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Characterizing the recent decline of water consumption in Italian cities

Caracterizando el descenso reciente del consumo de agua en ciudades italianas

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Abstract

There is increasingly more evidence showing that domestic water consumption is decreasing in many urban areas of the developed world. A large and heterogeneous set of factors may explain this decrease, ranging from structural phenomena, such as changes in the composition of urban populations or in the economic basis of cities to the implementation of more conscious policies such as technological improvements; citizen awareness or higher water prices and taxes. In this paper we examine the drop in water consumption for the ten largest Italian cities. The Italian water sector is characterized by a highly fragmented governance structure that results in a significantly inefficient distribution network, which might be highly exposed to the effects of climate change. However, there is strong opposition to privatization. In the paper we document the drop in water consumption in the largest Italian cities showing demographic (aging), social (migration) and economic (income) factors at the same time. Although it is unlikely that one single reason can explain the declining trend, our conclusion points to a combination of structural factors and specific policies that seem to be more intense in the Northern and Central cities than in the Southern cities.

Keywords: Water Consumption; structural factors; population; efficiency; cities; Italy.

Resumen

Cada vez existe mayor evidencia de que el consumo doméstico de agua está disminuyendo en muchas ciudades del mundo desarrollado. Un conjunto numeroso y heterogéneo de factores puede explicar este declive, desde fenómenos estructurales como cambios en la composición de las poblaciones urbanas o en la base económica de las ciudades hasta cambios tecnológicos, aumento de la concienciación ciudadana o precios e impuestos más altos para el agua. En este artículo examinamos el descenso del consumo de agua en las diez mayores ciudades italianas. El sector italiano del agua urbana se caracteriza por una gobernanza altamente fragmentada que genera ineficiencias importantes en las redes de distribución y que puede quedar muy expuesta a los efectos del cambio climático. Al mismo tiempo, sin embargo, existe una firme oposición a la privatización. La disminución en el consumo de agua en el caso italiano muestra al mismo tiempo factores demográficos (envejecimiento), sociales (migración) y económicos (riqueza). Nuestra conclusión apunta hacia una combinación de factores estructurales y políticas activas que parecen ser más importantes en las ciudades del norte y del centro que en el sur del país.

Palabras clave: Consumo de agua; factores estructurales; población; eficiencia; ciudades; Italia.

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1. Introduction

Water continues to be one of the main (if not the main) issues of concern for the future of humankind. At the global scale and with population growth and climate change exerting critical influences over supply and demand, water will become more and more problematic for a substantial proportion of the world population especially in the developing countries, many of which may experience serious water stress by 2025. According to the World Bank, available water resources per capita at the global scale fell from 13,395 m^3 in 1962 to slightly below 6,000 m^3 in 2014 and are expected to decline to 4,800 m^3 in 2025 (World Bank, 2015). Furthermore, this global trend hides significant inequalities in availability and access to this precious resource. In 2015, 844 million people (the poorest in urban areas and many of those living in rural areas) still lacked drinking water of an acceptable quality. On the other hand, close to 2.5 billion people did not have reliable and appropriate sanitation facilities (UNESCO and World Health Organization [WHO], 2015). Accordingly, water-related mortality, especially among children, continues to be a major issue of concern in many developing countries.

Inequality in access is reflected in the large disparities of water consumption per capita found around the world that range from few liters in certain African traditional nomadic groups to 1,000 liters or more characteristic of wealthy households with lawns and swimming pools of Arizona or California in the Western United States. Around 20 liters per day would be the absolute minimum for basic hygiene needs according to the World Health Organization. If we add basic household uses, this minimum quantity may increase to 50 liter per day. On average an American citizen consumes 425 liters per day. In Europe this quantity decreases to 237 liters per day in Italy and 150 in France. In some areas of the developing world, such as rural Madagascar, the quantity may fall to 10 liters per day (Gleick, 2003; Chenoweth, 2008; Federparchi, n.d.).

Against the persistent view in the forecasts and statements of many international organizations, recent data on water consumption, at least in the developed world, contradicts somehow the image of a continuing rising trend in this consumption. For several decades now, in certain areas of the world, water use in agriculture, manufacturing, cities and tourism appears to be declining both in absolute and in relative terms. This trend, however, needs to be approached very carefully and only empirically oriented studies can discern whether or not achieving significant saving and efficiencies in the use and management of a critical resource is becoming significant. Taking specifically the case of urban water in cities of the developed world, evidence indicates that decreasing trends in consumption are common (Weisz and Steinberger, 2010). Since approximately the beginning of the 1990s, most cities of the developed world see how their consumption of essential resources such as water and energy is decreasing. Evidence in this respect can be found in North America (Donnelly and Cooley, 2015); Australia (Cahill and Lund, 2013) and Eastern and Western Europe (Poquet and Maresca, 2006; Barraqué, Isnard, Montginoul, Rinaudo and Souriau, 2011; Hotlos, Glowacka and Kolodziej, 2012 ; March and Sauri, 2016).

More than being uniquely the triumph of a conscious sustainability rationale pushing cities towards more efficient uses, reasons for the decline in water consumption may be many and highly heterogeneous. In some extreme cases, "urban shrinking" (Moss, 2008) or the fast decline of cities in the former European socialist block is directly responsible for the drastic fall in resource consumption. In other cases, a succession of drought periods also results in diminishing consumptions that tend to persist over time even when droughts are over. This is the case for example of cities such as Barcelona (March and Sauri, 2016). Other documented exogenous drivers of the decline in water consumption are technology and behavior (March and Sauri, 2010; Domene and Sauri, 2006). Technological improvements range from the improvement of the urban water delivery network (especially the detections and repair of leakage) to the myriad of more water efficient fixtures and appliances for bathrooms, kitchens, and the household in general. Behavior includes two main strategies: awareness campaigns towards more responsible water consumption, and increases in water prices and taxation providing economic stimuli to save water (Rogers, De Silva and Bhatia, 2002).

Together with these more exogenous factors, there are other factors leading to decreasing levels of water consumption more related to structural changes in current urban societies of the developed world, including the ageing of the population, the arrival of large numbers of immigrants from low income areas to cities and countries (Spain, Italy) traditional emitters rather than receivers of immigrants, and the increasing inequities among urban citizens.

