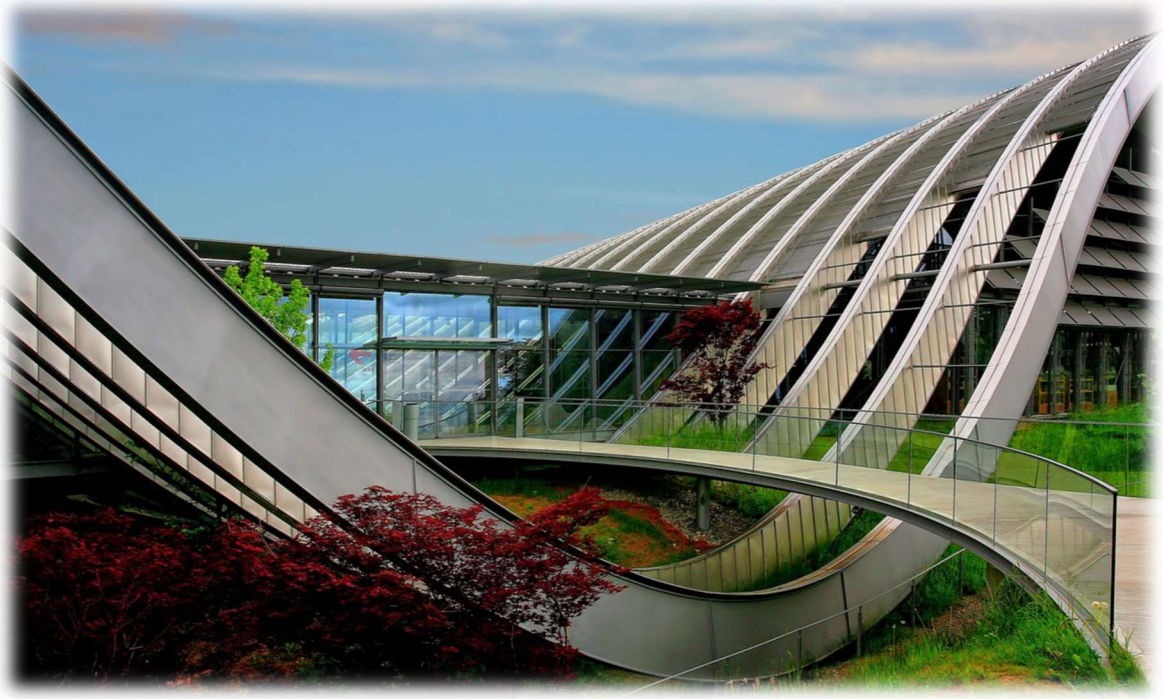
Including green infrastructure and ecosystem services in the smart concept

Synthesis Paper



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CEEweb for Biodiversity is a network of non-governmental organizations in the Central and Eastern European region. Our mission is the conservation of biodiversity through the promotion of sustainable development.

Introduction

This paper aims to introduce and examine green infrastructure planning throughout the so-called smart concept. Green infrastructure addresses the connectivity of ecosystems, their protection and the provision of ecosystem services and it is included in the frame of the EU Biodiversity Strategy. The strategy is built on the three objectives: smart, sustainable and inclusive growth[1]. To achieve these goals sustainable growth needs to go hand in hand with smart growth to collect the full benefits of a green economy, and improving the EU's performance in education, research/innovation and in the digital society. The concept of smart involves the use of digital and communications technologies and, as such, it tackles high-quality resource management and service delivery, however, the wider definition demands the efficient use of energy sources and innovative technology to save energy and costs and thus improve the quality of the life.

In the recent decade's green infrastructure (GI), a "strategically planned network of natural and semi-natural areas", has played an important role to minimize biodiversity loss and protect ecosystem services in the context of climate change. The green infrastructure must become "smarter" to respond to the sustainability and resilience challenges of the 21st century, which include environmental degradation, limited resources, urban migration and climate change[2].In fact, the global demand for environmental technologies, eco-friendly products and services and sustainable design ideas is expected to accelerate in the coming years. To do so, the EU Member States and regions should seize the promotion of smart green infrastructure and eco-innovation for sustainable growth with a holistic approach and a long-term perspective across the policy cycle. They need to invest more in the development of research and innovation and entrepreneurial capacity in areas such as sustainable energy, ecosystem services and to change their economies currently, based on the overuse of natural resources into greener and sustainable economies.

