

Designing Green Infrastructure Guidelines: A Methodological Approach

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Keywords: Smart Cities, Smart Growth, Green Infrastructures Guideline, Planning and Design.


Abstract: Natural capital and biodiversity are in decline as consequence of human activities. To promote the conservation of biodiversity and the achievement of sustainability goals, the European Commission proposes the use of green infrastructures (GIs), which are networks of natural areas aimed at the conservation of ecosystems and providing ecosystem services in urban and peri-urban areas. Effective implementation of GIs is hindered by institutional and behavioural barriers; thus, public administrations issue guidance documents to steer GI planning, design, realization, and maintenance. Current guidance documents mainly contain references to components of GI. The scientific literature lacks specific methods for the design of guidelines concerning the implementation of GI. In this respect, we identify and propose a method for drafting up guidelines aimed at GI planning and design in regional and local Italian contexts. The method is rooted in the analysis and summary of scientific and grey literature and consists of six phases. The results of this study are a first step for steering municipal and regional administrations at the development of GI guidelines tailored for specific contexts.


1 INTRODUCTION


Urbanization and anthropogenic activities have led to land consumption (Foley et al., 2005; Metzger et al., 2006) triggering landscape fragmentation, loss of habitat, and degradation of ecosystems, which negatively affect natural capital and biodiversity in several contexts (Helm, 2015; Maes et al., 2015; Magaouda et al., 2020). In modern cities human health can be negatively affected by pollution, high temperature, and mental and physical stresses (Kaluarachchi, 2021). Uncontrolled urbanization leads to phenomena, such as the urban and sub-urban sprawl, i.e. “the rapid expansion of the geographic extent of cities and towns, often characterized by low-density residential housing, single-use zoning, and increased reliance on the private automobile for transportation” (Rafferty, 2019 quoted by Ledda et al., 2019). In this regard, the promotion of ‘compact

cities’ –a “spatial urban form characterised by ‘compactness’” (OECD, 2012)- is a solution commonly accepted by scholars and policy (Artmann et al., 2019), although “[o]ne main constraint to compact cities [...] is the low proportion of urban green spaces” (Artmann et al., 2019). However, green spaces are key for delivering health benefits and (Kaluarachchi, 2021).

At global level, Agenda 2030 sets 17 sustainable development goals including guaranteeing life on earth, fighting climate change, and sustainable cities. The European Commission has released the European Union Strategy (EU Strategy) for Biodiversity 2030 (European Commission, 2020) to address consequences due to human activities. A Green Infrastructure (GI) is considered as a strategic solution to addressing these phenomena (Hermoso et al., 2020; Valente et al., 2020). The European Commission acknowledged the relevance of GI

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defining it as “a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services” (European Commission, 2013). A GI can be intended as a redefinition of ecological network. While the concept of ecological networks was mostly related to the defragmentation of habitats and protection of ecosystems, GI has both ecological functionality and role related to social, cultural, and economic activities involving human communities (Magaudda et al., 2020). GI provides ecosystem services, meant as interconnection of common benefits (Andreucci et al., 2019), which arise from interactions and internal processes of ecosystems that can increase people’s wellbeing (La Notte et al., 2017). GI has also the potential to promote smart growth (Artmann et al., 2019). According to Artmann et al. (2019) “smart growth is often used synonymously with compact cities” and smart growth can be defined as “a process to achieve compact cities as a sub-target of smart cities” (Artmann et al., 2019).

In Italy, GI is mainly dealt with in documents that include rules and references to the potential elements that define a GI, such as ecological networks, public parks, Natura 200 sites, forest areas, etc. (MATTM, 2013). Iriga et al. (2017) claim that the adoption by local councils of policy tools -such as guidelines based on scientific literature- can increase the successful implementation of GIs in more sustainable cities. Despite its relevance, the inclusion of GI within planning tools is still limited by (i) a scarce understanding of the concept of GI, and (ii) the complexity of planning processes concerning environmental and social contexts (Lai et al., 2019).

In front of these barriers, national, regional, and local administrations should issue specific guidance documents for steering GI planning, implementation, and maintenance. In this regard, methods for designing guidelines (GI guidelines) are key to ease the integration of GI principia, concepts, and best practices in planning and programming tools. Scientific literature lacks in research studies about methods for drafting up guidelines focused on the integration of GI in sectoral plans and programs. Guidelines can be broadly defined as protocol directions useful to translate into practice the most critical elements concerning the legislative principles. Guidelines allow practitioners to steer both operational objectives and typical actions to be developed for projects implementation. Several scholars (Ibáñez Gutiérrez and Ramos-Mejía, 2019; Klemm et al., 2018; Langemeyer et al., 2019) have

focused on the drafting of guidelines for the design of GI-like ensembles.

