, bathing, fishing). Only during the second wave of European water legislation, i.e. in the 1990s, the focus was enlarged to the agricultural sector.

After the institution of the European Union (by the Treaty of Maastricht, 1992), a shift occurred towards a more comprehensive legal and institutional mechanism to improve water management, in particular, by means of the 2000 Water Framework Directive. However, the acknowledgement of the European Directives on water quality in Italian legislation occurred in general many years after the directives had been issued. Furthermore, the rules of the Merli Act were revised by Law 650/1979, particularly for wastewater discharges into water bodies, and by Law 172/1995, which gave the regions the power to set up their own emission standards. The influence of the new European Directives on environment protection and sustainable development had already led to the establishment, by Law 349/1986, of the

Ministry for Environment, with responsibilities for many issues which previously were covered by the Ministry of Public Works.

The most innovative aspects of the recent water legislation were introduced by Law 183/1989. It was the conclusion of a long process which started soon after the disrupting flooding of Florence and Veneto region (November 1966), under the drive of two technical-scientific works:

- the De Marchi Committee for hydraulic defense and soil conservation problems (Commissione Interministeriale 1970);
- the National Water Conference (Conferenza Nazionale Acque) for the problems of water resources uses, pollution control and institutional reform (CNA 1972).

The new law aimed at adopting an integrated approach to water and soil conservation problems within the river basin boundaries, regardless of the administrative boundaries. It established the River Basin Authorities with the task of coordinating all the activities of water-related planning, water works construction and control.

The key concept of the act is the river basin plan, conceived as a tool to collect relevant information and to identify the needed actions for:

- flood defense and soil conservation;
- water supply for different uses;
- pollution control of water bodies (rivers, lakes and aquifers).

The law identified three levels of river basins, based on their importance, size and location:

- the first level considered basins of national interest under the direct responsibility of the state; it included six River Basin Authorities in the largest Italian river basins (Po, Adige, Piave, Arno, Tevere, Liri-Garigliano-Volturno);
- the second level considered basins of interregional interest including rivers whose territory belongs to 2 or more contiguous administrative regions, though not so important to be considered of national level; 18 interregional River Basin Authorities were established to be run jointly by the governments of the affected regions;
- the third level included basins of regional interest, belonging entirely to one single region. The law entrusted the regional governments with the setup of regional river authorities.

Furthermore, the law established a National Committee for Soil Defense aimed at coordinating the actions, which however operated only for a short period. It also reformed the National Technical Services, which were transferred under the jurisdiction of the Prime Minister, with the task of organizing and managing the information system on hydro-meteorological data. Another important innovation was the introduction of concept and practice of the “minimum river flow”, i.e. an ecological in-stream flow to be guaranteed downstream of diversion authorized by a withdrawal license.

In 2006, Law 183/1989 was abrogated formally, but all its fundamentals and principles were maintained, with only minor changes, in the context of the broader Environmental Code of Decree 152/2006.

A sweeping reform of the municipal water services was introduced by Law 36/1994 which modified the previous management structure based upon the prevailing responsibility of the municipalities in their territory or of organizations supplying water (e.g. Apulian Aqueduct) or treating wastewater effluents for a number of municipalities in some parts of Italy. First of all, Law 36/1994 introduced important innovations in the general principles of water resources government. It stated that all surface and groundwater resources must be considered public and should be used according to criteria of solidarity and sustainability. It stated also that drinking use has priority over all other uses, followed by agricultural use under water scarcity conditions.

The management of municipal water services has been reformed significantly by considering it as a unitary service. The law put the three elements of the urban water cycle (water supply, sewerage, and wastewater treatment) under a single responsibility in order to simplify the management structure, to account for large-scale interconnected systems, to obtain scale economies and to improve the protection of water sources from pollution. The reform included territorial, functional and financial features. Territorial scale was established in terms of "optimal territorial areas" (OTAs), in Italian ATO, (i.e. Ambiti Territoriali Ottimali) to be defined by regional governments, thus including several municipalities, in order to overcome the fragmentation of water management at municipal level (more than 5000 management bodies) and to develop organizations with increased size in terms of both served population and supplied volume. Better functioning is pursued by separating the duty of strategic direction and control of the service (performed by a public OTA's authority) and the duty of the management of Integrated Water Service, to be performed by a management company, either private, public or in public-private partnership. A full cost recovery pricing criterion was envisaged in order to ensure that the tariffs charged to users should cover all the costs of the services, including opera- tion, replacement and investments costs.

The rules regarding the water withdrawals for agricultural use were established by RD 1775/1933, which distinguished between small and large withdrawals (identified by the threshold of 1000 l/s, with even more constraining exception when the irrigated surface is larger than 500 ha). The RD 215/1933 gave priority to the land reclamation consortia in the licensing system with reference to individual applications. This priority was limited by DLgs 275/1993, which introduced new criteria for granting new licenses, in order to account for the quantitative and qualitative characteristics of the water body and for the rational use of water. It established the conditions for the renewal of the irrigation licenses and established that new groundwater abstraction licenses should be given for uses other than drinking purposes only in case of lack of other sources of supply.

The same legislative decree introduced a minimum ecological flow to be guaranteed in the stream. While the operation and maintenance costs are normally paid by the irrigations users or by the land reclamation consortia (totally or partially), the investment costs for building infrastructure for irrigation water supply were covered in general by the state, e.g. through the Southern Italy Development Fund (Cassa per il Mezzogiorno) or the Green Plan (e.g. Law 27.10.1966 and following acts). The rules to allow the reuse of treated wastewater for irrigation, and also for municipal uses such as washing of roads, supply of dual aqueducts networks or cooling systems or for industrial use (such as water anti-fire or for washing), have been established by DM 185/2003.

The Legislative Decree 152/1999 (modified by DLgs. 258/2000) rearranged the previous Italian legislative framework on pollution control and water quality improvement according to the European Directives 91/271 on urban wastewater treatment and 91/67 on protection of water from agricultural pollution and also according to the proposals of the new European

Water Framework Directive, which was ongoing at that time. The decree introduced the objectives of a minimum standard of water quality in the water bodies and a specific level connected to each particular use (production of drinking water, bathing, support to fish life, etc.). It modified the previous standards on wastewater effluents (irrespective of the specific water body characteristics). It distinguished the actions for protection and restoration on the basis of the exposure of the site to eutrophication and of its vulnerability to pollution by nitrates originating from agriculture.

Although Law 183/1989 had been issued with the objective of a unitary approach to soil conservation (including flood defense), water quality protection and water supply for various uses, many of the following laws adopted a different orientation. In contrast to the results of the Parliament Commission which had confirmed the validity of the coordination approach of Law 183/1989, the subsequent politics reversed to face the problems in separate ways for each sector, thus deeming to assure more effective results. In particular, this approach was adopted to overcome the delays in the preparation of the comprehensive plans and to timely solve the dramatic effects of frequent flooding and landslides events. In fact, after the hydrogeological Sarno disaster (which resulted in 159 fatalities), the Decree 180/1998 (indicated as Sarno Act, approved by the parliament as Law 267/1998), introduced the Hydrogeological Asset Plan, aiming at identifying the areas with high risk and at defining the necessary mitigations measures and works (commitment of River Basin Authorities or regions) and the urgent plans for emergency (commitment of the Civil Protection Service). The latter institution had been already established by Law 225/1992 with a more general purpose of coping with all natural and man-made disasters. Law 226/1999 introduced the extraordinary plan for areas under high risk, while Law 365/2000, issued after another flooding disaster (Soverato, with 13 fatalities), defined the procedures for approval of Hydrogeological Asset Plans and for developing meteorological monitoring.

Despite the increase in planning tools, the implementation of the planned actions to fight flooding and landslides was very limited, due to the economic crisis and bureaucratic delays which affected the amount of investments and the timely construction of hydraulic works. In the same years, policy on flooding risk mitigation increased the role of the meteorological monitoring service and of the civil protection, also as a consequence of a conceptual shift from the structural measures for flood defense to the measures for reducing damages by means of early warning systems and improved actions of aid during extreme flooding events. In particular, the directive of the President of the Council of Ministers 27.2.2004 improved the organization of the multifunctional centres and established the warning system for hydrogeological and hydraulic risk.

The following step in the legislative process was the incorporation of previous tools into the Legislative Decree 152/2006 (Environmental Code), which covered all aspects of the soil defense and water resources use and protection. However, this act missed the opportunity to simplify and improve the very complex system of planning tools and management responsibilities in the water field.

The publication of the European Directive 2007/60/EC on the assessment and management of flood risks increased the complexity of the planning tools, since it required drafting the new Flood Risk Management Plans. The 2007/60 proposal to evaluate mapping of flooding hazard and risk was actually very similar request to the tools envisaged already by the Italian legislation but limited to the flooding without considering landslides. The D. Lgs. 49/2010 acknowledging the European flood risk directive, gave responsibility to the District Authorities for the preparation of this plan and con- firmed the duty of regions in providing the part of the plan for hydraulic risk mitigation system. This duty must be carried out in cooperation with the National Department of Civil Protection.