The Green Infrastructure and Ecosystem Service Concept

In the context of climate change, the GI has an important role in reducing the need for energy, providing ambient cooling effects, reducing floods at the local level, restoring local groundwater reserves, allowing the soil to absorb acidity, and so on. Green infrastructure (green areas, rooftop and vertical greenery, private gardens, green corridors, etc.) is a "strategically planned network of natural and semi-natural areas" and it is an emerging concept where new ways to biodiversity conservation and ecosystem protection are combined with other land-use objectives,

[1] European Commission, (2018), Environment, Strategic Environmental Assessment-SEA. Available at: http://ec.europa.eu/environment/eia/sea-legalcontext.htm.

[2] Crncevic T, Tubic, L, Bakic O., (December 2017) For CLIMATE SMART AND GREEN CITIES. No.38, pp 35-71.

such as agriculture, forestry, recreation, mitigating and adapting to climate change, etc.[3]. Green infrastructure is not only about connecting ecosystems per se, but also about strengthening them and their services to provide cost-effective alternatives to the traditional 'grey' infrastructure.

There is a growing understanding of its potential at the national, regional and local levels. Indeed, GI has positive impacts on the local economies (lower capital, maintenance and operational costs in comparison with grey infrastructure, tourism, energy savings, etc.), public health, employment and the resilience of the transport system. More green spaces can increase recreation spaces, allowing residents to enjoy greenery without leaving the city[4]. However, there are still substantial barriers such as physical and fiscal constraints, low attentiveness of the planning system, a lack of discourses supporting GI and Ecosystem Services (ES) and limited awareness[5]. Promoting green infrastructure requires a strong collaboration network with a wide range of public-private partnerships. These can include local authorities, local energy and innovation agencies, NGOs and associations, housing corporations, technology developers and providers, urban planners and architectural specialists[6].

The smart concept

Smart is a broad concept and it has several definitions, but this paper considers the concept of Smart as the use of digital information and communications technologies (ICTs), and other means to improve quality of life, efficiency or urban operation and services, and supports the reduction of cost and energy consumption, integrates public service functions and involves the citizens. In Europe in these recent years, the concept of smart growth has influenced government planning policies, and it is one of the sustainable development goals included in the Europe 2020 Strategy. The concept of "smart" is underpinned by several core areas: economic dynamics and innovation (Smart Economy), environmental sustainability (Smart Environment), quality of administration (Smart Governance), accessibility (Smart Mobility), human capital (Smart Society) and quality of life (Smart Living). Making green infrastructure "smarter" is necessary to respond to the numerous challenges in the 21st century, such as environmental degradation, limited resources, urban migration and climate change[7]. To do so, the EU Member States and regions need to change their

[3] European Commission, (2016), *The forms and functions of green infrastructure*. Brussels, European Commission.
[4] Interreg Europe, (2017), *the Development of green infrastructure in EU regions.* Available at: https://www.interregeurope.eu/news-and-events/news/1026/development-of-green-infrastructure-in-eu-regions/. Accessed 10. May. 2019.
[5] Byrne and Yang, 2009, Dodson, 2009, Grădinaru and Hersperger, 2018, Kambites and Owen, 2006, Matthews et al., 2015, Rall et al., 2015. Advancing urban green infrastructure in Europe: Outcomes and reflections from the GREEN SURGE project, Urban Forestry & Urban Greening Volume 40, April 2019, Pages 4-16.

[6] Ambrose-Oji,B.,Buijs,A., Gerőházi,E., Mattijssen, T.,Száraz,L.,Vander Jagt, A., Hansen,R., Rall,E., Andersson, E, Kronenberg, J., and Rolf, W. 2017, Innovative Governance for Urban Green Infrastructure: AGuideforPractitioners,GREENSURGEprojectDeliverable6.3,UniversityofCopenhagen,Copenhagen.
[7] Crncevic T, Tubic, L, Bakic O., (December 2017) For CLIMATE SMART AND GREEN CITIES. No.38, pp 35-71.

economies currently based on the overuse of natural resources into greener economies through eco-innovation. Smart solutions in cities that create opportunities, unlock growth potential and allow businesses to thrive and encourage youth employment.

