New water footprint indicators for urban water cycle

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Abstract

The Water Footprint - WF is an indicator of anthropogenic pressures on aquatic systems. It is widespread and scholars have developed numerous insights into the virtual water flux activated by the global trade in agricultural and livestock products. In this study the flow of water resources that crosses the urban territories is reviewed through some contributions by researchers of WF and Urban Metabolism. Two new indicators are then developed to measure the phases of the anthropogenic cycle of water, starting from urban consumption. These indicators were then used to measure the urban footprint in Italy calculated as: drinking water consumption and volumes lost due to waterproofing of urban land. The total value of the blueprint of Italian municipalities is estimated at UBW = 5.184ml / m3 / year, while the green footprint is UGW = 1.123.860 ml / m3 / year. The calculation method is proposed so that it can be a useful tool for planners to identify the types of water use in urban areas to develop an bottom up approach.

1. INTRODUZIONE

The international community considers urban systems as the physical form in which it will be possible to achieve the objective of sharing equal rights to the benefits deriving from the current level technological systems development and to the natural resources use. The New Urban Agenda document approved by the United Nations Conference "Housing and Sustainable Urban Development" on October 2016, underlines how cities can be the source of resolution, rather than the cause of the challenges our world is facing. Agenda III aims to be a tool for decison making and stakeholders in urban planning based on the aspirations and needs of a civil society; able to imagine and realize the great structural transformations determined by the imprints of human systems on the territories. It proposes new urban planning skills, including supporting to: "*A greater capacity of national, sub-national and local governments in gathering, mapping, analyzing and disseminating data and promoting evidence-based governance* (n.159)". The goal is to promote shared knowledge using comparable data at global and local level, including through population surveys.

The World Economic Forum (2017) estimates that given that more than a billion people currently live in urban areas, water scarcity constitutes and will constitute the major risk that national and local governments will have to plan with new instruments in the short term.

Water scarcity is the subject of numerous studies of the Water Footprint Network, which has implemented a methodology for measuring the anthropogenic uses of water flows based essentially on three indicators: green water due to the use of precipitation flows; the blue water taken from the surface and underground water bodies, the gray water understood as the total flow of the dirty water introduced into the water bodies.

According to Hoekstra & Mekonnen (2012) water resource planning has been focused mainly on meeting the growing demands at local and regional level, without questioning the national level total volumes. A complete vision of national consumption has been lacking, both for drinking water services and for industrial consumption. The authors have measured with the WF indicators the water average global consumption and have quantified equal to 1: 385 m3 / year per capita in the period 1996-2005.

The WF indicators are widely shared by the scientific community and particular the studies aimed at measuring virtual water which "travels" with crop products and livestock farms. The virtual water concept, created by Allan (1999), is understood as the required water to satisfy the global dimension of the agricultural and zootechnical market. Not being subject to rules concerning the right to "water use" (unlike the right to emissions in the atmosphere, now regulated by the Kyoto Protocol Emission

Trading), it allows large operators to "move" water flows across continents , without any logic except economic. The effects on large urban areas of these food streams unhooked from the territories in which they are produced, is among the main concerns of international organizations first of all the FAO, (2011).

Compared to the vastness of the studies carried out on virtual water, the urban water footprint - the water used for drinking water consumption - has been the object of lesser attention by scholars. Probably because only in the last decade the city water scarcity begins to establish itself as a global problem. Naturally, this is a very different phenomenon, because water scarcity in urban areas does not mean exactly a consumption that tends to zero, as it happens in regions stressed by intensive irrigation. What worries the students of the Urban Water Footprint is the relationship between the large flows of water entering the urban territories, and the effects that this flow can have on the hydrological environment in terms of water volumes and water quality.

This study is questioning the possibility of declining the water footprint indicators to have shared values on the water use in urban areas, where "value" means a measurement of used and subtracted water from the natural environment for human use. First of all, a cognitive framework will be made on the studies that have been interested in giving "value" to the water flows of the urban context.

In paragraphs 3 and 4 footprint indicators have been proposed to measure the of water consumption variability in urban territories. We then calculated the Blue Water Footprint and the Green Water Footprint of the urban water flows. In paragraph 5, some uses of indicators developed in accordance with the WF methodology and literature have been identified. It is also argued that these indicators can be useful for urban planning with a bottom up approach.

2. THE URBAN ENVIRONMENT AS A FLOW OF RESOURCES IN / OUT

The Footprint that human systems culture imposes on terrestrial ecosystems is conditioned by processes of mutual adaptation between plant and animal species. These biochemical dynamics, while modifying ecosystems, unconditionally tend to bring them back into states of dynamic equilibrium in which each element is part of a whole. This scientific awareness, which has made its way in the last decades starting from Gaia theory, Lovelock (1980), then accompanied the scientific optimism on the resilience of the terrestrial system, which somehow has fed exponential uses of natural resources in the human economy.