Since the District Authorities, established by the D. Lgs. 152/2006, had not started yet their activities, the D. Lgs. 219/2010 entrusted the responsibility of drafting the plans required by European Directives to the National River Basin Authorities (besides to the regions responsible for districts located in main islands). These authorities completed the plans within the deadline (June 2015), in particular, pro- viding the hazard maps and the risk maps. However, the planning process emphasized the difficulties of an effective coordination among the different bodies and among the different planning tools, thus confirming the necessity of a simplification of the too complex regulation.

The more recent efforts are oriented to foster the implementation of designed measures. The Law 164/2014 aimed at accelerating the use of financial resources for hydrogeological risk mitigation by agreements between regions and Ministry of Environment, by the revocation of unused funds and by the allocation of new financial resources to the regions for flooding mitigation in urban areas. The law also established priorities of actions with the joint purpose of reducing the risk and of improving ecosystems and biodiversity.

The DPCM 15/9/2015 has contributed to foster the actions for flood risk mitigation by means of a plan for urban areas with a large amount of population exposed to flood risk. The Law 221/2015, besides the innovations on municipal water service for drinking use, which were mentioned previously, amended the Environmental Code in district definition, structure of District Authorities and new rules for prevention of flooding risk. These rules include a program of sediment management in river basins and specific instructions to remove unauthorized buildings in high-risk areas as well as to reduce vulnerability of buildings to hydrogeological risk at municipal level.

The Italian legislation does not include a specific mandatory act for drought management. The D. Lgs. 152/2006 makes mention of “the actions against the drought risk” only in a list of the contents of the district plan, which includes also the actions against the risk of flooding and landslide and the actions to pursue the economic and social objectives and the land protection; however, no indication is provided on the methodology to identify these actions. A few indications for defining objectives and contents of a drought management plan have been given in the following regulations documents.

Nowadays, the European Commission suggests the Member States to adopt drought management plans, but this advice is not mandatory. In fact, the technical report of the Water Scarcity and Drought Expert Network (E.C 2007) has extended the objectives and criteria of the Water Framework Directive 2000/60 to fight the drought, recommending that the member states develop and implement measures aiming at preventing and alleviating drought and water scarcity, by adopting an approach of risk management instead of crisis management. The report envisages that the authority responsible for the district water planning provides a drought management plan, to be incorporated into the River Basin Management Plan as supplementary plan according to Article 13.5 of WFD. Its specific objectives are (i) to guarantee sufficient water availability to cover water human needs and to ensure the population’s health and life, (ii) to avoid or minimize negative drought impacts on water bodies and (iii) to minimize negative effects on economic activities.

2.2 Institutions related to water safety

The President of the Council of Ministers is responsible for the approval of the decrees concerning methods and criteria for basin planning and implementing water and soil

management measures, for the approval of the river basin plans and of other acts concerning the direction and coordination of intervention at the lower level. The same President of the Council, through the Department of Civil Protection, controls the Civil Protection Service.

The Minister for Environment, Land and Sea Protection is responsible for the enforcement of most of the rules on water resource planning, soil defense planning, water use (in particular domestic supply) and water quality standards. A very important responsibility is the duty to apply European Directives and approve the plans prepared by the District Authorities according to the Directives 2000/60/EC and 2007/60/EC.

The Minister of Infrastructures and Transport continues to carry out part of the activities of the previous Minister of Public Works. It includes, at the national level, the directorate responsible for dams and water infrastructures.

The Minister of Agricultural Food and Forestry Policies and Tourism has responsibility for agricultural development and irrigation programs. It manages the forest services through the State Forestry Body that is dedicated to the protection of forests, environment and agriculture. This body has recently merged into the Carabinieri Corp.

The Minister of Health has responsibility for the quality of drinking water and, in cooperation with the Ministry of Environment, establishes rules for the control of water quality through all stages of the process from withdrawal to delivery to the consumer. Besides, together with the Minister of Agricultural Food and Forestry Policies, the Minister has responsibility for the quality of water used for irrigation.

The main coordination role at national level is in charge of the Conference State-Regions and Autonomous Provinces. It has a key role in resolving frequent conflicts among central government and one or more regional governments, also in the matter of water and soil management measures.

Among the institutions responsible for implementing national policy with regard to water-related disasters, an important role is assigned to the Civil Protection Service, established first by Law 225/1992 and revised by the DLgs 1/2018 under the control of the Department of Civil Protection (Presidency of the Council of Ministers). The “civil protection” includes all the activities aimed at protecting life, property and settlements from risk of damage arising from natural and anthropogenic disasters (including flooding, landslides and drought).

The Institute for Environmental Protection and Research (ISPRA), under the authority of the Ministry for Environment Land and Sea, has the role of helping the public administration in many commitments (e.g. development of environmental data bases, synthesis of the planning provisions provided by the river basin authorities, guidelines for meteorological and hydrographic monitoring).

A key role in the security of dams and the correct operation of reservoirs is played by the Directorate for dams and water infrastructures, part of the Ministry of Infrastructures and Transport, established by the DPR 254/2007. The Directorate approves the projects of dams higher than 15 m and capacity greater than 1 million m3.

Under the surveillance of Ministry of Health, the National Institute of Health (established in 1934, as Institute of Public Health) is a technical-scientific body responsible of research, advice, control and training on public health, including water quality issues.

An important function of surveillance on the companies for management of municipal water services is carried out by the Authority for Regulation Energy Networks and Environment

(ARERA). The Authority is independent from the government and has five members elected by the Parliament for 7 years.

The main institutions for research on water in Italy are the universities, the National Research Council (CNR), as well as research institutes funded by other ministries. In particular, the CNR, founded in 1923, since 1989, is under the Ministry of Education University and Research. In particular, the researches of the IRSA (established in 1968) refer mainly to the management and protection of water resources and the development of methodologies and technologies for water and wastewater treatment. The researches of the IRPI regard the fields of natural hazards with emphasis on geo-hydrological hazard, environmental protection and sustainable use of geo-resources.

At the district level, the District Authority has the following main responsibilities:

- drawing the district plan and the plans required by the European Directives and the programs of actions

- checking the coherence between the objectives of the district plan and the measures of planning and programming at European, national, regional and local levels on soil defense, fight to desertification, water resources protection and management and

- analyzing the impacts of human activities on surface and groundwater resources as well as an economic analysis of water uses.

The policy making and planning role at regional level is carried out by the regional government, including the President of the Region and several regional councilors (Assessori), which share the responsibility of regulating the sectors of water resources and soil defense through many departments. The complexity of coordination is similar to that of the central government level. Regional governments provide

- the drawing up of the Regional Plan for Water Protection,

- the definition of the Optimal Territorial Areas and the procedures for the choice of the company managing the Integrated Water Service,

- the organization of regional services

- the creation of bodies to guarantee the quality of the water service to the citizens of the region and

- the regulation of the duties of the bodies for water resources management in agriculture and industry sectors.

The network of regional functional centres for civil protection manages the system of alert with regard to hydrogeological and hydraulic risks that is made of two stages the forecasting of severe meteorological events and the stage of monitoring and watching.

The Regional Agencies for Environment Protection (ARPA) have been established by the Law 61/1994. They monitor aspects of the environment (air, water, soil) to control pollution, and they both support the local organizations (municipalities, provinces) and maintain an information system on the environment. In particular, ARPA monitors climate, quality of drinking, bathing and coastal water, polluted discharge, treatment plants, etc. and develops campaigns for environmental education.

At inter-municipal level, the Optimal Territorial Area Government Body, as established by the Law 36/1994 (Law Galli), issues directives and controls the management of the municipal services (aqueduct, sewage, treatment plants) unified within the Integrated Water Service.

Municipalities, which carried out the services of drinking water supply and municipal uses, of sewage and of wastewater treatment until the Law 36/1994, have now the role of establishing the government body of the Optimal Territorial Area, according to the reform of municipal services. In several cases, municipalities continue to provide the water supply, sewage and waste-water treatment services, since the plants were not assigned to a management body of the Optimal Territorial Area.

2.3 Ongoing processes

2.3.1 Existing legislation and practices aiming at the drinking water safety

In Italy, the quality of water intended for human consumption is governed by Legislative Decree No. 31 of 2001, which implements Directive 98/83 / EC and which applies to all water intended for drinking use, for the preparation of food and drink, both at home and in food businesses, regardless of their origin and type of supply.

The term "quality of water intended for human consumption" implies, in addition to drinking use, also the contact of water with the human body during the various washing practices, taking into account both the average, adult and healthy population and the sensitive groups such as children, the elderly and the sick.

The implementation, therefore, of all the provisions described in the standard and compliance with the parameter values, at the point where the waters are made available to the consumer, determine the assessment of "suitability" of the water for human consumption in conditions of lifelong security. The maximum allowed parameters and values are generally based on the guidelines established by the World Health Organization and on the opinion of the scientific committee of the European Commission, while more restrictive values and additional parameters, for example "chlorite" and "vanadium", are determined by the Istituto Superiore di Sanità, after consultation with the Superior Health Council.

For completeness of the regulatory framework, mention should also be made of Ministerial Decree 174 of 6 April 2004, relating to the materials that can be used in water distribution systems and, lastly, the regulation governing the equipment intended for changes in the organoleptic characteristics of the drinking water.

It’s useful also to mention the Legislative Decree of 15 February 2016, n. 28, which establishes the requirements for the protection of the health of the population with regard to radioactive substances present in water intended for human consumption.

