08.

Sessione speciale Greening the city:challenges and opportunities

Francesco Orsi

Introduzione

As the urban population increases worldwide, so does the necessity of actions aimed at the enhancement of green space in cities. The literature about the positive effects of natural areas on the livability, ecological resilience and climate change adaptability of urban settlements is vast and growing. Yet, the actual possibility to make cities greener is faced with a series of planning issues related to, among other things, the identification of socially and ecologically suitable areas for parks, the consideration of the consequences of larger green areas on compactness, the modification of the existing urban fabric. The session will explore this topic from both a theoretical and a methodological perspective, with an emphasis on the identification of sustainable strategies.

Nàiade: a project proposal for the exploration of water surfaces for the spatial rethink of urban gardens in urban fabrics

Gian Andrea Giacobone

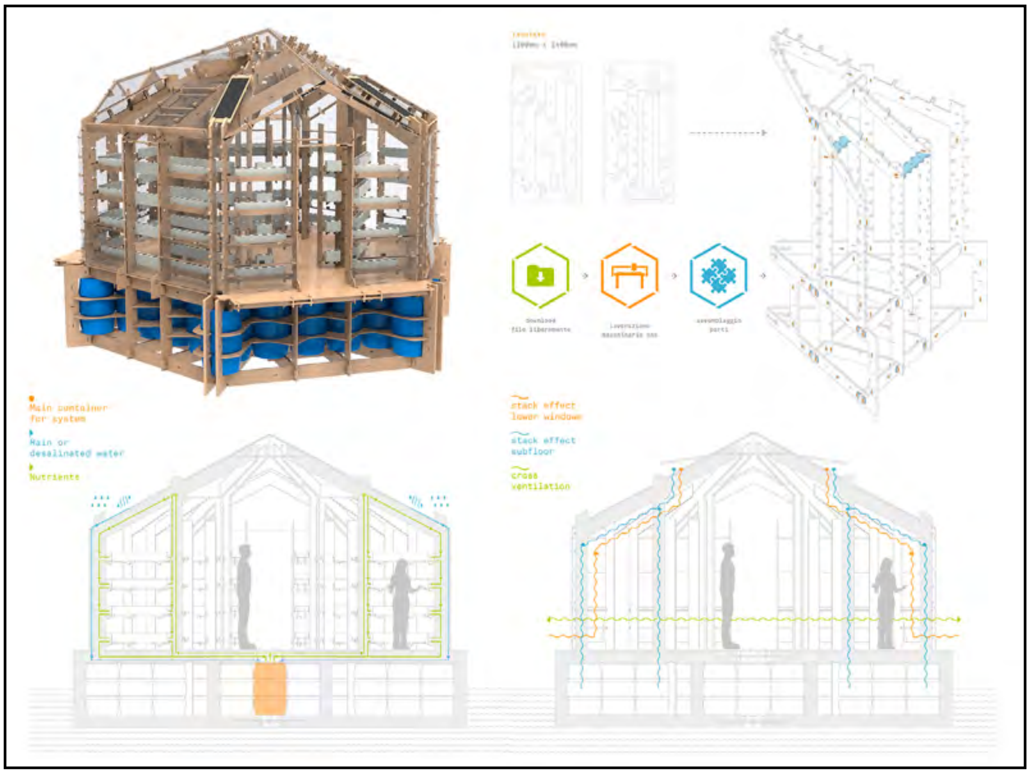

Figure 1– Representation of different Nàiade's features, in particular its floating platform, its manufacturing process by digital fabrication, its water circuit of hydroponic system and its natural system of passive ventilation. Credit: Gian Andrea

Greening the city: challenges and opportunities

Urban farming is a well-know reality widespread on current urban fabric. It deals with management and recovery of green areas inside the cities and is tightly linked with the local and self-made food production. Its main purpose has always been to ensure a supplying of food to its community of reference, but in the evolution of technology development, urban garden has been able to assume further and different social, ecological and cultural connotations, which are often opposed to the problems arising from today's modern society. Its role within the cities becomes relevant during the industrial development as healthy response against the mechanization of factory life. Moreover, urban garden constitutes a central and social role for livelihoods of urban communities during the war crises, as it is less sensitive to the risks of traditional distribution chains, creating a durable pattern of food resilience (Maltz, 2015). Over time, the growing prosperity of industrialized countries puts the productivity of urban garden in the background, enabling it to take symbolic values such as environmental sustainability compared to capitalist consumerism and territorial enhancement against urban degradation. Through tightly relationship with food system, the phenomenon of urban farming becomes a subject of study that perfectly fits in the urban planning principles of a city frame.

Horticulture is not only an agricultural food production tool, but it is also an indispensable element for the city as a territorial requalification. Inside the city, urban farming can play an active role both in landscaping and in environmental planning. If they are well managed, agricultural food spaces can be transformed into territorial markers that become for the local community a deterrent to tackle the urban degradation and to fight criminality or vandalism in favour of more secure spaces (Harris, 2009).

Characteristic of urban gardens

On this basis, it is possible to integrate the urban garden even within the broader concept (declared by the European community) of green infrastructure (Russo et al, 2017), intended as a tool that provide environmental, economic and social benefits through natural solutions against the grey infrastructure of modern urbanization (Lafortezza et al., 2013). The assumed value is found in its characteristic of being an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations (Benedict and McMahon, 2002). Therefore, urban garden assumes several functions in its overall vision which consequently have several advantages for its own society. One of the first benefits lies in food production as it can offer the food security of a community in reduced parts through both self-production and the creation of small economical forms of exchange or ethical purchasing. In addition, incorporating into a logic of local food system (i.e. a network of production and food consumption that operates on the short distribution chain), urban garden favours a sustainable development of food manufacturing. Unlike agricultural food system, urban farming improves resources, energies to maintain the system active and reduce distances between producer and consumer by working on small local scale. The expansion of green areas in cities, including urban gardens, improves microclimate through the natural evapotranspiration process of soils (Tei and Gianquinto, 2010). The presence of a natural ecosystem in the urban context reduces the powders in suspension and the pollution load of many compounds, including NO_2 - nitrogen dioxide (Tei and Gianquinto, 2010). In the social sphere, urban garden favours socialization between different groups of people and social classes, thus becoming an aggregation and integration tool for all the different members of the community, especially for the most disadvantaged categories such as homeless people, children, elderly and ethnic minorities (Bailkey et al., 2007). Thanks to its pedagogical role for children and adolescents, urban garden is a great tool to facilitate learning, respect for the environment and cognitive and physical development, while for elderly category is a great incentive to improve their cognitive and motoric skills (Tei and Gianquinto, 2010). Urban garden plays also an important role in contributing to human health and wellbeing (Tzoulas et al., 2007), as it helps people to fight, in the form of therapeutic function, against alienation and isolation forms that afflict urban life, particular psychological and physical disturbances, or social disadvantages (Matsuo, 1998). The happiness of urban garden is not just contemplative but it is found in the active relationship with it. Taking action within a cultivated space makes human being an active part of surrounding life and makes him feel in symbiosis with it (Zavalloni, 2010). The importance of green urban fabric is an excellent element of value for the development and requalification of urban spaces that can rely on more sustainable food systems integrated with the city liveability. The goal is to maintain its central role within the urban communities and to renew its features and functions in relation to the current environmental and urban context.