Ecological Footprint scholars support the need to introduce appropriate indicators for measuring human pressure on natural systems Wackernagel & Rees, (1996). These Indicators are calculated not on the basis of the environmental characteristics compromised by human systems, but on the consumption of natural resources used in anthropic processes. The purpose of these indicators in the intentions of the authors was also to evaluate the land biocapacity coefficient, understood as the ability of natural systems to recompose states of equilibrium as a result of disturbances caused by human action. In fact, the dynamics of natural ecosystems have biological resilience times not compatible with the aggressiveness of the anthropic impression, Tiezzi (1989). The flow of resources consumed by the city has been the subject of studies on urban metabolism that describes the urban environment as a hybrid system where the main ecosystem cyclicities "intertwine" to the technological system built by man Baccini et al., (2012), Kennedy C et al., (2007), Gisotti (2007)

In particular, the in / out water flows that cross the city, develop dynamics that alter the pre-existing ecological characteristics, determining in most cases, new ecosystem cycles Varriale, (2017). As shown fig. 2, in anthropogenic water cycle there are many alterations of environmental processes and consequent risks for urban environment, including:

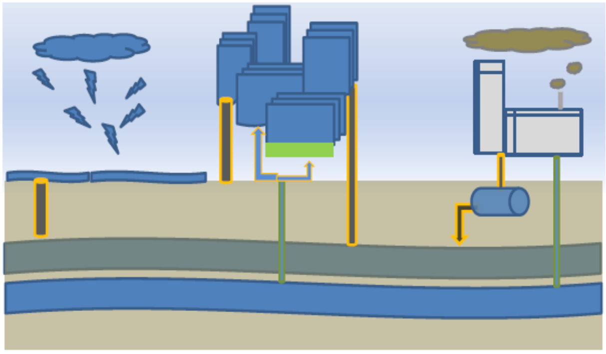


Fig. 2, Water antropic cycle

extraction from underground water tables with the risk of stress from the refill tanks until the water table lowering

- collecting rainwater in mixed systems conveyed directly into the disposal networks, with risks of urban flooding
- unauthorized withdrawals by economic operators with the risk of illegal discharges of industrial waste into the sewage system
- risk of increased losses from drinking water networks due to the obsolete status of the plants

In anthropogenic water cycle occurs the breaking of natural ecosystem cycles , and huge volumes of water are lost, particular in urban environments. Many scholars wonder themselves on this broken cyclicity and on how to recompose it starting detailed analysis of the water flow that cross the city. The metabolic water flow passes through the city to "nourish" it of all natural and anthropic elements, then come out and returned to the natural environments in qualitative and quantitative different conditions. Initially the studies on the Water Footprint, have argued that to measure the total volume of these flows there is the difficulty of measuring a dynamic flow subject to continuous changes. Indeed, the section of a watercourse can give different measurements of its flow rate according to the seasons. Furthermore, in the Footprint approach the measurement does not exactly match the volume, but the volume used, that means the part of the flow used for anthropic purposes. That volume in anthropic uses has a different value from that in nature.

In Seyam et al. (2003), water flow is defined as the missing link between water measurement and hydrology. Therefore, considering the inflows and outflows of water in a territory, the resilience of water resource is the amount of rainfall that recharge the territories where is pumping. It follows that the continuous water withdrawals from the water catchment areas for the supply of adduction networks, constitutes in fact a loss of value water flow.

According to Costanza, (2000), the attribution of the value of natural resource is necessary when must to make choices about the benefits deriving from its use. Generally the value of the costs and benefits of an environmental resource is difficult to quantified because it is necessary to evaluate a wide range of benefits including ecological sustainability, efficiency and social equity. But it is only the latter, according to Costanza, which favors the definition of the value of the resource, through public discussion, through a governance that aims to share the resource as a public good.

The need to globally share the value of water is also supported by Vörösmarty & Hoekstra, (2015) which signal the need for actions to face up the dangers of scarcity and pollution water with standards universally concerted on the sustainable water use. The assessment of water use in urban areas with WF indicators has been the subject of less attention by scholars. This is probably due to the fact that scholars have considered it more important to provide documented data on water stress in local or regional basins, to stimulate actions in the direction of sustainability by decision-makers at the government level, Chapagain (2012). In fact, in the study conducted on the Zambezi Basin, the authors had calculated the full value of all uses of the flow of the reservoir, including the value of virtual water stored by food and zootechnical products, to analyze the "geographical transfer" of water in global trade. Seyam et al. (2001). The urban water footprint is a very different phenomenon from the scarcity determined by the global virtual water trade. The water scarcity of urban areas is not exactly a consumption that tends to zero, what worries the scholars is the relationship that the large flows of water that enter urban territories can have with the urban ecosystem. Evidently the water value varies from the observation point: the footprint of vast regions or watersheds has a different meaning from the urban one, in the first place because the scale river basin of the urban water footprint is within of urban or periurban borders.

There are several studies that highlight the problem of the scale to evaluate the water footprint. Ma D. et al., (2015), for example, in the analysis of the WF in Beijing, show that the water consumption of the megalopolis is about ten times higher than the volume of resources available in the peri-urban area, which translates into inevitably in critical dependence of external water. Rushforth & Ruddell 2015 in the city of Phenix in Arizona estimate that the WF is wider than the regional footrpint, blurring towards other nations with the consequence of having to face the right to water with different political stakeholders. Other studies have instead focused on the development of new indicators to measure WF in urban areas. The study of. Wolfgang et al. (2016) proposes a methodology to evaluate the use of water on an urban scale. New indicators are proposed to quantify the consumption of drinking water networks on urban district scale The indicators are developed for the three blue, green and gray footprint and calculated both for the volumes of the drinking water of the supply networks collected into the sewage networks and both for the flows deriving from precipitation.

In order to plan resources based on the consumption reported in the footprint analysis, Agudelo-Vera et al. (2011) suggest the integration between those who manage water resources and those involved in urban planning, so as to ensure the principle of circular causality of the resources that enter and leave the urban territory. Monstadt (2009) provides an interesting contribution to the new perspectives of WF analysis in urban planning. The author also argues that the complex interdependencies between cities, network infrastructures and urban ecology could widen our understanding of the ways in which we can develop, govern and renew cities in a sustainable way.

