

Water Resources for a Sustainable, Smart and Resilient Urban Development: The Case of Italy

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Abstract. Water is a common good indispensable for the survival of living beings, it is a finite resource that increasingly conditions human economic and social development. The minimum biological need per capita for human survival is 5 L of water in 24 h. Without food you can live a month. Without water you do not exceed a week. In order to be able to talk about acceptable living conditions, no less than 50 L of water are required per day for every human being. Over 1 billion people drink "unsafe" water and 3.4 million people each year (5,000 children a day) die from waterborne diseases. The water emergency does not only concern developing countries but also the advanced Europe. Water governance affects both developing and all other countries. The complex supply and distribution and purification situation imposes universal strategies to guarantee socio-economic development in this delicate phase of climate change. The aim of the work is to present the main characteristics of the water management, including risks and opportunities, in the Italian case.

Keywords: Water · Smart cities and territories · Sustainable development

1 Introduction

Water is a common good indispensable for the survival of living beings, it is a finite resource that increasingly conditions human economic and social development [1].

71% of the earth's surface is covered with water but 97.5% is salty. Of the remaining 2.5% only 1% is usable for human activities (the remaining part is mainly in the form of ice). Of this 1%, 93% is used for agricultural purposes. The minimum biological need per capita for human survival is 5 L of water in 24 h. Without food you can live a month. Without water you do not survive longer than a week. In order to be able to talk about acceptable living conditions, no less than 50 L of water are required per day for every human being. The problem is that, according to data released by the World Health Organization (WHO) [2], currently 2.1 billion people live without safe

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water at home and more than 700 children under five years of age die every day from diarrhea or diseases linked to unsafe water and poor sanitation [3]. According to the 2018 World Report on the development of water resources [4], currently, around 4 billion people live in areas where water is scarce for at least a month a year, and this amount is set to rise, with a world population that could reach 10.2 billion units by mid-century. Today we use a total of about 4,600 km^2 of water: 70% goes for agriculture, 20% for industrial activities and 10% for household consumption. However, the demand is destined to grow: in the last 100 years it has increased by six times, and each year rises by 1%.

The water emergency does not only concern developing countries but also the advanced Europe. According to the WHO [5], "in 2015 more than 62 million out of 912 million people, lack access to an adequate sanitation facility and 14 million do not use a basic drinking-water source. While access has increased in the last decades, there are notable disparities between rural and urban areas. [Moreover] 14 diarrhea deaths a day are estimated attributable to inadequate water, sanitation and hygiene".

The need for an adequate availability of the water resource brings to the fore the role of the infrastructures that guarantee its use. A role amplified by the rapid technological restructuring that has produced important effects on urban-territorial economies: greater access to the global market, intensification of local competition, the decline of traditional production processes, the emergence of a second process of "de-industrialization" in urban areas.

From the analysis of community and global policies, infrastructures, in its various characterizations, increasingly emerge as a growth factor.

The reference development models, used in particular by international organizations such as the World Bank, focus on the availability of infrastructures in the sectors considered strategic, and current EU policies are addressed, for relaunching economy and growth, towards more sustained investments in infrastructures.

This approach is particularly evident in those analyses [6] that relate the presence of infrastructures in the territory and the per capita income levels: where the levels of infrastructure are higher than the national average, there are often fewer inequalities among the per capita income levels.

Infrastructures are increasingly becoming a measure of competitiveness, especially if we look at the new European scenario resulting from the integration process which, involving the removal of barriers to labor and asset mobility, and greater capital mobility, is characterized by more competitive conditions compared to the past.

In this new context, every regional economy in the EU is exposed to greater competition, not only for what concerns the supply of products, but also in the offer of location factors for productive activities. For the economically weaker European regions and in particular for those most disadvantaged due to the lack of infrastructure and services (such as Southern Italy), the risk of succumbing to the competition for the attraction of Foreign Direct Investment (FDI) increases. It also increases the risk of losing a part of its entrepreneurial and investment resources to the benefit of more advanced areas, favored by the presence of external economies connected to agglomeration factors, or to benefit other regions capable of ensuring companies obtain a better relationship between benefits and costs.

