URBAN_WFTP
Central Europe project 4CE439P3

Urban Water Footprint

PROJECT FINAL ABSTRACT

"URBAN water footprint: a new approach for urban water management"

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The next challenges of the application of the water footprint approach in urban areas

The study is innovative and useful in a number of ways. This is the first detailed and comprehensive framework on Water Footprint Assessment of urban areas in Central Europe region. The project is successful in identifying specific water issues using the framework of Water Footprint Assessment in the three labs developed.

The Assessment framework is based on the manual developed by Water Footprint Network [Hoekstra et al 2011[1]]. The scope and boundaries of such assessment is determined by the level of existing information and understanding of the water footprint within the selected cities. The suggested water footprint accounting models for three different levels can form a basis for accounting the internal water footprint within an urban area based on the level of information available and scope of the study chosen. The additional module in the accounting framework where external water footprint of the city is analyzed, plays a key role in addressing the water related issues in urban areas in a holistic framework as a large part of the water footprint related to food and industrial products are external to most of the cities.

The project has estimated the baseline water footprint accounts, and suggests a set of broad response options for three labs. Currently it doesn't provide the full sustainability assessment of the water footprint of the selected regions.

[1] Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and Mekonnen, M.M. (2011) The water footprint assessment manual: Setting the global standard, Earthscan, London, UK

However even at this first level of assessment, the project has identified key areas to focus for a sustainable, efficient and equitable use of water resources within a city area. The framework will immediately benefit with improvements such as:

- the water footprint accounts of city should also include external water footprint and its assessment;
- the estimation of the grey water footprint can improve following the guidelines from WFN [Franke et al 2013[2]]. The source [point versus non-point] of grey WF plays a key role in identifying appropriate response options;
- the rate of groundwater recharge and degree of built-area has a direct consequence in the blue water availability in the basin. A through assessment based on the dynamics of this relation could reveal key intervention points for future developments;
- understanding how the household water supply and sewage treatment system function in a city area is a key in the assessment of both blue and grey water footprint within the city area;
- the current study is a snapshot of the existing situation. For a resilient response strategy the blue, green and grey WF and blue water scarcity should be based on future scenario under climate change, population growth, degree of urbanization and its effect on water demand;
- the response strategies could benefit from a full sustainability assessment of the water footprint accounts using environmental, social and economic criteria as suggested in the Water Footprint Assessment manual developed by WFN.

[2] Franke, N.A., Boyacioglu, H. and Hoekstra, A.Y. (2013) Grey water footprint accounting: Tier 1 supporting guidelines, Value of Water Research Report Series No. 65, UNESCO-IHE, Delft, the Netherlands.

Key issues and recommendations in scaling up the framework can be summarized as:

- the findings form three labs developed show that water resource management within the city area not only depends on its internal water resources but also on where its external water footprints are located;
- the water scarcity and water pollution issues are not limited to the city boundaries, and are largely key attributes of the whole basin where these cities are situated. Hence, for a comprehensive water policy, the cluster approach of combining key urban and rural areas situated in the concerned basin is appropriate;
- the level of assessment is defined by the level of information available, location specific water issues, and level of awareness of the role the water footprint assessment plays in water management in urban areas. Data availability and quality are the two main issues and hence any improvement in data collection and data storage systems to facilitate data processing is key for further refinements in these studies;
- the water allocation (abstraction license, waste water discharge regulations, water rights) plans and policies in a city could benefit from a holistic water footprint assessment including both the internal and external WF and their sustainability assessments;
- the current study can provide a generic template for scaling up such assessments in other cities globally.

The combined effects of climate change and growing demand on water will put more pressure on the existing water resources. The interactions between human usage, management of water and the response of nature to such human activities are complex. Therefore, we need various tools to assist us in coping with the challenges in managing these precious water resources. Water Footprint Assessment is such a tool and is useful in helping us better understand what and where the pressures on freshwater resources are and what changes are necessary to improve the sustainability, efficiency and equitability of water use. It is a holistic tool unifying both quantity and quality aspects in water resources assessment, planning and management. The information developed in this study can also function as a platform or as an instrument for discussion and dialogue among city regulators, water utilities and water users.