However, it should be noted that the issue of risk assessment and management has been addressed at international and European level, with new approaches based on risk assessment and management in the drinking water supply chain.

In particular, in 2004, the World Health Organization (WHO) introduced the Water Safety Plans into the supply chain of water intended for human consumption: the 2004 guidelines were however repeatedly updated.

The criteria set out in the Water Safety Plan have as main objective the organization and systematization of the management practices already applied to the production of drinking water and also encourage risk assessment and management along the entire drinking water supply chain (Lucentini et al., 2014a, b).

In 2015, the European Union passed the EU Directive 1787/2015 / EU, with which significant innovations were introduced to the 1998 Directive: in Italy, these changes were implemented with the Ministerial Decree of 14 June 2017, which introduced national level, albeit in a non-binding way, the Water Safety Plans (Piani di Sicurezza dell'Acqua - PSA).

The Water Safety Plans are the most effective preventive model, an extensive preventive model and guaranteeing access to safe water over time, through the application of integrated and balanced control measures, extended to the collection environment, water bodies, treatment of water and water-drinking distribution up to the internal supply of buildings (Lucentini et al., 2019).

The plans ensure the quality of the water distributed through an accurate definition and control of the conditions associated with each possible event that can determine threats for the availability of the resource in the environment and in water systems, also due to infrastructural deficits, environmental stress and climate change, or involve the presence of chemical, physical or microbiological risk factors in every phase of the hydro-drinking supply chain, up to the moment of use of the water.

The Water Safety Plans direct the water control system towards a predictive risk assessment and management approach, based on the preventive analysis, the adoption of measures and the control of the effectiveness of the measures adopted, assessed in a personalized way for the specific aqueduct system in question, of which all phases of the production chain are analyzed punctually; this approach represents a substantial revolution of approach with respect to the concept of surveillance of a series of analytical parameters, also allowing flexibility of the management system with respect to emerging contaminants, currently not subject to systematic monitoring, and / or vulnerabilities of the systems that could be directly or indirectly impacted by climate change.

The Water Safety Plan is specific to each individual Water Supply System and constitutes a strategic tool for the planning and identification of investment priorities relating to the individual Water Supply System (Di Francesca, 2019).

At national level, the issue of Ministerial Decree of 14 June 2017 marks a fundamental step to strengthen the quality of water to protect human health (Guerra et al., 2017), taking into account the indications already consolidated in the revision of Directive 98 / 83 / EC; in fact, the new national standard intends to overcome the limits of the current monitoring regime on distributed water, of a retrospective type and based on the "tap" control of a limited number of parameters, generically applied to each aqueduct system.

The adoption of risk analysis, according to the WSP model, therefore represents a national strategic choice to overcome the limits of the current control system on water intended for human consumption, with the intervention priorities listed below:

- effectively prevent water-drinking emergencies due to parameters currently not subject to ordinary monitoring, such as PFAS or microcystins, considering any plausible dangerous event in the sources, in the uptake and in the entire water-drinking supply chain, projected in the scenario altered by ongoing climate change;

- increase the prevention of the dangers of chemical, microbiological or virological contaminations, also thanks to an enhancement of on-line monitoring, early-warning and remote- redefine the protection areas of the springs, according to the provisions of the Water Framework Directive, and the "water supply areas", through the updated identification of the water-drinkable supply chains, the connections between them, the homogeneity of the water in distribution and the geographic areas / users served; this action is also essential to optimize the representativeness of the sampling / monitoring, in view of the application of Legislative Decree 28/2016 on the monitoring of radioactivity in water;

- enhance the sharing of information and data, as an expression of due diligence, between the institutional bodies which, for various areas of competence, monitor and protect the territory, such as the regional environmental agencies and local health companies, who possess essential knowledge on the dangers of contamination along the entire hydro-drinking supply chain; these include, inter alia, geogenic elements in contact with the aquifer, the existence of landfills or polluted sites, spills of pollutants, contamination following fires, releases from agricultural and livestock activities, sites mining or military, illicit discharges;

- have a flexible evidence-based risk analysis model through which, where and where necessary, adapt the resilience of water systems to trends and extreme climatic events and strengthen the degree of physical protection of infrastructures and resources;

- allow citizens to participate more consciously and actively, improving communication in ordinary and critical situations and reinforcing, on the basis of evidence, the credibility of local authorities and health and environmental control authorities;

- create databases, constantly updated by the territorial institutions and subjects, in particular by the water utilities and by the regional environmental agencies, shared with the local and central health authority, on the water supply systems and on their control which, according to harmonized procedures, can feed a rapid surveillance network on a regional and central basis, as well as public information via the national water portal.

The strengthening of regulatory actions to support the implementation and approval of water safety plans in the water sector is the central element of the recast process of the European directive on the quality of drinking water and in the revision of the national legislative corpus of the drinking water sector.

At the national level, the Ministry of Health, the Higher Institute of Health and interregional coordination bodies have shared the goal of adopting the Water Safety Plans for all water management systems in 2025. The implementation of the plans, which has been underway for some time in large drinking systems, is spreading towards smaller systems and is involving medium-small managers, albeit in a few difficulties. At the same time, the multi-level training action and the strengthening of the regulatory plan are being strengthened, both as regards the approval of the plans and to facilitate more effectively the exchange of fundamental data for health prevention, between competent authorities and water utilities.

It should however be stressed that the whole process will undergo significant changes following the revision of the European Directive 98/83 / EC, currently underway; in this regard, some of the guidelines that seem to emerge in this sense are set out below.

In February 2018, the European Commission formulated a text of a proposal to recast the directive on the quality of water intended for human consumption to support Member States to manage drinking water in a sustainable and resource-efficient way, and to contribute to reduce energy consumption, water losses and the volume of plastic bottles in circulation, increasing people's confidence in the quality of tap water. The use of the risk-based approach

is one of the central elements on which the new directive is based, together with the revision of the list of parameters, the transparency of information for the consumer on water resources and the water-drinking service, materials in contact with water. As expressed in the Commission's intentions, the new risk-based approach to security will contribute to more targeted security checks in cases where the risks are higher.

The preventive safety planning for drinking water was based to a very limited extent in Directive 98/83 / EC. At a considerable distance from the risk analysis models that inspire the safety for human health of other products, such as the manufacture of drugs or food production, the introduction of the risk-based approach in the water sector took place at the level European in 2015. Directive (EU) 2015/1787, which amended Directive 98/83 / EC, was aimed at allowing member states to derogate from monitoring programs, until then based on controls of predefined lists of parameters and monitoring frequencies, functional only to the volumes of water distributed. However, the directive established the conditions for performing a credible risk analysis, based on the WHO guidelines for the quality of drinking water that define the Water Safety Plan, even for small systems, and which together with the EN 15975 standard -2 constitute the internationally recognized principles on which the production, distribution, control and analysis of the parameters in water intended for human consumption is based.

The framework of the 2015 directive, based on the principles of risk analysis, is maintained in the recasting process, but is extended well beyond the, albeit important, objective of defining monitoring campaigns that focus time and resources on risks relevant for each specific territorial circumstance and system, and can avoid analysis and allocation of resources on irrelevant issues.

In Italy, the introduction of the Ministerial Decree of 14 June 2017 and joint work by the central, regional and local Health Authorities and the Regulatory Agency (ARERA) has led to a vast expansion of the Water Safety Plans. However, it should be considered that the process of adopting the Water Safety Plan must necessarily take into account the revision of the entire legislative corpus based on the recast of Legislative Decree no. 31/2001, which will derive from the transposition of the new Directive on the quality of water intended for human consumption. There will also certainly be greater interconnections with the regulatory provisions on environmental protection and control.

As part of this process, the following actions are underway at national level (Lucentini et al., 2019):

• Completion of the national training program on the Water Safety Plans and elaboration of the approval guidelines under the aegis of the Ministry of Health with the support of the Istituto Superiore della Sanità and with the competent State - Regions coordination bodies;

• Information system on the quality of drinking water in Italy through permanent census activity, under the coordination of the health authority, to guarantee exhaustive and updated information to citizens and the European Commission, as a fundamental tool to control exposure to potential risk factors, but also to know the contributions of mineral elements provided by the waters;

• Scheme of decree on materials, reagents, means of treatment of drinking water based on a third party certification, approval, marking and traceability.

2.3.2 Level of implementation

The assessment of the level of implementation of the WSPs is fundamental to understand the evolution of the diffusion of the WSPs and ascertain the existence of critical issues or obstacles to their adoption.

2.3.2.1 Previous assessment

In September 2019, Utilitalia, the main national association of Italian water utilities, carried out a survey aimed at assessing the degree of implementation of the WSPs. The number of companies that responded to the survey was 42, corresponding to 28.9 million inhabitants and to an annual distributed flow rate of 2.6 billion cubic meters. The sample is therefore relative to almost half of the Italian population (approximately 47.8%). However, it should be noted that the companies most sensitive to the issue of WSP implementation and generally more structured mainly responded to the survey: this circumstance must therefore be duly taken into account, as the extension of the survey results to all companies in the Italian water sector should not be immediate. Many of the companies in the water sector are directly managed by the Municipalities and, in almost all cases, do not have a WSP. It should also be noted that, after implementation, the WSP is assessed by the Higher Institute of Health and approved by the Ministry of Health. The survey made it possible to ascertain that the population with started WSP is equal to 4.18 million inhabitants, corresponding to 14.5% of the sample: therefore, 85.5% of the sample does not have a WSP.

