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Journal of
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This special issue collects a selection of peer-review papers presented at the 8th International Conference INPUT 2014 titled "Smart City: planning for energy, transportation and sustainability of urban systems", held on 4-6 June in Naples, Italy. The issue includes recent developments on the theme of relationship between innovation and city management and planning.

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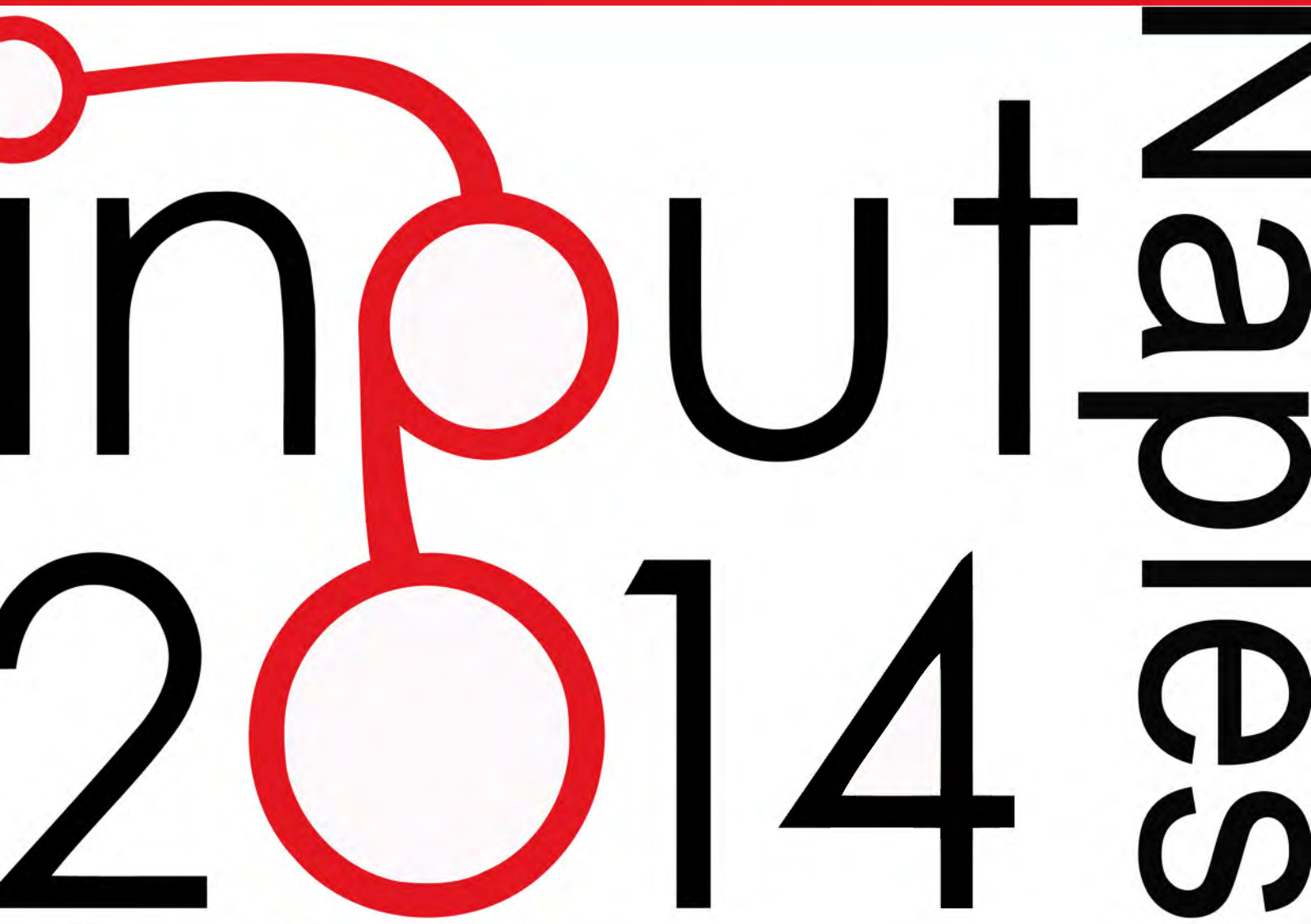

Smart City

planning for energy, transportation and sustainability of the urban system

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SMART CITY

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TeMA Journal of Land Use, Mobility and Environment

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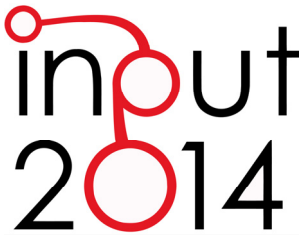
TeMA Journal of Land Use, Mobility and Environment

This special issue of TeMA collects the papers presented at the 8th International Conference INPUT 2014 which will take place in Naples from 4th to 6th June. The Conference focuses on one of the central topics within the urban studies debate and combines, in a new perspective, researches concerning the relationship between innovation and management of city changing.