It is precisely the technological networks, in which flow natural resources (water networks, electricity grids), which from urban planning perspective, favor the holistic approach of the design of urban spaces. In fact, *these must function as an integral part of a broader system, which also concerns participation, human capital, education and learning in urban development*, Papa et al., (2013).

Footprint analysis has been reproduced in urban planning, while urban population behavior analysis has been the subject of a wide range of studies starting from the School of Chicago. Footprint analysis have rarely been reproduced in urban planning, while urban population behavior analyzes have been the subject of a wide range of studies starting from the Chicago School. The study Gargiulo & Russo, (2017) aims to investigate how cities influence energy consumption and CO2 emissions. The study shows that many studies have been developed on the relationship between the physical characteristics of urban form and energy consumption, while the research focus rarely compares CO2 emissions with other urban characteristic areas such as functional, geographical and socio-economic aspects. The city in many studies continues to have a two-dimensional shape. Research rarely analyzes urban territories as processes of social action. In the upcoming dailing footprint assessments carried out with indicators developed ad hoc to account for water consumption of certain behaviors of users in the main Italian cities.

3. DRINKING WATER CONSUMPTIONS

The first problem that water consumption planning has to face is related to the uncertainties of data on consumer behavior. Consumer behavior in Italy for the period 2000-2011 has been analyzed. From the ISTAT data relating to 116 municipalities in Italy in the period observed, there is a substantial reduction in household consumption per capita of 5.35% (m3 / day) with reductions ranging from 8 to 22 m3 / d. In according ISTAT data relating to 116 municipalities in Italy in the period observed, there was a substantial reduction in household consumption per capita of 5.35% (m3 / day) with reductions ranging from 8 to 22 m3 / day. In the same period there was a population increase of 4.5%. We asked ourselves to what extent the increase in population can lead to alterations in the supply of drinking water services, by evaluating the deviations around the average of consumption. The distribution of the consumption reduction rate between 2001/2011, shows in Fig.1, is around an average value of 8.56. But the interesting datum is that of negative values around zero which attest to significant increases in consumption. This trend was compared with demographic trends and we found that the rate of consumption reduction is fairly distributed both in the provinces with an increase in population and both with an decrease in population. In some cases, where the population has decreased significantly, there have been less significant reductions in consumption of water consumption, tab.1. The trend of the population is therefore not a significant process for the definition of drinking water of the trends consumption as already demonstrated in a study on the negative correlation of energy consumption and population density Gargiulo & Russo, (2017). Yet nevertheless, many estimates of water requirements have been based on population density. To compare these conclusions with the choices made by the water service companies, the volumes of water introduced into the urban networks of the national territory were measured.

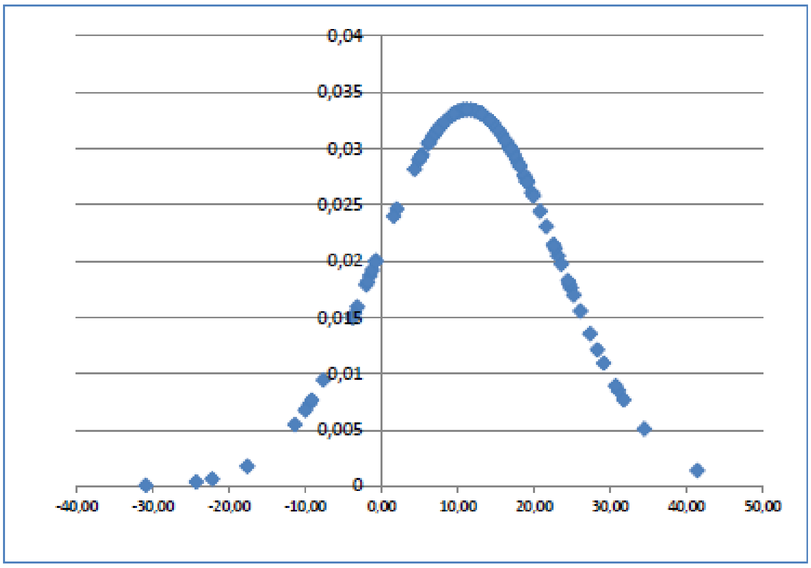


Fig. 1 Distribution of water consumption - population, 2001/2011 Istat Data

Province	Tasso di riduzione dei consumi	saldo demografico 2001/2011
Trieste	0,99	-10061
Treviso	5,89	3382
Cremona	2,65	-1298
Isernia	5,4	873
Caserta	0,71	552
Benevento	4,51	-307
Nuoro	11,87	-204
Sassari	5,31	3053
Oristano	1,73	488
Catanzaro	2,99	-5887
Crotone	2,46	-1129
Reggio Calabria	6,14	464
Catania	1,66	-19208
Caltanissetta	11,39	300
Messina	11,56	-8764

Tab.1 Reduction volumes entered /population, Istat Data

We have divided the data of the volumes entered for the period 1999-2012 (ISTAT data) into three main steps: 1999-2005; 2005-2008, 2008-2012 to evaluate regional variations. The objective was to verify consistent trends of growth or reduction of water volumes by region. The graph shows that volumes introduced into the network in the three periods vary in an inconsistent way in all the regions, Fig.2..