Urban issues

Today, the relationships between agriculture, food and cities are at the centre of profound transformations that push cities to reorganize their spaces. The continuous growth of population and its rapid turmoil, the prospect of a reduction in primary productive resources (e.g. soil, water, biodiversity) and the problem of accessibility of them are some elements that influence today's society development (Cavallo and Marino, 2016). The project, with its solution, tries to solve these factors through new technological solutions that can rethink the use of urban gardens in a more resilient way. It does not want to be the only objective to be achieved but one of the possible alternatives that can be taken to develop a system that reacts to the needs of current context. The idea focuses mainly on the creation of common green areas for food production that can be released from static nature of its own plots. This need is essentially driven by two variants: on one side there is a loss of cultivable space (due to both increasing urban density (Kelly, 2010) and deteriorating soils because of their intensive use, associated with the growth of food demand) (Fao, 2015); on the other side, there is a constant climate change that presages rising water levels, consequently putting at risk the viability of all urban areas connected directly with this problem. Many of the world's cities rising close to water surfaces, coastal areas, or they are subject to periodic waterlogging and flooding by nature (Abash et., 2012). In particular, territories that include monsoon area are constantly exposed to this natural and often catastrophic phenomenon, which makes water infiltration a risk for farmlands as a source of agricultural food production. The problem of flooding hits crops and their relative soils dedicated to cultivations, causing a strong impact on the entire economic and food system of local population. Flooding sets in motion a variety of physical, chemical and biological processes that alter the capacity of soils to support plant growth. Flooding with moving water often removes soil by scouring or adds soil by transport and silting (Kozlowski, 1984).

Changes in soil structure following flooding typically include breakdown of aggregates, deflocculating of clays, and destruction of cementing agents. Major chemical changes include decrease in or disappearance of O_2, accumulation of CO_2, increased solubility of mineral substances, reduction of Iron and Manganese, anaerobic decomposition of organic matter, and formation of toxic compounds. Flooding of soil with non-saline or saline water inhibits seed germination as well as vegetative and reproductive growth, alters plant anatomy, and induces plant mortality (Kozlowski, 1997). The effects of this process are already present in various regions that with the expected increase in sea level may still increase. About a third of the world's irrigated land and half the land in semiarid and coastal regions is influenced by excess salinity, and that about 10 million ha of irrigated land are abandoned annually because of excess salinity (Kozlowski, 1997).

Case studies

Based on these elements, research finds great inspiration for a possible solution through some historic and current models of floating gardens. They have been made and developed thanks to the needs of their own cultures, acquiring their particular resilience and adaptability characteristics directly from the reference context. The importance related with these examples is that they create a symbiotic relationship with the water element using it to take benefits for cultivation. One of the typical historical examples is Chinamapa (raised bed), a farm developed in the various lakes in the valley of Mexico by the Mesoamerican population in the pre-Hispanic time. Chinamapa is a sort of artificial island made by a mix of mud and vegetation and it is supported by willows, which allow floating elements to be higher than the lake level. This thing permits to cultivate plants taking advantage by the capillarity of soil to capture water, useful for harvest. A system of channels and ditches around the islands allowed water level control and communication between multiple plots (Coe, 1964).

Another example is located on Shan plateau, in the territory of Myanamr, where there is an ancient local population of fishermen named Intha (children of the lake). This ethnicity lives literally on the water, as the whole population has settled inside the lake through the use of residential buildings on stilts. Their main livelihood consists predominantly of fishing and agriculture. The latter activity is only possible thanks to floating gardens. They are made up by a frame of hyacinths and algae on which is placed soil for cultivation, and they are anchored to the ground by bamboo poles. They arise due to both the lack of soils for cultivation and the necessity to adapt lands to changing lake level during the rainy periods.

The last case study comes from Bangladesh. This Asian region is frequently exposed to the monsoon phenomenon, which often causes floods and infiltrations by sea water along its terrain, provoking discomforts in farming communities. A sustainable system of floating agriculture has been designed to adapt agriculture to constant climate change problems. As in the previous two examples, this project is also based on a floating platform made by a structure of bamboo and hyacinths, on which is positioned a mix of clay and vegetation waste. This traditional floating garden is a great resource for community's nutrition security in territories with high risk of flooding but remains a laborious and time-consuming construction (Chowdhury and Moore, 2017). The necessity to fight the rise of sea levels has had to intensify research for this type of system. Therefore, it exists a recent system created by a Bangladeshi research group called Ifcas (Integrated Floating Cage Aquageoponics System), which uses water contact to create a circular system between plants and fishes aimed to livelihood of families allocated in critical areas of the country (Haque et al., 2015).

Project proposal

These examples have enabled research to get insights toward the design of a food system for multiple communities located within different cities, exploiting the layout of urban water network. Many aquatic surfaces are present within cities and they are mainly used as communication channels, leaving open the possibility of exploiting them from other points of view. Revisiting the concept of urban gardening in city context, Nàiade project proposes the creation of a versatile and interconnected food production system combining the benefits of horticultural practices with a design perspective linked to the creation of floating greenhouse for different environmental and social contexts.

Naiade is a floating greenhouse that release agriculture from ground by expanding the concept of urban farms also through urban water networks. This thing is permitted thanks to the creation of a controlled environment composing of alternative cultivation practice that differs from traditional one for using soil-less techniques called hydroponics. The choice was made thanks to the versatility of this specific process that makes urban farming able to shape its structure on multiple horizontal and vertical surfaces, with a greater optimization of available space and resources for cultivation. By freeing crops from ground, they have more possibilities to effectively distribute themselves even on artificial surfaces. Mostly, they have the ability to use verticality as an element that can fully exploit the reduced horizontal surface limited by urbanization. In fact, from these characteristics, the realization of many green interventions in the cities has generated two distinct macro typologies of urban garden such as roof gardens and vertical farms.

The advantages offered by hydroponic cultivation are inside the efficiency of its method. It removes the soil from cultivation and consequently reduces labour cost and the use of pesticides necessary for the prevention of plants from infestations and diseases that are easily found during crop growth phases. For greenhouse, the "soil-less" method is important because the weight of soil is eliminated in favour of greater lightness for the flotation of structure. In addition, there is excellent water efficiency. The hydroponic system reduces water quantity used for irrigation and constantly recycles water into circuit of nutrients that it is often lost (in the traditional

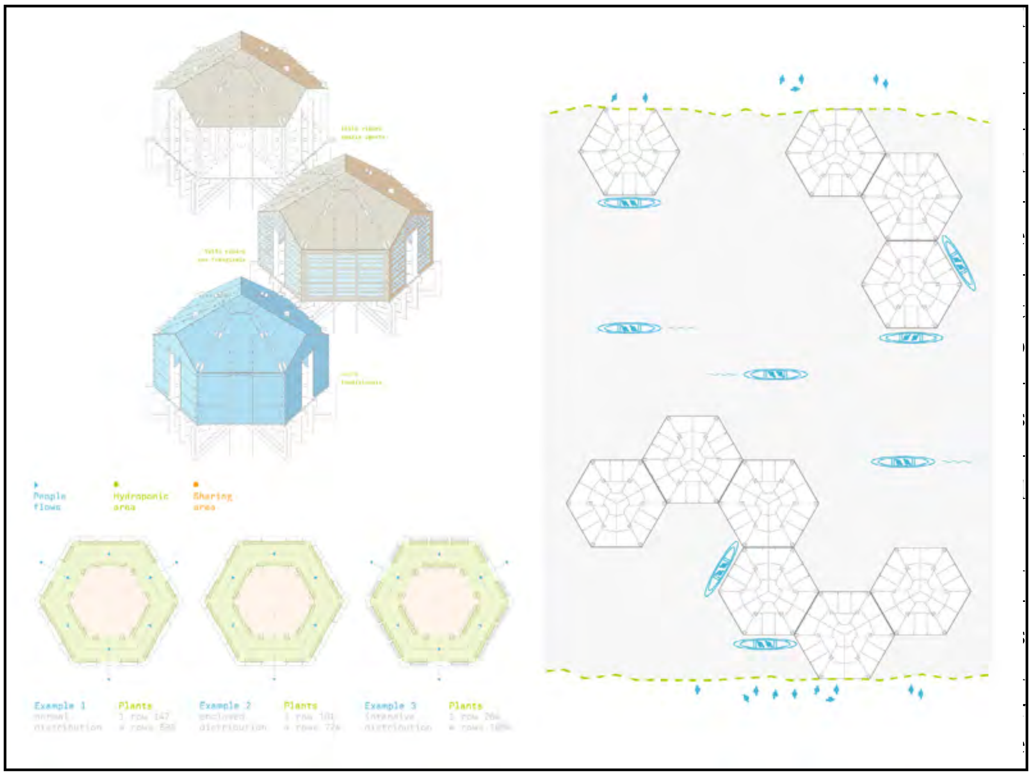

Figure 2– Representation of Nàiade's features, in particular its versatile shell, its modular system and it crop distribution. Credit: Gian Andrea