Although the infrastructural endowment represents a necessary condition, it is not a sufficient condition for starting a sustainable development path. Only an efficient (smart) management of resources and of its infrastructures makes it possible to obtain such a result. In this framework will be analyzed the case of water resources for civil use in Italy.

2 The Withdrawal of Water Resources in Italy

Water has unique properties, including being the only chemical compound that can be found in the three phases (liquid, gaseous and solid) and for this reason it is also the main element with spatial distribution that varies over time [7].

In particular, the largest reservoir of fresh water in the world consists of groundwater, which amounts to more than 97% of all fresh water available on earth (excluding glaciers and polar ice caps). The remaining 3% is mainly composed of surface waters (lakes, rivers, wetlands) and soil humidity.

Given competing pressures it is estimated that by 2030 global water demand can exceed actual availability by 40% [8]. The need for water is, in fact, closely linked to various sectors: we use water, as well as for civil uses, to generate and sustain economic activities and agriculture, commercial fishing, energy production, industry manufacturing, transport and tourism.

The amount of resource available is conditioned as much by orogenetic factors as by climatic factors. The climate factor is central as the out-flows are mainly closely related to the influxes. In most regions the predominantly impermeable soil structure and the absence of natural reservoirs of significant capacity do not allow an effective time lag of the two phenomena. The historical seasonal variations that characterize the meteorological situations of the individual regions have recently been associated with global events that tend to exalt their extreme values.

Climate change in progress, together with the increase in rainfall and the increase in atmospheric temperature are the main phenomena that modify the geographical distribution of water [9].

The set of climate change, places of precipitation and collection of natural water resources and concentration of water demand for personal and productive uses (management and distribution) constitute the local and global scenario [10].

In this context, also the imbalances related to the quantity of water available between populations increase (USA, 580 L/day; Italy 380 L/day; Germany, 200 L/day; China, 90 L/day; Cambodia, Haiti and Uganda, 10 L/day), increasing also the gap between health, well-being and social status [4], boosting tensions and conflicts [11].

In particular, on a global scale there has been a noticeable increase in temperature, the effects of which can change the circulation of air masses in the atmosphere. The forecast models provide significant indications, which in Italian latitudes highlight a more accentuated space-time concentration of precipitation, a decrease in snowfall and an increase in evaporation volumes with a consequent decrease in outflows. Italy is

included in a climate transition zone between the European continental area and the Mediterranean one. The virtual separation line between the two areas can be approximated in correspondence with the regions of Tuscany, Emilia Romagna and Sardinia. South of this hypothetical climate dividing line there is a lower general rainfall with a tendency to establish long periods of drought. In the area to the north of this line, the annual amount of rainfall remains almost unchanged, but rainfall tends to be concentrated in high intensity cyclonic events. The fact that these climatic conditions recur in the short term accentuates the imbalance between the availability and demand of the water resource, as not only is availability reduced, but the time lag between availability and demand increases. The quality of water resources is also constantly threatened by pollution and by hydro-morphological changes due to the man activity, which cause tangible alterations, even in quantitative terms, of aquatic eco-systems.

Looking at the water for civil use (that covers 20% of the plurality of use)[1], in Italy the total amount of water withdrawal from environment in 2012 was about 9.5 billion of cubic meter (Table 1) according to an articulated framework of sources (Table 1) - 48% from groundwater (water well), 10.37% from lakes and reservoirs, 4.7% from watercourses, 37% from spring water, 0.1% from desalted waters.