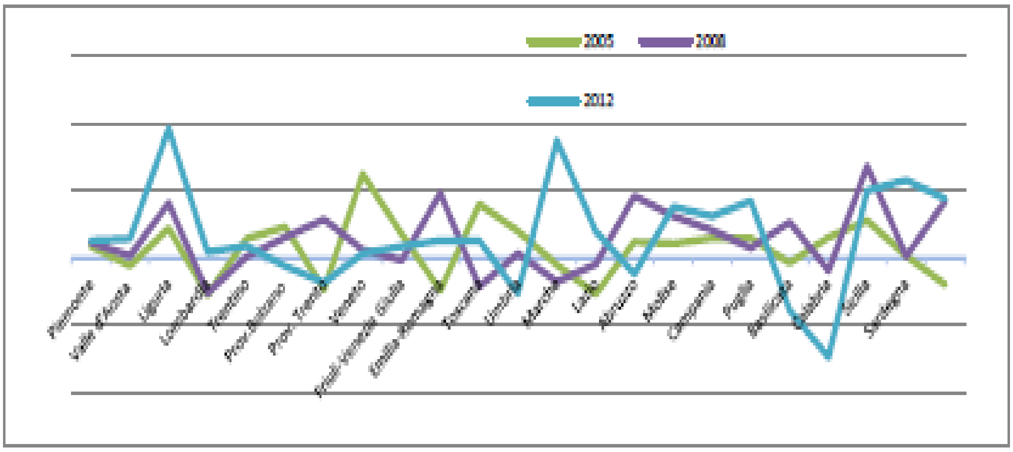


Fig. 2, Variation water volumes introduced in water network at 1999 / 2012, Ispra Data

For example, in the Marche region, volumes are fairly constant in the first two periods, increasing significantly in the third While the opposite happens in Calabria, in the third period the volumes introduced into the network are decreased significantly in the third period.

These variations can be explained both due to the needs of the drinking water network (with the aim of regulating the pressure of the stations), and according to the consumption recorded in the final balance in the previous years. In any case, this measurement confirms the instability of consumer behavior that perceives water consumption more as a right, rather than a commodity offered on the services market. The hypothesis that the population does not have a clear awareness of their water footprint and the context in which it is exercised, is confirmed by a survey in USA of 2017 conducted on 1020 participants to evaluate the most effective behaviours for the reduction of Water consumption, Attari, (2017).

The findings of the survey showed that the majority of respondents in the choice between efficiency and savings, indicated the savings as a solution to excessive consumption (for example by choosing shorter showers, alternating water when brushing their teeth, etc.) rather than indicate efficiency improvements (replacement of toilets, dirty water recovery facilities, etc.).

	2016
Consumatori Italia acqua bottiglia	54.721.800
Consumo in l/anno/p.c.	206
Bottiglie acqua in mgl*	12.700
Export /l in mg	1.130
Consumo italia l/mg	11.570

Tab. 2, Statistiche bottigle plastiche su dati Censis

** mgl= in migliaia litri*

Then water is perceived as good that belongs the private sphere of the subject, determinated by individual choices in which it bases the inalienable right to water. The survey findings conducted by Censis (2016), in Italy on the consumption of bottled water confirm this hypothesis. The survey conducted in 1995/2016 on the consumption of bottled water in Italy, it is observed that 90.3% of the population declares to drink at least 0.5 L/GG of bottled water, for total 206 L/year p/c consumption. So the water consumed has a "social" value different from the need for natural right to water. Finally, as indicated in the tab. 2, the total Imprint of bottled water in Italy, including exports, is equivalent to 12,700,000,000 l / year. If we want to quantify the drinking water consumption - the water that Italians consume to quench their thirst and for personal use, we have the following:

$$W_{ci} = W_p + W_b = 2.446.434.000 + 12.700.000 = 15.146.434\ m^3/y$$

Where W_p = volumes of potable water (Istat 2012); W_b = consumption of bottled water. The following are two new indicators to quantify the blue and green footprints in Italy, which take into account the consumption described above.

4 BLU WATER FOOTPRINT

Il totale dei consumi idropotabili calcolato nel precedente paragrafo, costituisce una parte del volume di Acque blu così come generalmente viene calcolate nell'account del WF che distingue acqua blu, verde e grigie. Per quanto riguarda i consumi di acqua blu come indica la fig.3 le regioni con un impronta Blu più significativa sono : Piemonte, Lombardia, Lazio, Campania, Sicilia.

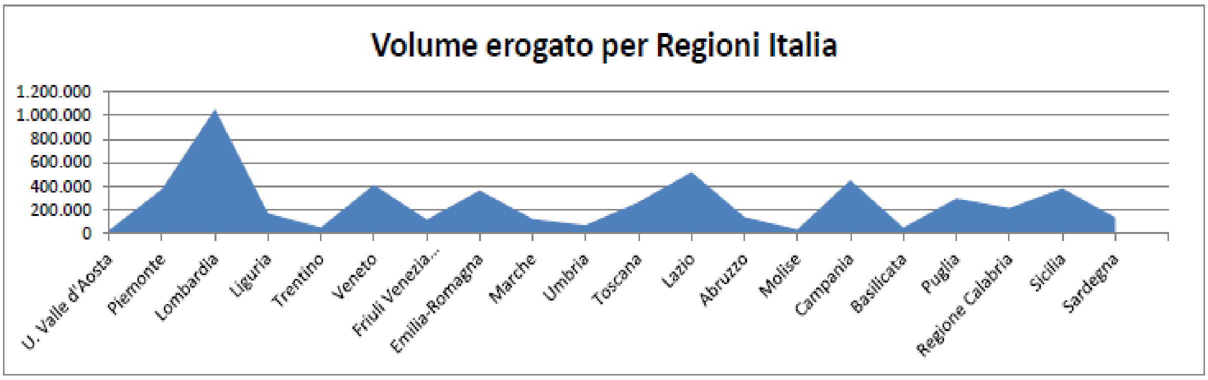


Fig. 3, Water volume distributed by regions, Istat 2015

Actually the blue urban water footprint is not only due to the resident population consumption, but to the sum of the processes that lead to the provision of the water service in a city, of which:

- users of private homes including processes relating to the private sphere and families, including: personal cleaning, food, laundry, cleaning the house, care of private gardens and communal areas, etc.
- users of public buildings and collective institutions such as: hospitals / private clinics, schools / universities, markets, prisons, banks, public and private offices, religious institutes, etc.,
- users for various public services such as: management of urban green spaces, urban spaces; public fountains, street washing; fire service, sports facilities tank cleaning, sewer cleaning, etc.

