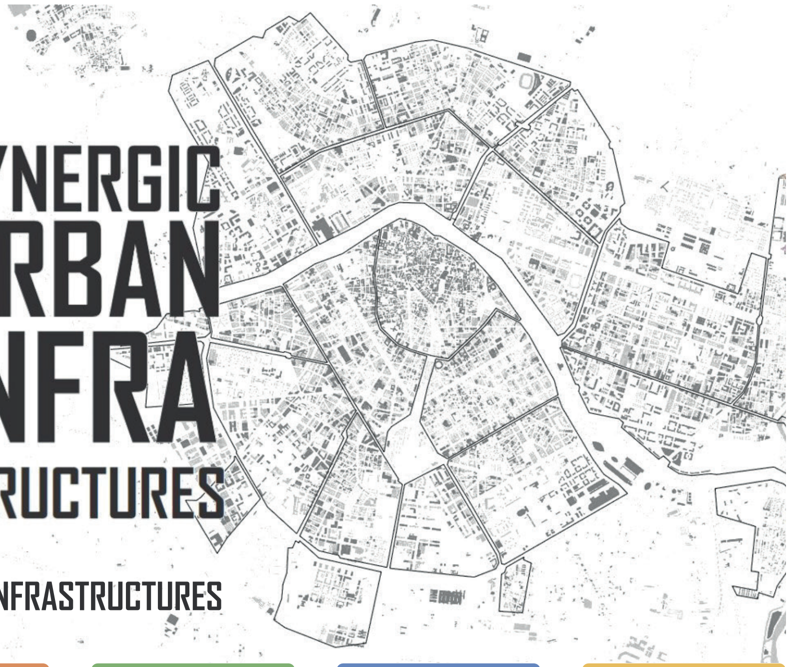
VLC SYNERGIC URBAN INFRA STRUCTURES



VALENCIA SUMMER SCHOOL ON SYNERGIC URBAN INFRASTRUCTURES

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Editors
Juanjo Galan Vivas
Luis Bosch Roig

Authors
Juanjo Galan Vivas
Mrudhula Joshy
Stefano Salata
Fabio Bayro Kaiser
Christian Larisch
Alena Cohrs
Carolina Pacchi
Christoph Wessling
Maciej Lasocki
Kinga Zinowiec-Cieplik
Luis Bosch Roig
Julia Deltoro Soto
Christa Reichter
Adolfo Vigil de Insausti

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Graphic design and layout
Júlia Martínez Villaronga
Juanjo Galan Vivas

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2.2_BLUE INFRASTRUCTURES: PRINCIPLES, DIAGNOSIS AND TOOLBOX IN VALENCIA

Maciej Lasocki | Assistant Professor, Warsaw University of Technology

2.2.1 The team

Water management is an essential element in spatial planning, but it is not given much attention in urban planning education. This topic is perceived as too specific and covering just technical issues, but also as one that can be easily adapted to any functional and spatial concept after its completion. For students, water is usually a decorative element that adds landscape value to the spatial composition. It is also often perceived through the prism of flood risk or high groundwater, which complicates land development. The reason for this approach is certainly the climate zone in which we live, where there is (seemingly) no shortage of water. Experts know, however, that the central regions of Poland are home to one of the largest water deficits in Europe, and as the climate warms, they will be at risk of steppe formation. This makes it even more necessary to include the topic of blue infrastructure in urban planning education. The initiative of a summer school, which seeks synergy between various fields of knowledge, should be perceived then as a great opportunity to strengthen skills and exchange knowledge in international cooperation. The team of teachers from Warsaw University of Technology was led and coordinated by Dr. Maciej Lasocki (Assistant Professor, , Faculty of Architecture), whose work was supported by Dr. Dorota Pusłowska-Tyszewska (Faculty of Building Services, Hydro and Environmental Engineering, Chair of Environmental Protection and Management), and by Dr. Kinga Zinowiec-Cieplik and Dr. Magdalena Grochulska-Salak, specialized respectively in landscape architecture and pro-environmental design. When selecting students from among those who applied, it was tried to maintain the principle that half of the participants came from outside the field of architecture and urban planning, and had competences in the field of blue infrastructure. The team of students was finally composed by Paweł Szymański and Mateusz Szabra from the 3rd and 4th year of the bachelor's degree on Environmental Engineering studies, respectively, by Monika Urbaniak from the 4th year of Civil Engineering in Transport, and by three students from the bachelor's degree on Architecture: Zofia Gancarczyk (3rd year), Alicja Sutkowska (4th year), and Julia Sobieraj (4th year). Assessing the composition of the team, it can be said that the students seemed interested in the mixed composition and the opportunity to learn from each other. They were also motivated to demonstrate their range of skills well in front of the others. However, there was some difficulty in adapting competencies. Environmental engineering students demonstrated technical knowledge to design detailed infrastructure solutions. However, they did not have the ability to look at the infrastructure design on a larger scale, at the level of city-wide systems. Architecture students were unable to relate such detailed considerations to a very general view of the city and the analysed area. On the one hand, it was a learning experience for both parties. On the other hand, it made it difficult to analyse phenomena together.