purification system placed on the roof of the structure and then integrated into the irrigation circuit. Another feature is the passive ventilation of the shell that imitates the nature of the termites (Pauli, 2010). The structure has windows 120 degrees each other on the bottom of the enclosure creating a cross ventilation. Further roof openings allow the air to create the stack effect through the heat difference between the air close to the waterline and the heated air inside the greenhouse through the sun's radiations. The passive process results in energy savings and considerable autonomy over HVAC (Heating, Ventilation and Air Conditioning) systems that rely on electricity (Sassi, 2006).

Being inclusion as a Nàide prerogative, the necessity to have a multi-context adaptable structure from the various global communities has pushed the project in search of a form that is as flexible and efficient as possible. The choice relies on the use of a hexagonal module (as the most efficient form of the relationship between area and energy and materials used for its construction), which can be scalable on multiple levels of urban community and extendable to several forms of aggregation social. The ability to combine these platforms together can therefore generate different forms of food development, ranging from a livelihood level to small fa-

of only one material is conceived in a design disassembly method to facilitate assembly or dismounting of structure, but also to improve its sustainability throughout its life cycle. Instead, a polycarbonate shell has been designed as it has advantages in terms of machine-to-light and light transmission while guaranteeing UV protection. The combination of these two elements has made it possible to think of different configurations of the structure where it can be configured as a traditional polycarbonate greenhouse with or without openings, or as an open or closed space covered by a single wooden roof, depending on the needs of the community. The interior space distribution is also thought to be modelled according to its specific use. Mainly along the perimeter of the greenhouse, which also has internal corridor function, we find modules for hydroponics, while in the centre there is a common space used for the equipment and control of the water system. In a modular system communication between the different platforms is possible through the connection that takes place along the hexagon apothems. Additionally, depending on community needs, you may have more or less intensive production around the perimeter. Floating is made possible by recycling 49 barrels for rainwater, converted into floats and equally distributed over an area of 24 square meters, where one of them is used for the hydroponic system. An open source electronic system (made up of low-cost sensors and actuators and powered by 6 solar panels placed on respective sides of hexagon) controls the irrigation system and constantly monitors the state of health of the environment. The essential parameters measured are: pH, EC (electrical conductivity), humidity, temperature and luminosity.

The purpose of this project is to create a system participated and shared by the various urban communities that can create a local, resilient, autonomous, self-sustainable and sustainable system of both green and agro-food areas, compared to the dysfunction of the current economic model. The idea is aimed to a strategy that can symbiotically integrate human space with nature by finding floating gardens an alternative to today's fragility of urbanization. As internet, the project looks at the design of a multi-local node network that links different sites and communities with different individual identities to create a shared system within urban fabric. The set of these groups allows the creation of new ways of action that subsequently are able to realize an inclusive and self-organized system where basic knowledge - knowledge of food, cultivation and production - becomes a common good accessible to everyone (Manzini, 2010). Thanks to the network, every person providing their skills with collaborative work times and through multimedia tools expands sharing information and knowledge. With network, people promote exchanges of sprouts, garden products, work tools, experiences and stories that are extended outside the community by expanding its aggregate potential (Bussolati, 2012).

For this reason, naiade model integrates the project with an online service where freely accessing the structure files and knowledge base for system development, where everyone can contribute to the development and maintenance of the project. By bringing together a vast and heterogeneous group of people, it creates a social capital that is able to create a distributed, equal and collaborative technology platform. In this way, you can freely exchange goods and services at almost zero marginal cost, with the possibility of having a democratic, widespread and bottom-up production (Rifkin, 2014). In addition, the network allows the distribution of the project in different contexts of world without any intermediation, leaving space for reinterpreting the ways in which a product has been historically generated, distributed and sold (Howe, 2010). The structure and system schemas are designed to be easily reproduced and assembled by a heterogeneous user, even from unskilled labour, to make the project as inclusive as possible. The importance of this phase is covered by a form of engagement that creates an interaction between people and the system throughout assembly phase. The irrigation system is designed to make usable plant supervision also remotely, in order to favour the exchange of social relationships. Thanks to the presence of this collaborative character, Náiade has the potential to create and evolve its ecosystem in favour of a resilient and sustainable urban design, through the involvement of schools, institutions, citizens and other communities.

Results

In conclusion, the project analyses the theme of urban gardens and its relationship with urban fabric, identifying a new line of research in water cultivation. Its development is designed to solve critical issues and problems of today's cities. By identifying some case studies of historical and current floating gardens, the project has developed its own floating structure (with a controlled environment) through the construction of a widespread and participatory urban system composed by several modules connected to each other. In addition, present socio-economic context has made possible the realization of a modular structure, freely accessible online and adaptable to multiple global environmental contexts.

Hence, Nàiade is interpreted as a possible contribution to research, useful to determine the growth of knowledge and ideas in the field of urban gardens.

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Greenery as common ground

Cristina Mattiucci

This short paper aims to open a discuss how (and if) the role of greenery has been changed fifty years later the Italian law fixed the minimum standard area to consider in urban planning, to give people a good quality of urban life, in order to question how it could became an issue for the urban agenda.
It will be here below briefly synthesized two main points for a debate, in the framework of the panel "Greening the city: challenges and opportunities" of the *X INU Study Day*, moving from theoretical statements in relationship with empirical data came from a case-study research (Mattiucci, 2011-2014) in Trento, in order to update the same role of planning in providing a good quality of life.
We will make reference to the broader territory in the province of Trento, where the fieldwork has been carried on, where it has been observed that the traditional contrast between urban and rural feature has been increasingly blurred, since the traditional economic activities or the settlements are spread out over a complex network of centers and sub-centers, often driven by a complex system of factors shaping the peculiar urban growth in the mountain areas. Indeed, even if the mountain cases have been traditionally considered either as rural or as urban (among others: Dematteis, 1975, 2009), nowadays, due to their territorial patterns or depending on the predominant interpretative models, the complex relationship between urban and rural features of mountain territories manifests a high degree of hybridization – in usages, forms and policies – a relationship an appraisal that represents a distinguishing feature of these territories.