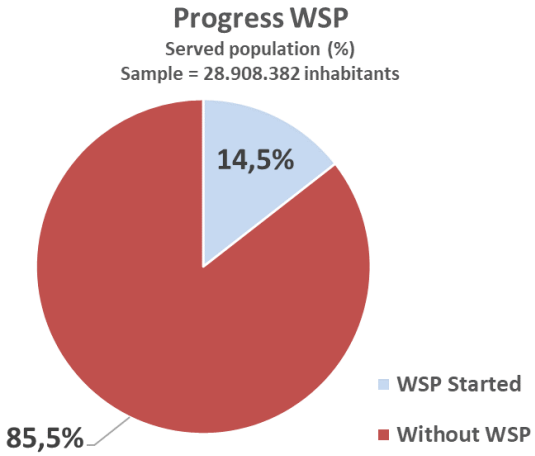

Figure 9 –WSP progress (Source: Utilitalia).

As regards the degree of implementation of the WSPs, it appears that of the 42 companies in the sample, only 1 implemented the WSP for the whole population, 9 companies implemented the WSP with a percentage between 0.1 and 60% of the population served and the remaining 32 companies have not yet started the WSP. Furthermore, the data acquired by Utilitalia do not allow to fully understand the relationship between the percentage of implementation of the WSPs, the population and the company size: however, there is an increasing percentage of achievement with the size of the companies.

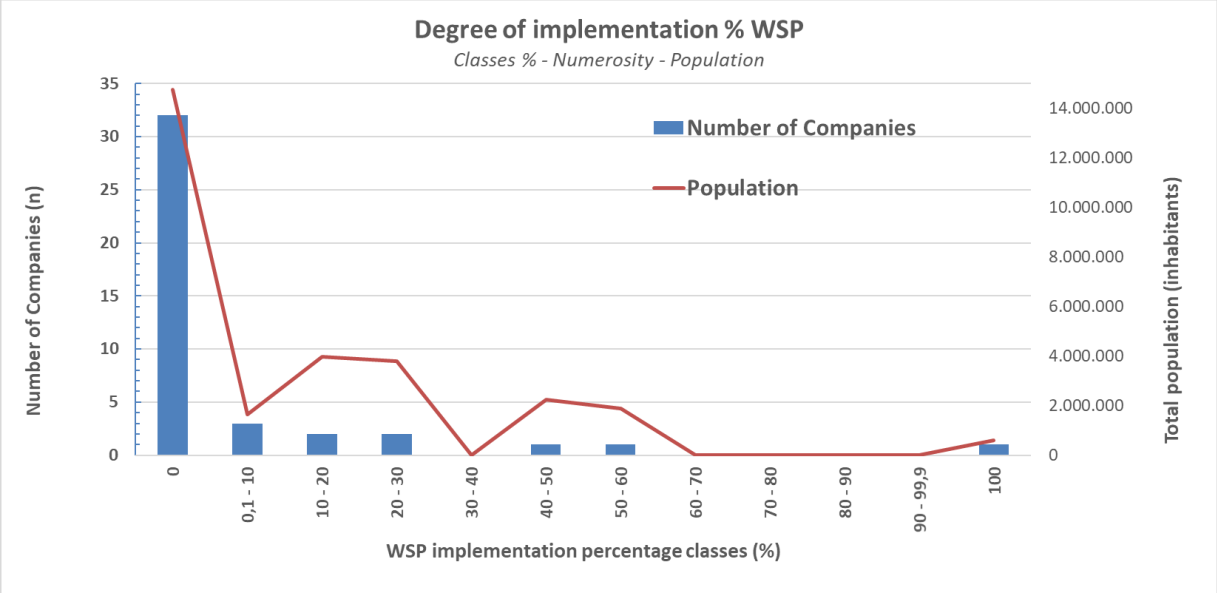

Figure 10 – WSPs degree of implementation (Source: Utilitalia).

As regards the timing of the realization of the WSPs, it must be said that these are undoubtedly complex planning documents, which in the specific Italian context require not only technical assessments, but also the completion of administrative procedures that typically take place in the span of some years.

The survey conducted by Utilitalia allowed the entire sample to understand what is the timing necessary for the implementation of the WSP: the graph highlights that there is no clear relationship between the population served and the time required for the implementation of the WSP. However, the considerable breadth of the range relating to the years necessary for the implementation of the WSPs is underlined and how, in many cases, more than 8 years were considered necessary for the implementation of the WSPs. This circumstance constitutes further proof of the complexity of this document.

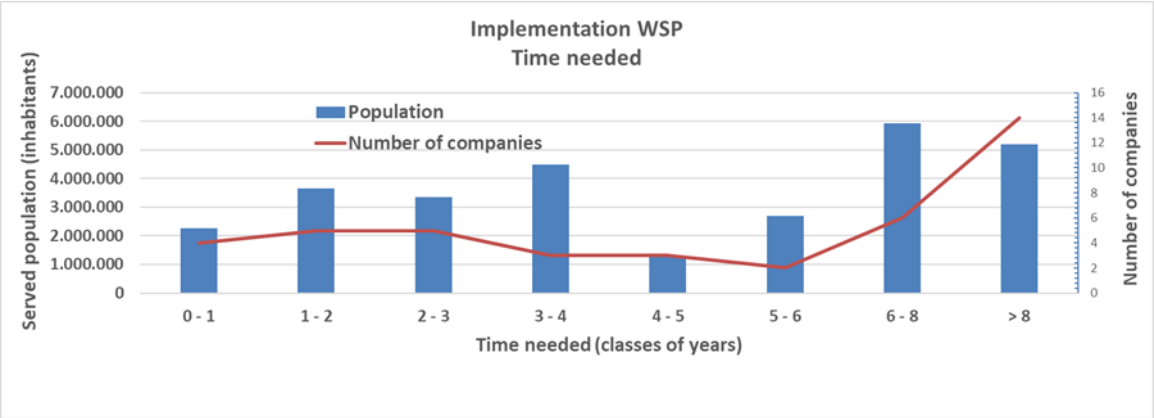

Figure 11 – Time needed for WSP implementation (Source: Utilitalia).

2.3.2.1 New MUHA survey

During the first months of MUHA, CNR (LP) and DPC (PP10) partners contacted and involved Utilitalia, the Italian Water Utilities Association, in the project (prot.n. 328962020 of 05/06/2020) to coordinate an updated national survey on the WSP implementation, with

a special focus on the four hazards considered in the project. A final version of the questionnaire as well as the way to manage the questionnaire (multiple choice interactive questionnaire hosted on a web platform) has been agreed on July 2020. The questionnaire structure is presented and discussed in Annex 1

On July 19th, Utilitalia, in collaboration with the MUHA Italian partners, shared the questionnaire (figure 12) with all the associated water utilities, for the first Italian national consultation that specifically investigates the response of water utilities to specific hazards in the framework of the WSPs implementation.

Figure 12 – Front page of the MUHA-UTITALIA questionnaire.

The number of companies that responded to the survey was 31, corresponding to 30.5 million inhabitants, slightly more than 50% of the Italian population. In the following, we consider the results of the survey as representative of the Italian national situation. As the questionnaire also anticipates information specific to the deliverables DT1.1.4 and DT1.1.5, in the following the results of the survey will be presented in aggregated form and considering an associated level of WSP implementation. More detailed information specific to each hazard will be presented in deliverables DT1.1.4 and DT1.1.5.

The degrees of implementation, updated to October 2020, is presented in Figure 13 as a function of the company size (in terms of population served) and location. The overall degree of implementation is 21.4%, to be compared with 14.6% for the first consultation done on September 2019 by Utilitalia (Figure 9) over a similar sample. This indicates that the Italian water utilities are currently in the process of implementing WSP.

The degree of implementation clearly depends on the size of the water utilities, intended as served population (panel a). In fact, 7 out of 9 of the "large" (large identifies in the following WUs serving more than 1 million inhabitants) have begun the process, with 28.8% of the population served covered by WSP. Differently, 5 out of 22 small water utilities (< 1 million inhabitant served) has begun the process, with only 2.9% of population covered by WSP. Moreover, the level of implementation also depends on the geographic location (categorized as North, Center and South-Islands Italy) showing significantly higher degree of implementation at Center and North than South (panel c). Finally, results specifically aggregated on the ADRION region, with 12.8% of population served by WSP, are presented (panel d).