Dr. A.K. Chapagain,
Science Director, Water Footprint Network

Water resources in the European Union

World population growth, economic development and climate changes have put a lot of stress on the availability of natural resources such as water. In fact this resource, which is fundamental to guarantee life of human beings and ecosystems, is present in limited quantity on earth. As a consequence a growing number of countries are dealing with the issue of water scarcity at the same facing acute water pollution resulting fuelled by unsustainable use of the resource base. Recent estimates of the United Nations, shows that within 2025 over two/third of the world population will live in water scarce regions.

Also in Europe there are evidences of this significant issue; recent estimates show that 10% of the European population and the 20% of the territory are suffering of the consequences of limited water availability. Since 1980, the number of droughts in Europe has increased, and they have become more severe, with negative effects on European economy and society (fig. 1).

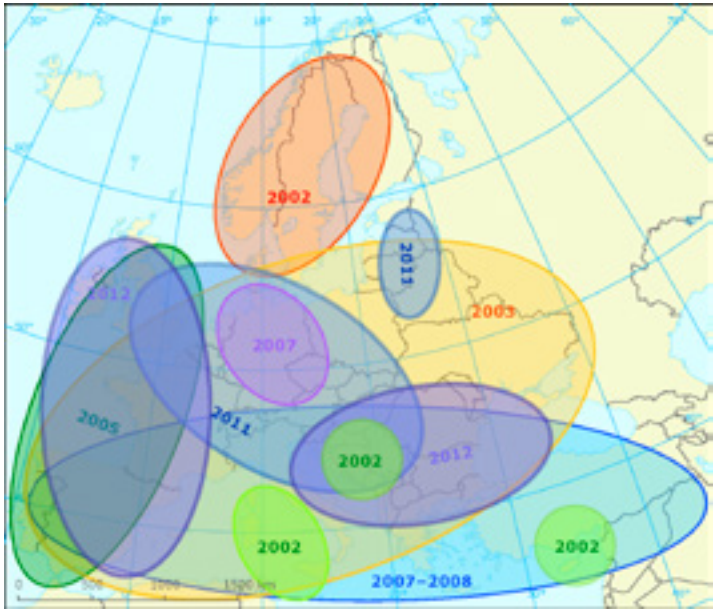

Figure 1 Maps of recent Water droughts in Europe (EU, 2012)

Considering that 75% of European citizens lives in cities, a large share of pressure on this precious resource arises from the demand and use of water intensive goods and services. Water management at urban level is therefore recognized to be a priority.
To address the social, economic and environmental issues related to water, the European Union (EU) in 2011 launched a policy document titled "Roadmap to a Resource Efficient Europe" (EU, 2011) and identified the need to apply innovative scientific approaches to guarantee the correct management of local water resources.
One of the most relevant approaches recognized by the EU to positively contribute to water management is the **Water Footprint Assessment** one.

What is a Water Footprint?

It is a measure of the appropriation of freshwater resources that considers direct water use (use of water within the urban boundaries) and indirect water use (e.g. use of water in the supply chain of the goods and services consumed in the urban area). This water use, called the water footprint, can be separated into three components based on the sources of water used:

- the Blue Water Footprint: is the consumption of blue water resources (surface and groundwater withdrawn and not returned to the same water body within a catchment area);
- the Green Water Footprint: quantifies the human consumption of the so-called green water. Green water is the part of the precipitation stored in the soil or which temporarily stays on top of the soil or vegetation. The green WF is particularly relevant for agricultural and forestry products (products based on crops or wood). It refers to the total rainwater evapotranspiration (from fields and plantations) plus the water incorporated into the harvested crop or wood;
- the Grey Water Footprint: is the volume of freshwater that is required to assimilate the load of pollutants based on natural background concentrations and existing ambient water quality standards.

There are many examples of the application of this measure to products, processes, organizations, group of consumers, specific regions, and nations.

Through the application of the Water Footprint Assessment following the manual developed by Water Footprint Network (Hoekstra et 2011[3]) it is possible to identify strategies and actions to guarantee a sustainable use of water resources.

The Project "URBAN_WFTP - Introduction of Water Footprint (WFTP) Approach in Urban Area to monitor, evaluate and Improve the Water Use"

It is a CENTRAL EUROPE project that applied the Water Footprint Assessment framework to different central Europe urban areas in order to improve currently used technologies and to integrate innovative tools for monitoring and managing citizens' water use, water networks and wastewater treatment systems. The project started in November 2012 and involved 9 partners from 5 different European Countries (Table 1) and ends on November, 31st 2014.
The general objectives of the projects are to:

- promote sustainable water use;
- development of appropriate response strategies and application of appropriate technologies to achieve the sustainable, efficient and equitable water use.