Table 1. Total amount of water withdrawal from environment (2012) - thousands of cubic meters[a]

District	Spring	Well	Stream	Lakes/artificial basin	Marine/brackish water	Total
Po River	666,703	1,769,610	97,558	86,083	0	2.619,954
E. Alps	426,823	601,754	67,952	1,054	0	1,097,583
N. AM	166,169	459,814	210,773	84,765	1,094	922,615
Serchio River	8,084	23,787	0	0	0	31,871
C. AM	957,947	340,523	13,153	24,126	0	1,335,749
S. AM	1,055,561	871,440	49,058	425,342	0	2,401,401
Sicily	169,735	419,456	4,631	113,350	6,853	714,025
Sardinia	39,655	40,818	3,521	246,026	0	330,020
Other	5,075	352	0	0	0	5,427
Total	3,495,752	4,527,554	446,646	980,746	7,947	9,458,645

[a]E. Alps = Eastern Alps; N. AM = Northern Apennine Mountains; C. AM = Central Apennine Mountains; S. AM = Southern Apennine Mountains

In Italy the lack of water is a national emergency: in the summer of 2017, 10 regions have declared the state of calamity. It should be noted that climate change (increase in temperatures, concentration of rainfall - increasingly short and violent - in some months of the year alternating with long periods of drought, contraction in

[1] The use of water in Italy is distributed as following: civil – drinking water (20%), industrial (21%), energy (5%), agricultural (51%), zootechnical (3%).

volumes of glaciers) is leading to a decrease in availability in the main river basins - Po, Adige, Arno and Tevere - and the consequent reduction in water outflows. In particular, in 2017 there was an exceptional lack of available water resources: in all four major river basins, the average annual flows recorded a decrease compared to the average of the reference period 1981–2010, with an average overall reduction of 39.6%).

The classic response to the lack of water resources is the use of dams. In Italy there are 534 Great Dams (Table 2): about 72% in regular operation (of which 57% for hydroelectric use), about 21% in experimental operation, 5% out of service, while the remaining 2% is still under construction; and about 10,000 littles reservoirs. The authorized volume of the Great Dams is about 11% less than the potential reservoir volume. This difference is substantially due to the tests still in progress which contribute with a 7.5% volume less than the potential reservoir volume.

Table 2. Summary at national level of the state of operation of the Great Dams (June 2017)[a]

Status	Dams		Capacity (millions m^3)		Difference
	N	%	Potential	Authorized	%
Under construction	666,703	1,769,610	97,558	86,083	0
In testing	426,823	601,754	67,952	1,054	0
In exercise	166,169	459,814	210,773	84,765	1,094
Limited capacity	8,084	23,787	0	0	0
Temporary out of order	957,947	340,523	13,153	24,126	0
Total Great Dams[b]	3,495,752	4,527,554	446,646	980,746	7,947

[a]Source: Ministry of Infrastructure and Transport - General Directorate for Dams and Water and Electricity Infrastructures (ex RID).

[b]Including 3 billion cubic meters determined by regulatory barriers of the large pre-alpine natural lakes (Garda, Maggiore, Iseo, Orta, Varese)

Looking at the regional data (Table 3) it is evident that this criticality particularly affects the southern regions (besides the case of Umbria) which see an average of 20% in terms of non-used volume.

The total potential volume of large Italian dams is 13.748 billion m^3, which however is not evenly distributed: 28% in the north, 15% in the center and the remaining 57% in the south and on the islands. It should also be noted that 58% of the volume is for irrigation use.

Despite the presence of numerous dams, a particularly critical water emergency occurs cyclically in Southern Italy. This situation follows a series of years of increasingly low thunderstorm rainfall, which occurred in the last decade due to a high level of network losses, as shown in the next paragraph.

Table 3. Regional distribution of the state Great Dams (June 2017).[a]

Region	Dams	Potential volume	Authorized volume	Difference
	n.	Millions of m^3		%
Piedmont	59	374,46	368,11	1,70%
Aosta Valley	8	142,48	130	8,76%
Lombardy	77	3876,17	3838,04	0,98%
Trentino-South Tyrol	37	647,68	630,68	2,62%
Veneto	18	237,97	234,97	1,26%
Friuli-Venezia Giulia	12	190,86	181,55	4,88%
Liguria	13	60,69	59,4	2,13%
Emilia-Romagna	24	158,91	153,42	3,45%
Tuscany	51	321,11	312,18	2,78%
Umbria	10	430,4	236,61	45,03%
Marche	16	119,07	114,07	4,20%
Lazio	21	519,06	518,15	0,18%
Abruzzo	14	370,38	370,38	0,00%
Molise	7	202,91	170,66	15,89%
Campania	17	293,1	249,78	14,78%
Apulia	9	541,42	464,03	14,29%
Basilicata	14	910,41	786,24	13,64%
Calabria	22	586,44	422,04	28,03%
Sicily	46	1104,98	850,93	22,99%
Sardinia	59	2505,49	2012,72	19,67%
ITALY[b]	**534**	**13.593,99**	**12.103,96**	**10,96%**