2.2.2 The workflow

The online work phase took place in accordance with the summer school schedule, and the work process was adapted to the willingness and capabilities of the participants within the freedom left by the organizers. In a series of lectures, we proposed two views on the role of blue infrastructure in the functioning of the city: from the point of view of technical solutions and parameters that are relevant when estimating the supply and demand of water, as well as from the point of view of the impact of water on the development of the city. Then, we organized the online workshop part, which was divided into three stages carried out over the next three weeks.

In the first one, students, based on preliminary information obtained from lectures, were invited to find interesting examples of blue infrastructure solutions. Since the topic of water retention seemed to be less familiar for the students and the solutions were new to them, we focused on various forms of retention. Each student received a separate topic: (1) open reservoirs and water gardens, (2) underground, closed reservoirs, (3) underground reservoirs with infiltration, (4) "hydroboxes" using substrates, composite materials retaining water, (5) temporary water reservoirs, rain gardens (6) retention on flat roofs, marsh roofs (see examples in Figures 2.2.1 & 2.2.2). In addition, each student received a second general, cross-sectional topic, in which they were expected to look for solutions in the field of water management that help solve a specific problem or potential in urban areas: (1) the use of water to improve thermal comfort in public spaces, (2) the use of surface water in cities for recreational

OPEN-AIR RETENTION TANKS / WATER GARDENS

GOALS

Open-air retention tanks and water gardens exhibit urban resilience by absorbing disturbances and adapting to environmental stresses.

These systems effectively absorb water and neutralize pollutants, contributing to cleaner urban water sources.

They are self-sufficient, managing stormwater while reducing urban temperatures.

URBAN FACTORS

Open-air retention tanks often require a large space and strongly influence the city landscape. The factors that need to be taken into account when designing such tanks are: biologically active area, site area, watershed area, functional public space index

SOLUTION EXAMPLE

France, Boulogne, Billancourt Park, designed by Agence Ter,

https://landezine-award.com/boulogne-park/

Figure 2.2.1: Example of water retention infrastructure (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

SHARING THE FUNCTIONS OF URBAN SPACE (WATER RETENTION)

GOALS

Counteracting the effects of flooding and more efficient use of space by sharing various functions by the area (e.g., retention, recreation, transport). Designing a city which allow to retain, purify and reuse rainwater.

URBAN FACTORS

lack of recreational space by the water, need to reducing the effects of extreme weather conditions, dense urban space

SOLUTION EXAMPLE

Water Plaza Rotterdam, Roads and ground level parking (sponge city Wuhan)

Example source:

https://www.mdpi.com/2073-4441/13/4/576

https://iopscience.iop.org/article/10.1088/1755-1315/295/3/032019/pdf

https://link-1springer-1com-1000096ut2a70.eczyt.bg.pw.edu.pl/article/10.1007/s12517-021-07706-y

Figure 2.2.2: Example of temporary rainwater retention (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

purposes, (3) natural methods of wastewater treatment, (4) sharing space with functions related to water management, floodplains, (5) renaturalisation of watercourses in cities, (6) use of water for energy generation (see example in Figure 2.2.3). All examples were to be accompanied by comments regarding design conditions and the advantages and disadvantages of using the presented solutions. Students were asked to look for examples from regions with a climate like that of Valencia. The aim of the students' work was to familiarize themselves with the topic and prepare preliminary material for the development of a "Toolbox".

The second stage consisted of analysing the conditions for water management in the study area. We divided the students into three interdisciplinary architect-engineer pairs. The aim was to facilitate the analysis by combining different approaches to the issue: engineering - prone to examining indicators, making calculations, and applying specialized knowledge, and urban planning - prone to generalization and to consider the spatial and functional context. Students analysed three issues: (1) water supply, its sources, including grey water sources, (2) water demand resulting from various land functions, (3) possibilities of collecting and utilizing sewage and rainwater, including its retention. This stage was intended to examine the conditions for land development in a typical way, but with a special focus on water.