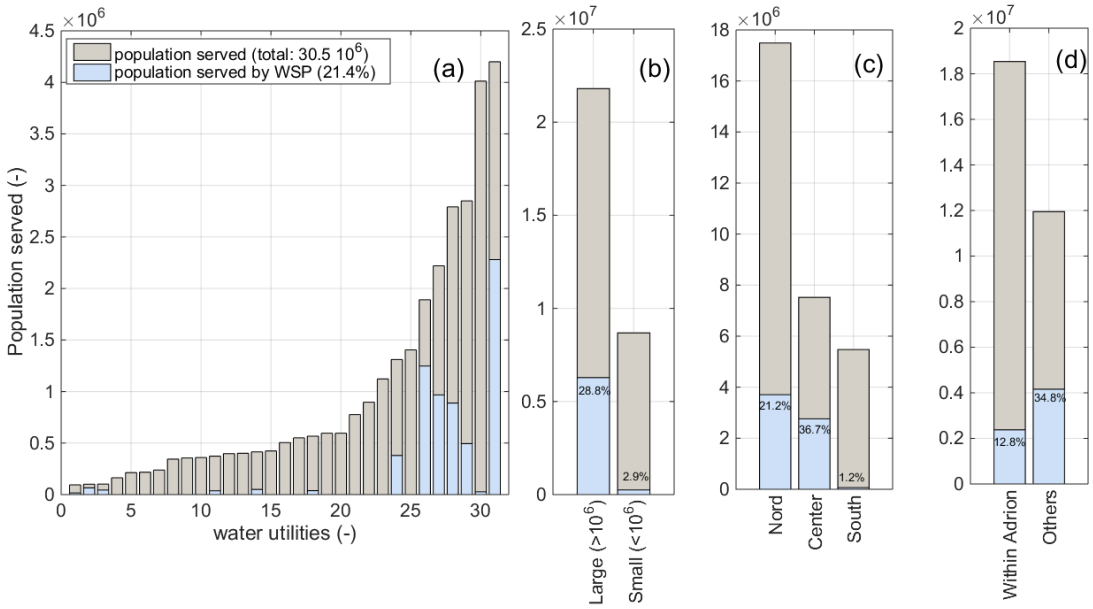

Figure 13 – Level of Water Safety Plan implementation as a function of population served (panel a), size , location (panel c) and belonging to the ADRION macro region (panel d). (source MUHA – Utilitalia)

Referring to the past 30 years, the most cited hazards faced by the water utilities (Fig. 14) is drought, followed by flood, accidental pollution, vandalism (preliminary analyses highlighted this could be rather relevant for WUs), and earthquake. No significant differences among small and large WUs emerge. The "Other" category is also included in the Figure 14, representing a generic option included into in the multiple-choice questionnaire to allow including hazards that are not explicitly considered in the project. Out of the 8 occurrences of "Other" hazards, 5 refer to landslide; 4 to "non – accidental" pollution, 1 indicates microbiological issues and 1 refers to the pandemic situation.

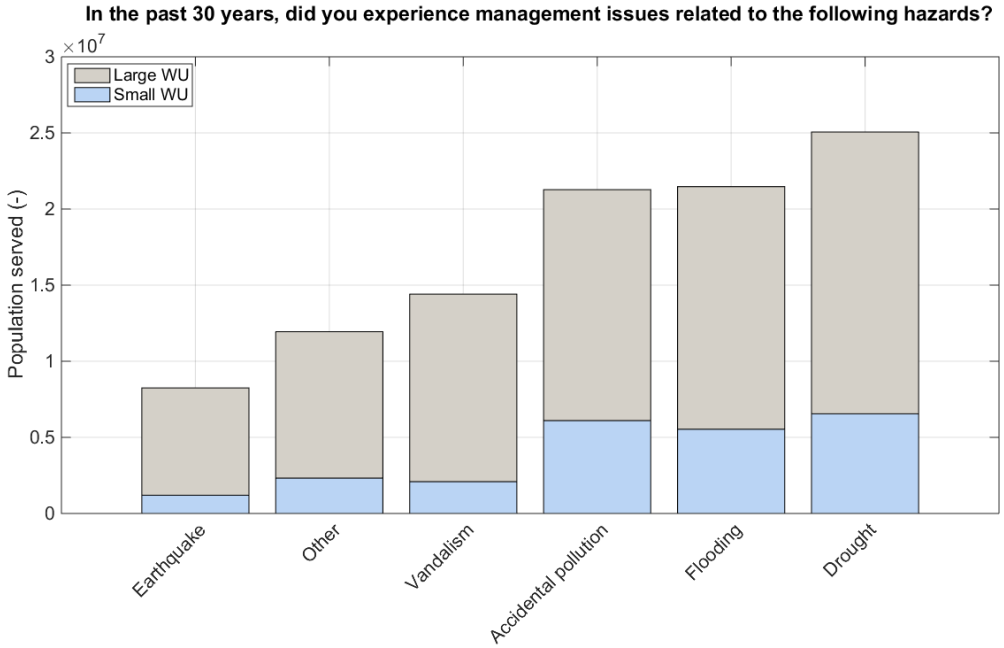

Figure 14 – Hazards faced by the water utilities over the past 30 years (1990-2020) in terms of population served for large and small WU (defined as having more and less than 1 million inhabitant served respectively). (source MUHA – Utilitalia).

In figures 15 to 18, more details are given on the current status of WSPs in Italy, implemented measures, available tools, main barriers and actors involved, needs and expected benefits. In order to address the dependence on WU size (figure 13), estimated as population served, the results are given for small and large WU.

More specifically, if for a relevant fraction of the population served with WSP, the WSP seems to be only partially implemented, for a large majority of the population, a risk management plan or a WSP is under development (figure 15, panel a). All WUs indicating that the WSP is not available (i.e. neither under development nor partially implemented) are small WU, whereas WSP is already available and implemented only in large WUs. Moreover, half (in terms of served population) of the WU (mostly large) indicate that they are activating actions to implement/update their risk management plans as required by the WSP (figure 16, panel b).

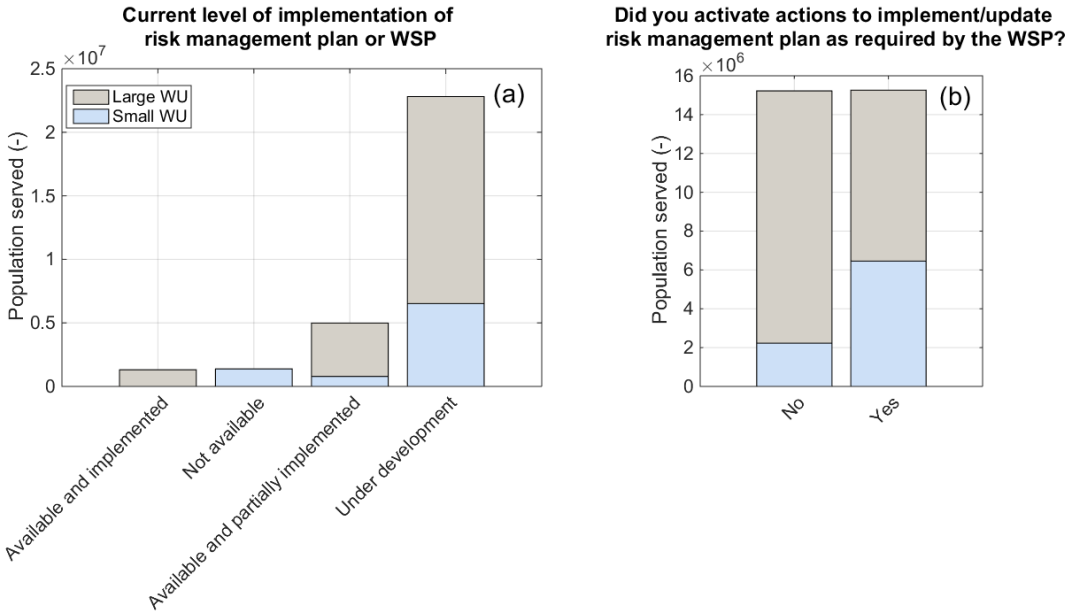

Figure 15 – Current level of implementation of risk management plans or WSP (panel a) and started activities (panel b). (source MUHA – Utilitalia)

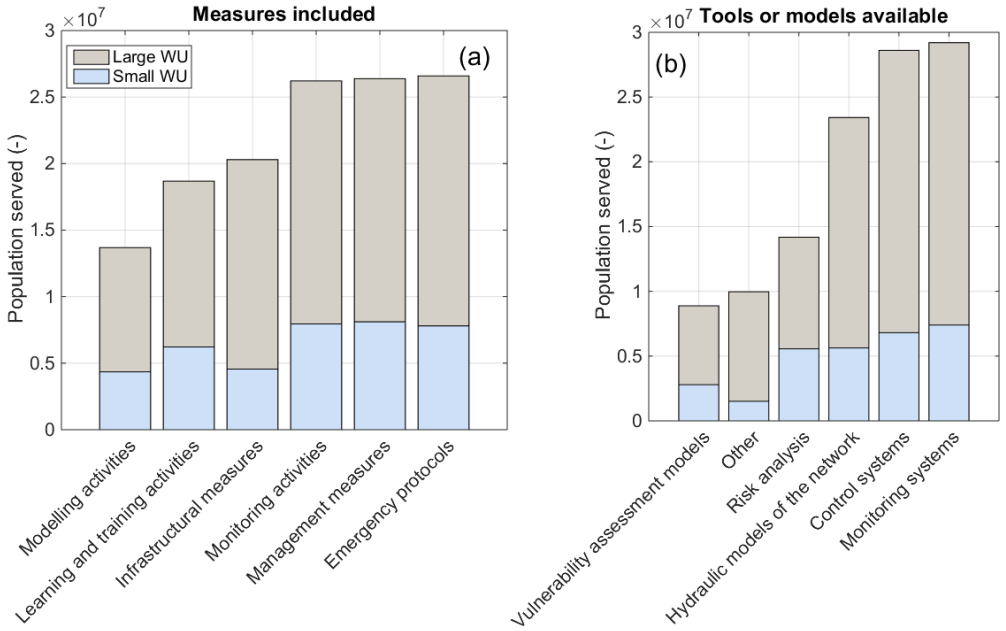

Figure 16 – Included measures tools and models in WSP implementation (source MUHA – Utilitalia)

According to Figure 16, the most cited measures included in the WSP are emergency protocols, management measures and monitoring activities, followed by infrastructural measures, learning and training activities and finally modelling activities. It is worth noting that small WU report (proportionally) learning and training activities more often than large ones (figure 16, panel a).