Greenery as desire

According to what already stated (Mattiucci, 2015) we can assume the open spaces, extended or interstitial in mega regional territories, as the places where, beyond their degree of naturalness, it is possible observe the multiple services (not only agricultural, but also ecosystem services and recreational and entertainment opportunity) connected to the greenery's desire of contemporary societies.
Open spaces contribute to the understanding "how landscape changes while cities expand" and the way by which the "landscapeness" (Mattiucci, 2013) takes many connotations within contemporary city. As we pointed out (ib.), the *landscapeness* is expressed by imaginaries, elements and features, by the way people use open space and claim for the landscape, reformulating continuously the concepts of nature, public space and inhabiting, beyond the manifold socio-spatial configurations they could take on.
Concerning what we have learnt form the case-study, in Trento, the open spaces near or within a short distance of the city, as the Network of Natural Reserves of Mont Bondone or the Argentario Plateau, are very frequented and thay the object of projects and actions of preservation that valorise the various activities occurring there, from civic usages, fisheries, forestry, hay cutting, wood gathering, hunting, grazing, mushroom picking, livestock farming, to mountain farming and beekeeping, as well as tourism and sports. Together with the multifunctional open spaces of the province (Diamantini, 2015), they belong to that landscape crossed and lived every day to a larger scale of the nearest peri-urban dimension that characterizes the metropolitan reality of Trento.
Moreover, by observing the landscape uses and policies, it emerges an attitude aiming to enjoy the landscape amenities in the horizon of the everyday and ordinary paths. The centrality of these open spaces therefore contributes evidence to reformulate relations of power in the territory, in particular the characteristics of the mountain area, where the landscape takes on a central role, even as a safeguard of territorial capital (Perlik, 2015) becoming the centre of policies and projects. Even the open spaces observed in the study contexts are paradigmatic to recognise the multiplicity of ways in which themselves help to shape the metropolitan dimension, assuming - as already identified elsewhere within the literature (Terrin et al. 2013; Bourdeau-Lepage, Vidal et al. 2014; Chomarat-Ruiz et al. 2015) - the features of natural spaces in the metropolis as no longer in opposition to the urban context and not only with planned and designed shapes, but rather emerging in many forms in the interstices, in the abandoned empty spaces, in the fringe areas or infill spaces, etc.

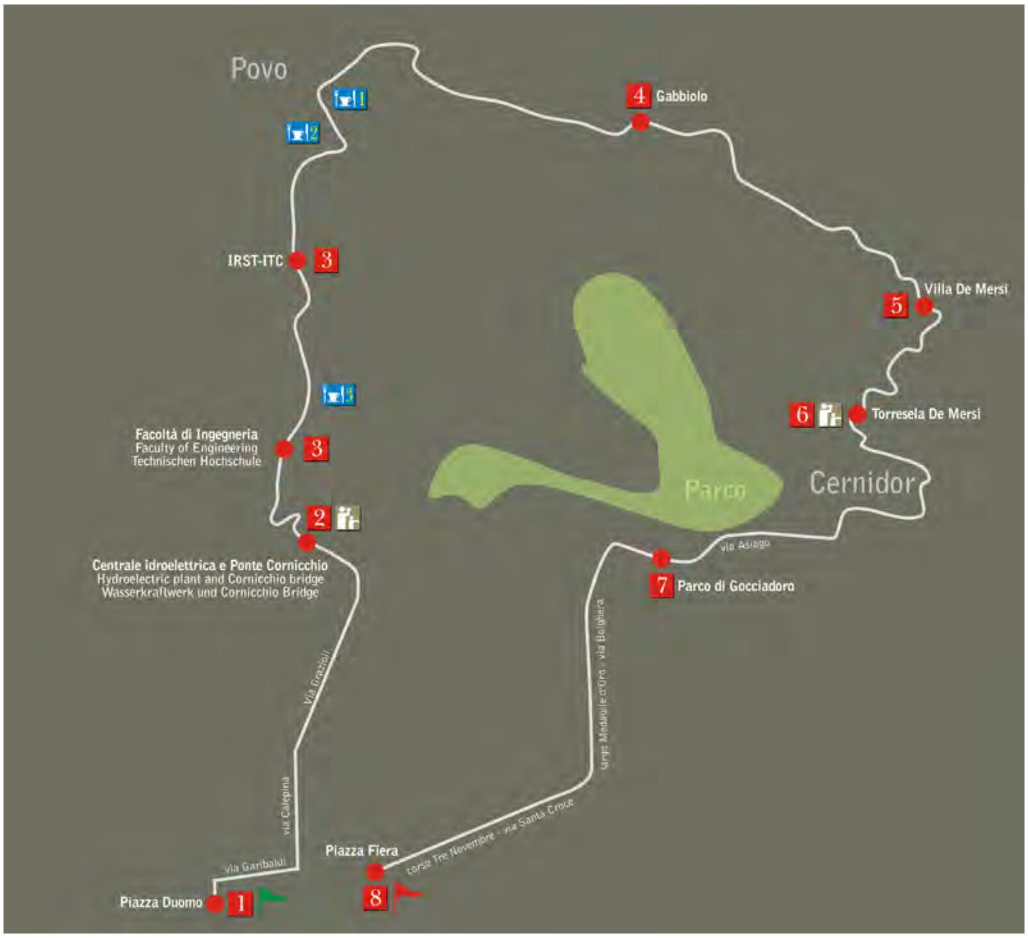

Figure 1– Urban Trekking aroud Trento: immaterial infrastructure to enjoy the landscape as public space

In these forms the socalled "verdissement de la société" is expressed, and it has to be recognised as a type of "call for green" or "the desire of landscape" which in itself takes on additional attributes, allowing to add new features and interpretations to the landscapeness, linked to the greenery and the environmental qualities and their various spatial presence as ordinary and everyday qualities of the urban life.

If we look at Trento case-study, the landscape -and so the green areas sorrounding the city - are characterized by the traits of a public space, confirming also the findings in other studies (Delbaere, 2010), with a peculiar feature of being as social primer, beyond its material features or its actual degree of greenery.

Greenery as a planning interistitutional issue

The features of greenery due to the practices and uses by contemporary societies, put in question governance and territorial policies at a broader strategical scale.

The Municipality of Trento promotes many initiatives for the "Network of Natural Reserves of Bondone Mountain", so that the governance of forest and mountain territory takes place in cooperation or otherwise in connection with the strategies taken at municipal level. For instance, the prospective of transformation of the areas included in the so called "Patto Territoriale del Monte Bondone" - that is an interistitutional policy for the areas very linked to Trento - is supported by the in the Urban Planning Policies and Plans of Trento, as in the *Varianti* (updating) at the provincial scale, so that to include these areas as subject of policies and projects.

Such interistitutional relationship is not only readable at the level of strategic planning , but even in the programmatic choices of the projects at the local level. For instance some little Municipalities of that Network of Reserves, such as Vason, are made objects of "urban renewal" strategies, in accordance with a more general planning and renewal of the "city mountain". Actually, according to these strategies, infrastructures, such as the municipal parking for about 150 vehicles, become a strategic projects to make an intermodal hub for some relevant new mountain centralities/facilities - as the Alpine Botanic Garden or a playground - emerging while the same area experienced a decrease of centrality among the ski itineraries and conversely an increase in what might be termed "attendances because the proximity".

The open spaces can then be identified – and so interpreted by policies and projects – as areas of consistent naturalness with significant ecosystems, or as spaces for multiple productions (not only agricultural, but also for ecosystem services, or *loisir*), or even as a shared collective (green) public space.

At this scale, in the polycentric dimension of the extended city, so the issue of the place for public sphere (Amin 2006; Bianchetti 2008) becomes an open issue, within which the landscape may be the container of the reformulation of policies in a relational form, supporting projects and policies to rethink local specificities facing of the multiplicities of the citizenships and the development processes.

Such perspective also implies to understand the scale on which spatial planning can contribute to the this goal.

One direction could be in the path of the experiences of other analogous contexts, already explored in a comparative perspective. In the French contexts, in the Grenoble area, as well as in the Agglomeration Grenobleuse, for instance, an interterritorial perspective has been developed in the last years (Vanier, 2008). It id based on "gouvernament par usage" which overcomes the istitutional perimeters, due to the evidence that the territories as political subject are not able to follow the evolution of the territories as social and economical subjetc, and has been tested in territorial strategies and scenarios directed by DATAR French Agency as "Territorie 2040" (territoires2040.datar.gouv.fr).

