Blue-Green Infrastructure and urban renewal: The case of Illyssus and Eridanos rivers, Athens, Greece

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Key words: Urban Blue-Green Infrastructure, history and modern world, urban renewal

SUMMARY

Worldwide, the development of Urban Blue-Green Infrastructure (UBGI) is recognized as an innovative tool for cities to manage urban water and improve urban environment's conditions and citizens' quality of life. In this paper, we present a new approach for UBGI integration in a densely populated but of long history urban area, Athens, Greece. Athens Historic Center has many and downgraded public spaces that are related to urban water or to urban green and co-exists with archeological sites, antiquities, and the modern city infrastructures. After a thorough analysis of the current state of the Illyssus and Eridanus rivers, that are known from the ancient times, a proposal for their transformation to livable UBGI is presented. This study's scope is to bring out neglected or misrepresented urban blue and urban green public spaces and to re-introduce them to the public as constant UBGI from the ancient times to nowadays, enhancing in parallel residents and tourists interaction with them either as important historic places or as contemporary recreational or even educational landmarks.

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1. Introduction

Worldwide, intense urbanization has led to cities over-development led by the development of gray infrastructures and with little room for the preservation of green spaces and natural landscapes within the urban agglomeration forming a dense and complex system. In the near future cities, megacities and greater metropolitan areas will have to deal on the one hand with over population and downgraded urban environment and in the other with the consequences of climate crisis, like extreme and heavy rains, floods and extreme high in the summer and low in the winter temperatures. To address and overcome those issues, cities have to enhance their resilience to climate change, to improve urban environment by strengthening urban-ecological ecosystems' livability and adopt sustainable urban development strategies.

Blue-Green Infrastructure in urban areas (BGI) play a key role in cities' strategies to overcome climate crisis, mitigate impacts of climate change in the urban environment and improve citizens living conditions. Urban Blue-Green Infrastructure (UBGI) is a wide urban network consisting of natural and designed/ man-made urban landscape elements, like open and green spaces (parks, tree-alleys, public squares, green roofs/ walls), urban lakes and rivers (of natural or diverted flow), ground or underground streams, rain water drainage systems, sea-side fronts, that have multiple functions for citizens and urban environment.

UBGI contribute to better environmental management of urban areas and mitigate the adverse effects of climate change (Ghofrani, Sposito, and Faggian 2017), safeguarding sustainable urban growth (Ahmed, Meenar, and Alam 2019). As urban drainage systems are a basic component of the infrastructure, UBGI constitutes flood risk management urban policy and policy implementation tool (Thorne et al. 2018), (Hamel and Tan 2021), guaranteeing urban drainage systems' sustainability (Williams et al. 2019), enhancing, in parallel, the sea-side and ocean fronts protection of cities developed in coastal areas (Evans et al. 2019) and urban ecosystems livability and sustainability (Kati and Jari 2016), (Hamann et al. 2020) (Drosou et al. 2019).

UBGI contributes to improvement of community attitudes towards the use of open public spaces for leisure and recreation (Lamond and Everett 2019). It also consists the basic criterion in residence selection (Williams et al. 2019), while it meliorates living conditions, especially of its surrounding built environment, and quality of life (Kozak et al. 2020), (O'Donnell et al. 2021).

Furthermore, UBGI is a fundamental element of urban regenerations projects and having a key role in cultural heritage protection (Dai et al. 2021). As urban water bodies have a wide range of historical dynamics (Iojă et al. 2018), thus in urban regeneration projects and cultural heritage

conservation and highlight, the full or partial restoration of water bodies' historic flow as part of today's city life through UBGI projects, is essential for their success.

2. Athens' water bodies

Athens is Greece's capital, and one of the most well known historic cities, all around, with constant human presence from the third millennium B.C. to nowadays. Already from ancient times the Athenian plain was famous for its agricultural products, e.g., olives and olive oil, grapes and wine, various vegetables that among other strategic characteristics (e.g., proximity to sea-front) made Athens one of the more powerful city-state of the ancient Greek World. Even the Athens Acropolis is built on top of a rock in the middle of the plain formed by two ancient rivers, the Illyssus and the Eridanos rivers, and is surrounded by natural underground or ground springs, which even today supply the Acropolis flora with water.