In the third stage, the students prepared a "toolbox", which we interpreted as a universal set of tools and design solutions that can be used to shape blue infrastructures in any context, and a localized set of specific indications for the potential development of the study area, which were based on the relationships between blue infrastructure and other elements of the analysed space. This stage of the activity was intended to prepare students to think about synergistic connections between various types of urban infrastructure.

During these three weeks, we met 3-4 times a week to discuss the scope of tasks, the expected method of their implementation, necessary corrections, and work progress. Students prepared for classes by developing presentations that were shown at the international review at the end of the 2nd week and were used in the final Task 1 presentation.

USE OF CANALS FOR RECREATIONAL PURPOSES

GOALS

Enhancing quality of life, creating community gathering spaces, promoting tourism and improving the city's attractiveness, creating a new landmark in urban structure, promoting green transport (kayaks, canoes)

URBAN FACTORS

The presence of a canal and access to water; Historical and cultural context; functional public space index;

SOLUTION EXAMPLE

Belgium, Bruges; The Floating Island / OBBA & Dertien12

https://www.archdaily.com/899820/the-floating-island-obba-and-dertien12

Figure 2.2.3: Example of water use in urban space (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

2.2.3. The knowledge

During the online phase, we tried to equip students with appropriate knowledge, with which they would join the work of international teams during the on-site phase. During our experts' lectures on blue infrastructure, a number of issues were discussed: (1) the water cycle in nature, (2) hydrological aspects of rainwater management and its benefits, (3) the concept of blue infrastructure, (4) methods of estimating blue infrastructure parameters and demand for it: the volume of rainwater and sewage, the capacity and absorption capacity of various forms of rainwater and sewage management, (5) various forms of water retention, (6) methods of reusing sewage, (7) the definition of the water footprint and the problem of sustainable development in water management, (8) ecosystem services provided by water. In addition to the theory, it was important to provide information about Valencia and the studied area. From the materials provided, students were to obtain information on water and wastewater management: (1) water sources, including canal irrigation system, (2) water supply network, (3) grey water sources, (4) retention reservoirs, (5) data regarding rainfall, (6) water demand for various land uses, (7) legal, environmental, logistic, social and spatial conditions for the development of various functions in the study area that differentiate water demand, (8) soil conditions related to water infiltration, (9) urban sewage system and sewage treatment, (10) potential wastewater recipients. This stage of work was understandable and easy for the students because they had studied this type of issues during previous classes. The excellent availability of materials allowed us to sketch a comprehensive picture of the city and external conditions for the study area (see example in Figure 2.2.4). It should be noted, however, that there was some difficulty in transferring general data into the specific conditions of the study area. For example, assessing the feasibility of expanding the water or sewage system for the area was beyond our capabilities. To achieve synergistic connections between various urban infrastructures, the costs of implementing different variants of blue infrastructures and the savings this may bring in the implementation of other types of infrastructure, should also be analysed. This type of estimates is not fully developed on economic research and that is why it is difficult to obtain expert support in this area. However, this would be an important direction for expanding the scope of interdisciplinarity on similar courses in the future.

2.2.4. The toolbox

The assessment of the study area, in terms of the development of blue infrastructures, turned out to be much more difficult for students. Students were faced with many variables and unknowns. First, they had to refrain themselves from designing a proposal for the site. However it would be helpful to assess the suitability of analysed areas for implementing specific solutions, but this stage was waiting for them in the on-site phase. Therefore, they had to estimate the suitability of these areas for various potential forms of development. At the same time, they had to focus only on the blue infrastructure. This situation, combined with the lack of detailed knowledge about the local conditions inside the study area, made the work less understandable to the students. They rightly felt that the analyses performed were quite general and the results did not seem satisfactory enough. Despite its general nature, assessment revealed the dependencies between blue infrastructure and other types of infrastructure. Students identified areas with various potentials for the development of: (1) functions requiring expansion of the water supply or sewage system, (2) gardening fed by canals, (3) urban greenery requiring irrigation, (4) housing generating demand for utility water, (5) industrial functions with high demands for water, (6) grey water management, (7) rainwater management through retention and infiltration. In this way, not only were the interdependencies of individual types of urban infrastructure identified, but the spatial occurrence of these dependencies was indicated (see examples in Figures 2.2.5, 2.2.6, 2.2.7 & 2.2.8). Despite its general nature, the set of produced maps were deemed useful for assessing the spatial solutions to be proposed during the development of the masterplan (on-site phase).