With reference to the landscape complex heritage – both cultural and material - strategic choices can be moreover put in relationship to the application at the local levels of the national strategies, which in turn intercept the European guidelines for the environment and the landscape, designing a new horizon for the urban agenda where the green takes on a central role, also to face with the complex issue of the quality of life, that implies several crucial issues as the accessibility to the urban facilities and so making the planning able to materialize the contemporary right to the city, in the path of the Lefevbre's topical work.

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Contribution of green spaces to the resilience of cities: mapping spatial (mis)matches of urban ecosystem services

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Introduction

Resilience theory for urban context refers to the ability of cities to deal with external and internal disturbances, while simultaneously maintaining social and ecological functions (Berkes, Colding, & Folke, 2003). Therefore, it becomes a conceptual foundation for the sustainable development of cities, given emerging challenges such urban population growth, climate change and multiple forms of poverty (Carpenter, Westley, & Turner, 2005).

Green spaces have been found to be of immense value thank to the provision of ecosystem services (ES), particularly those produced within cities – urban ecosystem services (Bolund & Hunhammar, 1999). These services are defined as the products of ecosystem structures and processes that societies demand (Fisher, Turner, & Morling, 2008), which in turn, become benefits when they are actually consumed by humans (Costanza et al., 2006). Because of their proximity to urban dwellers, urban ecosystem services directly affect their well-being and quality of life, ultimately improving the resilience of communities to disturbance events.

Recreation and food supply ES play an essential part in increase resilience. Recreation service helps to buffer communities against emotional, psychological and economical stressor. For example, some urban green spaces (UGS) reduce negative impacts of stressful life events by promoting opportunities for contact with natural environment and for participating in social and recreational activities (Chee, Lee, Jordan, & Horsley, 2015). While, promoting and supporting food supply through the urban agriculture greatly contributes to food security, nutrition and poverty alleviation of vulnerable social groups. Furthermore, the proximity of urban agriculture to residential areas may contribute to reduce food prices by cutting down cost of transportation and storage. This, in turn, is an effective strategy to encourage the purchase of more healthful food such as fruits and vegetable since individual dietary choices are primarily influenced by perceived value, perceived nutrition and taste (French, 2003).

Mismatches are defined as the differences in quantity between: the capacity of ecosystems to provide ES; the actual consumption of ES; and the demand of them. Specifically, mismatches occur when urban dwellers consume more than ecosystems can provide (i.e. unsustainable uptake mismatch) or when this consumption rate is not enough to meet the demand of ES (i.e. unsatisfied demand mismatch). The identification of mismatches suggests a deficit of ES benefits and hence, a reduced contribution of green areas to the resilience of cities. Furthermore, the unsustainable use of ES may jeopardize their provision on the long term, thus reducing resilience. Therefore, mapping mismatches at spatial dimension is of prime importance for informing governance, urban planning and management decisions (Geijzendorffer, Martín-López, and Roche 2015)quantities, spatial scales and dynamics. Mismatches, i.e., differences in quality or quantity between the supply and demand of ES, can occur in many different forms. Being able to identify these mismatches and their nature is of prime importance for informing governance and management decisions. This manuscript explores which mismatches can be detected by current ES supply and demand assessments and which mismatches currently remain unidentified. An analytic framework was developed comprised of five interlinked components of ES supply and demand linking nature and society (i.e., potential supply, managed supply, match, demand, and interests.

To this purpose, the aim of this preliminary paper will be to quantify and spatially map two typologies of mismatches for recreation and food supply services: unsatisfied demand and unsustainable uptake of ES. The analysis is made for two municipalities of the city of Havana, called "Plaza de la Revolución" and "Centro Havana", with clear differences concerning the urban morphology and urbanization history.

Developing and applying the framework to identify mismatches

We found in literature several frameworks used to identify mismatches (Baró et al., 2016; Burkhard, Kandziora, Hou, & Müller, 2014; Geijzendorffer et al., 2015; Schröter, Barton, Remme, & Hein, 2014; Villamagna, Angermeier, & Bennett, 2013). However, the definition of their components and mismatches differs among authors. Geijzendorffer, Martín-López, & Roche, 2015quantities, spatial scales and dynamics. Mismatches, i.e., differences in quality or quantity between the supply and demand of ES, can occur in many different forms. Being able to identify these mismatches and their nature is of prime importance for informing governance and management decisions. This manuscript explores which mismatches can be detected by current ES supply and demand assessments and which mismatches currently remain unidentified. An analytic framework was developed comprised of five interlinked components of ES supply and demand linking nature and society (i.e., potential supply, managed supply, match, demand, and interests argue that the discriminative capacity of some frameworks may not be sensitive enough to detect some mismatches. In this paper, we mostly follow the framework advanced by (Baró et al., 2016), which it clearly distinguishes between ES capacity, flow and demand. The first component of the framework, ES capacity, refers to the potential of green areas to provide ES, resulting from the combination of biophysical features and management practices (Geijzendorffer et al., 2015; Villamagna et al., 2013). It also addresses how urban dweller may benefit from ecosystem while maintaining their healthy and well-functioning, which are crucial characteristics to ensure the ES provision on the long term (Costanza, 2012; Fisher et al., 2008; McPhearson, Andersson, Elmqvist, & Frantzeskaki, 2015)especially in terms of energy efficiency, climate change adaptation, and social innovation. However, urban ecosystems have not been incorporated adequately into urban governance and planning for resilience despite mounting evidence that urban resident health and wellbeing is closely tied to the quality, quantity, and diversity of urban ecosystem services. We suggest that urban ecosystem services provide key links for bridging planning, management and governance practices seeking transitions to more sustainable cities, and serve an important role in building resilience in urban systems. Emerging city goals for resilience should explicitly incorporate the value of urban ES in city planning and governance. We argue that cities need to prioritize safeguarding of a resilient supply of ecosystem services to ensure livable, sustainable cities, especially given the dynamic nature of urban systems continually responding to global environmental change. Building urban resilience of and through ecosystem services, both in research and in practice, will require dealing with the dynamic nature of urban social-ecological systems and incorporating multiple ways of knowing into governance approaches to resilience including from scientists, practitioners, designers and planners." (Costanza, 2012; Fisher et al., 2008; McPhearson, Andersson, Elmqvist, & Frantzeskaki, 2015. The second component, ES flow, quantifies services currently received by urban dwellers, indirectly measures by the number of people that benefit from ES. The third component is the ES demand, which is conceptualized as the required level of ES to achieve a "desired state" (Villamagna et al., 2013). In this framework, this state is defined by social and environmental quality targets (Baró, Haase, Gómez-Baggethun, & Frantzeskaki, 2015; Paetzold, Warren, & Maltby, 2010).