Illyssus and Eridanos rivers have played an important role in Athens development from ancient times to nowadays in forming the contemporary urban landscape, the ground, and underground water management and the city's drainage system function and performance. For both rivers there are historic evidences of interventions to their natural flow from the ancient times; thus they can be characterized as timeless UBGI. Since Athens was proclaimed as the capital of the newly formed Greek State in 1833, both rivers were depicted in Athens' urban plans and maps as fundamental elements of the urban environment and urban planning, Figure 1.

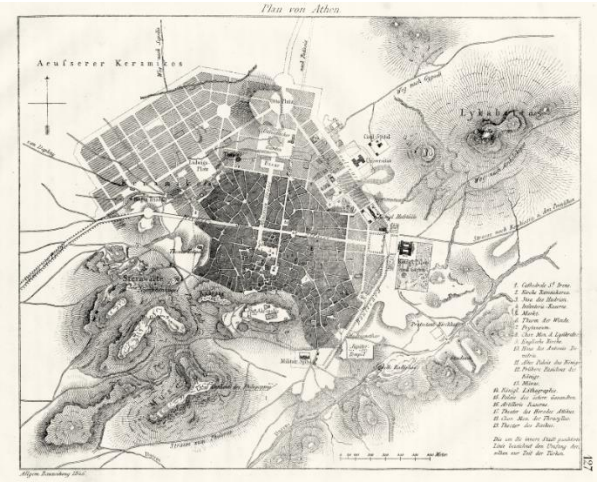


Figure 1: Athens Map by Hansen, 1846 (Hansen 1846)

2.1 Illyssus river

Illyssus river is one of the most well-known rivers of Athens, constantly flowing from ancient times to nowadays. Throughout its long history, the river is always a recreation pole, associated with ancient myths, ancient Athenian Mysteries and storytelling. Illyssus head is located at the northwest slope of Hymettus Mountain, flows at the northeast side of the ancient Athenian Plain, now densely populated urban area, forming the Illyssus plain and flows out at the Phaliric Bay, which is located close to Piraeus Port (approximate length 15 km). In the 1890s two dramatic floods (1896, 1899), contribute to the decision of partial flow reroute and coverage

though out all the river's length, Figure 2. In mid-1930 the river was partially covered in some of its parts running through the Athens city center as it was considered a serious infection source due to lack of constant flow during the summer.

Figure 2: Illyssus Plain and Plaka (Van den Brule n.d.)

2.2 Eridanos river

Eridanos river is Illyssus tributary and his head is at Lykabettus Hill. In ancient times, it was crossing Athens from the east to the west. From 500 B.C. major works were carried out and parts of the river were buried. The river burial was followed by extensive works as the ancient Panathinean Road was formed on top of it, as well its flow was diverted to two channels that were part of the ancient city's drainage and sewage system. The conversion of the river to underground drainage infrastructure was completed in the 1st century A.C. by the roman emperor Andrianos.

3. Illyssus and Eridanos rivers current condition in Athens City Center

Today, both rivers have partial surface and partial underground flow. Their underground flow is part of Athens' drainage network, run and maintained the Athens Water Supply and Sewerage Company (EYDAP S.A.). In Athens central area both rivers are flowing either surface or underground. Their surface flow is situated within the boundaries of Athens Historic Center and the formally declared Traditional Athens City Part (declared in 1979).

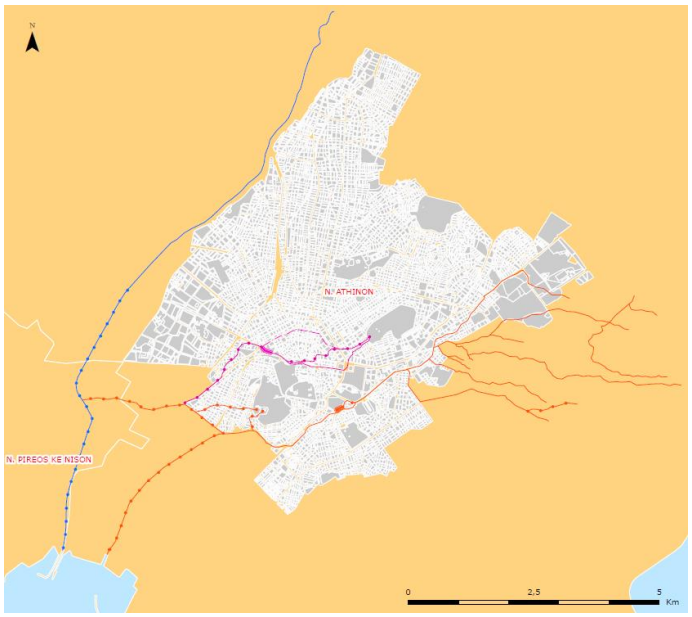


Figure 3: Illyssus (red) and Iriddanos(purple)contomporarry flow, within Athens municipality