[3] Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and Mekonnen, M.M. (2011) The water footprint assessment manual: Setting the global standard, Earthscan, London, UK

Logo	Partner	Country
	Department of the Industrial engineering of Padova University (Lead Partner)	Italy
	Veneto Productivity Center Foundation	Italy
	Municipality of Vicenza	Italy
	Department of the Environmental engineering of Innsbruck University	Austria
	Alps GmbH	Austria
	Nuremberg Chamber of Commerce and Industry	Germany
	Department of Environmental Science of Wroclaw University	Poland
	Wroclaw water management company	Poland
	Eszak Alfold Regional agency for the energy	Hungary

Table 1 Project Partners

The project objectives can be summarized as follow:

1. adapt the Water Footprint Assessment framework to be applicable to Urban Area; this activity was specifically performed by the three universities involved in the project: The University of Padova (Lead partner of the project), the University of Wroclaw and the University of Innsbruck;
2. activate three Urban Water Footprint Laboratories (UWFTP-Labs); these are virtual laboratories where people share ideas and determine intervention strategies to better manage water in Urban Area based on the applications of the Water Footprint Assessment approach adapted within this project. Three labs has been activated during the project: on in Vicenza, managed by the Municipality;

one in Wroclaw managed by MPWIK, local water management company; one In Innsbruck managed by alpS a center for climate change adaptation.

The adaptation of the Water Footprint Assessment approach to Urban Area

The Water Footprint Assessment (WFA) methodology (Hoekstra et al., 2011) developed by Water Footprint Network (WFN) can be applied for a holistic understanding of the sustainability of the water footprint of an urban area. Water Footprint Assessment[4] includes four phases:

- **phase 1: Setting goals and scope.** Identification of the objectives and scope of the assessment, including geographical/ temporal and process/ supply chain boundaries
- **phase 2: Water footprint accounting.** Calculation of the operational ("direct") and supply chain ("indirect") water footprint, including quantity and quality parameters
- **phase 3: Water footprint sustainability assessment.** Assessment of the water footprint against environmental, social and economic criteria
- **phase 4: Water footprint response formulation.** Identification of strategic actions to reduce the water footprint or improve its sustainability

However, since the very beginning of the project it has been clear that different Central Europe regions had different water related issues:

1. in the case of Vicenza the main issue was to determine indicators and information to support the future updating of the Urban Development plan; they therefore needed a detailed assessment of water use within the city and by different buildings located in the Urban Area;

[4] For additional details on Water Footprint Assessment please refer to the Water Footprint Assessment Manual (Hoekstra et al., 2011).

2. in the case of Wroclaw the main issue was to localize the different water related issue within the city in terms of both water consumption and pollution in order to better support the planning of water management practices and interventions. To do this a model to represent different indicators in different city area were needed;
3. in the case of Innsbruck the main issue is related to the indirect water use, the also called virtual water that is contained in products. The habits of the city of Innsbruck in terms of water use has therefore been the focus of the Water Footprint Labs

To satisfy the different needs of the cities involved in the project a multilevel approach has been developed in the first phase of the WFA (fig. 2).