Estimating the water supply of an urban environment it must takes into account all these processes for a correct planning of water needs. Many of these processes can be overestimated or underestimated because obviously they vary over time according to the evolution of the territory social dynamics where the amount of the population may not significantly affect. Some regions already have Regional Plans Water in which it is highlighted the importance of further data on the socio-economic characteristics that make up the water demand in an area. A factor to consider in the analysis of the water footprints of urban relates to the sources from which they are taken of volumes of water.

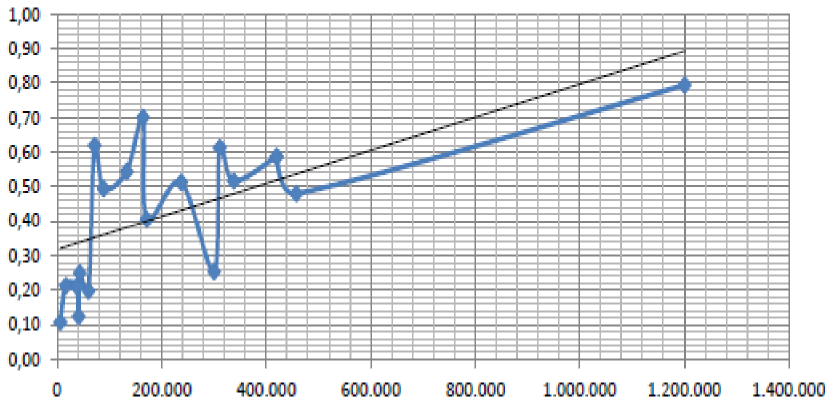


Fig. 4, Wells Withdrawls italian region, Istat 2012

The main sources of pumping in Italy are: the source, the well, the basin, the lake, or the surface water. As shown in fig.4, the well withdrawal represents, on average, the most used refueling in the Italian regions. In fact, the majority of regions satisfy more than 50% of their needs with groundwater withdrawals, with the exception of Basilicata, which makes only withdrawals from surface waters.

The recharge capacity of groundwater has difficult times to define determined both by the depth of the stratum and by the characteristics of the ground, for this reason it has a very significant value for the calculation of the blue imprint.

Water withdrawals from the Italian regions are distributed: well 48.3%, sources 36.3%, and surface waters only from the regions: Emilia Romagna (44%), Sardinia (75%) Basilicata 100%. The per capita consumption footprint is fairly uniform throughout Italy, with the exception of higher values in the regions: Aosta, Liguria, Lombardia, Abruzzo, Calabria.

The calculation of the water footprint can be identified as an early warning system Steffen et al. (2011). According to the authors*, the nature of the Earth-system dynamics-the nonlinearities, the tipping elements, the thresholds / abrupt changes-strongly that humanity needs a system to warn us when we are approaching such potentially catastrophic points.* An early warning system is a prerequisite for being able to recognize and steer away from such thresholds. Each boundary is placed within a zone of uncertainty that scientific research can reduce, zero or put in further alarm. It all depends on the ability to assimilate new scientific information on the terrestrial system, on ecosystems, on urban systems.

Italy' Urban Blueprint is characterized by a medium pressure on underground resevoiser and the large volumes fed into the urban grid, of which only part is consumed (fig.5). With the exception of Puglia that supplies more volumes than it take, all regions take out more than 60% of the water really they supply. The extreme cases are Basilica and Marche, which take almost 90% more than they consumed and Valle d'Aosta and Sardinia 70% more.