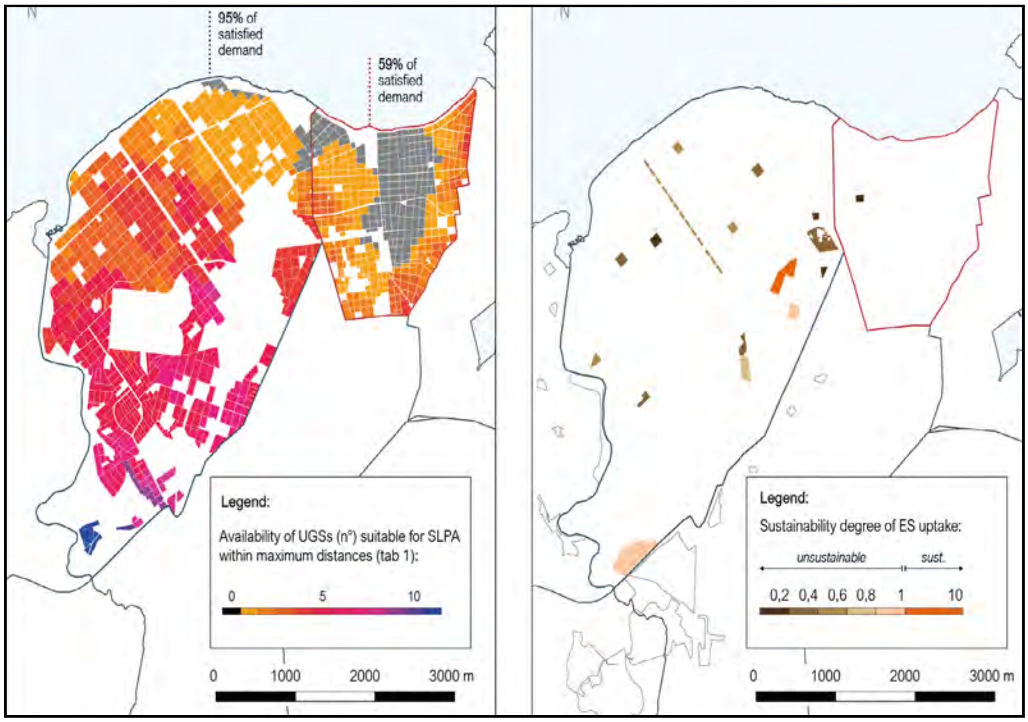

Figure 1- Mismatches of recreation ES. Figure 1.a shows the unsatisfied demand mismatch and figure 1.b the unsustainable uptake of ES mismatch.

We apply the framework to recreation and food supply ecosystem services and identify mismatches at urban block resolution scale. Capacity of recreation ES is quantified based on the minimum green space per capita of Cuban urban regulations, 9 m²/inh. The flow component is measured by the number of visitors by combining population density with targeted travel distances (Herzele & Wiedemann, 2003). While, demand of recreation service assumes as social quality target that "everyone should be able to reach at least one green area, of 0,5 ha to 60 ha of size, within certain travel distances" (Herzele & Wiedemann, 2003). The indicator to measure capacity for food supply was not defined. Instead, ES flow refers to the annual crop yield of urban agriculture in Havana in the 2016, that is 18 kg/m², and demand, which is 66 kg/inh. annually, was obtained by multiplying the minimum intake of vegetable and fruits recommended by (World Health Organization, 2003) by the reliance coefficient on urban agriculture of the Cuba National Food Program, that is 45%. Mismatches were identified by comparing in the same units of measure the ES capacity with flow and the ES demand with flow, resulting in unsustainable uptake and unsatisfied demand mismatch, respectively. Unsustainable uptake mismatch occurs when ES flow exceeds critical capacity value, while there is an unsatisfied demand mismatch when ES demand is higher than ES flow. The map of fig. 1.a shows the unsatisfied demand mismatch for recreation ES. It spatially represents the availability gradient of UGS suitable for practice recreational activities at an urban block resolution. Unsustainable uptake mismatch is shown in fig. 1.b and refers to green areas located within the administrative limits of the study locations. In this map, the unsustainable uptake is classified in five categories from 0 (i.e. the worst performance) to 1 (i.e. corresponding to critical capacity value) and a category of sustainable uptake characterized by results higher than 1.

Conclusion

In this paper, we have identified two typologies of mismatches inherent to urban ecosystem services, unsatisfied demand and unsustainable uptake, mostly following the conceptual framework proposed by (Baró et al., 2016). We have applied the framework for recreation and food supply services, and performed the assessment in two municipalities of the city of Havana. Mismatches were identified by comparing the capacity of urban green spaces to provide ES, the actual consumption rate of these services and the demand of them by cities. The municipalities of Plaza de la Revolución and Centro Havana have clear differences in the availability of green spaces, that was reflected in our results by dissimilar patterns of mismatches. Food supply service has the worst performance for both municipalities. While, for recreation, the unsatisfied demand is concentrated in Centro Havana municipality. In addition, most of the urban green spaces suitable for recreation service are under an unsustainable uptake regime in both cases study. These results may help to increase awareness among urban planners about vulnerable areas in terms of deficit of benefit from ecosystem services and unhealthy functioning and unsustainable provision of ES. However, we argue that some components of the framework should be deepened to effectively individuate unsustainable uptake and unsatisfied demand mismatches. Particularly, the contribution of built capital as well as the minimum configuration of structures and processes of ecosystem to the provision of ES on the long term should be addresses.

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Using simulation to design green and efficient urban configurations

Francesco Orsi

Introduction

There is considerable evidence today that a livable and healthy city is one whose inhabitants have easy access to public green space (Gidlöf-Gunnarson and Öhrström, 2007; van den Berg et al., 2010). Yet, the efficiency of a city is intimately associated with how accessible to people its services are. Hence, from a planner's point of view, the challenge is to design an urban configuration where any individual or household is sufficiently close to both public green space and a hub of services and cultural opportunities (i.e. a center). Even assuming this rather simplified vision, the problem is very complex because the location of each dwelling unit affects (and is affected by) the possibility of other units to be sufficiently close to the above-mentioned elements. Further, density matters: any attempt at locating dwelling units as close as possible to green space and a center is thwarted by the achievement of density levels that may not be acceptable by future residents. The problem involves so many complex interactions that it cannot be managed through traditional techniques, including spatial optimization: it should be investigated with simulation then, starting from its constituent units.

In the last 20 or 30 years, planners and geographers have devoted considerable efforts to the study of urban configurations as living systems (Batty, 2005), through the use of bottom-up techniques such as cellular automata (CA) and agent-based modeling (ABM) (Couclelis, 1989; Brown and Robinson, 2006). CA models represent the urban configuration as a set of cells whose state depends on the neighboring cells' state, whereas ABMs are CA models with the addition of autonomous entities (i.e. agents) that can move across, learn from and react to the surrounding environment.

This paper explores how ABMs can be used to design urban configurations that ensure adequate access to green space and services, while also keeping density within acceptable levels. The novelty lies in the use of simulation as a prescriptive rather than a descriptive tool, therefore helping planners define theoretical configurations that could be further discussed to get to feasible plans.

ABM as an urban planning tool

The use of ABMs as prescriptive tools (i.e. tools helping us understand how a system should develop) is rather uncommon and generally confined to such fields as logistics and industrial engineering. Some applications in planning do exist, however, contributing to the broader debate about planning support systems (PSS) (Ligtenberg et al., 2004; Saarloos et al., 2005). In these applications, the agents represent different groups involved in the planning process and trying to steer the urban development upon their preferences and expectations. The urban plan emerges from communication between agents in the form of an agreed upon set of decisions.

This paper further expands this concept, suggesting that an ideal urban configuration can emerge from the interactions between individual households, each seeking to find its most preferred location. This clearly does not reflect the way cities develop in the real world: it is only a trick that can be set up in a virtual world to identify widely accepted urban configurations. According to this idea, agents in the ABM represent households characterized by individual preferences towards their location within the city (e.g. distance from green space). A household's satisfaction can then be represented through a utility function, which the household tries to maximize by progressively moving to more suitable locations. As all households try to do the same, the overall system should step-by-step shift towards more widely accepted configurations, until the best (not necessarily optimal) one is found.