Both exogenous and endogenous factors play therefore an important role in explaining the causes of water consumption decline in cities. Therefore, our objective in this paper is to examine the factors that can influence the decline in water consumption in the 10 most important Italian cities (see fig 1). Our working

hypothesis is that the decline obeys to a combination of exogenous and endogenous factors. Among the latter we will focus on ageing, immigration, and income. Our analysis will be limited to domestic consumption which is a subcategory of the broader urban consumption, the latter including water used in manufacturing. One of the most important reasons of water decline in European cities has been the shift from industry to services but in this paper we will restrict the analysis to the domestic sector (Santini and Rulli, 2015).

The paper is organized as follows. In the next section we examine succinctly the factors or drivers of the decline in domestic water consumption. After this we introduce the Italian water context emphasizing the climate constraints for water development; the inefficiencies of the water delivery system, and the debate on the governance of the resource. Section 4 analyzes the decline, which we attempt to relate to factors such as population change; age, immigration and income. We then proceed to discuss the results in the context of relevant literature on the topic. Finally in the conclusions we summarize the main findings of the paper and attempt to discern the specificity of the Italian experience in relation to other contexts.

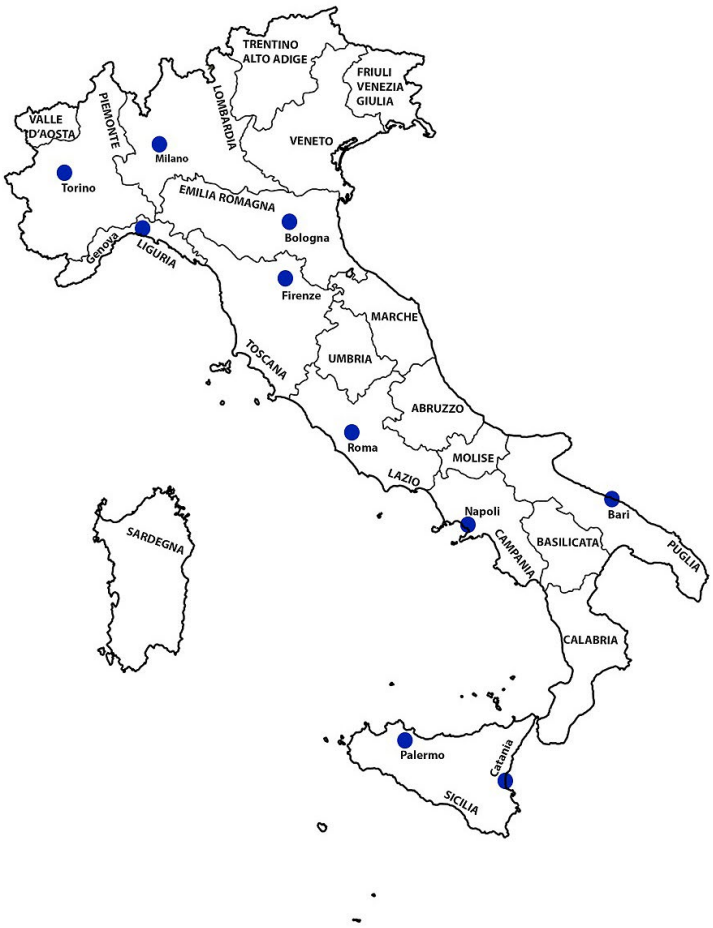
2. Methods

Our methodology has consisted in a literature review on factors behind the decline in water consumption in cities and a compilation and basic treatment of data for the 10 Italia cities considered in the paper. The decline in domestic water consumption has been linked to many factors of very diverse origins. As mentioned before, one first way to discriminate among these factors would be to divide them between those that are the product of conscious decision making (i.e. to raise water prices to curb consumption or to promote more efficient behavior when using water) and those responding to more structural phenomena such as, for instance, certain demographic characteristics of the population that may influence water consumption behavior (age) or certain characteristics of the built environment (urban density) leading also to different consumption patterns. Conscious actions may also be divided between those involving the promotion of water saving technology (in the bathroom or in appliances such as washing machines or dishwashers); the promotion of water responsible behavior (through, for instance, drought awareness campaigns) or the promotion of economic instruments (higher prices and taxes on water to foster conservation).

Our aim is this paper is not to examine all these factors in detail for the Italian case but to focus solely on three particular variables: ageing, immigration, and income. All of them frequently appear in the list of independent variables influencing urban water consumption. The common argument is that in cities of the developed world, the elderly and immigrants from developing counties tend to consume less water per capita than the average citizen (Nauges and Reynaud, 2001). Evidence regarding the elderly, however, is not conclusive. Certain studies in Australia and Europe corroborate more frugal consumptions among older segments of urban populations compared with the younger segments (Gregory and Di Leo, 2003; Gilg and Barr, 2006; March, Perarnau and Sauri, 2012) but in other cases the reverse appears to be true (Hamilton, 1983). This may vary too according to geographical context and factors such as the urban form. Thus, for example, in Southern Europe, elderly people tend to live in relatively small apartments with not too many water dependent appliances and with patterns of behavior more inclined to conservation. Contrarily, elderly people living in Australia or the Western United States may use more water simply because they live in single houses or condominiums with possibly gardens and other water dependent amenities. Regarding immigrants it is important to differentiate according to their socioeconomic status. Thus immigrants from the developing world coming to European cities tend to live in older and with fewer water fixtures housing than average citizens (Ajenjo *et al*., 2008). For example in New York City water consumption per capita among immigrants is 20 percent smaller than ware consumption by locals (Pfeffer and Mayone, 2002). To this we may add in many cases mire frugal behaviors regarding water consumption for cultural or religious reasons (Smith and Ali, 2006). Both the elderly and immigrants from developing countries are especially vulnerable to periods of economic crisis and one of the ways they tend to respond to income cuts is by reducing the consumption of resources such as water and energy. Prices and taxes may have a greater impact on the elderly because of smaller incomes that have not kept pace with the strong increases in the price of electricity, gas and water of the last years. Until relatively recently, it was assumed that income had an important role in determining the use of a particular resource. In other words, higher incomes would correspond with higher water consumptions (Dalhuisen, ~~et al.,~~ Florax, De Groot and Nijkamp, 2003; Domene and Sauri, 2006). However, income may influence water consumption negatively, for instance through a greater ability to purchase water efficient appliances (March and Sauri, 2009). For other authors income may lead to changing habits that reduce

the consumption of water from the network but increase the consumption of water coming from other sources, most notably bottled water (Wilk, 2006).