3.1. Illyssus river current condition, Athens Central area.

Illyssus surface flow is located at the southeast side of the Athens Olympion archeological site. It is declared archeological site, since 1960, the Illyssus riverbed. The site covers a distance of 400 meters in length and 25 meters from both sides of riverbed middle, starting from the Kalimarmaron Stadium and ending just across of the Agia Foteini church, where its flow becomes underground and is parallel to Arditou Street, Figure 4 & Figure 5.

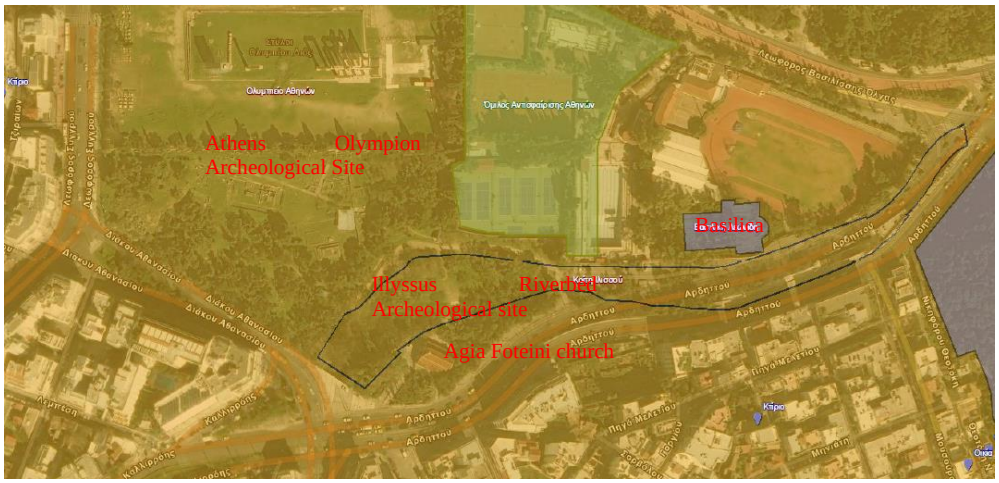
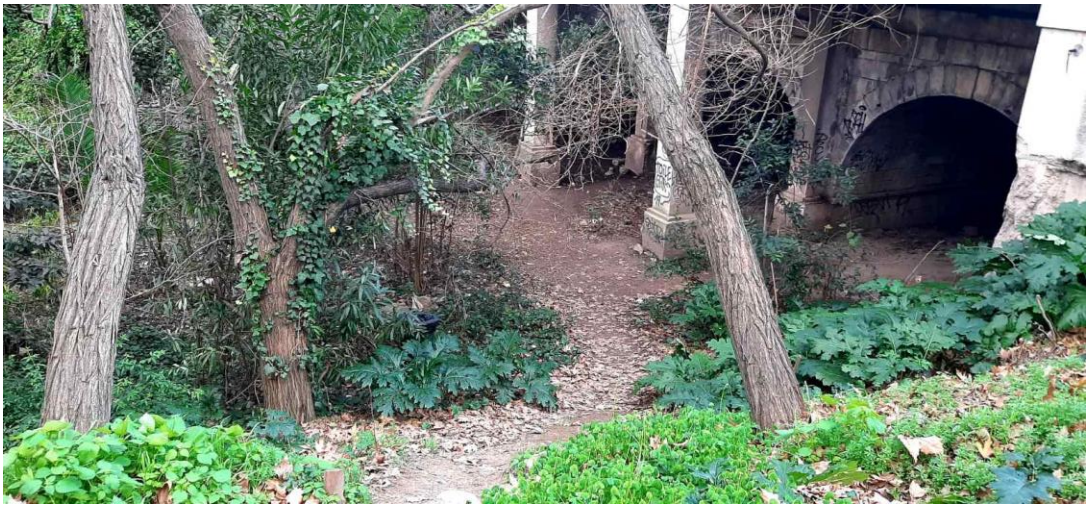


Figure 4: Illyssus riverbed archeological site and sourounding environment (source: Archeological Cagastre Internet Map, authors elaboration)

The Illyssus riverbed archeological site is considered as part of the ancient Athens urban tissue and landscape. Alongside the riverbed and close to the Kalimarmaron Stadium the Early

Christian Basilica of Illyssus - Martyrium of Saint Leonides is located, but there is no access to the river bed as the Basilica is fenced.