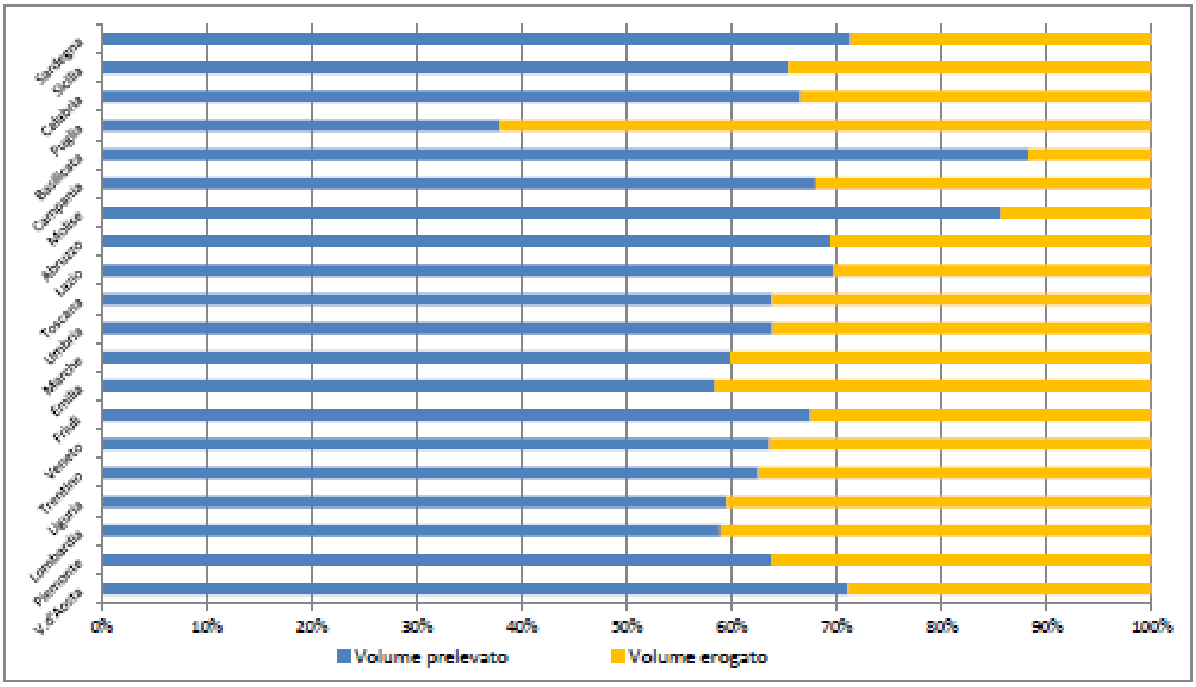


Fig. 5, Water volumes withdrawn and supplied, ISTAT 2012 data.

It is reasonable therefore to think that the calculation of the Blueprint must take into account these dynamics that impact on the peri-urban territories that supply the cities. In order to characterize the water uses of an urban area, the processes that must be taken into account for calculating urban footprint are:

UW = underground withdrawals

If / f = water network in / out

UBW = Urban behavior.

The urban behaviour referred to water – UBW, is a measure with which we want to collect more detailed information on actual water consumption in the urban environment, and we suggest it is determined by:

$$\sum UBW \quad = \quad C_{wb} + C_{wp} + C_{wu} + C_{wc,} + C_{we} \qquad (1)$$

Where: C_{WB}=water bottles consumption, C_{wp} = consumption of aquatic parks/water sports, C_{wu} = consumption invoiced to households, C_{wc} = consumption invoiced to industrial and commercial users, C_{we} = consumption invoiced to industrial energy users and high Environmental impact.

Obviously these are volumes with different capacities (the only energy industry, for example, covers 74% of water consumption in Lombardy) but they could characterize the blue footprint in the context in which it applies. The UBW is an indicator that expresses both volumes of water taken from the natural environment and the way in which these volumes are used in Anthropic uses.

Consumption water parks are generally estimated at around 20 l / second for a daily volume (12h) of 684 m3. We calculated the footprint in C wp = 1.684.800 m3 / year, referred only to the first 15 national parks in the summer.

It should be borne in mind that generally parks, as well as energy production companies or metallurgists, have a high environmental impact due to the large flow rates they require in the production cycle. Often these operators are supplied directly on the water table. Authorizations to the levy are regulated at regional level by limits on daily flow rates, but there are no shared and objective data on the consumption invoiced by the companies in these withdrawals.

Data on industrial and trade footprints, which are classified as economic operators, are not particularly monitored by the bodies issuing permits for water withdrawals. For this reason we have used the aggregate data of per capita water consumption, which also includes the economic sector. Using the data in our possession, the value of blue water impressions in urban areas in Italy is: UBW = 5.184ml / m3 / year where we have calculated only volumes invoiced to domestic and private users, and our estimates of other volumes including Cwp and Cwb.

5. GREEN FOOTPRINT

In the WF account the green water is calculated as irrigation water volume used in agricultural areas and is used as the virtual flux exchanged globally. Instead in this study the green water is intended only as a flow deriving from rainfall in urban and peri-urban areas.

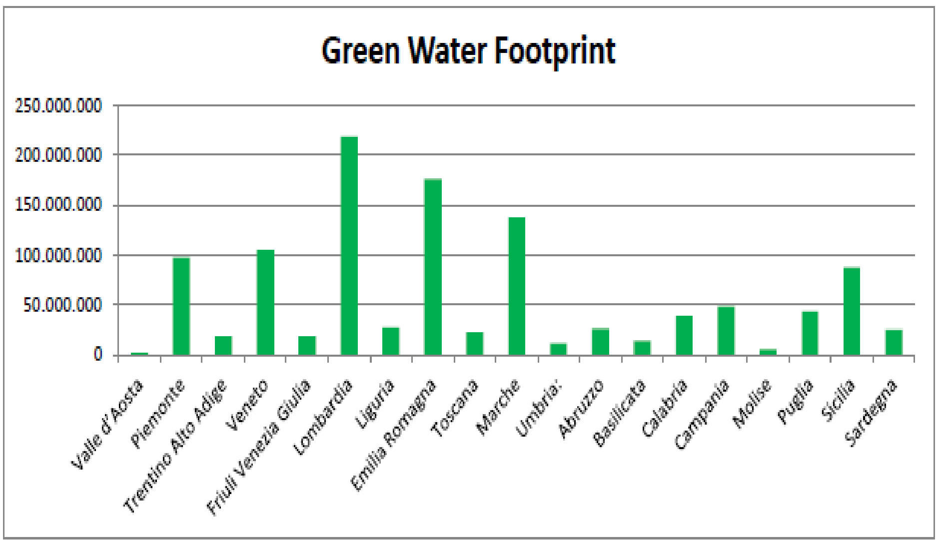
The flow determined by meteorological events, in the account of the Footprint is called renewable water because, under natural conditions, the flow of water is distributed in the soil by percolation, and in the atmosphere by evapotranspiration.