Figure 1. Italian regions and cities included in the study



Own elaboration.

3. Results

In terms of overall water availability, Italy can hardly be defined as water stressed country. Overall, water resources in the country amount to some 190 km^3 per year or some 3,140 m^3 per inhabitant (Tozzi, 2016). Water actually used constitutes around 24 percent of the overall figure which in per capita terms represent about 750 m^3 per year (Santini and Rulli, 2015). Up to 60 percent of the water may be used in irrigation; 25 percent in industry, and 15 percent in cities (Scarascia, Di Battista and Salvati, 2006). These figures need to be corrected according to internal differences. Thus in the North and Center, urban-industrial uses represent the largest proportion of water used while in the South and the Islands, with less rainfall, more evapotranspiration, and an important agricultural sector, irrigation is dominant (Martire and Tiberi, 2007; Massarutto, 2015). In terms of water footprint, that is the amount of fresh water used to produce goods and services, its value in Italy amounted to 132 billion cubic meters per year or 6,309 liters per capita per day in 2012. The country is the third net importer of virtual water in the world (62 billion cubic meters per year), after Japan and Mexico (Adinolfi and Di Pasquale, 2014). Concerning urban uses, 85 percent of the water delivered to cities is groundwater and only 15 percent surface water. Water use in Italian cities attained 228 liters per capita per day in 2008 which is one of the largest figures in the European Union only below Cyprus, Ireland and Latvia. Moreover, and for a variety of reasons (including but not limited to a perception of poor quality), Italians are among the largest world consumers of bottled water. These and other challenges are to an important extent related to the highly fragmented managerial

structure of the Italian water sector with more than 7,000 agencies and entities and 13,000 aqueducts. Water recycling and reuse, and alternative resources (only 0.2 % of water actually available comes from desalination plants) are still quite marginal (Santini and Rulli, 2015).

Domestic water consumption in Italian regions varies significantly. Figures are highest in the Northwest (with a maximum of 461liters/person/day (lpd) in the Valle d'Aosta) and decrease towards the Center and the South, with values in Toscana and Puglia below 200 lpd. For Italy as a whole, water consumption fell from 243 liters per person per day in 2008 to 228 lpd in 2012 (6.1 percent decrease). The central regions, in particular Toscana and Lazio, experienced the largest decline (in Lazio there was the maximum reduction of 16.5 percent). In general, all regions showed a decrease in registered water per capita, with the exception of Calabria (gain of 3.3 percent over the period considered) and Basilicata and Puglia, the latter with less than 1 percent.

3.1. The challenges of climate

An important challenge to the Italian water sector is posed by climate. Italian records show that during the 20th century summer rainfall has decreased around 20 percent and average temperature has risen by 1.5 °C (Scienzia in Rete, 2010). The warming trend appears to manifest itself faster than global averages. A new record of increase in temperature was registered in 2014 with 1.45 °C above the average for the period 1971-2000. Globally, in the same year the temperature was 0.46 °C higher than the average for the period 1971-2000 (Bia, 2016). This and other data appears to confirm that, during the recent decades, the warming trend in Italy has progressed at average values twice as large as the average values for the Earth as a whole. This phenomenon may be related to the increasing presence of high pressure conditions over the Italian Peninsula, which shift from North Africa to the Mediterranean and from here to the Atlantic. High pressures divert storms and create the conditions for more frequent droughts and therefore for growing impacts on cities and on the food processing sector as happened in the winter of 2015-2016, known as the "winter of the drought" and coinciding with the warmest and driest year (2015) in recorded history. At the beginning of February 2016 the capacity of the three main lakes of Northern Italy dropped to an all-time low (Lake Garda showed a decline of 33 percent), while in some places minimum flows for several major rivers were recorded. The Po River reported water levels two meters lower than in the same period of 2015 and also below those of the winter of 2007 which was very dry as well (Bia, 2016). In January 2016, lack of precipitation forced many municipalities to issue measures restricting water consumption. This trend has exacerbated the already precarious situation of Italy regarding water availability. Thus 15 percent of the Italian population, approximately eight million people, stands below the minimum water requirement of 50 liters of water per day per person during four months per year (June-September) The possibility of cities deprived of drinking water and facing emergency situations (as it has already happened historically from Sicily to Tuscany) becomes very real.

Future prospects for water availability face additional important challenges, especially those derived from the effects of climate change (García-Ruiz, López-Moreno, Vicente-Serrano, Lasanta-Martínez, and Beguería, 2011; Milano *et al*., 2013). Located in the central area of the Mediterranean basin, Italy is likely to experience the rising temperatures and decreasing rainfall that many models envisage for this area during the next decades (Giorgi, 2006; Galleotti and Roson, 2012). Declining precipitation values will mainly affect water availability for agriculture in the short term and groundwater recharge (critical for urban water supply) in the longer term. River flows may decrease due to global changes, particularly land use changes (Billi and Fazinni, 2017). At the same time, water demand is expected to rise in the next decades after increasing requirements for agricultural production and after population growth. Moreover, precipitation tends and will tend to occur more frequently in sudden, highly intense evens that produce floods and mudslides

3.2. The (in)efficiency of the Italian urban water delivery systems

A major problem of the Italian water supply network is its poor performance expressed as water that does not reach or it is no registered at the final point of consumption (Passino, Benedini, Dipinto and Pagnotta, 1999). At the regional level, water unaccounted for (network losses and other detractions) amounts to approximately a third of the water delivered showing strong variabilities depending on the region. Figures oscillate between 43.3 percent in the South and 30 percent in the Northwest (De Gironi-

mo, 2013). Valle d'Aosta, in the Northwest, observes the lowest value (21.9 percent) while the island of Sardinia records the highest value (54.8 percent). Up to 40 percent of the supplied water which is roughly equivalent to more than 10,000 m^3 per kilometer is lost before reaching end uses. Losses per kilometer of water conveyance systems in the region of Campania reach 25,000 m^3 while in Cosenza (Calabria), 70 percent of the water fed into conveyance systems does not arrive at its final destination. Extremely high water losses are recorded in Campobasso (65 percent) and Latina (66 percent) as well. There are regions such as Basilicata and Sardegna that bill just a third of the water supplied. Contrarily, in Emilia Romagna, Umbria and Marche, loss values are less than 3,000 m^3/km. To an important extent, losses are directly related to the poor state of the delivery network and the widespread extension of leakage. However, there are also cases of illegal and unregistered captures. According to the Minister of the Interior, Italian domestic water resources are subject to thefts organized and performed by illegal tanker trucks that supply entire neighborhoods and villages, as a form of territory control (Tozzi, 2016).