(a)

(b)

Figure 5: Illyssus riverbed, surface and undergound flow junction: (a) slope-top view, (b) basin view (authors field research January 2022)

The riverbed has not constant flow during the summer and anhydrous periods, and thus its basin is walkable, Figure 6 (a). Access to the riverbed's basin is feasible by the Agia Foteini Church surrounding open space, through a non-formed passage of the river's slope, thus is not easily accessible.

Furthermore, riverbed's flora is not cleaned, maintained and preserved, Figure 6(b), thus in practical does not attract visitors that would like to explore it, while there are no information signs for visitors to interact with the site and to have an exciting experience of sightseeing or daily life in a timeless UBGI. In addition to the miss-maintenance of the site, there is no direct

connection with its neighboring archeological site of Athens Olymion and the Basilica. Thus, the site is neglected and practically hidden.

(a)

(b)

Figure 6: Current condition of Illyssus: (a) riverbed basin, (b) flora, (authors field research January 2022)

3.2. Eridanos river current condition, Athens Central area.

Eridanos surface flow is located at different spatial locations, in the Athens Historic Center. Its first surface flow is located at the Monastiraki Metro Station, at Monastiraki square, and was discovered during the station's construction period. It is a roman-period buried riverbed, surrounded by workshops, houses, extensive water supply and drainage systems and is an active archeological site within the station's underground facilities, accessible to anyone that has access to the station's platforms (Figure 7a). The site is also visible form Monastiraki sq surface level (Figure 7b).

(a) (b)

Figure 7: Eridanos river archeological site at Monastiraki Metro Station: (a) Underground site, (b) Top-view Monastiraki level (authors field research January 2022).

The second part of the surface flow of the river is located in the Ancient Agora of Athens archeological site, 300 meters west of the Monastiraki Metro Station, Figure 8.

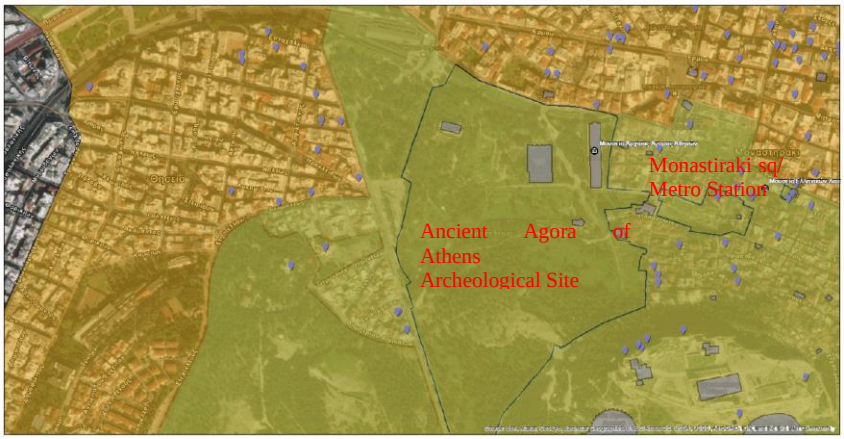


Figure 8:Ancient Agora of Athens archeological site (source: Archeological Cagastre Internet Map, authors elaboration)

The Ancient Agora of Athens archeological site is its antiquities, but also as a natural urban landscape, where the green elements, trees, grass, coexist with the surface flow of Eridanos river, forming a unique blue-green space in the heart of the city. Within the site's boundaries (the site is fenced) the river main flow and branch are visible (Figure 9a). There are also small ancient tanks that are field either by the river's flow or by ordinary rainfall (Figure 9Figure 8b). Unfortunately, there are no information signs and no information on the river and its role for the Athenian urban but natural landscape that is livable over the centuries and has always been and UBGI.