[a]Source: Ministry of Infrastructure and Transport - General Directorate for Dams and Water and Electricity Infrastructures (ex RID).
[b]Including 3 billion cubic meters determined by regulatory barriers of the large pre-alpine natural lakes (Garda, Maggiore, Iseo, Orta, Varese)

3 Management and Use of Water for Civil Use

The availability of the water resource for civil use is affected by different losses during its management cycle: purification treatment (part of the water is used in the purification process, whereby the output volume from the implant is less than the incoming), losses of the municipal networks of distribution, inattentive use of end-users, inefficiency in the treatment of waste water (sewerage and purification) [12].

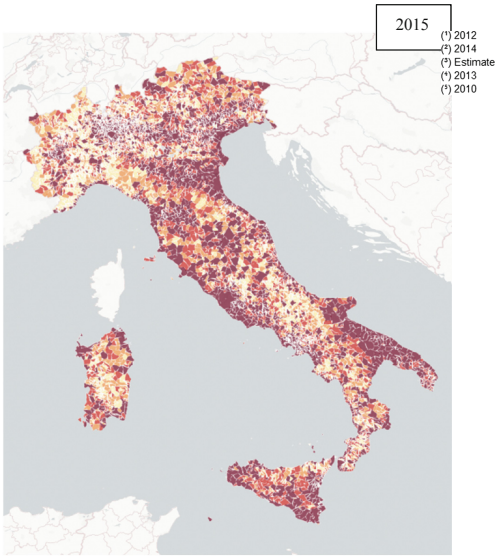
Water treatment technologies (fresh and waste) have improved over the last 20 years, however climate change and the growing demand for water require particular attention in the policy and conservation management of eco-systems (rivers, lakes, ponds and lagoons), both as sources and both as receivers [13].

In 2015, the total volume of water withdrawn for drinking use in Italy from the over 1,800 supply source management bodies amount to 8.32 billion cubic meters (Table 4)[2].

Comparing this data with that of the 28 countries of the European Union [14], Italy with 156 cubic meters per inhabitant (427 L per day) is the country with the largest withdrawal, followed by Ireland (135 m^3 per inhabitant) and Greece (131 m^3 per inhabitant). By contrast, Malta is the country where the value of the indicator reaches the minimum (31 m^3 per inhabitant). Rather low drinking water withdrawals are made in most Eastern European countries (Fig. 1).

Table 4. Water introduced into the municipal networks for the distribution of drinking water - thousands of cubic meters (2015). Source: Istat - Atlante statistico dei comuni (http://asc.istat.it/asc_BL/)

Region	2015	2012	Diff.%
Piedmont	584067	600420	-2,80%
Aosta Valley	26086	27430	-5,15%
Lombardy	1391876	1434135	-3,04%
Trentino-South Tyrol	159809	146909	8,07%
Veneto	647582	633857	2,12%
Friuli-Venezia Giulia	195590	204302	-4,45%
Liguria	238693	241338	-1,11%
Emilia-Romagna	469602	482537	-2,75%
Tuscany	426724	425579	0,27%
Umbria	101978	105473	-3,43%
Marche	168585	166550	1,21%
Lazio	972537	942144	3,13%
Abruzzo	230777	231353	-0,25%
Molise	53493	54329	-1,56%
Campania	820103	827502	-0,90%
Apulia	426648	448165	-5,04%
Basilicata	97754	70591	27,79%
Calabria	350038	327652	6,40%
Sicily	683149	693419	-1,50%
Sardinia	275000	293171	-6,61%
ITALY	8320091	8356856	-0,44%



The comparison between the volumes of water injected and dispensed makes it possible to assess the network water losses that represent an important criticality in the management of water resources [15].