An abstract model

Model description

Starting from the concept presented in the previous section, an abstract ABM was developed to design urban configurations that ensure easy access to green space and a center, and account for density. Agents in the model represent households and can move across the environment, which is composed of cells. A cell with no agents on it is considered green space. Hence, two land use types are considered: built-up and green space. Each agent is able to measure three variables: distance from green space, distance from a provider of services (i.e. a center) and density. Distance from green space is computed as the average distance from the n closest green cells, where n can be defined by the user. Distance from the service provider is computed as the straight distance from the center of the environment. Density is computed as the number of other agents on the cell where the agent is currently located.

Each agent is assigned a utility function, which is a weighted linear combination of the values of the above-mentioned variables and the agent's sensitivities to those variables. Each agent has a unique personality, given by a unique set of sensitivity values. All sensitivity values are negative: households want to minimize the distance from green space, the distance from services and density. During the simulation, they will then have to trade off a slightly longer distance from green space against a lower density or a slightly higher density against a shorter distance from services.

In order to prevent unsolvable conflicts between agents during the simulation, the ABM has an embedded cooperation mechanism according to which agents move to locations that improve their own utility while not detracting too much from their neighbors' utility. In fact, if agent A moves to a cell that is currently empty (hence, green), it will affect the condition of agent B, which is currently next to that cell and therefore very close to green space, worsening its conditions. The user can define how cooperative agents must be during the simulation.

The simulation starts from a random spatial distribution of agents across the entire environment. At each time step, agents check the cell where they are and the eight surrounding cells to identify the location that maximizes their utility, while safeguarding their neighbors' utility. If the best location is the one the agent is currently at, it will simply not move. Simulations were run considering 1000 agents.

Results and discussion

The cooperation mechanism is key to finding acceptable configurations. In fact, lack of cooperation (i.e. agents simply try to maximize their utility) or extreme cooperation (i.e. agents simply try to maximize others'

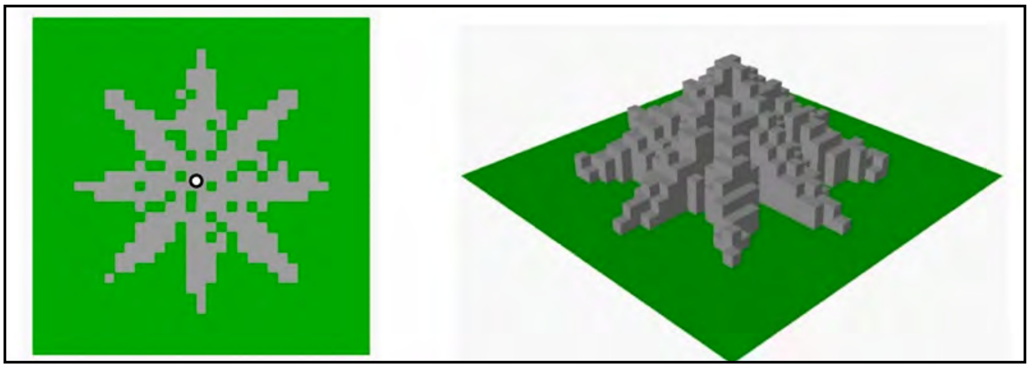

Figure 1 – Urban configuration generated by the model when assuming distance from the center increases more slowly (i.e. shorter travel time or perceived distance) along the horizontal, vertical and diagonal directions. The height of bars reflects density.

utility) result in either instability over time or an inefficient configuration. When cooperation is moderate instead, the system progressively evolves towards more efficient configurations until agents no longer move (i.e. they cannot improve their condition anymore).

The final configurations are all characterized by density being highest in the center of the environment and decreasing for increasing distance from the center. Green spaces are interspersed in the urban fabric ensuring none is too far from one of them. Households living in dwelling units at the outer margin of the agglomeration can compensate their significant distance from the center with lower densities and greater proximity to the countryside.

Figure 1 shows, using both 2D and 3D visualization, the output of a simulation, which was run assuming distance from the center increases more slowly along the horizontal, vertical and diagonal directions. This assumption is intended to mimic what happens in a real city, where movement along some directions is easier (hence, travel time or perceived distance are shorter) owing to the presence of transport infrastructures. Not surprisingly, green space is mostly concentrated in the areas comprised between the above-mentioned directions, whereas the built-up areas are found along those same directions. Households could then move reasonably quickly to the center and yet enjoy nature a few steps from home.

Two observations can be made about the configuration presented in Figure 1. First, there is consistency between the design achieved by the model and what proposed by some real urban plans (e.g. Copenhagen Finger Plan of 1947), suggesting the model supplies reasonable outputs. Second, not only does the model help figure out the qualitative aspects of a design: it also allows the determination of the quantitative aspects (e.g. how wide should the agglomeration be? How dense in its different areas?).

Possible uses of the proposed model

About 70% of the world's population will be urban by 2050 (UNDESA, 2014), raising a number of concerns about how to ensure a decent quality of life for all. The ability to make cities greener while also guaranteeing accessible services and acceptable density levels seems absolutely crucial to addressing such concerns. The model presented in this paper reflects an innovative approach to that: it rests on the idea that the ideal urban configuration can come out of an interaction process in which virtual households attempt to find their preferred residential location, driven by their goals and the need to acknowledge their neighbors' goals. Currently, the model is extremely simplified, but it can be improved to account for new variables (e.g. distance from specific services) and the presence of pre-existing urban features that agents should deal with in their search.

Evolutions of the model presented in this study can be used for three tasks. The first one is the design of new settlements. The model could help planners easily compute density levels at various locations and understand where to locate green spaces. The second one is the densification of existing settlements. The model could be applied on an existing urban fabric, accounting for two social groups: residents and newcomers. The goal would then be to identify which areas could be densified (and to what extent they could be densified) so that both groups are satisfied. The third one is the zoning of settlements. The model could be applied on an existing settlement to determine land uses and density levels that would bring in the greatest benefits to the population. All of these model applications require users to have a thorough knowledge of people's preferences in order to estimate meaningful sensitivity parameters. Such knowledge could be acquired through, among other techniques, stated preference surveys or hedonic regression analyses in the study area. The use of the proposed modelling approach is clearly one step of a broader planning process, where simulation outputs are discussed with all relevant stakeholders so as to define a feasible plan.

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A methodology to planning green infrastructure to face hydrogeological risks

Michele Grimaldi, Isidoro Fasolino

Abstract

Green Infrastructures (GI) can mitigate the effects of climate change and extreme events that they pose, managing, for example, the devastating power of floods or landslides, re-establishing spaces and functions. Many tools are available and many more emerging. The challenge is ensuring that well planned GI, providing functions which will meet numerous planning objectives.

We propose a methodology for the effective planning of a GI network that can help public policies. The application of the methodology highlight how it is possible to identify the contact points between the protection of ecological integrity and the mitigation of landslide risk, in line with EU strategies. The methodology therefore provides a new way of drawing the GI, which is generally based on the specific ability to favour biotic and abiotic flows. In this case, we try to optimize this pattern by also maintaining and raising all *Ecosystem Services* (ES), starting from the regulation of the soil disruption.

Objectives

The word resilience has proved attractive because it appears to offer a way to bring different disciplines and perspectives under a single conceptual umbrella.

We propose a methodology for the effective planning of a GI network that will help achieve numerous benefits,

including reducing risks to people and property.

The challenge is to ensure that well planned GI, providing functions which will meet numerous planning objectives, can go beyond the purely scientific and environmental framework and become an integral part of public policies; but this requires thorough planning, design and management.

We tried to develop a GI network using existing European data through a *Geographic Information System* (GIS) was taken from published and reclassified sources for analysis purposes.

The choices made during the data processing and analysis are based on expert opinions and are open to public control.