(a) (b)

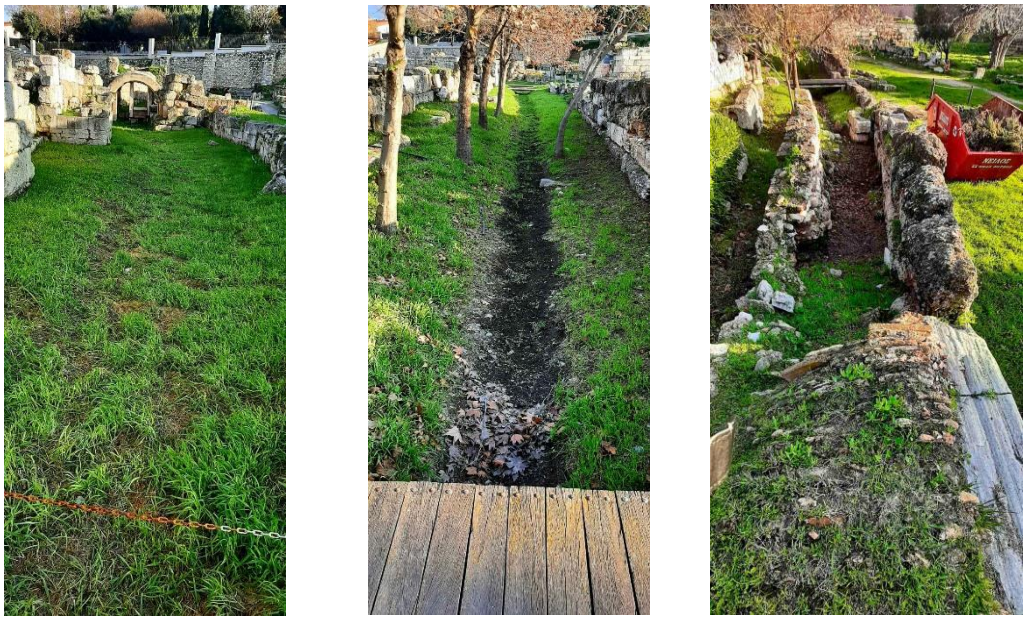
Figure 9:Eridanos river at Ancient Agora of Athens archeological site: (a) riverbed, (b) ancient tank (authors field research January 2022).

The most well-known archeological site for Eridanos river surface flow is the Keramikos Archeological site, located 600 meters west of Ancient Agora of Athens archeological site, Figure 10. Keramikos (ceramic), was ancient Athens' pottery workshops area. Situated in Eridanos riparian, the area was constantly flooding, during ancient times, so it was not suitable for residential area and thus besides the pottery workshops, it developed to the most important ancient cemetery. Alongside the river, the Iera Odos was starting, the ancient route connecting Athens to Elefsina that is still in use.

Figure 10: Keramikos archeological site (source: Archeological Cagastre Internet Map, authors elaboration)

The Keramikos archeological site is also a well-preserved Athenian natural landscape, where Athenian trees thrive, is grassy almost throughout all year (even in summer), and exquisite neoclassical listed buildings co-exist with the antiquities. Eridanos riverbed is delimited either

by the ancient constructions or by its currently natural flow, and is only accessed via two wooden bridges.



(a) (b) (c)

Figure 11: Eridanos river at Keramikos archeological site: (a) Central Ancient Athens Gate view, (b) surface flow, (c) ancient canalization constructions (authors field research January 2022).

At the end of the archeological, that is delimited by Piraeus STR (currently located above ancient Athens northwest wall) at the junction of contemporary Iera Odos street, the river drops into a catacomb, that is in EYDAP SA jurisdiction.

4. Illysus and Eridanos rivers role in urban renewal

Today, Illyssus River flows through or alongside important archeological sites and contemporary cultural hot spots, like Greek National Gallery, while Eridanos major part of its natural flow is situated within the boundaries of Athens Historic Center, Figure 12 and Figure 13 respectively.