In this study for the calculation of the urban water footprint it was considered that the waterproofing of urban territories is the cause of "water consumption". In reality it is meteoric waters that are subtracted from the natural flow and are conveyed to the collecting networks to be disposed of. Obviously, more the waterproof surface is large, greater is the water that is subtracted from the natural environment. On these considerations we have therefore calculated the Green Water as:

$$UGW = [\ (A_{gu} - A_v) * I_{pr}\ ] - G_{reen}\, I_{nf} \qquad (2)$$

where UGW = urban green water; A_u = Urban Area; A_v = Urban Green Area + Protected Area + UAA Urban Agricultural Area (Istat 2016); I_{pr} = Provincial index of precipitation, $G_{reen}I_{nf}$ = Green infrastructure.

The data calculated for the municipal territories of all the Italian regions, have been aggregated here by Regions. We have calculated the urban green footprint on the national territory is UGW = 1.123.860 ml / m3 / year. The most significant green footprint is that of the Lombardy region, followed by Emilia Romagna, Marche, Veneto, Piemonte, Fig. 5.



Regioni Italia	Green Water Footprint in l/mq
Valle d'Aosta	2.070.801
Piemonte	97.387.882
Trentino Alto Adige	18.517.015
Veneto	104.883.152
Friuli Venezia Giulia	18.517.015
Lombardia	217.759.434
Liguria	27.374.494
Emilia Romagna	176.120.082
Toscana	22.632.870
Marche	137.706.227
Umbria:	11.219.645
Abruzzo	26.332.883
Basilicata	14.128.918
Calabria	39.071.058
Campania	48.010.692
Molise	6.082.316
Puglia	43.445.966
Sicilia	87.440.791
Sardegna	25.149.410
Totale Italia	1.123.850.651

It should be noted that there is no public data for Green Infrastructures, so, where the cities will become smarter, it will be possible to complete the calculation by lightening the Urban Green Water with the infrastructures that recover and recycle urban water.

6. Water intelligence: the boundaries of the urban water footprint

The blue and green calculated footprints (stress of the surface and underground basins and soil waterproofing) indicate impressive ecosystem problems that cities will not be able to cancel in the short term if not for joint intelligence actions. The governance of the parties involved will have *the ability to bring together technological, economic, social and eco-compatible factors in urban planning that sees sustainability as the critical element of urban quality and a determining factor in competitiveness,* Papa (2017), and the ability to attract resources, know-how and investors.

It can't be ignored that the financing of many water sustainability projects will be beyond out of reach of public administrations. To date many political decisions are aimed at increasing the efficiency of the drinking water networks through innovations able of network self-regulation (in terms of losses and relative pressures of flows), with the aim to reducing the serious wasteful that the water distribution service registers in Italy (the about 45% of the volumes losses) Giugni (2017).

But even the implementation of these soft technologies clashes with financial difficulties of administrators. According to Vörösmarty C. J. (2015), all this suggests that water governance in the future may not be the exclusive domain of a regional government or a public one. According to the author, although water remains a public resource, it can be hypothesized that the role of companies and private investors can become fundamental in the management of water resources. So urban planning will have to deal with a plurality of actors and with more defined governance tools.

On the other hand, the ambitious Smart City projects financed and implemented only by large private investors, such as the Masdar project in Abu Dhabi, were failures in terms of the competitiveness of the urban territory. The urban sustainability project must be supported by the incremental growth of social capital, which is based on a greater degree of cooperation and interaction among the stakeholders of the cities Papa (2017).

Water intelligence can’t be understood only as a technology to save and recover the waters of the urban anthropic cycle. The great transformations of urban areas can be started both with a new capacity to govern by putting together the pieces of highly complex social action, and by the ability to coordinate actions, projects and integrate technologies that are still developed separately from each other, but that have clear synergies in their operation and must be shared by their users Gargiulo & Russo (2013).

It is necessary to recalibrate the sustainability objectives towards new and necessary dynamic balances. Likewise it happened with the boundaries of the climate that initially had a limit of 450 ppm of CO_2, and then dropped to a more optimal threshold level of 350 ppm. Everything suggests that the anthropic footprint must be managed in concert with a research capable of analyzing the phenomena of our dynamic social, indicating the limits, the threshold values beyond which our footprint can not be pushed. About these borders water intelligence will have to work.

7. Conclusions

The indicators proposed and elaborated according to the Water Footprint methodologies, present two substantial innovations in the studies on anthropogenic pressures, including:

1. first of all the characterization of the anthropic use of the natural resource starting from the behavior of the networks of social actors - ANT Latour, (1999). Often Footprint studies aim at ecosystem considerations that want to evaluate for the effects that the anthropic use of resources imposes on the natural system. Instead in this study the main concern is to

characterize the behavior of the ANT networks to develop programs for the sustainability of anthropic uses;

2. moreover, the urban dimension of the green footprint. The GWF in the WF account is defined as the renewable resource that is subtracted from its ideal cycle to enter the virtual cycle of trade in agricultural and zootechnical goods. This approach does not take into account the urban ecosystem that is characterized by large waterproof surfaces that break natural ecosystemic circularity. For this we have calculated the green waters according to the waterproof surfaces of the city. That is, the calculation of the GWF occurs in the face of a territories that "consumes" the meteoric waters, taking them away from the natural cycle of water.

The purpose of the study was to investigate urban consumption, a sector not very detailed by the WF. We have seen how consumption data often entrusted to water service operators, do not give evidence of all the phenomena that contribute to urban water footprint.