The integration of Green Infrastructure into smart development concept based on CEE and European experience

The synergy of the smart concept into green infrastructure can play a decisive role in regulating the climate at the national, regional and local levels and improving the quality of life for the residents. According to De Angelis et al. (2013), GI is an important part of a smart city, as smart city should enable all elements of the development, including the economy, environment, mobility, human capital and living GI connects the environment and living, and at the same time spreads to the governance component.

Central and Eastern European countries are facing several challenges in the field of spatial planning. These include the climate change impacts like increase in warm temperature extremes, water temperature and forest fires as well as decrease in summer precipitation, economic values of forests, floods and natural disasters that especially impact densely populated areas (EC, 2013[8]). Additionally, the majority of the formerly heavy industrialized Central European cities possess plenty of unused degraded areas for the valorization of which resources and solutions are not always at disposal.

In 2009, green city index (Siemens, 2009)[9] rated the environmental performance of 30 leading EU cities by taking into account 30 individual indicators for each of them. Indicators cover a wide range of environmental areas – environmental governance, water consumption, waste management and greenhouse emissions. On the measurement scale, the Central European cities rate in the last third of 30 EU cities compared in this way. The Spa-ce.net conference (Bratislava, 2014)[10] and experiences from the transnational projects, e.g. ReSource, have shown that Central European countries show certain resistance to the introduction of the new concepts, such as GI and resilience. This might root in the capacity of the spatial planning epistemic communities and certain skepticism towards everything that is "eco", environmental, etc. [11] This is also highlighted by the EIB Investment Survey (2017), which shows that several CEE cities still register gaps in basic infrastructure and reported underinvestment over the last five years.

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[8] European Commission (2013) *Study of Adaptation at Regional Level in the EU.* Brussels, European Commission.
[9] Siemens AG (2009). European Green City Index. Munich, Siemens AG.
[10] Spa-ce.net (2014) "Proceedings of Empirical Evidence of Urban Resilience in Central, Eastern and South-Eastern Europe". Centre of Excellence (UM STU). Bratislava, 2014.
[11] Golobic, M., Marot, N. & Muller, B. (2015) "Green Infrastructure in Central, Eastern, and South-Eastern Europe: Is there a universal solution to environmental and spatial challenges?" Urbani izziv. Volume 26, No. supplement, November 2015.

Innovation is positively related to urban wealth and economic growth. The green city index revealed a strong correlation between wealth and a high overall ranking of the index, as 9 out of 10 best-ranked cities have GDP per capita of more than 31.000 EUR. In the core area of the Smart Environment, the performance of some CEE regions is particularly low compared with the EU overall ranking. Regarding the main obstacles for CEE municipalities, the EIBIS survey (2017) showed how a low budget, the length of the approval process and technical capacity hinder investments and performances. Investing in CEE capitals would promote the economic development of CEE regions and support cohesion in the EU. Even though the CEE municipality's plans are more focused on infrastructure modernization than the EU average, domestic disparities kept on increasing caused by their lower economic productivity. Other pressing issues like unemployment, illegal settlements and lower participative engagement of society additionally hinder the performance of these cities.

However, some of the positive examples in the CEE region include innovative ideas, regarding specific environmental initiatives. Smart green infrastructure projects could incorporate a capacity function, satisfying the basic infrastructure needs, and an efficiency function, making cities more favorable for innovation and growth. In 2016, Ljubljana won the European Green Capital Award[12], after implementing over 1700 projects to make the city green, clean, safe and improve the everyday lives of the residents, as a part of their Ljubljana 2025 vision, created in 2007. One of the most significant changes was turning the 10-ha area of the city center into the pedestrian area and limiting access to motor vehicles, thus becoming a popular stage for diverse cultural and social activities[13]. Other projects such as new urban parks and green areas, upgrading of the embankments with communal infrastructure, retrofitting of the buildings and setting-up former brownfield sites as sports and recreational surfaces, connecting the physical assets of the city to social networks and the territorial capital of a specific urban neighborhood.