The most cited tools or models available are monitoring systems and control systems, followed by hydraulic models of the networks, while risk analysis and vulnerability assessment models are almost missing (figure 16, panel b). “Other” tools and models include existing hydro-geological / infrastructural maps and vulnerability analysis or research and models on risk or vulnerability analysis currently under development.

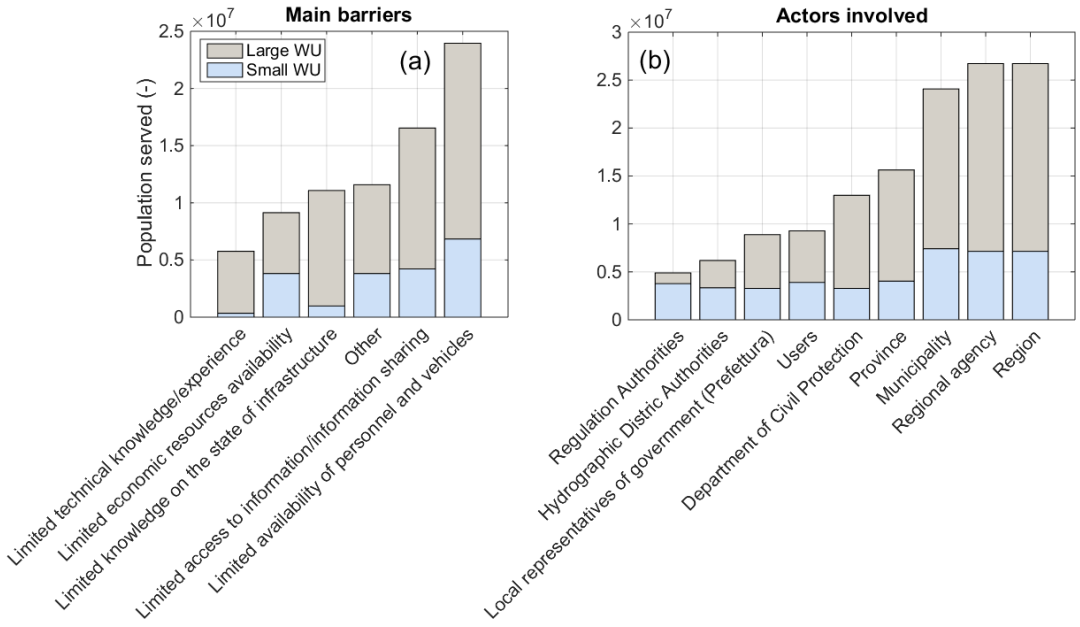

Figure 17 –Main barriers (panel a) and actors involved (panel b) in implementing WSP. (source MUHA – Utilitalia)

Figure 17(a) shows the main barriers indicated by WUs as bottleneck for the implementation of WSP, whereas Figure 17(b) illustrates the actors involved in WSP or, more in general, in risk management plans. The limited availability of personnel and vehicles is the most cited barrier that can slow down the actual implementation of the WSP, followed by the limited access to relevant information (and the limited information sharing). It is worth highlighting that limited economic resources or technical knowledge/experience are the least cited, following also the limited knowledge on the state of infrastructures (mostly for the large WU) (figure 17, panel a). Among the "Other" barriers, WUs mainly refer to reports/communications issues, fragmentation of available information and to the high number of stakeholder involved in the process. Some of these 'other' barriers can be definitely included into the "limited access to information/ information sharing" class, which definitely highlights that the lack of a structural access to information is the main barrier to the WSP implementation.

The most cited actors involved in WSP implementation are operating at local level (municipality and region). Inter-regional or national institution or administrations are less cited (figure 17, panel b). This result could be strictly related to the challenges and the complexities of communicating at a higher level of coordination, associated with the lack of a structural access to information discussed above.

Starting from the mentioned barriers as a way to identify opportunities for WSP implementation, increasing the economic and/or human resources availability could support the implementation of WSP (figure 18, panel a). Other elements, such as learning and training activities, availability of models and technical tools, information from monitoring system and improved technical and infrastructural knowledge could contribute as well.

Concerning the elements that can mostly benefit of WSP, Figure 18 b highlights that springs and extraction systems are high-ranked, followed by water treatment plants and

water supply networks. It is worth noting that distribution networks are a major concern mainly for small WU. Other WU refer e.g. to stakeholder structures, as well as to hydro-geological context of resources.

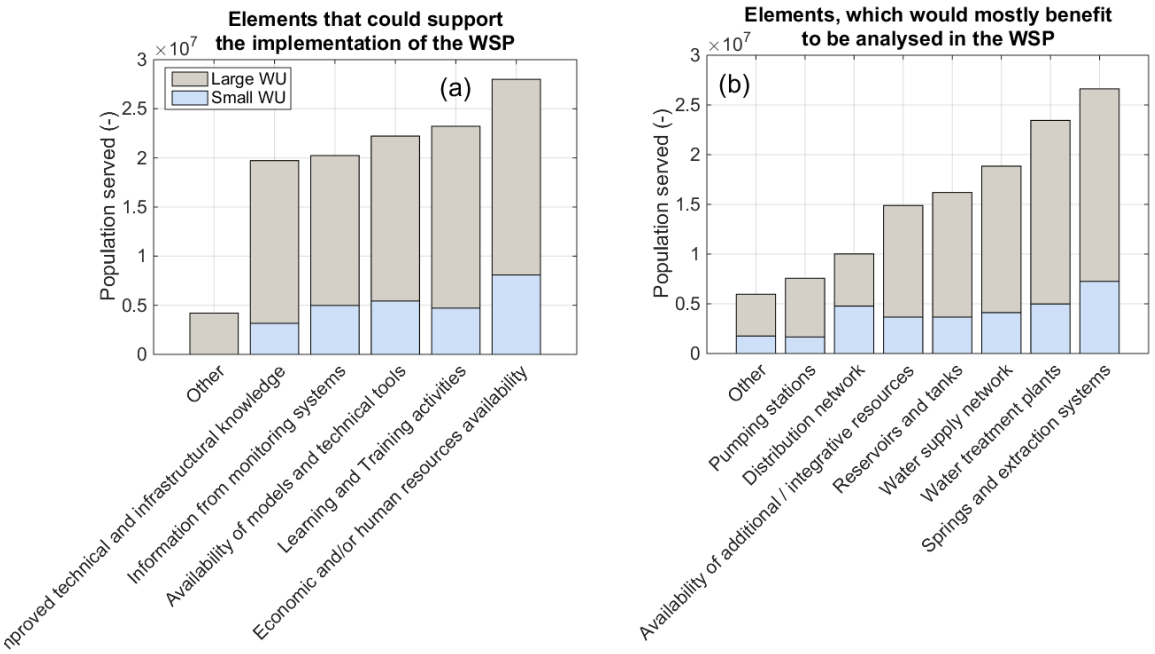

Figure 18 –Elements that could support the implementation of WSP and elements, which would mostly benefit from WSP. (source MUHA – Utilitalia)

Finally, it is worth noting that, excepted few singularities highlighted in the previous description, despite a different level of WSP implementation, the proposed results indicate that small and large water utilities mostly share the same priorities and barriers.

2.4 Tools

As already written, in the 2004, the World Health Organization recommended water suppliers to develop and implement Water Safety Plans (WSP) as the most effective mean to assure the quality of the water supply and the protection of the health of consumers.

This model was transposed in Italy by Istituto Superiore di Sanità in the 2014 “Guideline for risk assessment and management within the drinking water chain according to Water Safety Plans” (Lucentini et al., 2014b).

It consists of the overall risk assessment and risk management from catchment to tap, to protect the water intended for human consumption and the system, as well as to control any process potentially affecting water quality, with the aim of assuring on a continuous way the absence of physical, biological and chemical hazards in drinking water. Risk based approach will also facilitate the flexibility of hazards management of emerging contaminants which are not systematically monitored, and /or vulnerabilities of water supply systems to direct and indirect impacts due to climate change. The guidance is addressed to water suppliers and health authorities as well as to all the stakeholders interested in different way to the drinking water quality. Criteria, methods and procedures are provided in clear and practical terms to develop and implement WSP in drinking water supplies in Italy, independently by their dimension and by the volumes of supplied water.