3.3. Urban water management between the public and private sector

Italy has developed one of the more comprehensive water supply and sanitation infrastructures in Europe. The *Acquedotto Pugliese*, for example, is the largest water aqueduct system in the continent with more than 19,000 km of pipes; 6 water treatment plants, and 164 sewage treatment plants. The Italian water system includes 291,000 km of channels, pipes and other conveyance structures, 16 percent of which, however, operates in critical conditions and needs full redevelopment. Regarding supply, virtually all Italian municipalities (99.7 percent) are served by the water supply network and 99.5 percent have access to the public sewerage system. It is estimated that in the next 30 years 65 billion Euro will be needed to repair aqueducts, sewage and waste treatment plants. (La Repubblica, 2017) In Italy the process of privatization of water services began in the mid-1990s through various legislative measures that recognized the inability of the Italian state to manage these services (based on 7,000 different agencies) efficiently. Despite the reform of water management systems approved by the Italian Parliament in 1994 (Carrozza, 2011), this fragmentation still hampers efficient management. However, other voices claim that reform was addressed to introduce private models of water governance following the EU interest in fostering competition in the provision of public services, and that local governments have struggled to prevent private management (Carrozza and Fantini, 2016). The final clash between advocates and opponents of the privatization of water services took the form of a referendum held in June 2011 in which Italians opposed the privatization package proposed by the Berlusconi administration and asserted the idea of water as a common resource and a human right.

One of the first consequences of the privatization process of the 1990s was the increase in tariffs although these tariffs tend to be low in comparison with other European capitals. In 2014, the price of domestic water in Milan was 0.8 €/m^3. In other cities such as Bologna, Torino, Naples or Rome this price was below 2 €/m^3 in clear contrast with figures, for example, in Barcelona (3.2 €/m^3), London (4.7€/m^3) or Copenhagen (8 €/m^3) (International Water Association [IWA], 2014). Low prices are probably related to low investments in the network, and to physical and managerial inefficiencies. For example, the fragmentation of management in more than 700 entities makes difficult to raise the estimated 5 billion euros per year needed to upgrade to efficient levels the water delivery network. In Italy, investment in water infrastructure amounts to the equivalent of 30 euro per inhabitant while in Germany this figure rises to 80 euro, to 90 euro in France, and to 100 in the United Kingdom. It is estimated that "to bring the level of Italian water infrastructure in line with European standards, 65 billion Euros should be invested in thirty years" (La Repubblica, 2017).That said, water prices in Italian cities have increased in the last decades although at a slow pace, and investments have increase as well but again, moderate gains in the Northern capitals have to be compared with the chronic underinvestment in the South.

Finally and before examining consumption trends, it is worth noting that Italian cities experience important losses from the municipal water networks (see table 1). On average, losses add up to more than a third of the water delivered but there are also substantial differences among cities. The lowest figure belongs to Milano with slightly over 10 percent of losses which indicates a highly efficient system (Carra, 2014). At the other extreme Catania registers an astonishing 57 percent (that is more than half the water delivered is lost) while Naples, Bari and Firenze record values above 40 percent. For some organizations such as the Organization for Economic Cooperation and Development (OECD) (2011) the fact that water in Italy is underpriced probably explains the lack of investments to improve water infrastructure and therefore the persistence of leakage.

Table 1. Water losses in the distribution networks of the 10 largest Italian cities. 2012

City	Losses in water delivered (in %)
Rome	36.4
Milano	10.2
Napoli	41.1
Torino	36.9
Palermo	33
Bologna	21.3
Genova	29.2
Firenze	43.8
Bari	40.7
Catania	56.9
Average	35

Source: Instituto Nazionale di Statistica (Istat). Censimento delle acque per uso civile. https://www.istat.it/it/archivio/acqua

3.4. Water consumption trends in the ten largest Italian cities

Next we will examine the evolution of water consumption in the ten largest Italian cities for the period 2002-2011. It is important to clarify that the figures presented in the following tables correspond to registered volumes (liters/person/day) in the final points of consumption (i.e. households) and not to figures entering the city water networks. Therefore, our data does not take into account water losses in the public network, although a reference needs to be made to this issue because, as said before, Italy probably observes one of the highest rates of network water losses in Europe.

Following the same trends of most European urban areas, water consumption in Italian cities is falling at least in per capita terms. The decline in domestic water consumption was already noticeable in many European cities during the 1990s but Italy remained an exception. Between 1991 and 2001, for instance, Milano was the only large city observing a downward trend in consumption. Other cities such as Torino and Bologna did not experience changes while in Roma, Cagliari, Genova, Ancona and Palermo water consumption per capita actually increased (Poquet and Maresca, 2006).

The period 2002-2011, however, saw a significant change and, with a few exceptions, water consumption per capita experienced a more or less pronounced decrease in the major cities (see table 2). Decrease in per capita water consumption shows however, important differences. In Genova, Roma and Torino consumption in 2011 was around 25 percent smaller than consumption in 2002. In Bologna, Firenze and Bari, decline oscillated between 16 and 11 percent while in Catania and Palermo there was a small increase in consumption. The reduction experienced in Milano (8 percent) is comparatively small, probably reflecting a longer period of decline than the other cities. Still, with the exception of Catania, water consumption per capita in the Northern cities remains higher than in Southern cities, sometimes by 30 percent or more.