The second part of the "toolbox" contained more precise tools for estimating the parameters of blue infrastructure: (1) calculating the demand for irrigation of agricultural fields, (2) calculating the demand for usable water for residents, (3) dimensioning areas for water retention, including roofs, (4) calculating the efficiency of the sewage system, (5) estimating the capacity of water infiltration into the ground. This was the contribution of our environmental engineering students, which could also be useful in estimating the feasibility of some solutions in the masterplan (see algorithm in Figure 2.2.9). However, it was evident that the use of algorithms would demand much effort – exceeding the available time for the on-site workshop. It would also require quite detailed designs that would allow for strict calculations.

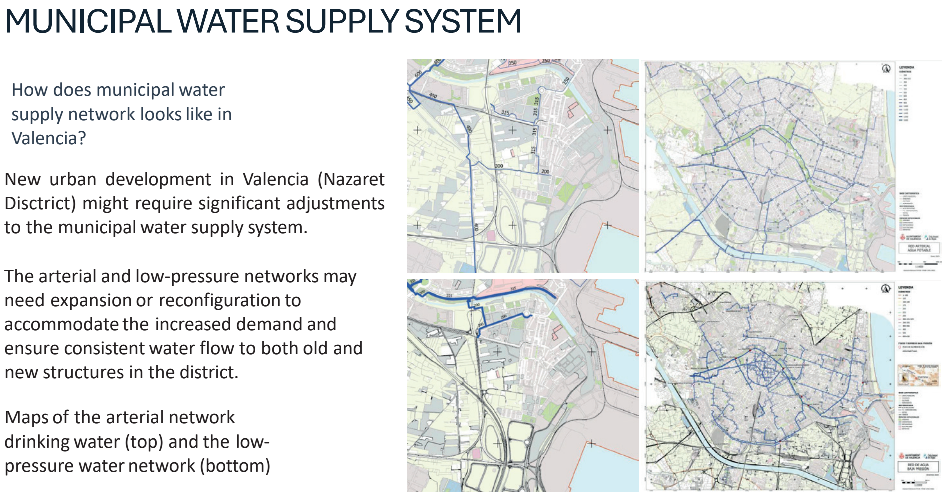


Figure 2.2.4: Analysis of the water supply network in the Nazaret area (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

WATER DEMAND - URBAN GREEN SPACES

Figure 2.2.5: Assessment of areas suitable for new green spaces (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

WATER DEMAND - RESIDENTIAL DEVELOPMENT

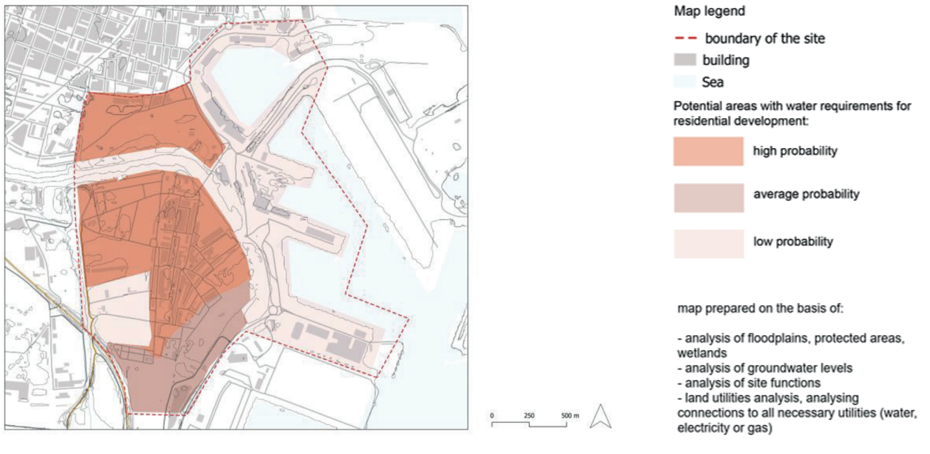


Figure 2.2.6: Assessment of areas suitable for new housing (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