TeMA Journal of Land Use, Mobility and Environment

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EIGHTH INTERNATIONAL CONFERENCE INPUT 2014

SMART CITY. PLANNING FOR ENERGY, TRANSPORTATION AND SUSTAINABILITY OF THE URBAN SYSTEM

This special issue of TeMA collects the papers presented at the Eighth International Conference INPUT, 2014, titled "Smart City. Planning for energy, transportation and sustainability of the urban system" that takes place in Naples from 4 to 6 of June 2014.

INPUT (Innovation in Urban Planning and Territorial) consists of an informal group/network of academic researchers Italians and foreigners working in several areas related to urban and territorial planning. Starting from the first conference, held in Venice in 1999, INPUT has represented an opportunity to reflect on the use of Information and Communication Technologies (ICTs) as key planning support tools. The theme of the eighth conference focuses on one of the most topical debate of urban studies that combines , in a new perspective, researches concerning the relationship between innovation (technological, methodological, of process etc..) and the management of the changes of the city. The Smart City is also currently the most investigated subject by TeMA that with this number is intended to provide a broad overview of the research activities currently in place in Italy and a number of European countries. Naples, with its tradition of studies in this particular research field, represents the best place to review progress on what is being done and try to identify some structural elements of a planning approach.

Furthermore the conference has represented the ideal space of mind comparison and ideas exchanging about a number of topics like: planning support systems, models to geo-design, qualitative cognitive models and formal ontologies, smart mobility and urban transport, Visualization and spatial perception in urban planning innovative processes for urban regeneration, smart city and smart citizen, the Smart Energy Master project, urban entropy and evaluation in urban planning, etc..

The conference INPUT Naples 2014 were sent 84 papers, through a computerized procedure using the website www.input2014.it . The papers were subjected to a series of monitoring and control operations. The first fundamental phase saw the submission of the papers to reviewers. To enable a blind procedure the papers have been checked in advance, in order to eliminate any reference to the authors. The review was carried out on a form set up by the local scientific committee. The review forms received were sent to the authors who have adapted the papers, in a more or less extensive way, on the base of the received comments. At this point (third stage), the new version of the paper was subjected to control for to standardize the content to the layout required for the publication within TeMA. In parallel, the Local Scientific Committee, along with the Editorial Board of the magazine, has provided to the technical operation on the site TeMA (insertion of data for the indexing and insertion of pdf version of the papers). In the light of the time's shortness and of the high number of contributions the Local Scientific Committee decided to publish the papers by applying some simplifies compared with the normal procedures used by TeMA. Specifically:

- Each paper was equipped with cover, TeMA Editorial Advisory Board, INPUT Scientific Committee, introductory page of INPUT 2014 and summary;
- Summary and sorting of the papers are in alphabetical order, based on the surname of the first author;
- Each paper is indexed with own DOI codex which can be found in the electronic version on TeMA website (www.tema.unina.it). The codex is not present on the pdf version of the papers.

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SPECIAL ISSUE

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GEODESIGN FOR URBAN ECOSYSTEM SERVICES

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ABSTRACT
This paper argues about the use of Geodesign tools in planning for enhance the Ecosystem Services provision in a urban context. Recently evolved from GIScience, Geodesign is an emerging field dealing with 2D and 3D representation tools developed for environmental design. On the other hand, the ES concept has become a central issue in environmental planning and research, dealing with the services provided by ecosystems to sustain and fulfill human life and well being. However, both Geodesign and ES still lack of a real integration in planning practices. While Geodesign tools appear to be stuck in rendering realistic 3D urban environments, the use of the ES concept in planning processes is still largely missing. For these reasons this paper will take advantage of concepts and tools from Geodesign and Ecosystem Services disciplines and will explore how they can be integrated in a methodological framework to generate Geodesign solution aimed at increasing the provision of urban ecosystem services.