Table 2. Water consumption in the 10 largest Italian cities (in lpd). 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change 2002-2011 (%)
Roma	264	253	254	253	245	238	237	234	234	201	-24
Milano	248	239	220	223	225	224	232	235	228	228	-8
Napoli	205	204	198	203	208	175	170	165	162	160	-22
Torino	277	258	241	238	243	226	223	221	210	211	-24
Palermo	152	153	162	167	169	163	159	159	157	153	0.6
Bologna	181	183	179	185	178	177	180	178	162	160	-11.5
Genova	224	218	207	195	200	197	189	186	174	163	-27
Firenze	160	157	155	152	148	150	155	154	154	138	-14
Bari	180	168	164	159	158	158	154	151	151	150	-16.5
Catania	222	216	220	219	219	224	224	221	223	230	3.5

Source: Instituto Nazionale di Statistica. Censimento delle acque per uso civile. https://www.istat.it/it/archivio/acqua

Next we will describe trends in factors that may contribute to the explanation of this decline, beginning with population changes which will serve us as a contextual element. Table 3 shows population changes in the 10 largest Italian cities between 2002 and 2011. From the table it can be deduced that the population of most cities stagnated or declined during that period, in some cases (Naples, Palermo, Genova and Catania) rather noticeably. In fact, only the capital, Roma recorded slightly larger numbers in 2011 compared to 2012 whilst very small increases can be observed for Torino, Firenze or Bari.

Table 3. Population change in the 10 largest Italian cities. 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change 2002-2011 (%)
Roma	2,540,829	2,542,003	2,553,873	2,547,677	2,705,603	2,718,768	2,724,347	2,743,796	2,761,477	2,614,263	2.9
Milano	1,247,052	1,271,898	1,299,439	1,308,735	1,303,437	1,299,633	1,295,705	1,307,495	1,324,110	1,240,173	-0.5
Napoli	1,008,419	1,000,449	995,171	984,242	975,139	973,132	963,661	962,940	959,574	961,106	-4.7
Torino	861,644	867,857	902,255	900,608	900,569	908,263	908,825	909,538	907,563	869,312	0.9
Palermo	682,901	679,730	675,277	670,820	666,552	663,173	659,433	656,081	655,875	656,829	-3.8
Bologna	373,018	373,539	374,425	373,743	373,026	372,256	374,944	377,220	380,181	371,151	-0.5
Genova	604,732	601,338	605,084	620,316	615,686	610,887	611,171	609,746	607,906	584,644	-3.3
Firenze	352,940	367,259	368,059	366,901	365,966	364,710	365,659	368,901	371,282	357,318	1.2
Bari	315,068	314,166	328,458	326,915	325,052	322,511	320,677	320,150	320,475	315,408	0.1
Catania	308,438	307,774	305,773	304,144	301,564	298,957	296,469	295,591	293,458	293,104	-5

Source: Instituto Nazionale di Statistica. Demografia in Cifre. http://demo.istat.it

Next we turn to aging and immigration shown previously to play some role in explaining water consumption trends. Table 4 describes the evolution (in percentage) of the population older than 65 years between 2002 and 2011 in the same cities. Of the ten cities, only Bologna escapes the trend towards ageing of the population. In seven of the ten cities, including Bologna, the population older than 65 years exceeds 20 percent of the total and in three (Bologna, Firenze and Genova) this age group exceeds 25 per cent of the total. The North-South demographic divide, with older populations in the North and younger populations in the South, is also very clearly reflected in the table with Bari, Napoli, Palermo and Catania registering percentages near or below 20 percent.

Table 4. Population above 65 years (% of the total). 2002-2011

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Roma	19	19.6	19.7	19.9	20.5	20.8	21.2	21.4	21.6	21.7
Milano	22.9	23.5	23.3	23.3	23.4	23.7	23.9	24.1	23.9	23.6
Napoli	15.5	15.8	16.1	16.3	16.7	17.1	17.3	17.6	17.6	17.9
Torino	22.5	23.1	23.3	23.5	23.5	23.7	23.7	23.8	23.9	23.9
Palermo	14.7	15.2	15.5	15.8	16.2	16.5	16.8	17	17.2	17.5
Bologna	26.6	26.7	26.7	26.7	27	27	27	26.7	26.3	25.9
Genova	25.7	26.2	26.6	26.7	26.4	26.7	26.9	26.9	26.9	26.7
Firenze	25.7	26.1	25.8	25.8	25.8	26	26	25.9	25.7	25.5
Bari	17.2	17.7	18	18.1	18.7	19.1	19.5	19.8	20.1	20.5
Catania	17.8	18	18.2	18.4	18.7	18.9	19.1	19.3	19.5	19.8

Source: Instituto Nazionale di Statistica. Demografia in Cifre. http://demo.istat.it

Concerning immigration, the recent population growth in Italian cities is to an important extent a consequence of the arrival of foreign nationals. Between 2001 and 2011, the foreign population living in Italy grew from 1,334,889 to 4,029,145 persons and the proportion of foreigners over nationals increased from 2.3 percent of the total to 6.7 percent. Given the low fertility rates and the aging of the population, immigration is the factor that currently fuels population growth in the country. During the same period Italian nationals decreased by more than 250,000 individuals (0.5%), while foreign individuals increased

by 2,694,256 people (201.8 percent). In other words, after almost two decades of stagnation the population in Italy began to grow again thanks to the arrival of immigrants and their higher fertilities. In table 5 we can acknowledge the evolution of immigration for the ten largest Italian cities between 2004 and 2011. Again, the most important differences concern Northern and Southern cities. The highest number is found in Milano, where 17.5 percent of the registered population is foreign. Smaller but significant proportions are found in Torino, Firenze, Bologna and Roma while the proportion of immigrants in the Southern cities is comparatively very small (below 5 percent in all cases) but growing quite fast. Also of note is the speed at which the foreign population is expanding with percentages in 2011 twice or greater than the percentages of 2004.

Table 5. Foreign population (in % of the total)

	2004	2005	2006	2007	2008	2009	2010	2011
Roma	4.8	5.69	5.79	7.33	8	8.84	9.74	11.26
Milano	8.33	10.93	12.44	13.12	13.58	13.87	15.05	17.52
Napoli	1.09	1.49	1.74	1.97	2.22	2.53	2.86	3.06
Torino	6.15	7.69	8.52	9.24	11.32	12.61	13.54	14.69
Palermo	1.90	2.11	2.23	2.22	2.40	2.62	2.77	3.08
Bologna	5.71	6.79	7.53	8.14	8.96	10.46	11.48	13.05
Genova	3.53	4.61	5.33	5.77	6.08	7.01	7.53	8.62
Firenze	7.59	8.22	8.88	9.57	10.29	11.08	12.46	14.00
Bari	1.83	1.98	1.71	1.67	1.92	2.02	2.28	2.81
Catania	1.75	1.86	2.02	1.99	2.25	2.55	2.93	3.14

Source: Instituto Nazionale di Statistica. Demografia in Cifre. http://demo.istat.it

In table 6 we show the evolution of average income in the 10 cities of the sample. Average incomes increased between 2005 and 2011 everywhere but especially in the Southern cities. Still, significant income differences between the North and the South continue to be the norm and in 2011, the average income in the city heading the ranking (Milano) is 50 percent higher than the average income of the city closing this ranking (Catania). At any rate, from the table it can be deduced that water consumption decline took place in a context of income growth thus confirming the decoupling trend between material wealth and resource consumption characteristic of developed countries in recent years (Swilling, Robinson, Marvin and Hodson, 2013).