PURIFIED WASTEWATER MULTIPURPOSE USE

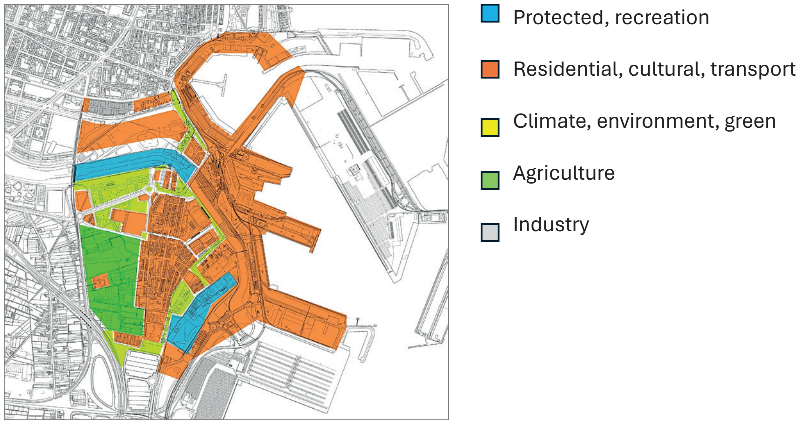


Figure 2.2.7: Assessment of areas according to possible grey water consumption (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

INFILTRATION MAP
(based on topography, green areas and soil permeability)

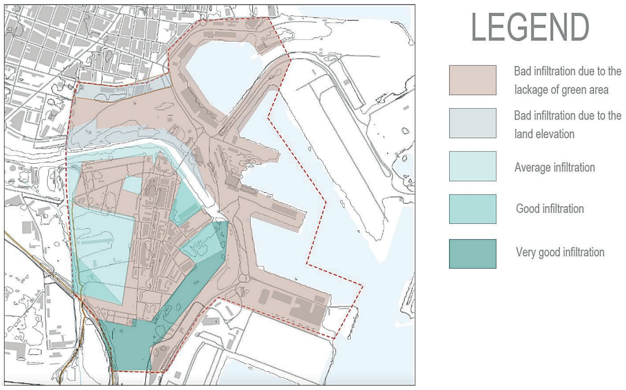


Figure 2.2.8: Assessment of areas according to infiltration potential (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)

MODELING THE WATER DEMAND OF AN IRRIGATED FACILITY

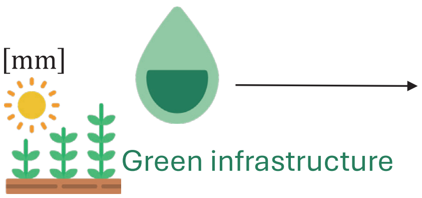
$$\text{POM} = \frac{10^{-3} \cdot POM_{net}[mm] \cdot 10^{4} \cdot F[ha]}{\eta[-] \cdot \Delta t[s]} \left[\frac{m^3}{s}\right]$$

TABLE 2. Average ET_o for different agroclimatic regions in mm/day

Regions	Mean daily temperature (°C)		
	Cool ~10°C	Moderate 20°C	Warm > 30°C
Tropics and subtropics			
- humid and sub-humid	2 - 3	3 - 5	5 - 7
-arid and semi-arid	2 - 4	4 - 6	6 - 8
Temperate region			
- humid and sub-humid	1 - 2	2 - 4	4 - 7
-arid and semi-arid	1 - 3	4 - 7	6 - 9

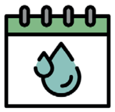
1. $\mathbf{POM_{net}} = \text{Ret}_{\text{max}} - \text{Ret}_{\text{F*}}$ [mm]

2. F[ha] – field of the crop



3. $\boldsymbol{\eta}[-]$ – efficiency of water use by the plant (0,7) (depending on the method of irrigation)

4. $\Delta \boldsymbol{t}[s]$ - length of time interval (day/month/year)



- $\boldsymbol{Ret\_max}$ = 60 mm
- $\boldsymbol{Ret_{F*}} = P - ET_I\ [mm]$

(final retention forecast)

P- average precipitation (day/month/year)

$\mathbf{ET_I}$ - Initial crop evapotranspiration

- $\boldsymbol{ET_I} = \boldsymbol{k_c} \cdot \boldsymbol{ET_0}\ [mm]$

ETo - Reference crop evapotranspiration (based on meteorological parameters)

kc - crop coefficient [dimensionless] (for grass = 1)

Figure 2.2.9: Algorithm of irrigation water demand calculation (source: Szymański, Szabra, Urbaniak, Gancarczyk, Sutkowska, & Sobieraj, 2023)