KEYWORDS
Geodesign, Urban Ecosystem Services, Urban Planning

1 INTRODUCTION

Geodesign is an emerging, interdisciplinary field that has evolved from Geographic Information Systems (GIS) and encompasses digital, 2 and 3 dimensional representation tools developed for environmental design (Goodchild 2010). Over a relatively short span of time, Geodesign has moved from a neologism to the focus of contemporary researches on urban design integrated with modern IT tools (Miller 2013), thanks to the swift development of IT world and computational capability of personal computers. The advantage of Geodesign tools is that they can handle a wide spectrum of spatial complexity. This tools show a promising role in involving many stakeholders in planning processes by ensuring a feedback between future visions of changes and present actions and offering a learning process also known as "higher order learning" (Brown, Vergrat, Green and Berchicicci 2003). Yet, despite this central role in urban planning and design, Geodesign isn't currently integrated in land-use processes and still remains the domain of IT applications, mainly because it is non-intuitive and relatively difficult to use. Contemporary Geodesign approaches are mainly focused on single rendering of 3D urban landscapes, but they are often disconnected from general objectives of sustainability planning.

Ecosystem Services (ES) are the conditions and processes through which natural ecosystems and the species that compose them sustain and fulfil human life (Daily 1997). These services include, among others, purification of air and water, mitigation of floods and droughts, detoxification and decomposition of waste, generation and renewal of soil fertility, regulation of climate, moderation of temperature extremes, provision of aesthetic beauty and intellectual stimulation (Bolund and Hunhammar 1999; MEA 2005). The concept of ES represents a consolidated theoretical reference for a number of different disciplines, such as ecology, forestry, agricultural science, environmental economics and urban/landscape planning. However, the inclusion of ecosystem services in planning processes is still very limited, especially in Italian urban planning, where there is a general lack of knowledge by decision makers about these issues.

The field of urban and landscape planning appears to be to most straightforward destinations for the outcomes of Geodesign and Ecosystem Services disciplines. Geodesign tools are naturally and closely intertwined with urban planning and have very recently emerged as a specific opportunity, to better accommodate landscape architects, urban and regional planners, and architects with geospatial technologies (Wilson 2014). They can act as a mean to make complex urban planning problems more readily understandable, in order to broaden public participation, and to improve decision making (Steinitz 2008).

On the other hand, the fast and widespread evolution of the ES concept is seen by a number of scholars and scientists as a not-to-be-missed opportunity to inform planning authorities in finding solutions that respond to competing social and environmental needs.

For these reasons, the integration of concepts and tools from Geodesign and Ecosystem Services disciplines is a promising way for urban planning to achieve significant results of long term sustainability in the urban environment.

2 GEODESIGN TOOLS FOR URBAN ECOSYSTEM SERVICES

There is very limited research ongoing about the relation between Geodesign and Ecosystem Services: querying these two words in academic databases (Scopus, ISI Web of Knowledge) returns only a couple of occurrences.

Current literature have clearly underlined the importance of ES. To prevent a decrease of the quality of ecosystems, the ES concept has become a central issue in environmental planning (Fisher and Turner 2008), allowing the assessment and mapping of services provided by different ecosystems. The concept is also view

as useful for communicating the multiple ways in which natural systems contribute to human well-being and highlighting the (monetary) value of provided ecosystem services (MEA 2005; Pavola and Hubacek 2013).
Despite the growing body of literature on ES, still many challenges remain to structurally integrate ES in planning (de Groot et al., 2010) and rhe use of the ES concept in planning is still largely missing.
Even more limited is the application of ES concept to urban planning field (Gómez-baggethun and Barton 2013), where the ways of including ES into planning choices about future land-use assets are still fairly unexplored (La Rosa and Privitera 2013). Moreover, general approaches of ES assessment do not consider information about detailed land cover composition in urban contexts: having a look at land cover compositions at finer scale reveals significant differences in terms of provision of ES (Lakes and Kim 2012). 3D dimension (height of tree or buildings and building and consequent volume of leaves and built structures) has been never considered in current ES assessment.
In this direction, the use of Geodesign solutions can overcome the limited applications of ES concept in urban planning. Testing and assessing designed spatial configurations of land-use and land cover at detailed scale would be a crucial information to decision makers especially at the municipal level, where the most relevant choices about land-use are taken and the pressure from different stakeholders is higher. In synthesis, the use of Geodesign for planning ES in urban context would allow to:

- increase the credibility of decision on land-use with a detailed design of land-use and land cover;
- improve the communication of key messages, such as the right choice of design element might maximize the provision urban ES;
- explore and communicate alternative decisions about land-use according to available financial resources.