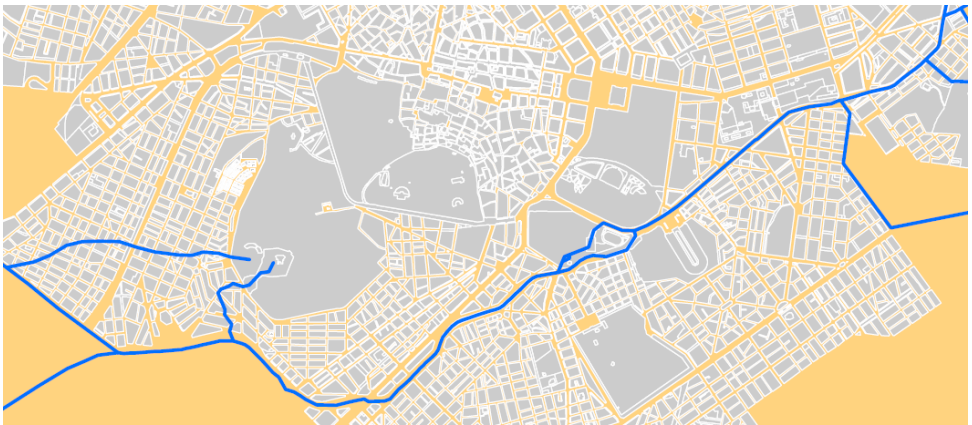


Figure 12:Illyssus Natural flow in Athens City Center (authors elaboration)

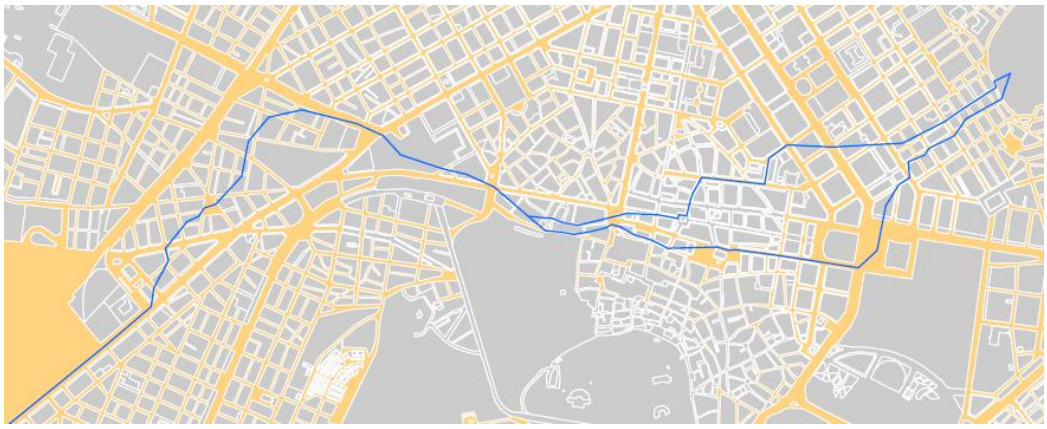


Figure 13: Eridanos Natural flow in Athens City Center (authors elaboration)

Thus, both rivers could be part of urban regeneration policies, and become part of the city's life as walkable routes and places of recreation relaxation and pleasure not only for tourists but also for Athens' residents. As both rivers have surface parts surrounded by Athenian flora, they could be further exploited and given to residents for daily free use.

Concerning Illyssus river, in the current riverbed archeological site, wide range remediation projects are required, so as the site could be accessible on the one hand, and recreation pole for Athens Historic Center on the other. In this context, entering and exiting the archeological site and the river basin signaling is fundamental. Furthermore, alongside the site recreation areas must be properly created, facilitating social gathering and children's play spots, regarding its archeological value. Social gathering areas could be equipped with information panels so as residents and tourists can have access to its longtime history to engage with the rivers history and archeological value that spreads over the centuries. Walking routes, inside the site and connecting it to the neighboring archeological site of Athens Olympion, are necessary, so as the site would be part of residents' everyday life, and part of the wider walkable route of the city center that connect various archeological sites around the Athens Acropolis. The underground part of the river, that is under the responsibility of the EYDAP SA and is close to the archeological site, must be highlighted, through the creation of educational routes run by the company, so as both citizens and tourists get aware about the importance of the underground water and drainage system, being able in parallel to discover the city's hidden underground world.