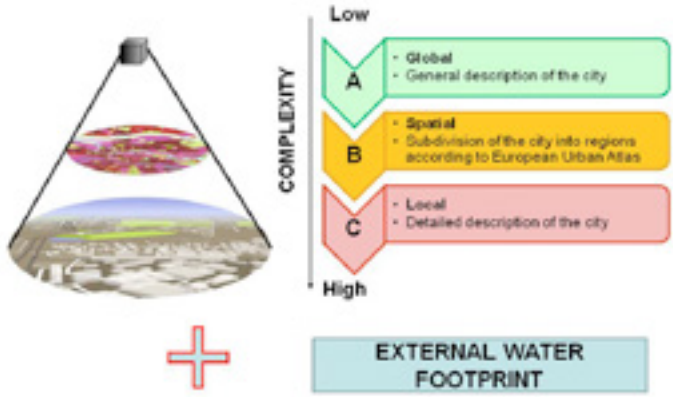

Figure 2 Different levels of Urban Water Footprint Assessment

The water footprint accounting at level A is made at global scale [called Model A]. Model-A has been applied in all the different UWFTP-Labs and served to identify the main hotspots related to water and set a baseline of the general description of the city water related issues. The water footprint accounting at level B [called Model B] uses a geographical information system (GIS) to create spatial distribution of water footprint within the city boundaries. It has been applied specifically to the city of Wroclaw. The detailed WF accounting at level C [called Model C] determines the city water footprint through a multi-linear modelling approach. It is applied to Vicenza. As the three levels only includes direct water footprint of consumption. The indirect water footprint of consumption [External WF] of the city originating from the consumption of water intensive goods and services produced outside the city boarders is quantified with the help of trade [import and export] data, starting from statistical data analysis, has been applied in Innsbruck.

The Urban Lab of Vicenza

Vicenza is located in the northeast part of Italy in the Veneto Region (45°N, 11°E). The majority of the land consists of green areas (forest, woodlands and gardens) and agricultural areas which cover about 50,6% of the city area. 34,8% of the whole area is built-up and consists of private houses, industry, public and commercial buildings. In the year 2011 the city's population counted 115.675 inhabitants.

Activities of Vicenza Lab

The labs has worked on two main topics:

- **support the creation of specific knowledge** on how water is managed in the city to support the future update of the urban development plan;
- **create awareness among citizens** on the use of water and on the concept of water footprint in order to improve their consciousness related to water issues and help them to better manage water in their House.

To accomplish this targets the Vicenza UWFT-Lab realized several workshops and meeting with the University of Padova, local water management companies and with citizens. Two questionnaires have been specifically designed and sent to citizens with a high response rate. The first questionnaire was focused on water consumption, the second one was related to the water discharges.

Key response and lessons learned in Vicenza

Through the application of model A and model C to the city of Vicenza the UWFTP-Lab has been able to identify the main hotspot related to water footprint in the city and determine a set of suitable response strategies to improve the sustainability of water footprint. Model A and Model C have been successfully applied and gave the following key-responses:

- blue water footprint (consumption of surface and ground water from lakes and rivers) and Grey water footprint (a measure of pollution of freshwater) are significant and need to be addressed in the water management practices of the cities;
- to improve the water footprint specific policy needs to be developed with focus to household water use (direct water use), private building construction regulation, the diffusion of water saving technologies and development of improved water network facilities;
- to reduce blue water footprint there is a strong needs to improve the knowledge on the private water used from wells and develop

policies for sustainable groundwater use. For this it is also necessary to understand the effect of urbanized area on permeability of the surface influencing the recharge of groundwater;

- to reduce grey water footprint, the most cost effective response strategy is to separate rainwater and wastewater streams, and therefore needs investment in infrastructure development helping this separation;
- it is fundamental to increase the water awareness of Vicenza Citizen with specific focus to wastewater and water saving technologies.

What's next for Vicenza?

Vicenza UWFTP-Lab has already started to work on the improvement of the sustainability of its water footprint. The key next steps identified are:

1. **increase the effective runoff:** reduce rainwater infiltration in wastewater streams;
2. **improve knowledge on water losses and private uses from wells;**
3. **insert water footprint indicators in the plans for the sustainable development of the city.**

The Urban Lab of Wroclaw

Wroclaw is located in the southwestern part of Poland (51°N, 17°E). The altitudes within the city ranges from 103.53 to 155.72 m above sea level [Szymanowski and Kryza, 2009]. Majority of the land cover in Wrocław consists of green areas (forests, grasslands, wastelands) and agricultural areas which cover about 48% of the city area. About 41% of the whole area is built-up and consists of housing estates, industry and warehousing, areas of service and administrative functions among others. The city in 2011 counted 631.200 inhabitants.

Activities of Wroclaw Lab

The labs has worked on two main topics:

- **support the creation of specific knowledge** by acquiring data to assess the Water Footprint through Model A and B;
- **identify strategies to improve water and waste water management in new investments and suggest changes in Local Regulation;**
- **create awareness among citizens** on the use of water and on the concept of water footprint in order to improve their consciousness related to water issues and help them to better manage direct water use in their houses.