Despite the link between of Geodesign and urban planning is claimed to be central (McElvaney 2012), current applications of Geodesign are mainly focused on producing complex, appealing 3D virtual urban landscapes, but often show no sound objectives or policies of urban sustainability as their bases. For this reason, the integration within urban planning of ES concept and Geodesign techniques appear to be of great importance to achieve relevant results for a sustainable the urban environment. A proposal for using Geodesign tools for integrating Urban Ecosystem Services into planning follows below.

2.1 A METHODOLOGICAL PROPOSAL

The main assumption of the methodological proposal here presented is that physical features such as land-use/land cover and socio-ecological variables are identified as the main components of urban ecosystems, thus influencing the production of ES (Bolund and Hunhammar 1999). These features can act as the main information sources for ES assessments, as they are able to provide information about environmental, physical and social characteristics of the urban environment. They can be represented by the following variables:

- land-use classes (according to the 4 level of the legend of Corine Land Cover data set);
- land-cover classes (trees, shrubs, grass, herbaceous vegetation, buildings, streets, other impermeable surfaces);
- census data (total population, children, elderly people, …).

These variables can be used for the calculation of a set of spatial indicators for the assessment of ES, as explained below.
A first set of ecosystem services can be derived from literature (Burkhard *et al.* 2009; de Groot *et al.* 2010; MEA 2005), trying to encompass the most relevant categories of service. The set includes: (1) provision of

food and fodder, (2) provision of wood/timber, (3) clean air provision, (4) local climate regulation, (5) global climate regulation, (6) water balance regulation, (7) clean water provision, (8) soil erosion protection, (9) recreation and ecotourism, (10) aesthetic value, and (11) biodiversity.
The criteria for the choice of the ES are: to be among the most used assessed ES in current literature, to span all categories of ES according to MEA (2005). Each of the previously identified ES can be assessed by one or more indicators. An initial set of indicators available in literature is reported in reported table 1. This set should be always subject to a check aimed at verifying the possible use of indicators according to data availability.

ECOSYSTEM SERVICES CATEGORIES	SERVICES	INDICATORS
Regulating	Water balance regulation	Water balance regulation: water retention capacity [m³ * ha-1], run-off coefficient [Ψ], soil sealing [%]
	Climate regulation	Local climate regulation: albedo [%]
		C-Sequestration - storage of C in soil and biomass [kg C ha-1]
	Soil erosion protection	C-factor (USLE model)
	Capacity for biological regulation	Number of habitats for pest control species
Provisioning Ecological integrity	Biological diversity	Composition of flora and fauna communities
	Ecological Connectivity	Connectivity index
	Water cycles	Ground water recharge [m3 * ha-1]
	Evapotranspiration	Evapotranspiration [area of evapotranspiring land covers/ total area]
	Production of plant biomass	Food and fodder from plants [t * ha-1 *a-1]
		Biomass for industrial use / processing [t * ha^{-1} *a^{-1}]
	Bio-resource production	Biomass for energy production [t * ha^{-1} *a^{-1}]
		Food from livestock [t * ha^{-1} *a^{-1}]
	Cool air production	Clean air production [m³ * ha^{-1} * h^{-1}]
Human health and well-being	Recreation and social values	Number/area of green spaces
		Number of visitors of green space
		Aesthetical value (expert opinion)

Tab.1 A possible set of indicators for urban Ecosystem Services

The second step of the method assesses the ES using spatial indicators selected in the previous phases. First indicators are calculated in a GIS environment on the base of available land-use, land cover and census data. Since indicators are expressed with different units and scales of values/scores, they need be transformed to a relative scale from 0 – 100 by mathematical normalization. Moreover, some ES, i.e. regulating and cultural services and to a minor extent some provisioning and supporting services, depend strongly on the geographic location of urban ecosystems or land-use/land cover classes. For example, cultural services provided by urban green spaces can be dramatically increased when these areas are well distributed in the urban context. These aspects are always excluded from ES assessments and require the inclusion of urban ecosystem mosaic (or mosaic of land uses) in the assessment models. Thus the spatial configurations of land-use/land cover must be expressed in terms of specific spatial features (heterogeneity, density, contiguity) and used to assess some of the indicators.