Eridanos River is already connected, in a way, with the city's everyday life, either in the case of residents or in the case of tourists. The interesting about this river, is the fact that wider parts of its current flow coincide to institutionalized pedestrian routes or public spaces that are partially developed and constructed, located in Athens Historic Center, Figure 14. It is important to highlight the river's flow, either by partially uncover its riverbed during the construction of a new pedestrian route or a new public space (like in the case of Monastiraki Metro Station), or by signaling its flow alongside the existing pedestrian routes network. For the part of its flow (and its branches) that are located within the archeological sites of Ancient Agora of Athens and Keramikos, analytical information signs and IT information infrastructure

must be installed. Thus, residents rediscover its history and its importance for the city and tourists be able to get familiar with its archeological, historical but also current importance. Within those two archeological sites recreation areas, that could also be used for educational purposed, could be created. In that way, residents and tourists get familiar not only with archeology but also with the co-existence of antiquities, cultural heritage elements and natural landscape of a modern city of long millennia history, like Athens.

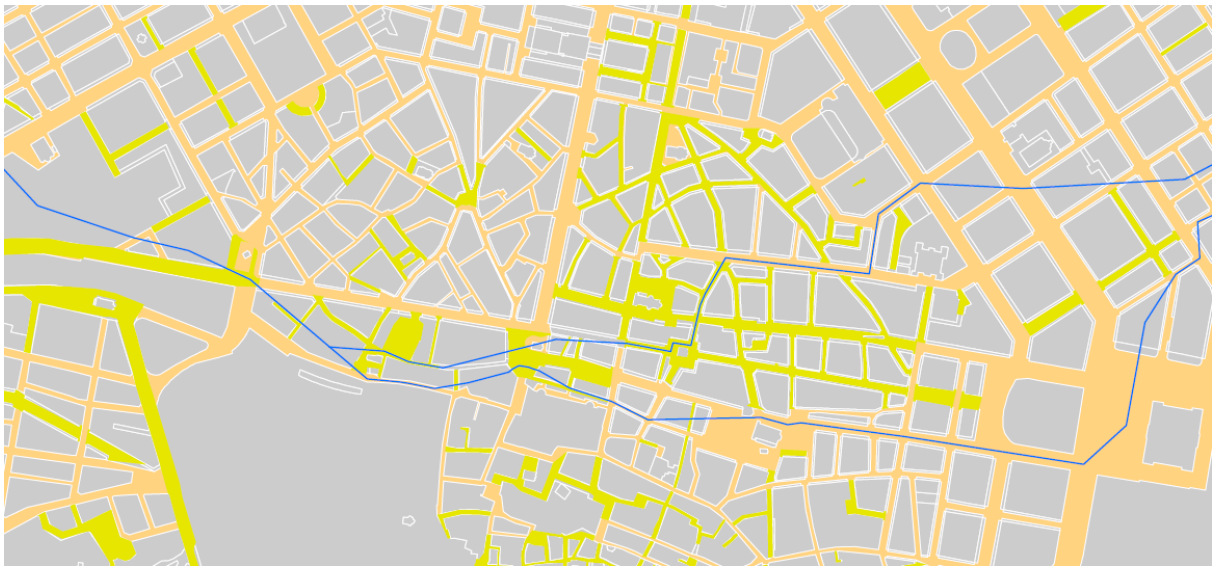


Figure 14: Eridanos current flow, surface or underground in respect to institutionalized pedestrian routes (green) and public spaces (beige) ((authors elaboration).

5. Conclusions

In this paper, the timeless presence of water element in Athens Historic Center in the light of Urban Blue Green Infrastructure is presented. Illyssus and Eridanos rivers flow through Athens for over 2.500 years and have been continuously a basic element of the Athenian urban landscape all this time long. Both rivers are UBGI from ancient time to nowadays, and today are part of the Athens Historic Center archeological sites but also of the city's drainage system. Nonetheless they are not as highlighted and intercorrelated to citizens' daily life and to tourists visiting tours. By highlighting both rivers and through remediation and landscaping projects, Illyssus and Eridanos rivers could transformed into important attraction pole for citizens and tourists. Further, they could become importan recreation and knowledge poles and prominent UBGI landmarks, that will enhance Athens' reputation as a city with timeless UBGI that are constantly in use.

REFERENCES

Ahmed, S., M. Meenar, and A. Alam. 2019. Designing a Blue-green Infrastructure (BGI) Network: Toward Water-sensitive Urban Growth Planning in Dhaka, Bangladesh. Land 8 (9): 138.