The management criteria proposed by the WHO guidelines, and recommended in the Italian guidelines, have the following objectives:

- promote the new management model of WSPs at national level;

- provide the authorities of the National Health Service with adequate methodological tools, to enable them to participate in the elaboration of the WSPs and to be able to evaluate their adequacy for the purpose; in particular it is important to underline that, at the moment, the introduction of the new management models is totally voluntary and experimental, and the current legislation in the field of drinking water quality (Legislative Decree 31/2001 and subsequent amendments), specifically requires the compliance with the parametric values indicated, in the points of conformity established in the same decree;

- acquire information on how the proposed principles are applied and on the outcome of the implementation of the WSPs; the information thus obtained can provide useful ideas for further integrating and updating the guidelines and for sharing Italian experiences at Community level, also with a view to a possible introduction of the principles of WSP in the revision process of Directive 98/83 / EC;

- evaluate the possibility of introducing the principles of WSP at national regulatory level.

At the moment, the adoption of the WSP models is voluntary, and the suitability for water consumption is regulated by the current Legislative Decree. n. 31 of 02.02.2001 and subsequent amendments, bearing the object "Implementation of Directive 98/83 / EC relating to the quality of water intended for human consumption", and in particular by compliance with the parameters of the water supplied, at the points of delivery in the same decree.

2.5 Risks, bottlenecks, challenges

The implementation of a Water Safety Plan undoubtedly constitutes a significant commitment for a Water Utility, but in the same way it is the most valid and most updated tool to allow the improvement of the security of water supply.

In this framework it's important to know what are the most important challenges faced by the water utilities. Gilardoni (2018) summarizes what are the most important strategic challenges faced by the water utilities.

Drivers	Challenges	Component of the integrated water service
Material		
Environment and quality of the resource	Pollution of water bodies	Purification and water quality
	Depletion of the surroundings environment and aquifers	
Quality of the water supply infrastructure	Water availability/Overexploitation	Water supply infrastructure
	Deterioration of mains and pipes	
	Leakages	
	Increasing quality standards	
	Human- and naturally-induced shocks	
Energy	High consumption of electricity	Wastewater treatment systems
	High costs	

Immaterial		
Financial affordability	Decreasing public funds	Finance
	Small increases in tariffs	
	Specific risks of the sector	
	Bankability of projects	
Managerial complexity	Conflicting interests (Customer expectations, affordability, NIMBY, NIMTO, BANANA)	Management
	Legal and Regulatory Framework	

Table 3 – Summary of the most important strategic challenges faced by the water utilities (Source: Gilardoni, 2018).

Implementation of Water Safety Plan, therefore, it's a new and very important challenge for water utilities and, in many cases, it's not easy for some reasons.

Preliminary contacts with the Water Utilities made it possible to identify some aspects of particular relevance, summarized below, also on the basis of some assessments made by Water Utilities (Anzalone et al., 2019):

• The complexity of the development of WSPs and the consequent need for a multidisciplinary and multi-stakeholder approach;

• The cost of this activity, especially in terms of time spent by qualified and specifically trained personnel;

• The need for a structured approach;

• The need for Water Utilities to receive adequate support from Public Administration for the acquisition of data and information essential for risk assessment.

The quality of each WSP will inevitably be commensurate with the competence, professionalism and commitment of all the members of the multidisciplinary team.

It is clear, however, that in-depth and shared plans will be particularly effective tools for raising the quality of the water service, safety and consumer confidence.

In general, the benefits and difficulties associated with the implementation of WSPs in Italian water utilities are substantially similar to what has already been noted in European water utilities: in this regard, Tsoukalas and Tsitsifli (2018) have summarized, based on the examination of the literature, the main benefits and difficulties that emerged in the implementation of WSPs in European water utilities.

The main benefits of WSPs implementation include the improvement of drinking water quality, the better analysis of observed deviations, the increase in compliance with regulation, the improvement of employees' performance, the better monitoring in water source, the effective risk assessment and the decrease in customer complaints. On the other hand, the successful implementation of WSPs in water utilities can be limited by a number of factors, such as the absence of legislation, the inappropriate monitoring system, the limited staff experience, the difficulty in assessing all potential hazards and the lack of supporting activities (Tsoukalas e Tsitsifli, 2018).

Benefits	Difficulties	References
Better analysis of observed deviations	Absence of legislation Inappropriate monitoring system	Viera, 2007

Benefits	Difficulties	References
Increase of compliance with legislation Decrease of diarrheal incidents Improvement of drinking water quality	Lack of financial resources Limited staff experience	Gunnarsdottir et al., 2012
Better monitoring in water source Better control of microbial contamination Systematic collection and processing of physicochemical and microbiological data Increase of production efficiency Improvement of employees' performance		Mayr et al., 2012
Extreme weather risk assessment		Curk et al., 2006
Effective risk assessment associated with compounds that are not controlled by routine monitoring Increase of consumer confidence		Lucentini et al., 2016
Increase of consumer awareness Finding of financial resources Development of drinking water safety management strategies	High residual concentration of hazardous substances Inappropriate design of landfills Inadequate sewerage network	Samwel et al., 2010
Effective risk assessment Avoid of serious failure Increase of reliability Facilitation of communication		WHO, UN et Economic Commission for Europe, 2011
Improvement of drinking water quality Efficient treatment of drinking water Increase of compliance with legislation Decrease of diarrheal incidents		Setty et al., 2017
Increase of water utilities reputation Increase of consumer confidence Decrease of customers' complaints Identification of unknown hazards Improve of drinking water quality Better response in emergencies Increase of employee awareness Improve of record keeping procedures	Limited access to chemical materials approved for contact with water Difficulties in assessing all possible hazards Limited staff time Lack of financial resources Lack of supporting activities Lack of adequate equipment	Loret et al., 2016

Table 4 –Main benefits and difficulties of WSPs implementation in European water utilities (Source: Tsoukalas and Tsitsifli, 2018).

On the basis of the scientific literature review, Tsoukalas and Tsitsifli (2018) conclude that the critical success factor is quite difficult to determine because there is a great diversity in the ability of development of both drinking water safety management systems in water utilities among different countries and among regions in the same country. There are many possible causes as, for example, the production capacity, the employees' skills and experience, the corporate culture, the kind of water supply (groundwater, surface water and sea water), the distribution system, the legislation.

Water Safety Plans implementation have to deal with new scenarios and new challenges: it's worth noting that the implementation of a Water Safety Plan have to integrate aspects of climate change and it's not easy for smaller water utilities: in a recent literature review, Rickert et al. (2019) found that aspects of climate change have been integrated in WSPs in

diverse regions of the world and in large as well as to a lesser extent in small water suppliers, making water suppliers more resilient to the anticipated effects of climate change than a reactive approach would.

In Italy the situation is more complex: as already written, the Italian water sector has always presented a differentiated and fragmented landscape in terms of companies' size, performance, technologies, corporate governance and financial means. Some players are part of integrated businesses (multi-utility), also offering electricity, gas, transportation or waste disposal; some others focus only on water and wastewater services (mono-utility). Furthermore, there is a unequal distribution of the resource, from the dryer South to water-rich mountains in the North, from big towns to rural village (Guerrini and Romano, 2014; Gilardoni, 2018).

There is a huge variety of governance model: the integrated water service can be run by small municipalities which directly manage the integrated water service as part of the local administration, through ad hoc department, or by in-house, limited or listed companies, controlled by local administrations via majority shares, but in some cases open to private investors. It's relevant to note that, very frequently, municipal offices lack the the technical expertise and financial resources to manage a water system in an efficient manner. On the opposite, the vast majority of Italian infrastructure is managed by a few players, which provide water services for more than half of the Italian population, on an industrial scale (Gilardoni, 2018).

On the basis of the first preliminary contacts with the water utilities, a qualitative SWOT analysis was developed which made it possible to highlight the following strengths, weaknesses, opportunities and threats in the process of implementing the Water Safety Plans. Note how some aspects are fully in line with the results of the previous study.

STRENGTHS	WEAKNESSES
• High level technical know-how; • Synergies between gas and water;	• Aged systems; • Small WSS; • High losses rate; • Lack of skilled staff in small WSS; • Lack of financial resources; • Limited staff time; • Difficulties of coordination; • Lack of supporting activities; • Inadequate pricing;
OPPORTUNITIES	**THREATS**
• Improvement of drinking water; • Climate change adaptation measures; • Access to EU funds; • Increase of consumer confidence; • Increase of reliability.	• Climate change; • Hazardous events; • Financial crisis;

Table 5 – WSPs implementation in Italian water utilities: SWOT analysis.

3. Specific hazards/risks addressed by the water safety procedures in Italy

The most complete reference document issued by a national public authority in Italy is the ISTISAN Report 14/21 "Guideline for risk assessment and management within the drinking water chain according to Water Safety Plans" (Lucentini et al., 2014b), which provides analysis and technical indications on the matter.

In this document, the terms "hazard" and "risk" to health are used according to the definition given in the WHO guidelines for drinking water :

- a hazard is any agent that can potentially cause harm to health;
- a dangerous event is an episode or situation that can lead to the presence of a danger (what can happen and how) in water for consumption;
- the risk is the probability that an identified hazard causes damage to the consumer who uses water, and also takes into account the seriousness of the damage and / or its consequences.

On the basis of the previous considerations, the definition of hazard assumes a qualitative connotation, while the concept of risk is inherent in a combination of probability of occurrence and severity of the effects, based on a quantitative estimate.