Table 6. Average income in 10 Italian cities (in constant euro/capita)

	2005	2006	2007	2008	2009	2010	2011	% Change
Roma	26,668	27,624	29,173	29,453	29,820	30,284	30,544	14.5
Milano	30,973	32,959	34,783	35,194	34,964	35,751	36,253	17.0
Napoli	21,968	22,745	25,000	25,213	25,566	25,884	25,875	17.8
Torino	23,192	24,164	25,558	25,662	25,782	26,300	26,499	14.2
Palermo	21,756	22,551	24,725	25,036	25,265	25,363	25,613	17.7
Bologna	25,801	26,675	28,045	28,167	28,449	28,719	28,809	11.7
Genova	22,429	23,060	24,408	24,771	24,877	25,238	25,616	14.2
Firenze	24,356	25,367	26,930	27,142	27,422	27,822	28,132	15.5
Bari	22,112	22,915	24,698	24,949	25,281	25,719	25,878	17
Catania	20,338	21,057	22,925	23,130	23,370	23,645	23,822	17.1

Source: Instituto Nazionale di Statistica. Demografia in Cifre. http://demo.istat.it

4. Discussion

While decline in water consumption is a firmly established trend in virtually all cities in the sample, the causes of such trend are difficult to discern. On the one hand, our data is water consumed at the final

point of destination and that does not include losses in the network, which is a major source of decline in other contexts (Lux, 2008) or water theft, still significant in certain Italian cities (De Rubertis, 2016).

Regarding the demographic variables of age and immigration, water consumption is falling especially in cities undergoing processes of aging and diversification of the population according to origin. March, Perarnau and Sauri (2012), contributed statistical evidence to the relationships between ageing, immigration and water consumption in Barcelona. In summary the argument is that as population ages and becomes more diversified with the entrance of nationals from developing countries, water consumption tends to fall. This appears to be the case in the Italian cities of the sample as well. However, the relationship with water consumption is probably filtered by other factors, especially the housing stock. Thus in the Barcelona case, for instance immigrants and (perhaps less so) the elderly tend to live in apartments with few water appliances than city averages. Hence this may result in less water consumption, in the case of immigrants also by larger household sizes. It is likely that Italian cities are characterized by similar trends, especially the Northern cities with large concentrations of immigrants (Marconi, 2014).

Another finding of this study is that water consumption decline takes place in a context of growth in income for all the cities considered. This trend shows the decoupling between economic growth and resource consumption characteristic of many cities in the recent decades despite the fact that Italy is the largest consumer of bottled water in the world (Wilk, 2006) and that, therefore, decoupling would need some qualification. Finally, it has not been possible in this paper to estimate is the role played by other factors involving technological and behavioral changes such as the expansion of water efficient devices in households (toilets, showers, washing machines, etc.) or the launching of water awareness campaigns to stimulate more responsible behaviors by citizens in the use of water (Aprile and Fiorillo, 2017). The severe drought of 2016-17 implied the declaration of the State of Emergency in several Italian regions and citizens were asked to curtail non-essential uses such as garden irrigation, car washing or the filling of swimming pools (Spagnolo, 2017).

5. Conclusions

Italy occupies a significant place among the European countries with high water consumption per capita. In part this is the result of a favorable climatic and hydrological setting in much of the country but also to an infrastructural and governance system plagued with problems, above all, leakage in the urban delivery networks. In this paper, however, we have documented how Italian cities are undergoing a process of reducing their water consumption even without considering advances towards a greater efficiency of the water delivery networks. Overall, this process appears to have begun somewhat later than in other European cities (Poquet and Maresca, 2006) and shows also the otherwise common differences between Northern and Southern Italy (Santini and Rulli, 2015). Thus the decline in water consumption of the Northern cities is usually larger than the decline in the Southern cities although it is also true that, generally, water consumption per capita in cities such as Milano or Torino exceeds that of Palermo or Bari by 30 percent or more. As hypothesized, the decrease in water consumption occurs also in a context of population stagnation in most cities with growing proportions of the elderly and immigrants (Marconi, 2014). We have pointed out how, in other European urban areas, there appears to be a relationship between the ascendancy of these two demographic groups and the decline in water consumption per capita although this needs to be put in the context of the characteristics of the urban fabric where these groups (especially immigrants) tend to live probably in small flats with few water devices (March, Perarnau and Sauri, 2012).

The many factors that intervene in shaping water consumption in cities have probably been at work in Italian urban areas as well (Tozzi, 2016). However, the Italian case also shows poor investments in the maintenance of the urban water cycle and chronic inefficiencies in the nation's water systems. For some, this state of affairs can only be overcome with drastic changes in the governance of water, especially privatization and price increases able to offset future pressures of climate change in terms of increasing droughts and falling water supplies (OECD, 2011). For other voices, however, the modernization of the Italian water system must be a collective effort strongly based on communal principles (Carrozza and Fantini, 2016). However, both arguments may fail to acknowledge the role of structural factors related to demography, social conditions, income and also the urban form. In this paper we have attempted to provide a very sketchy picture of some of these factors. Much more detailed work with survey and interview data would be required to gain a better understanding of the causes of domestic water consumption decline.

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References

Adinolfi, F. and Di Pasquale, J. (2014). *Italy's Water Footprint*. Retrieved from http://www.expo2015.org/magazine/en/sustainability/italy-s-water-footprint--.html

Ajenjo, M., Blanes, A., Bosch, J., Parella, S., Recio, A., San Martin, J. and Sintes, E. (2008). *Les condicions de vida de la població immigrada a Catalunya*. Barcelona: Editorial Mediterrània.