The third step is the definition of a set of Geodesign solutions (2D and 3D) according to literature review and environmental features of the study areas. Each Geodesign solution include a combination of base elements of land-use and land-cover (Fig. 1). Examples of design solutions encompass different combinations of buildings and/or streets/public space layout with different area covered by trees, shrubs, lawns and water and thus presenting different permeability/evapotranspiring ratio. All Geodesign solutions are sketched and mapped with 3D GIS software (for example, ESRI City Engine) and will be based on vector base GIS information (shapefile) containing the 2D spatial composition of land-use and land cover. This would allow to include the designed solutions in a geodatabase that comprehend all attributes and features related to each solution (land-use, land-covers, covered area, height, permeability ratio, cost of implementation per area unit) as well as the relative geographic vector information.

Fig. 1 Example of green corridor and bike/pedestrian pathway

Figure 1 and Figure 2 show a couple of examples of Geodesign solutions for two green urban corridors integrate with bike and pedestrian pathways. They have a width varying from 20 m to 14 m, with a total percentage of green cover varying from 75% to 70% and permeable surface at 92% and 100% respectively. They can composed by a bed of arboreal species with a width between 7.8 m and 6.8 m. Trees have their maximum height between 5 m and 12 m and canopy width between 3 m and 6 m. Species of Ligustrum japonicum, Phillyrea Agustifolia, Magnolia grandiflora, Celtis Australis can be used. One way cycle (1.5 m wide) and pedestrian are paths (from 2.1 m to 2.5 m) included in this solution. Corridors can be paved with bituminous layer. Cycle and pedestrian paths are always paved with natural permeable materials. Zoysia Japonica specie can be used for lawns, as it is a very resistant specie for Mediterranean climate. The result of this Geodesign solution is a configuration of public green spaces where usability (cultural services), thermal comfort (regulating services) and safe mobility can be achieved. The shade along cycle and pedestrian paths is a key element considering the climate condition of the city, characterized by long and hot summers (regulating services).

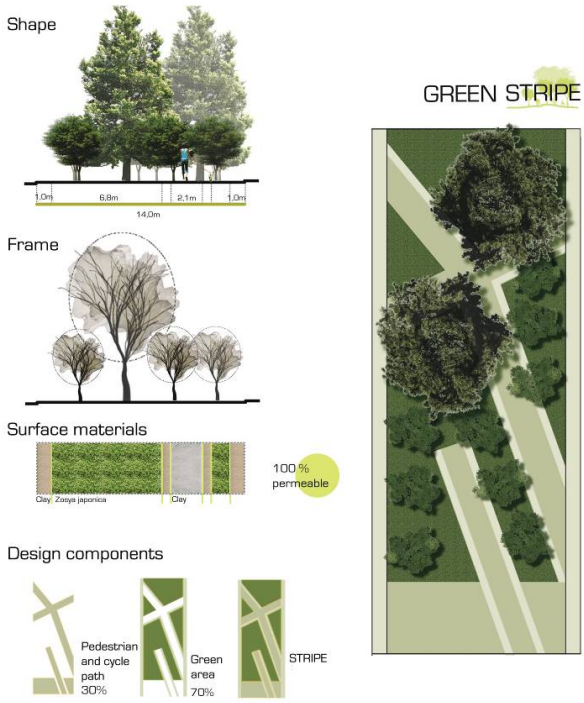

Fig. 2 Example of green corridor

Particular importance should be attributed to the vertical dimension of proposed design solutions, since the provision of ES can be very different when, for example, being equal the area covered by a land-use, there are different heights of buildings and trees or different permeability ratios. Of course, the costs for each solutions need to be evaluated, based on appropriate literature and urban design projects' reviews. This represents a crucial information that will allow to quantify the effectiveness of proposed solution in terms of benefits/cost ratio.