Dai, Xin, Lunche Wang, Minghui Tao, Chunbo Huang, Jia Sun, and Shaoqiang Wang. 2021. "Assessing the Ecological Balance between Supply and Demand of Blue-Green Infrastructure." Journal of Environmental Management 288: 112454.

Drosou, Nafsika, Robby Soetanto, Ferry Hermawan, Ksenia Chmutina, Lee Bosher, and Jati Utomo Dwi Hatmoko. 2019. "Key Factors Influencing Wider Adoption of Blue–Green Infrastructure in Developing Cities." Water 11 (6): 1234.

Evans, Ally J., Louise B. Firth, Stephen J. Hawkins, Alice E. Hall, Joseph E. Ironside, Richard C. Thompson, and Pippa J. Moore. 2019. "From Ocean Sprawl to Blue-Green Infrastructure–A UK Perspective on an Issue of Global Significance." Environmental Science & Policy 91: 60–69.

Ghofrani, Zahra, Victor Sposito, and Robert Faggian. 2017. "A Comprehensive Review of Blue-Green Infrastructure Concepts." International Journal of Environment and Sustainability 6 (1).

Hamann, Frieder, Godecke-Tobias Blecken, Richard M. Ashley, and Maria Viklander. 2020. "Valuing the Multiple Benefits of Blue-Green Infrastructure for a Swedish Case Study: Contrasting the Economic Assessment Tools B£ ST and TEEB." Journal of Sustainable Water in the Built Environment 6 (4): 05020003.

Hamel, Perrine, and Leanne Tan. 2021. "Blue–Green Infrastructure for Flood and Water Quality Management in Southeast Asia: Evidence and Knowledge Gaps." Environmental Management, 1–20.

Hansen, Christian. 1846. "Plan Von Athens." Wien. https://www.flickr.com/photos/athens_greece/15720071273/in/album-72157629855961843/.

Iojă, Ioan-Cristian, Gabriela Osaci-Costache, Jürgen Breuste, Constantina Alina Hossu, Simona R. Grădinaru, Diana Andreea Onose, Mihai Răzvan Nită, and Hana Skokanová. 2018. "Integrating Urban Blue and Green Areas Based on Historical Evidence." Urban Forestry & Urban Greening 34: 217–25.

Kati, Vierikko, and Niemelä Jari. 2016. "Bottom-up Thinking—Identifying Socio-Cultural Values of Ecosystem Services in Local Blue–Green Infrastructure Planning in Helsinki, Finland." Land Use Policy 50: 537–47.

Kozak, Daniel, Hayley Henderson, Alejandro de Castro Mazarro, Demián Rotbart, and Rodolfo Aradas. 2020. "Blue-Green Infrastructure (BGI) in Dense Urban Watersheds. The Case of the Medrano Stream Basin (MSB) in Buenos Aires." Sustainability 12 (6): 2163.

Lamond, Jessica, and Glyn Everett. 2019. "Sustainable Blue-Green Infrastructure: A Social Practice Approach to Understanding Community Preferences and Stewardship." Landscape and Urban Planning 191: 103639.

O'Donnell, Emily C., Noelwah R. Netusil, Faith KS Chan, Nanco J. Dolman, and Simon N. Gosling. 2021. "International Perceptions of Urban Blue-Green Infrastructure: A Comparison across Four Cities." Water 13 (4): 544.

Thorne, Colin R., Emily C. Lawson, C. Ozawa, Samantha L. Hamlin, and Leonard A. Smith. 2018. "Overcoming Uncertainty and Barriers to Adoption of Blue-Green Infrastructure for Urban Flood Risk Management." Journal of Flood Risk Management 11: S960–72.

Van den Brule, Alfred. n.d. "La Vallée d'Illyssus, 1907." Travelogues (blog). Accessed May 1, 2022. https://el.travelogues.gr/item.php?view=39481.

Williams, J. B., Roshni Jose, Cletus Moobela, D. J. Hutchinson, Richard Wise, and Mark Gaterell. 2019. "Residents' Perceptions of Sustainable Drainage Systems as Highly Functional Blue Green Infrastructure." Landscape and Urban Planning 190: 103610.

BIOGRAPHICAL NOTES

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Eleftherios Poulis is an undergraduate student, at the Department of Surveying and GeoInformatics Engineering, University of West Attika. His is working his diploma thesis on Urban Green Blue Infrastructure of Historic urban areas.

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