Aprile, M.C. and Fiorillo, D. (2017). Water conservation behavior and environmental concerns: Evidence from a representative sample of Italian individuals. *Journal of Cleaner Production*, 159, 119-129. https://doi.org/10.1016/j.jclepro.2017.05.036

Barraqué, B., Isnard, L., Montginoul, M., Rinaudo, J.D. and Souriau, J. (2011). Baisse des consommations d'eau potable et d´eveloppement durable. *Responsabilité et Environnement*, 63, 102-108. https://doi.org/10.3917/re.063.0102

Bia, S. (February 1, 2016). Allarme siccità, il Po senza acqua: quattro metri più basso della media. "Colture a rischio". *Il Fatto Quotidiano*. Retrieved from https://www.ilfattoquotidiano.it/2016/02/01/allarme-siccita-il-po-senzacqua-quattro-metri-piu-basso-della-media-colture-a-rischio/2423917

Billi, P. and Fazzini, M. (2017). Global change and river flow in Italy. *Global and Planetary Change,* 155, 234-246. https://doi.org/10.1016/j.gloplacha.2017.07.008

Cahill, R. and Lund, J. (2013). Residential Water Conservation in Australia and California. *Journal of Water Resources Planning and Management*, 139, 117-121. https://doi.org/10.1061/(ASCE)WR.1943-5452.0000225

Carra, I. (March 13, 2014). A Milano l'acqua costa il 6% in più. L'aumento è retroattivo: vale anche per il 2013. *La Reppublica.it*. Retrieved from http://milano.repubblica.it/cronaca/2014/03/13/news/a_milano_l_acqua_costa_il_6_per_cento_in_pi_l_aumento_vale_anche_per_il_2013-80920727

Carrozza, C. (2011). Italian water services reform from 1994 to 2008: decisional rounds and local modes of governance. *Water Policy, 13*(6), 751-768. https://doi.org/10.2166/wp.2011.030

Carrozza, C. and Fantini, E. (2016). The Italian water movement and the politics of the commons. *Water Alternatives, 9*(1), 99-119. http://www.water-alternatives.org/index.php/alldoc/articles/vol9/v9issue1/306-a9-1-5/file

Chenoweth, J. (2008). Minimum water requirements for social and economic development. *Desalination*, 229, 246-256. https://doi.org/10.1016/j.desal.2007.09.011

Dalhuisen, J.M., Florax, R.J.G.M., De Groot, H.L.F., and Nijkamp, P. (2003). Price and income elasticities of residential water demand: A meta analysis. *Land Economics*, *79*(2), 292-308. https://doi.org/10.2307/3146872

De Gironimo, G. (2013). Consumi di Acqua per Uso Domestico e Perdite di Rete. *IX Rapporto sulla Qualitá dell Ambiente Urbano*, Roma 11 October. Retrieved from http://www.areeurbane.isprambiente.it/it/pubblicazioni/rapporti/ix-rapporto/slide-dei-capitoli/cap-5

De Rubertis, P. (13 January, 2016). Bollette acqua, luci e ombre del nuovo metodo tariffario. Con aumenti in vista. *Il Fatto Quotidinao*. Retrieved from https://www.ilfattoquotidiano.it/2016/01/13/bollette-acqua-luci-e-ombre-del-nuovo-metodo-tariffario-e-aumenti-in-vista/2372680

Domene, E. and Sauri, D. (2006). Urbanisation and water consumption: Influencing factors in the metropolitan region of Barcelona. *Urban Studies*, *43*(9), 1605-23. https://doi.org/10.1080/00420980600749969

Donnelly, K. and Cooley, H. (2015). *Water use trends in the United States*. Retrieved from http://pacinst.org/publication/water-use-trends-in-the-united-states

Federparchi, IT (n.d.). *L'acqua nel mondo*. Retrieved from http://www.parks.it/acqua/finish/pdf/acqua.nel.mondo.e.in.italia.pdf

Galleotti, M. and Roson, R. (2012). Economic Impacts of Climate Change in Italy and the Mediterranean. Updating the Evidence. *Journal of Sustainable Development*, *5*(5), 27-41. http://dx.doi.org/10.5539/jsd.v5n5p27

García-Ruiz, J.M., López-Moreno, J.I., Vicente-Serrano, S.M., Lasanta-Martínez, T. and Beguería, S. (2011). Mediterranean water resources in a global change scenario. *Earth Science Reviews*, 105, 121-139. https://doi.org/10.1016/j.earscirev.2011.01.006

Gilg, A. and Barr, S. (2006). Behavioral attitudes towards water saving? Evidence from a study of environmental actions. *Ecological. Economics*, 57, 400-14. https://doi.org/10.1016/j.ecolecon.2005.04.010

Giorgi, F. (2006). Climate Change Hot Spots. *Geophysical Research Letters*, *33*(8) LO8707, 1-4. https://doi.org/10.1029/2006GL025734

Gleick, P.T. (2003). Water Use. *Annual Review of Environment and Resources*, 28, 275-314. https://doi.org/10.1146/annurev.energy.28.040202.122849

Gregory, G.D. and Di Leo, M. (2003). Repeated behavior and environmental psychology: the role of personal involvement and habit formation in explaining water consumption. *Journal of Applied Social Psychology*, 33, 1261-1296. https://doi.org/10.1111/j.1559-1816.2003.tb01949.x

Hamilton, L. (1983). Saving water: a causal model of household conservation. *Sociological Perspectives*, 26, 355-374. https://doi.org/10.2307/1389190

Hotlos, H., Glowacka, J. and Kolodziej, A. (2012). Water demand variations in the water distribution system of Wroclaw. *Ochrona Srodowiska*, *34*(4), 23-28.

Instituto Nazionale di Statistica (2017). Censimento delle acque per uso civile. Retrieved from https://www.istat.it/it/archivio/acqua

Instituto Nazionale di Statistica (2017). Demografia in Cifre. Retrieved from http://demo.istat.it

International Water Association (IWA) (2014). International Statistics for Water Services. Retrieved from http://www.iwa-network.org/wp-content/uploads/2016/06/International-Statistics-for-Water-Services-2014.pdf

La Repubblica (June 22, 2017). Acqua: tariffe italiane tra le più basse d'Europa, ma mancano 5 miliardi di investimenti. Retrieved from http://www.repubblica.it/economia/rapporti/osserva-italia/conad/2017/06/22/news/acqua_tariffe_italiane_tra_le_piu_basse_d_europa_ma_mancano_gli_investimenti-168711422

Lux, A. (2008). Shrinking cities and water supply. In D. Hummel (ed.). *Population dynamics and supply systems* (pp. 161-179). Frankfurt am Main: Campus Verlag.