The total water losses percentage, the rate of water supplied that does not reach end users, amounted to 41.4% nationally, equal to 3.45 billion cubic meters, in 2015 (was

[2] 76.3% of this volume, amounting to just over seven billion cubic meters, was measured using suitable measuring instruments while the remaining 23.7% was estimated by the source managers. In the absence of meters, it is common to use the maximum concession flow rate as an estimate parameter, although it does not correspond to the actual withdrawal value.

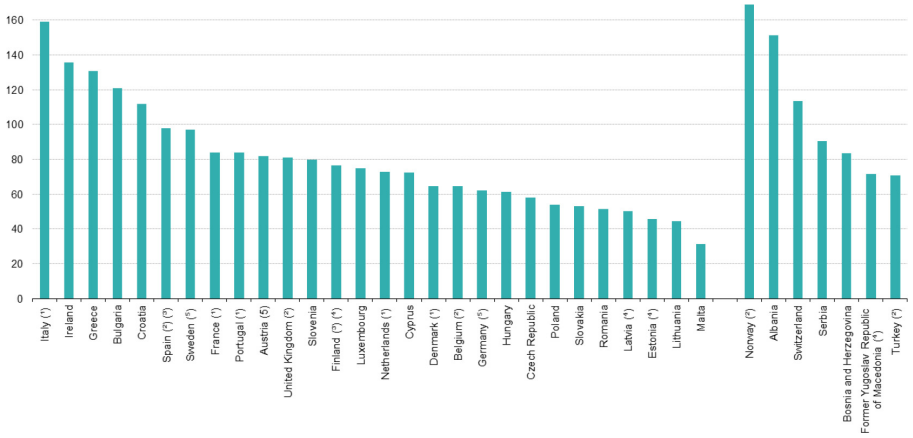


Fig. 1. Withdrawals of drinking water in 28 EU countries. Year 2015 or last year available, cubic meters per inhabitant. (Source: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Total_freshwater_abstraction_for_public_water_supply,_2015_(m³_per_inhabitant)_V4.png)

38% in 2012). In detail the real water losses, due to corrosion or deterioration of the pipes, breaks in the pipes or faulty joints and inefficiencies, amount to 38.3%; while apparent water losses, attributable to unauthorized consumption and measurement errors, are 3.1% of the water introduced into the network [16].

Utilitalia (the association of water, energy and environmental Italian companies), analyzed 54 companies that serve over 30 million people discovering that the average dispersion rate in the North is 26%, in the Center and in the South by 46%. Old pipes often run underground and maintenance is scarce. 60% of the infrastructures were laid over 30 years ago (70% in large urban centers) and 25% have over half a century of life (40% in large cities) [17].

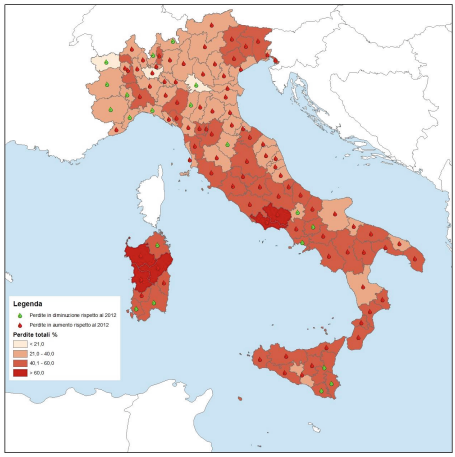
These high dispersion and losses levels (Table 5), that are increasing in almost all the municipalities [14], are explained by the age of the pipelines (36% are between the ages of 31 and 50, and 22% have over 50) and by the very low average price of water in Italy. A cubic meter (1000 L) of water in Italy costs 1.43 euro, compared to the European average value of 4.01 euro [18].

Particular attention should also be paid to the treatment of wastewater, which, if not properly treated, is a potential source of pollution of groundwater [19]. In Italy the situation, from this point of view, is rather critical (so much so as to be subject to sanctions by the EU), high-lighting at national level in 2015 an average value of about 40% of untreated wastewater[3] (Fig. 2).