The hazards can be microbiological, physical, chemical and radiological. The identification of the hazards is essential to ensure the application of adequate protection measures and / or to identify the necessary treatment requirements.

Dangerous events can occur for natural causes or can be provoked and their manifestation can take place in every part of the water system, from collection to distribution to the consumer.

Effective risk management starts with the identification of all potential hazards, their sources and possible dangerous events and is functional to the subsequent risk assessment stages that each hazard can constitute and to define the measures to keep risks under control on a priority scale.

In this context, factors such as climate changes, natural disasters, possible accidental contamination, should be taken into account. The ISTISAN 14/21 Report does not take into account other risks like cyber attacks or intentional damages.

The same document does not go into the merits of the specific measures that must be taken against accidental pollution, floods, droughts, earthquakes, providing only risk assessment criteria for the use of those who must draw up the Water Safety Plans and to indicate possible control measures to be adopted in the different phases of the drinking water system.

4. Conclusions

The Italian water sector is very complex and articulated due to numerous factors, both natural and anthropic. From a natural point of view, in Italy there is an unequal distribution of the water resource, consequent to the different pluviometric, hydrographic and

lithological conditions existing on the national territory. However, it must be underlined that in Italy there are multiple anthropogenic factors which, in some cases, determine the reduction of available water resources and, in extreme cases, water crises: network losses, obsolescence of the structures, lack of interconnections, high fragmentation and management, sometimes inadequate planning, shortage of economic resources, etc. In addition, there is a considerable variety of management forms in Italy, both public and private, ranging from large-scale investee companies, present mainly in the Center-North, to economic management typical of the regions of the South.

In this highly articulated context, unprecedented environmental and climatic emergencies have led to significant impacts on water resources and on the integrated water cycle with health hazards that undermine the protection of the fundamental right to safe water and sanitation (UN Sustainable Development Goals 6).

For these reasons, it was necessary to adopt a more innovative risk assessment and management approach, extended to the entire drinking water supply chain, in analogy with what happened in the pharmaceutical and food industry sectors.

The Water safety plans are based on a preventive risk assessment and management approach that better guarantees the fundamental objective of protecting human health, compared to traditional strategies based exclusively on the assessment of conformity of the finished product. Furthermore, this approach allows to optimize the resources necessary to guarantee the quality of the water resource distributed by the specific Water Supply System.

The impact deriving from the introduction of a Water Safety Plan in a Water Supply System is variable according to the degree of complexity, the state and efficiency of the system: in some cases this may involve a simple revision and connection of operating procedures and the elimination of redundant measures / controls, in others it will require more significant investments such as the introduction / modification of treatment systems.

The fundamental objective of a Water Safety Plan is to improve the quality of the water distributed, also guaranteeing efficiency from the point of view of resource management: in fact, the introduction of appropriate measures to control potential contamination risks can combine a higher degree of water quality to the reduction of redundant analyzes along the water supply chain.

However, it is evident that the implementation of a Water Safety Plan constitutes not only an important opportunity for Water Utilities, but also a significant challenge from an organizational, technical, economic and managerial point of view.

In Italy the process of progressive implementation of the Water Safety Plans has experienced a very important moment, firstly with the issue of the Guidelines of the Istituto Superiore della Sanità in 2014 and, three years later, with the Ministerial Decree of 14 June 2017 which implemented Directive 1787/2015.

The greatest difficulties are found above all in small to medium sized Water Utilities, due to factors of a mainly organizational and managerial nature, although there is no lack of critical issues in the implementation of the WSPs by the more structured Water Utilities.

In the background, the recast process of the European Directive 98/83 / EC, which will be followed by the issue of a national regulatory act transposing the new Drinking Water Directive, will undoubtedly constitute a further challenge not only for Water Utilities, but also for the Public Administration.

Acknowledgements

The authors would like to thank Tania Tellini and Marco Gatta (Utilitalia), for their cooperation and for giving access to the data of the 2019 Utilitalia survey about implementation of the Water Safety Plans in Italy.

Web links

[1] EUROSTAT. https://ec.europa.eu/eurostat/web/environment/water

[2] ISTAT - Censimento delle Acque per uso civile (2015). https://www.istat.it/it/archivio/207497

[3] UTILITALIA. https://www.sipotra.it/wp-content/uploads/2019/03/Utilitalia.pdf

[4] WORLD BANK. https://data.worldbank.org/indicator/

References

Anzalone C., Maffini F., Minelli L., Muracchini T. (2019) –Prime esperienze di PSA in provincial di Bologna. Ecoscienza, 2, 30-31 (in Italian).

Curk C.B., Rozic Z.P., Daskalou O. (2006) -Activity 4.4 Water (re)sources protection and cross border water (re)sources management. In Cross Border Resources Management: Water Safety Plans; DRINKADRIA: Ljubljana, Slovenia.

Di Francesca E. (2019) – PSA, le opportunità per il Servizio idrico integrato. Ecoscienza, 2, 28-29 (in Italian).

Gilardoni A. (2018) – The Pursuit of Excellence in the Water Industry. In: Gilardoni A. (2018) (Ed.) - The Italian Water Industry, pp. 3-20, Springer.

Guerra R., Di Benedetto A., Lucentini L. (2017) - Sicurezza delle acque destinate al consumo umano: in campo un nuovo sistema per superare nuove sfide ambientali e climatiche. Quotidiano Sanità, 20 september 2017 (in Italian).

Guerrini A., Romano G. (2014) – Water management in Italy: Governance, performance and sustainability. Springer.

Gunnarsdottir M.J., Gardarsson S.M., Elliott M., Sigmundsdottir G., Bartram J. (2012) - Benefits of Water Safety Plans: Microbiology, Compliance, and Public Health. Environ. Sci. Technol. 46, 7782−7789.

Loret J.F., Blaudin de Thé C., Martin Alonso J., Puigdomenech Serra C., Kayser G., Bartram J. (2016) - Assessing the costs and benefits of water safety plans. In Proceedings of the IWA World Water Congress, Brisbane, Australia, 9–14 October 2016.

Lucentini L., Achene L., Cadum E., Colagrossi R., Fuscoletti V., Nigro Di Gregorio F., Veschetti E., La Sala L. (2014a) – Water Safety Plans, le linee guida italiane. Ecoscienza, 3, 16-18.

Lucentini L., Achene L., Fuscoletti V., Nigro Di Gregorio F., Pettine P. (2014b) (Eds.) – Linee guida per la valutazione e gestione del rischio nella filiera delle acque destinate al consumo umano secondo il modello dei Water Safety Plans. Istituto Superiore di Sanità (Rapporti ISTISAN 14/21) (in Italian).

Lucentini L., Achene L., Veschetti E., Fuscoletti V., Nigro Di Gregorio F., Colagrossi R., Di Benedetto A. (2016) - Water Safety Plan implementation in Italy. In Proceedings of the International Symposium on Sanitary and Environmental, Rome, Italy, 19–23 June 2016.

Lucentini L., Rossi P., Scopelliti M. (2019) – Water Safety Plan, esperienze e prospettive. Ecoscienza, 2, 14-17 (in Italian).

Mayr E., Lukas A., Aichlseder W., Perfler R. (2012) - Experiences and lessons learned from practical implementation of a software-supported water safety plan (WSP) approach. Water Sci. Technol. Water Supply, 12, 101–108.

Rickert B., van den Berg H., Bekure K., Girma S., de Roda Husman A.M. (2019) – Including aspects of climate change into water safety planning: Literature review of global experience and case studies from Ethiopian water supplies. International Journal of Hygiene and Environmental Health, 222, 744-755, https://doi.org/10.1016/j.ijheh.2019.05.007.

Rossi G., Benedini M. (2020) (Eds.) – Water resources of Italy. Springer.

Samwel M., Jorritsma F., Radu O., (2010) - Lessons from Water Safety Plans for Small-Scale Water Supply Systems as Developed by Schools in Romania; Water and Sanitation–Facts and Experiences. Available online: http://www.wecf.eu/download/2010/03/ wsp_romania.pdf (accessed on 5 June 2017).

Setty K.E., Kayser G.L., Bowling M., Enault J., Loret J.F., Serra C.P., Alonso J.M., Mateu, A.P., Bartram J. (2017) - Water quality, compliance, and health outcomes among utilities implementing Water Safety Plans in France and Spain. Int. J. Hyg. Environ. Health, 220, 513-530, doi:10.1016/j.ijheh. 2017.02.004.

Tsoukalas D.S., Tsitsifli S. (2018) – A Critical Evaluation of Water Safety Plans (WSPs) and HACCP Implementation in Water Utilities. Proceedings, 2, 600, doi: 10.3390/proceedings2110600 (www.mdpi.com/journal/proceedings).

Vieira J.M.P. (2007) - Water Safety Plans: Methodologies for risk assessment and risk management in drinking water systems. In Water in Celtic Countries: Quantity, Quality and Climate Variability; Ferreira, J.P.L., Vieira, J.M.P., Eds.; IAHS: London, UK, Volume 310, pp. 57–67.

World Health Organization, United Nations, Economic Commission for Europe (2011) - Small-Scale Water Supplies in the Pan-European Region. Available online: http://www.euro.who.int/__data/assets/pdf_file/0018/140355/e94968.pdf?ua=1 (accessed 26 May 2017).