Exploring nature-based solution

Green Infrastructure (GI) consist of a network of natural and semi-natural areas strategically planned with other environmental features, designed and administered to provide a wide range of *Ecosystem Services* (ES). The importance is given to the ES provided as well as the use and management of the soil, with the aim of delivering a set of environmental benefits while maintaining and improving the ecological functions (Lennon and Scott, 2014). GI can mitigate the effects of climate change and extreme events that they pose, managing, for example, the devastating power of floods or landslides, re-establishing spaces and functions.

The importance of GI about strategy for adapting to climate change aims is identified by the EU policies in the following documents: Exploring Nature-based Solution of European Environment Agency (EEA) – EU; Seventh Environment Action Programme - 7EAP (Decision No 1386/2013/EU); EU Biodiversity Strategy (COM/2011/244 final); 2013 European Commission Strategy on Green Infrastructure (COM/2013/0249); Regional Policy 2014-2020; Water Frame Directive (2000/60/CE); Nitrates Directive (91/676/EEC); Floods Directive (COM(2006)15).

In particular, *Exploring Nature-based Solution* of European Environment Agency (EEA) - EU, shows the need for GI to mitigate vulnerability to atmospheric agents, climate change and, in particular, landslide risk.

About the Flood risk in Europe, the potential landslide hazard is based on the European Landslide Susceptibility Map (ELSUS1000).

Soil erosion depends mainly on precipitation as well as more superficial properties of the soils (Crozier, 2010). Plant cover plays an important role in soil conservation and in the prevention of landslides (Stokes et al., 2013).

According to a study prepared by the EEA, there are many tests that determine how rising landslides are due to climate change. In particular forests, along with other vegetation, are able to reduce the presence of surface landslides. Their global increase is due to the excessive use of natural resources and deforestation, as well as increasing urbanization and uncontrolled land use.

Studies show the ability of ecosystems to mitigate the risk of landslides based on the presence of protective forests and the potential danger of landslides.

The integration of both maps involves delineating a potential GI network to mitigate the impact of landslides hazard.

The theme of GI is closely related to Ecosystem Services (ES), a set of functions naturally provided by ecosystems (Costanza et al., 1997; Burkhard, B. et al., 2010), which are fundamental to maintaining the resilience of a territory.

About the *Ecosystem Services* (ES), the Millennium Ecosystem Assessment (MEA) (2005) has provided a useful classification by dividing ecosystem functions into four main categories:

- Ecological Integrity (EI) (or Supporting): these functions collect all the services needed to produce all other ESs and contribute to the (in situ) conservation of biological and genetic diversity and evolutionary processes.
- Regulating (SR): In addition to maintaining the health and functioning of ecosystems, regulatory functions collect many other services that have direct and indirect human benefits (such as climate stabilization, waste recycling), which are usually unrecognized until they are lost or degraded;
- Provisioning (SA): These functions collect all those resources supplying services that natural and semi-natural ecosystems produce (oxygen, water, food, etc.).
- Cultural (SC): Natural ecosystems provide an essential consultation function and contribute to the maintenance of human health by providing opportunities for reflection, spiritual enrichment, cognitive development, recreational and aesthetic experiences.

The protection from the hydrogeological disasters falls under the Regulation as SR6 service.

Green Infrastructures (GI) can mitigate the effects of climate change and extreme events that they pose, managing, for example, the devastating power of floods or landslides, re-establishing spaces and functions (Austin, 2014; Benedict and McMahon, 2006; Lafortezza et al., 2013). The main elements of GI include parks, private gardens, agricultural fields, hedges, trees, woodland, green roofs, green walls, rivers and ponds.

Methodology

The aim of this study is to develop a methodology that allows to detail the procedure outlined in the European document translating them into actions onto a more detailed scale in the territorial and urban planning.

The methodology requires a Ecosystem Services (ES) Assessment. Several tables found in current literature (Müller et al. 2011; Fisher and Turner, 2008) containing ES, defined by MEA, values for each soil class of Corine Land Cover (CLC) have been compared.

The different values found in literature for each ES, relative to the four macro-classes, according to the type of soil cover were homogenized by performing an arithmetic average operation.

The assessment is based on the ability of the different types of soil cover to provide individual service: 0 = no capacity; 1 = low capacity; 2 = relevant capacity; 3 = average capacity; 4 = high capacity; 5 = very high capacity.

The proposed methodology is based on a spatial analysis implemented in the GIS environment and consists of three macro-phases:

1) Identification of soil uses that maximize the ecosystemic erosion control (SR6) service at high and very high danger areas;

2) Construction of networks that maximize ecological integrity and multifunctionality of GI;

3) Identifying strategic priorities.

The macro-phase 1) consists of the following steps:

- assigning value scores associated with each land use according to the CLC classification;
- Identifying the combination of levels of danger with the patches that maximize the SR6 service.

The distribution of the danger from landslides is identified by the Hydrogeological Basin Central Campania Authority (2015).

The geodatabase is made up of information from the Agricultural Utilization Soil Map (CUAS) of Campania Region (2009).

From the intersection, the patches that maximize the SR6 service in combination with the high danger (P3) and very high danger (P4) areas have been identified.

The macro-phase 2) involves the construction of networks by using cost-distance analysis, using as the resistance values the corresponding scores for soil utilization related to the *Ecological Integrity* (IE), the combination of the latter with *Regulating Erosion* (SR6) and the combination of SR6 with the other ES values, as *Regulating* (SR), *Provisioning* (SA) and *Cultural* (SC):

a) Network which maximize the ecosystem services (ES): IE;

b) Network which maximize the ecosystem services (ES): IE - SR6;

c) Network which maximize all the ecosystem services (ES): IE – SA – SC – SR – SR6.

The Graphab software was used to design the networks: to generate the graph and calculate the different metrics at local and global levels.

The macro-phase 3) is articulated in:

- network measurement using network analysis through appropriate indices;
- comparison between the different networks in order to define their maximization;
- definition of strategic priorities.

A comparison was carried out between the different networks in order to define their maximization as well as define the mitigation strategy.

Discussion and Perspectives

The *Rural Development Program 2014-2020* (PSR 2014-2020) of the Campania Region depicts the regional territory as a territory affected by worrying symptoms of abandonment, partly caused by the decline in agricultural land and demographic impoverishment, with three quarters of it being characterized by mountainous and hilly areas where soil conservation policies with relevant erosive dynamics. Current climate change increases the danger and risk of landslides and floods, the potential risk of erosion and more generally degradation of the soil. Is important, about that, to provide for assessment mechanisms of the areas with high risk of landslides and erosion due to the great importance of resources assigned to the environmental theme.

It is worth noting the PSR 2014-2020 and the specific Measure about Creating and / or restoring and / or expanding green infrastructures and agrarian landscape elements. This measure aims to achieve the sustainable development objective of Campania agro-food business, foreseeing it necessary to improve the environmental conditions of the territory from an agro-climate point of view, pursuing a satisfactory state of conservation of the biodiversity.

From reading the overlay map of the Sr6 distribution and the map of the landslide hazard distribution, the concomitant use of high-value Sr6 soil with P3 and P4 hazard levels emerges. This information indicates that, on the one hand, the use of the soil performs a protective action, while on the other hand it alone does not contribute to the resolution of the problem due mainly to geological and geotechnical conditions.

In conclusion, to achieve the resilience of a territory, it is very important to promote the mainstreaming of risk assessments into land-use policy development and implementation, including into urban planning.

The methodology therefore provides a new way of drawing the GI, which is generally based on the specific ability to favour biotic and abiotic flows. In this case, we try to optimize this pattern by also maintaining and raising other ES, starting from the regulation of the soil disruption.

The challenge is, in fact, to ensure that well planned GI, providing functions which will meet numerous planning objectives.

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