[3] For non-compliance in the implementation of Directive 91/271/EEC, implemented by Italy with Legislative Decree 152/2006, on the treatment of wastewater, Italy has already suffered two sentences by the European Court of Justice, the C565-10 (Procedure 2004-2034) and C85-13 (Procedure 2009–2034) and the launch of a new infringement procedure (Procedure 2014–2059).

Table 5. Network dispersions in Italy by Regions and Province

Region	2012	2015	Difference 2015-2012
Piedmont	38	35,2	-2,8
Aosta Valley	21,9	18,7	-3,2
Lombardy	26,5	28,7	2,2
Trentino-South Tyrol	25,6	29,8	4,2
Veneto	35,6	40	4,4
Friuli-Venezia Giulia	44,9	47,8	2,9
Liguria	31,2	32,8	1,6
Emilia-Romagna	25,6	30,7	5,1
Tuscany	38,6	43,4	4,8
Umbria	38,5	46,8	8,3
Marche	28,9	34,1	5,2
Lazio	45,1	52,9	7,8
Abruzzo	42,3	47,9	5,6
Molise	47,2	47,4	0,2
Campania	45,8	46,7	0,9
Apulia	34,6	45,9	11,3
Basilicata	38,5	56,3	17,8
Calabria	35,4	41,1	5,7
Sicily	45,6	50	4,4
Sardinia	54,8	55,6	0,8



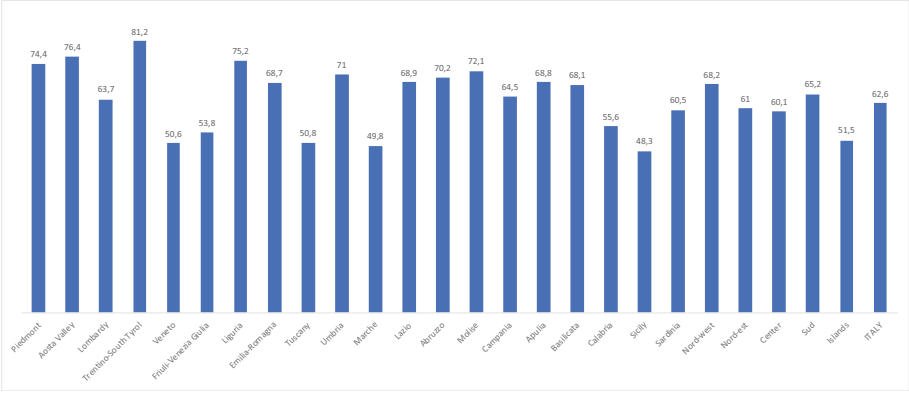


Fig. 2. % treated waste water compared to the total urban loads – 2015

In this context it is to be noted that in 342 municipalities, in which about 1.4 million inhabitants reside (equal to 2.4% of the total population), this service is absent, i.e., urban wastewater is not collected in public plants in operation. The most critical situations are recorded in Sicily, where there are 75 municipalities without purification (12.9% of the regional population), in Calabria with 57 municipalities (7% of the population) and in Campania, with 55 municipalities (3.9% of the population). With reference to the macro-regions, the highest purification rate is recorded in the North-West, where 68.2% of all the potentially generated load is treated. The least suitable is, instead, the purification system of the Islands, which guarantees a treatment of 51.5% compared to the potential generated.

A further element of reflection is provided by the water resources management system. First of all, it is important to point out that according to the Italian law the ownership of surface and underground water resources is always public. Its management, conversely, can be public, private or mixed. From the administrative point of view, based on a 1994 law then revised in 2006, Italy was divided into 64 ATOs (optimal territorial areas), while in 2011 there were 94. For each ATO there is an Entity of Government of the Area (EGA), which responds to the Region, which entrusts the water service to a manager. The objective of the legislation was to optimize the management reducing it to the minimum, making sure that for each ATO there was a single management of the services. However, assignments to single managers have not yet occurred in a complete manner throughout the national territory and for this reason, in some ATOs, numerous managements still coexist, although it is true that the process of unification of operations goes towards completion and has reached 82% of operators.