By 2020, Ljubljana intends to achieve a 21% renewable energy share in final energy use. The city has invested a lot into sustainable mobility, including electric car and bicycle-sharing systems, bicycle roots and buses powered with methane. The district energy supply of heat and natural gas, which today supplies 74% of all flats to increase to 80% by 2024, is among the more important environmental and energy-efficient practices that contribute to the quality of living and higher air quality in the city. Among European capitals, Ljubljana has the highest share of separately collected waste in households (65%). Ljubljana's case is a good example of collaborative planning and community participation activities (both top-down and bottom-up) towards developing a smart

[12] "European Green Capital Ljubljana Wins European Green Capital Award 2016." Ec.europea.eu. Accessed May 30, 2019. http://ec.europa.eu/environment/europeangreencapital/ljubljana-wins-european-green-capital-award-2016/.
[13] "Smart Ljubljana: Are Attractive Smart Cities More Successful?" Smart City Brand. January 1, 2018. Accessed May 30, 2019. http://smartcitybrand.com/smart-city/beauty-bias-are-attractive-smartcities-more-succesful.

city with integrated GI[14]. The participation of the citizens in the smart development process is high; an online portal to receive the citizens' initiatives has been set, which acts as an open innovation system encouraging bottom-up development. Some of the innovative ideas of Ljubljana's students include smart rubbish bin that compacts the rubbish, a bacteria power plant for generating electricity, a wireless charging lane for electric vehicles that could be fitted on motorways or bypasses and rainwater collectors with UV lights to purify the water and solar cells to power the lights. (City of Ljubljana report, 2016[15], EC, 2014[16]).

Another good example of good practice in GI planning has placed in Belgrade, where a Master Plan for the city was developed based on mapping of its green areas (GA) and biotope using the GIS technology. Using the Geographic Information System (GIS[17]) enables to complete the parcel inventory of zoning areas and perform an analysis of the percentage of land used in each category the density levels according to neighborhoods, threats to residential amenities, and proximity to unwanted land uses, and in that way assist urban planning. This information enabled the proper distribution of GA's, contributed to regulating temperatures at the micro-location level and better management of surface waters in Belgrade. Furthermore, it provides a base for the development of the strategy for climate change adaptation and the creation of a climate-smart and green city. On Belgrade's example, Crnčević et al. (2017) point out that the support from local authorities and an applicable long-term program are essential for the green and smart development and more efficient and economical maintenance, planning and development of the green areas.

Dealing with water pollution is a significant challenge, especially for the densely populated and industrial areas. Once considered as an outskirt of Budapest (where around 500.000 m3 of wastewaters are generated daily), the South Pest wastewater treatment plant, due to "urban sprawl", ended up being surrounded by populated districts. The increased developments of treatment activities resulted in dwellings near the site and higher loads on the facility, creating both odors, affecting neighborhoods around the property and operational issues, like high operating costs, occasional extreme foaming, and foul odors. However, in 2009 the Organica® Food Chain Reactor (FCR) was introduced, regarded as a breakthrough in wastewater treatment. The FCR facility, in addition to the traditional two-stage biological filtering, acts as a type of Fixed-Film Activated Sludge system and increases treatment with the help of natural, live plants (i.e. plant roots) and the artificial root system (i.e. a bio fiber inspired by root structures), allowing for the growth of healthy

[14] Pichler-Milanovič, M., Foški, M. (2015) Green Infrastructure and Urban Revitalisation in Central Europe: Meeting Environmental and Spatial Challenges in the Inner City of Ljubljana, Slovenia. Urbani izziv, 26(supplement).
[15] City of Ljubljana (2016). Ljubljana for you. Report of the European Green Capital 2016 Project.
[16] European Commission. (n.d.). Ljubljana. Retrieved June 1, 2019, from http://ec.europa.eu/environment/europeangreencapital/winning-cities/previous-finalists/ljubljana/
[17] GIS is a computer-aided system (hardware, software, data and users) for collecting editing, storing, modelling and analysing data, as well as for its alphanumerical and graphical presentation.

and robust biomass available for treating waste.

Also, the fixed biofilm results in an extended sludge age (SRT), whereby microorganisms and bacteria consume the contaminants in wastewater improving nitrogen removal in the biological stage and a much greater quantity and diversity of organisms thrive in the same physical space. Due to reduced suspended solids in the system, aeration requires less power, and secondary clarifiers receive decreased solids loadings. The FCR upgrade successfully resolved the secondary treatment-related issues of the South Pest wastewater treatment plant and enhanced the overall reactor efficiency, enabling it to treat 80 000 m3/d. It also provides an average 50% reduction in effluent total nitrogen, while requiring over 50% less aeration and 25% less sludge production, thus resulting in energy savings. The quality of the treated water discharged into the receiving Danube branch exceeds the European standards and to that the botanical gardens, replacing the wastewater pools, odorless operation and accessibility services to improve relations with the client's customer base in the surrounding neighborhood (CEEweb for Biodiversity, 2019[18], Leporello, 2013[19], Organica[20]).