The blue and green footprint are then calculated in Italy, with indicators that can be replicated in other national or local contexts for comparison. The UBW indicators proposed in this study are based fundamentally on some observations:

• not all human uses of water are monitor, specially withdrawals by economic operators

• calculation of withdrawals from underground reserves and surface water bodies does not take into account all the withdrawals made for the agricultural, industrial, tourism and leisure sectors

• the volumes of dirty water invoiced by the companies do not always correspond to the volumes of dirty water actually delivered to the water bodies

We tried to include the behavior of social actors in the method of calculation: consumers, businesses, utilities. This enriches the information needed to cope with the scarcity and water stress of urban areas. This bottom up approach must integrate in an organic way the limits and the potentials of the use of resources within technological systems capable of making a smart city. A further contribution to the calculation of the water anthropic cycle could also come from the spatial analysis of water flows ad local scale and from the studies addressed on "city boundaries" topics.

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9. Reference

Housing and Sustainable Urban Development (Habitat III), 2016, Quito, Ecuador, New Urban Agenda

World Economic Forum Annual Report 2016-2017, www.weforum.org

Hoekstra A. Y., Mekonnen M.M., 2012, The water footprint of humanity PNAS, vol. 109 no. 9

Allan, J.A. (1998), Virtual Water: A Strategic Resource: Global Solutions to Regional Deficits. Groundwater 36, N.4, 546,

FAO 2011, The state of world's land and water. Resources for food and agriculture. Managing system at risk, The Food and Agriculture Organization of the United Nations and Earthscan

Lovelock (1980) Gaia,

Wackernagel M, Rees W, (1996), Our Ecological Footprint: Reducing Human Impact on the Earth

Tiezzi E., (1984), Tempi storici, tempi biologici, Garzanti,

P. Baccini , P H. Brunner, (2012), Metabolism of the Anthroposphere. Analysis, Evaluation, Design. II°

C. Kennedy, J. Cuddihy, J.Engel-Yan, (2007), The Changing Metabolism of Cities, Massachusetts Institute of Technology and Yale University

G. Gisotti, (2007), Ambiente urbano, Introduzione all'Ecologia Urbana, D. Flaccovio ed.

Varriale R., (2017) The Urban Footprint in urban territories, Phd Thesis

Seyam I.M., Hoekstra A.Y., Savenije H.H.G, (2003) The water value-flow concept, Physics & Chemistry of the Earth

R. Costanza, R. de Groot, P. Sutton, S.van der Ploeg,S. J. Anderson, I. Kubiszewski, S. Farber, R. Kerry Turner, (2014) Changes in the global value of ecosystem services, Global Environmental Change, 152–158

J. Vörösmarty , A.Y. Hoekstra, S.E. Bunn, D. Conway, J. Gupta, (2015), Fresh water goes global, Science, vol. 349,

Chapagain, A.K., Tickner, D. (2012). Water footprint: Help or hindrance? Water Alternatives 5(3)

Seyam I.M., Hoekstra A.Y., Ngabirano G.S., Savenije H.H.G. , (2001), The value of freshwater wetlands in the Zambezi basin, IHE Delft

Ma, D., Xian, C., Zhang, J., Zhang, R., Ouyang, Z., (2015), The evaluation of water footprints and sustainable water utilization, in Beijing. Sustainability

Rushforth, R. R.; Ruddell, B. L. (2015), The hydro-economic interdependency of cities: Virtual water connections of the Phoenix, Arizona Metropolitan Area. In Sustainability: Rushforth, R.R.; Ruddell, B.L. The hydro-economic interdependency of cities: Virtual water connections of the Phoenix, Arizona Metropolitan Area. Sustainability

Wolfgang R., Scipioni A., Manzardo A., Loss A., Fialkiewicz W., (2016). Methodological proposal to assess the water footprint accounting ofdirect water use at an urban level: A case study of the Municipality of Vicenza, Ecological indicator

Monstadt J. (2009), Conceptualizing the political ecology of urban infrastructures: insights from technology and urban studies, Environment and Planning A 2009, volume 41

Papa R., Gargiulo C., Galderisi A., (2013) Towards on Urban Planners' perspective on Smart City, in Tema. Smart cities researches, projects and good practices.

Gargiulo, C., Russo, L. (2017). Cities and Energy Consumption: a Critical Review. Tema. Journal of Land Use, Mobility and Environment, Issue Volume 10(3), 259-278

Attari Z., (2017), Perceptions of water use, PNAS on line, http://resources21.org/cl/files//project482

_6358/How%20Much%20Water%20L1040.pdf

Censis, (2016). Il valore sociale rilevato del consumo di acque minerali, http://www.centromarca.it/

media/186291/consumi-acqua-censis.pdf

Papa R, Gargiulo C, Russo L, Franco S., (2017), On the relationship between the promotion of environmental sustainability and the increase of territorial competitiveness: the Italian case, Sustainable and development and planning, vol. 12, n.4, 2017, ed. WIT

Giugni M., De Paola F., Pugliese F., Romano P., (2017) A decision support system for urban stormwater drainage management, *E.W. Publications European Water* 57: 115-121, 2017.

Hoekstra A. Y., What scale for water governance?

Vörösmarty C. J. , Hoekstra*,* A. Y., Bunn S. E.*,* Conway D.*,* Gupta J. (2015), Fresh water goes global, Science, Vol 349 ISSUE 6247 sciencemag.org

Steffen W. L., Rockström J., Costanza R., (2011), How Defining Planetary Boundaries Can Transform Our Approach to Growth, Institute for Sustainable Solutions Publications.

Bruno Latour, Reassembling the sociale. An introduction to Actor-Network-Theory, Oxford University Press, New York, 2005