The last step of the method quantifies the changes in ES provision according to Geodesign solutions identified in the previous phase. To achieve this, Geodesign solutions can be structured into two groups of planning scenarios, that represent the spatial modification of current land-use pattern in the study area and are aimed at understating which ES and to what extent it may change according to these modifications. For example, planning Scenarios can be grouped in urban development and green spaces provision scenarios and each group of scenarios can be further divided in 3 sub-scenarios, according to the intensity (low, medium, high) of proposed urban transformations and thus considering an increasing cost for their implementation. This would allow to explore the changes on ES provision by Geodesign solutions in a more continuous way, moving from low intensity to high intensity transformations.

Each scenario results in a change of provided ES ad different scales, such as neighbourhood and the entire municipality scales. Within each scenario, different combinations of Geodesign solutions are tested, so to find an optimal set of solutions in terms of ES enhancement and relative costs. This means that the a single planning scenario can be constituted by different combination of Geodesign solutions. For example, a scenario of low urban development with a 30% of covered floor area can be obtained by several combination of single high rise buildings, lawn and trees or, as an alternative, semi-detached houses, ornamental orchards and shrubs. To find an optimal set of GeoDesign solutions, a Multi Criteria Model can be used, by defining an objective (the maximization of the ratio between provided ES and relative costs) and weighting each ES according to Analytical Hierarchy Process (Saaty 1980).

Figure 3 presents an example of the generation of a 2d design solution for an Non Urbanized area within the dense urban fabric of the city of Catania (Italy). The detailed layout include a proposal for an optimal localization of buildings, public facilities and greenspaces in the area in terms of provided Ecosystem Services (Martinico *et al.* 2014). This area is characterized by different function and land covers. For example, within the two designated Development Zones, multi-storey apartments, buildings for offices and retails up to five storeys can be allocated and a required minimum percentage of permeability of 30% is fixed in order to allow the natural infiltration of rain waters and decrease the urban surface run-off. In the new public greenspaces (representing about 50% of the area), the tree coverage is set to be higher than 25%. Moreover, new land uses such as allotment gardens and Community Supported Agriculture farms can be included allowing the increasing of provisioning services.

Fig. 3 A planning scenario to optimize Ecosystem Services provision

3 CONCLUSIONS

This paper proposes to understand how modern Geodesign spatial tools for urban planning can be used to provide design solutions aimed at the maximization of urban Ecosystem Services. Recently evolved from GIScience, Geodesign is an emerging field dealing with 2D and 3D representation tools developed for environmental design. The ES concept has become a central issue in environmental planning and research, dealing with the services provided by ecosystems to sustain and fulfill human life and well being. However, both Geodesign and ES still lack of a real integration in planning practices. While Geodesign tools appear to

be stuck in rendering realistic 3D urban environments, the use of the ES concept in planning processes is still largely missing. For these reasons the integration of the two concepts and relative tools can be used by urban planning to achieve results of long term sustainability for the urban environment.

The proposed method can be considered as an initial framework to use Geodesign tools in urban planning aimed at the optimization/increasing of urban Ecosystem Services. In this method, different GeoDesign solutions can be defined as combination of land-use/land cover elements of the urban environment such as building, paved areas, roads, trees, shrubs and grass. They are based on 3D GIS software modelling, able to sketch, render and map both at 2D and 3D scale. Different GeoDesign solutions are and their spatial configurations can included in planning scenarios to test and quantify the achieved change in provided Ecosystem Services. A set of planning scenarios involving different Geodesign solutions (in terms of number and types) can thus be tested and assessed in terms of costs for its implementation and enhancement of Ecosystem Services.

Through these Scenarios, planners of municipalities and decision makers will be able to understand precisely the effects of decisions on land-use on the provision of ES and to quantify the related cost for such decisions. Implementation of urban policies aimed at enhancing ES can be rather expensive and several Italian public administrations are suffering by a strong lack of resources. For this reason an accurate choice of Geodesign solutions that optimize the cost-effectiveness in increase ES can be of the utmost importance. Finally, the proposed methodological framework might be able to provide some significant scientific and socio-economical advancements:

- by obtaining a quantitative and documented assessment of the impacts of Geodesign solutions on ES provision at different urban scale;
- by quantifying the role of spatial configurations of land uses and land covers in the provision of ES;
- by making ES concept more appealing, actionable and useful by public administrations with the modern tools of Geodesign;
- by providing some practical tools (planning scenarios of Geodesign solutions) to public administrations, allowing them to make more efficient and sustainable decisions on future land-use assets of their urban contexts.

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