The Information and Communication Technologies (ICT) systems developed through the public-private partnership has enabled to use the previously unobserved data for better and 'greener' management of a city's life. In collaboration with Ireckon, the City of Breda, Netherlands has implemented a cloud-based system where citizens can optimize water use and improve environmental footprint. Water forms an integral part of the Breda's culture and brings a nice living environment, as the city is founded at the merging point of two rivers. However, it also brings challenges and needs permanent control to avoid flooding and other issues connected to water overflows. To secure the future of the city, Waterakkers project was started. Waterakkers is a large water reservoir in Breda, surrounded by a housing development. The solution links water and physical sensors at sewage plants to provide real-time data about water flow, asset management and measure the energy consumption of their pumps. The system allows predicting maintenance and seeing when pumps need to be fixed when they are using too much energy and the entire water energy of Waterakkers. The citizens can access real-time information on the status of water, helping to encourage greater awareness and consciousness of water use in the city. The platform is scalable and can be used for any type of water environment, with a limitless number of sensors and pumps. The experience of Breda shows that the ability to turn complex information into actionable insight means that more people can bring about positive change in their communities (Waterwakkers[21];

[18] Selmeczy, V., Morante, T., Bihunova B.M, Weber-Siwirska, M., Dostal, P., & Skarżyński, D.(2019). Smart & Green - On the spot in Visegrad cities. *CEEweb for Biodiversity*. http://www.ceeweb.org/wp-content/uploads/Smart-Green-brochure-EN.pdf

[19] Leporello, D. (2013). Opening the Site to the Public. Budapest Sewage Works Pte Ltd. https://cityhallwatch.files.wordpress.com/2015/03/20130304_delpest_leporello_eng_vegl.pdf

[20] "South Pest, Hungary - Innovative Solutions for Wastewater Treatment | Organica Water Inc." Organicawater. Accessed June 04, 2019. https://www.organicawater.com/case-study/south-pest-hungary/

[21] Waterakkers. (n.d.). Retrieved May 20, 2019, from http://www.waterakkersbreda.nl/Waterakkers/Information/home

Dudley, 2016[22]).

Financial Resources for the implementation of Green Infrastructure

Lack of funding is one of the most significant barriers to the implementation of green infrastructure. The following funding sources should be approached by countries, regions and cities seeking green & smart development can look for sources of funds to support the long-term projects:

1) Local, regional and central government programs and funds
2) Private sector
3) EU Transnational funding sources:
   - Life+
   - The EEA and Norway grants
   - Cohesion Fund (CF)
   - European Regional Development Fund (ERDF)
   - European Agricultural Fund for Rural Development (EAFRD)
   - Natural Capital Financing Facility
   - Interreg
   - European Social Fund (ESF)
   - Urban Innovative Action
   - European Investment Advisory Hub

Conclusion

This paper examined the CEE regions' state in the light of smart & green concepts and identifies the gaps and their causes. Including the green infrastructure into smart concept has been a long and ongoing process across all European countries. Indeed, Central and Eastern European regions are lagging behind the EU-28 average in innovation and productivity to address smart cities and regions. We highlight the lack of investment and technical capacity and weak planning capability to be among the most significant barriers to more sustainable and resilient development.

The experience of CEE and other European cities and municipalities reveal that long-term coordinated strategic planning and proper governmental (local, regional or central) support are essential to developing a smart green city. However, the public-private partnership and high rate of participation of the citizens have nonetheless importance, both increasing efficiency and encouraging innovation. The digitalization of governance allows for more efficient public governance and better information accessibility. Merging the green infrastructure with the modern

[22] Dudley, S. (2016). Understanding the role of technology. The Record, public sector, 135-138. Retrieved from http://www.technologyrecord.com/images/therecord/summer2016/TheRecord 1_public sector.pdf

technologies (i.e. ICT, GIS, Cloud-based, etc.) and integrating them to the governance process enables to use the previously unobserved data for better and 'greener' management of a city's life by creating systems, which reduce the costs of energy, operation and maintenance and increase participation and awareness among its residents.