The system is still very fragmented, with over two thousand operators surveyed, most of them operating in very small local realities, perhaps lost in the mountains, while the bulk of the system is now consolidated around some main operators. Almost half of the turnover is, in fact, generated by 5% of the operators.

More in detail [14], the municipal water networks are managed by a total of 2,306 bodies (331 specialized bodies manage 86.4% of the volumes put on the network, while 1,975 managers deal with the remaining 13.6%) operating in 8,024 municipalities (99.7% of Italian municipalities).

There are basically four types of water resources control: direct management (municipalities directly manage water resources and their supply) which serves 12% of the Italian population; public management (i.e., carried out by companies with entirely public capital) that reach 55% of the population; mixed management (that is carried out by companies with mixed capital, public and private) that reach 30% of residents in Italy, and managements entrusted to wholly private companies, which are decidedly few and serve just 3% of total users.

From the highlighted above data, the state of water services in Italy, burdened by a growing demand, appears rather lacking in all three relative phases of the water cycle: adduction, distribution and treatment of discharges [20].

The main critical points are:

- the insufficient drinking supply that concerns 35% of the population;
- the high percentage of water dispersed in the phase that goes from the adduction to the supply to the end-users;
- the limited territorial coverage of sewerage and purification services;
- the high number of irregularities found in the treatment of dis-charges;
- the failure to adapt the purification service to the EU regulations both in terms of service coverage and type of treatment.

These deficiencies are particularly serious in some areas of the country: the regions of the South and the two major islands suffer from serious infrastructural deficits, an aqueduct and sewerage network in very bad conditions (see the volume of water dispersed), as well as a structural underneath - equipment for sewage treatment plants.

4 A Possible Way

The data shown in the previous paragraph testify both a high shortage of water infrastructure, the lack of adaptation of existing ones and a lack of ordinary and extraordinary maintenance, as well as important managerial inefficiencies.

If it is true, however, that the improvement of the infrastructures contributes to the improvement of quality, only the synergistic action of management efficiency and adequate infrastructure is such as to guarantee a real improvement in the offer and consequently in the territorial development and growth.

It can be noted that at the political level development and growth are mostly treated as synonyms, not considering the various studies that, focusing on the role of the territory, define sustainable, resilient and smart development models, that overcome the concepts of growth, that is at the increase in production (GDP) and income. Looking solely at the quantitative progress (growth) of GDP (or GNP) means indeed to-tally denying its qualitative dimension. Today the word development cannot refer only to a process of an economic nature, but must be interpreted as a multidimensional process, the result of which is the general improvement of the living conditions of the current and future population through the most appropriate technologies. This means not only higher levels of education, good health and reduction of social inequalities [21].

It also means protecting the environment, stable institutions, guarantees of freedom and protection of essential rights. This regards too, the water, as stated by the SDG' 6th goal.

In this perspective, a correct infrastructural endowment (specifically the water supply) is a necessary but not sufficient condition for development, especially in a context that has become increasingly international and competitive.

If we should use an approach based on growth, the "simple" construction of new reservoirs, pipelines or the replacement of old and deteriorated pipelines would be the ideal solution. But such a solution, however useful, would not solve the problem. We need to move on to a smart approach, based on the efficiency in resource management and therefore on the determination and identification of what the demand of individual territories actually is; on the "sustainable" use of the available resources oriented to a reduction in waste and to an intelligent consumption, as well as the resilience of the infrastructures themselves, so that they can withstand the stresses and shocks they will inevitably face.