To accomplish these targets the Wroclaw UWFT-Lab involved into two main groups of stakeholders: the decision makers which have impacts on investments and policies, and the citizens of Wroclaw. Several workshops and meetings were held with the University of Wroclaw, local stakeholders companies, and citizens. A specific workshop has also been organized with 10 other water management companies of adjacent regions that proved their great interest in the approach developed in Wroclaw. The UWFTP-Lab performed also an analysis of professional and young citizen water use behavior.

Key response and lessons learned in Wroclaw

Through the application of model A and model B to the city of Wroclaw the UWFTP-Lab has been able to identify the main hotspot related to water of the city and determine a water footprint improvement plan. Model A and Model B have been successfully applied and gave the following key-responses:

- Blue Water Footprint (consumption of surface and ground water from lakes and rivers) and Grey Water Footprint (a measure of pollution of freshwater) are significant and need to be addressed in the water management practices of the cities;
- the blue WF in the city reduces the water availability within its boundaries, whereas the overbuilt surface increases the flash

and intensive floods. Hence, for a proper water management [including flood management], a sound understanding of the relation between flooding and blue WF is necessary. As groundwater flooding has a slightly longer lag time compared to surface water use, a proper hydrological assessment is needed in addition to water footprint assessment in this case. GREY WATER FOOTPRINT is particular relevant where the population density is higher; this result was possible thanks to the specific application of Model B that geo-localize the water footprint indicators;

- it is important to spread the diffusion of water saving technologies such as rainwater collection one; this practice is also supported by local incentives;
- it is fundamental to increase the water awareness of young people living in the city that resulted to be limited;
- young people and professionals are aware of the costs of water but have little knowledge of the environmental issues related to water management.

What's next for Wroclaw?

Wroclaw UWFTP-Lab has already started to work on the improvement of the sustainability of its water footprint. The key next steps identified are:

1. **increase the effective runoff:** limiting impermeable area in the city and working on the separation of separate sewer system;
2. **improve knowledge on water losses and private consumption**;
3. **linking water footprint to economic investments on new infrastructure and technologies.**

The Urban Lab of Innsbruck

Innsbruck is the capital of the federal state of Tyrol which is part of Western Austria. The city is located in the valley of the river Inn, one of the major alpine rivers, at an elevation of 574 m a.s.l. The lowest area is at 565 m and the highest point is formed by the Praxamerkarspitze with 2.638 m a.s.l. The area of the whole municipality counts 104.84 km^2 of which 32.3% are available for permanent settlement. Population by March 2013 counts 124,656 principle residence inhabitants plus another estimated 30,000 secondary residence or non-registered residents, mostly students.

Activities of Innsbruck Lab

The labs has worked on two main topics:

- **assess the specific water footprint of Innsbruck citizens and identify current behaviors;**
- **create awareness among citizens** on the use of water and on the concept of water footprint in order to improve their consciousness related to water issues and help them to reduce their personal water footprint.

To accomplish these targets the Innsbruck UWFT-Lab realized several workshops and meetings with the University of Innsbruck and local schools. The Lab has created a specific awareness approach based on four workshops (WS) that has been applied with specific reference to students of Innsbruck (fig. 3).

Figure 3 Awareness approach applied in Innsbruck

Key response and lessons learned in Innsbruck

Through the application of model A and assessment of the indirect water footprint by accounting the virtual water import into and export from the city of Innsbruck, the UWFTP-Lab has been able to identify the main hotspots related to water footprint in the city. Using the water footprint accounting Model A, and the assessment of external WF with the quantification of virtual water imports the UWFTP-Lab developed a set of appropriate response strategies to improve the sustainability of the water footprint of the consumers in the city. The following key lessons are learned:

- major component of the water footprint is related to the water use for food productions;
- reducing food wastes and changing diets can improve the sustainability of the water footprint;
- awareness raising through campaigning the issues, media coverages, and other social media interactions are necessary first steps in sustainable water consumptions;
- grey water footprint is the most relevant issue from direct water use in households;
- it is fundamental to increase the water awareness of Innsbruck Citizen.

What's next for Innsbruck?

Innsbruck UWFTP-Lab has already started to work on the sustainability of its water Footprint. The key next steps identified are:

1. **replicate the awareness experience in other schools.**

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Project partnership

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