March, H., Perarnau, J. and Sauri, D. (2012). Exploring the links between immigration, ageing, and domestic water consumption: the case of the Metropolitan Area of Barcelona. *Regional Studies*, *46*(2), 229-244. https://doi.org/10.1080/00343404.2010.487859

March, H. and Sauri, D. (2009). What lies behind domestic water use? A review essay on the drivers of domestic water consumption. *Boletín de la Asociación de Geógrafos Españoles,* 50, 297-314.

March, H. and Sauri, D. (2010). The suburbanization of water scarcity in the Barcelona Metropolitan Region: socio-demographic and urban changes influencing domestic water consumption. *The Professional Geographer*, *62*(1), 32-45. https://doi.org/10.1080/00330120903375860

March, H. and Sauri, D. (2016). When sustainable may not mean just: a critical interpretation of urban water consumption decline in the Metropolitan Area of Barcelona. *Local Environment*, 22(5), 523-535. https://doi.org/10.1080/13549839.2016.1233528

Marconi, G. (2014). Governo urbano e immigrazione. In L. Fregolent and M. Savino (eds.). *Città e Politiche in Tempi di Crisi* (pp. 273-283). Milano: Franco Angeli.

Martire, F. and Tiberi, R. (2007). *Acqua, il consumo in Italia*. Bologna: EMI Editore.

Massarutto, A. (March 31, 2015). Acqua. Quello che ancora vorremmo sapere dall'Istat. *Lavoce.info*. Retrieved from http://www.lavoce.info/archives/34002/acqua-quello-che-ancora-vorremmo-sapere-dallistat

Milano, M., Ruelland, D., Fernandez, S., Dezetter, A., Fabre, J., Servat, E.,…and Thivet, G. (2013). Current state of Mediterranean water resources and future trends under climatic and anthropogenic changes. *Hydrological Sciences Journal, 58*(3), 498-518. https://doi.org/10.1080/02626667.2013.774458

Moss, T. (2008). Cold spots of urban Infrastructure: 'Shrinking' processes in eastern Germany and the modern infrastructural ideal. *International Journal of Urban and Regional Research, 32*(2), 436-45. https://doi.org/10.1111/j.1468-2427.2008.00790.x

Nauges, C. and Reynaud, A. (2001). Estimation de la demande domestique d'eau potable en France. *Revue Economique*, 52, 167-185. https://doi.org/10.3917/reco.521.0167

Organization for Economic Cooperation and Development (OECD) (2011). *OECD Economic Surveys. Italy 2011*. http://dx.doi.org/10.1787/eco_surveys-ita-2011-en

Passino, R., Benedini, M., Dipinto, A.C. and Pagnotta, R. (1999). *Un Futuro per L'Acqua in Italia*. IRSA/CNR Report No. 109. Roma: Istituto di Recerca Sulle Acque.

Pfeffer, M. and Mayone, J. (2002). Immigrant environmental behaviors in New York city. *Social Science Quarterly*, 83, 64-81. https://doi.org/10.1111/1540-6237.00071

Poquet, G. and Maresca, B. (2006). La consommation d'eau baisse dans les grandes villes européennnes. *Consommation et Modes de Vie*, 192, unpaged.

Rogers, P., De Silva, R. and Bhatia, R. (2002). Water is an economic good. How to use prices to promote equity, efficiency and sustainability. *Water Policy*, 1, 1-17. https://doi.org/10.1016/S1366-7017(02)00004-1

Santini, M. and Rulli, M.C. (2015). Water resources in Italy: the present situation and future trends. In M. Antonelli and F. Greco (eds.). *The Water We Eat. Combining Virtual Water and Water Footprints* (pp. 139-143). https://doi.org/10.1007/978-3-319-16393-2_11

Scarascia, M.E., Di Battista, F. and Salvati, L. (2006). Water resources in Italy: Availability and agricultural uses. *Irrigation and Drainage*, *55*(2), 115-127. https://doi.org/10.1002/ird.222

Scienzia in Rete (December 31, 2010). *Climate change in Italy: what do we really know?*. Retrieved from http://www.scienceonthenet.eu/content/article/luca-carra/climate-change-italy-what-do-we-really-know/december-2010

Smith, A. and Ali, M. (2006). Understanding the impact of cultural and religious water use. *Water and Environment Journal*, *20*(4), 203-209. https://doi.org/10.1111/j.1747-6593.2006.00037.x

Spagnolo, M.E. (June 23, 2017). State of emergency declared in parts of Italy due to drought. *Lastampa in English*. Retrieved from http://www.lastampa.it/2017/06/23/esteri/state-of-emergency-declared-in-parts-of-italy-due-to-drought-V7qgIM89k4CmG0uLopjyCI/pagina.html

Swilling, M., Robinson, B., Marvin, S. and Hodson, M. (2013). *City-Level Decoupling. Urban resource flows and the governance of infrastructure transitions*. Paris: UNEP.

Tozzi, M. (2016). *Acqua: Risorse, consumi e problematiche in Italia*. Retrieved from http://www.toltedalcassetto.it/magra_pginfo_acqua_risorse_consumi_italia.htm

UNESCO and World Health Organization (WHO) (2015). *Progress on Sanitation and Drinking Water. 2015 Update and MDG Assessment*. Retrieved from: https://data.unicef.org/wp-content/uploads/2015/12/Progress-on-Sanitation-and-Drinking-Water_234.pdf

Weisz, H. and Steinberger, J.K. (2010). Reducing energy and material flows in cities. *Current Opinion in Environmental Sustainability*, 2, 185-192. https://doi.org/10.1016/j.cosust.2010.05.010

Wilk, R. (2006). Bottled Water. The pure commobity in the age of branding. *Journal Of Consumer Culture*, *6*(3), 303-325. https://doi.org/10.1177/1469540506068681

World Bank (2015). *Renewable internal freshwater resources per capita (cubic meters)*. Available at https://data.worldbank.org/indicator/ER.H2O.INTR.PC