The actions to be taken should so concern:

- increasing the availability of the water resource, if there is no possibility of tapping into underground aquifers or natural reservoirs (either because they do not exist or are almost completely used, and thus counter the negative effects of drought), by proceeding to a rational planning of resource with the creation of interconnections between different hydraulic systems, thus redistributing the resource not only in a temporal sense but also in a spatial one, channeling water where there is greater demand;
- contracting consumption through reducing the losses in the adduction and distribution networks, a prudent regulation of the network pressure and a tariff policy that disincentives too high consumption;

- managing efficiently the resource through a careful verification of the quantity of water supplied to the users through the installation of counters in correspondence of the single derivations;
- diversification of the water networks according to the specific needs of the use of the water supplied. For civil needs water with drinking characteristics is required, while lower quality water can be reserved for improper use (washing of cars, vehicles, garden irrigation, rinsing of sanitary appliances). Differentiation of the service based on the intended use of water can be achieved by adopting dual networks, which find favorable conditions of use when new plants are built;
- - the adoption of smart metering systems in homes. There are still too many cases in which citizens pay for water not on the basis of what they consume (or waste) but rather on the square meters of their home (a measure sometimes weighted according to the number of residents in the apartment);
- the use of natural techniques for the valorization of water built in close relationship with the landscape, such as structures for collecting rainwater[4] or traditional land preservation practices, rather than resorting only to man-made infrastructures, such as artificial water basins, irrigation canals or water treatment plants.

Starting from these considerations, the need to redefine the so-called "correct infrastructural endowment" emerges. This is a necessary condition for the realization of forms of sustainable, resilient and smart development especially in the European context, where the process of economic integration has exposed the regional economies to a constant comparison, not only for what concerns the offer of products but also regarding the offer of location factors for production activities. The main traditional indicators of the correct basic infrastructural endowment (the regional supply per capita, the dedicated financial resources, the services offered, the management, the costs of use) must therefore be integrated with territorial indicators based on the demand in relation to the different regional contexts.

The model that appears more appropriate, following the triple helix of Etzkovitz [23] and starting from the concept of territorial governance, places institutions, management bodies and citizens in a virtuous relationship and uses new technologies not as a new technological wave to be compared or as a tool of static analysis, but as a real design philosophy. The possibilities of overcoming the constraints represented by the scarcity of individual resources are thus made evident by exploiting the agglomerative advantages, identifiable in cooperation ties, in terms of exchange of experiences and sharing of resources, and above all in the formation of external economies of scale, represented by the significant reduction in asset management costs, thanks to the joint use of a series of services and infrastructures aimed at mitigating or eliminating impacts on the environment [24].

Preventing impacts on the reference ecosystem is related to the need to create forms of sustainable, resilient and smart development. The objective is a general improvement in the exploitation of resources based on a series of constraints and opportunities

[4] An example comes from China where the government has planned the creation of 16 sponge-cities, which by 2020 should be able to recycle 70% of rainwater thanks to better permeability of the soil and the restoration of adjacent marshes, as well as counteract floods and droughts [22].

represented by the elements of the reference context. This is the direction of the rules and (voluntary) tools operating in the context of the European Union and international, which propose restructuring models of processes focused on minimizing waste and production disadvantages for the continuous improvement of territorial performance [25].

Hence the need for an adequate methodology for forecasting and calculating the social, economic and environmental effects and implications, in order to overcome the constraint posed by a typically quantitative approach to the feasibility assessments, which arises from having applied partial techniques and purely economic cuts (i.e., the Analysis of preferences and sensitivity). By inserting the environmental variable, this last approach would show indeed all its limitations, because the vastness of the scales involved would assign to the environmental component a role limited to the simple minimization of the negative effects (the "externalities") of the territorial development strategies. Then it raises the need to develop an analytical method capable of identifying all the direct and indirect relations existing between the economic system and the social and environmental systems [26].

The answer can only be found in a multidisciplinary approach that allows for the complete integration of the various aspects and the different needs related to sustainability, resilience and smartness of a specific territorial area, aiming at maximizing the environmental quality and the quality of life (of its inhabitants).

This approach must therefore be transformed into an endogenous model of socio-economic development, through the application of adequate tools to face the logic of the qualitative approach of local and global environmental complexity, in analogy with the ancient Rome's approach to 'Curator aquarum' [27]; unique and highest authority of water policies related to the ancient known world. The interdisciplinary and global approach are therefore the only viable way for the responsible management of water understood as a universally recognized common good [28].

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