The aim of this paper is at contributing to the stream of scientific literature, which has scarcely dealt with methods for drafting up guidelines concerning the design of GI. Namely, this study proposes a scientific method aimed at drafting GI guidelines at sub regional scale in Italy. The method is rooted in international scientific literature and considers the best practices emerging from the grey literature, i.e., Italian guidelines released at sub regional scale, and is easily applicable in spatial planning practice.

The paper unfolds as follows. Section 2 reports on the methodological approach and it is divided into two subsections concerning the state-of-the-art summary and the scrutiny of GI guidelines released in Italy (the so-called grey literature). The state-of-the-art summary addresses the ever-increasing importance of GI in the context of scientific literature and points out the inclusion of GI in spatial planning practice and emerging weaknesses. We consider the grey literature to tailor the proposed method to the Italian context. In Section 3, we present and describe the findings, namely, the method for designing GI guidelines. In Section 4, we discuss the findings by stressing the main contribution of the study and pointing out its main limitations. Finally, in Section 5 we summarize the innovative elements of this study and remark its contribution to the scientific panorama.

2 METHODOLOGICAL APPROACH

The methodological approach consists of three steps: (i) state-of-the-art summary concerning previous research studies dealing with the design of GI guidelines; (ii) collection of GI guidelines (on-line search and selection); (iii) proposal of method for designing GI guidelines.

The analysis and summary of previous publications allow us to identify the main guidance and critical issues that scholars point out and that should be considered in the drafting of GI guidelines or guidelines that consider components of GI. The state-of-the-art summary provides the study with a sound scientific basis (see the first step of the method, in Section 2.1).

The collection and selection of GI guidelines allow us to figure out the main scheme or rationale of such documents (second step, Section 2.2). In other

words, the scrutiny of the grey literature is key to tailor theoretical principia, suggestions, or guidance to documents released in a real scenario. This is important for making the method applicable in practical arenas of regional or sub regional contexts (Section 2.2).

In addition to the scrutiny of scientific and grey literature, we consider key strategies issued at international, European, and Italian level (UN, 2015; European Commission, 2020; MATTM, 2017) that a proposal of GI guidelines should refer to. In other terms, the method proposed in this study explicitly refers to strategies concerning GI or sustainability objectives.

Finally, we distil the main advice and suggestion emerging from scientific literature and tailor them in respect to the rationale that generally characterize the Italian guidelines released at local scale. Accordingly, in Section 3, we propose the method for drafting up GI guidelines, which is rooted in the contents of Section 2.1 and 2.2.

2.1 State-of-the-Art Summary

Scientific literature includes studies that regard the drafting of guidelines to design a specific GI or one of its components (elements). Ibáñez Gutiérrez and Ramos-Mejía (2019) studied the drafting of GI guidelines for the design of green roofs in the urban area of Bogotá (Colombia), with the purpose of promoting the use of GI in local policies. The method proposed by Ibáñez Gutiérrez and Ramos-Mejía (2019) included: (i) analysis: study of scientific and grey literature (guidelines and other documents); (ii) sharing: discussion concerning the guidelines to be written and the findings acquired from literature and involvement of government actors; (iii) drafting of draft guidelines; (iv) sharing: discussion and verification with several stakeholders (representatives of the local government, construction industry, green roof entrepreneurs, designers and environmentalists) and public meetings aimed at acquiring everyone's opinions; (v) revision of the draft guidelines, which depends on the involved actors' observations; (vi) approval: achievement of the widest possible consensus on a detailed and definitive version of GI guidelines, according to a multi-scale approach. Klemm et al. (2018) developed guidelines for different contexts, according to a methodological approach based on 'Research through design', i.e., the authors wrote preliminary guidelines and then asked professionals to incorporate such preliminary guidelines into the planning processes. The drafting of the guidelines included: (i) drafting of

preliminary guidelines -according to the scientific literature- for designing GI aimed at the adaptation to climate change in urban environment; (ii) integration of the preliminary guidelines into the design processes, in collaboration with professionals and assessment of critical points; (iii) review and improvement of the preliminary guidelines. Langemeyer et al. (2019) pointed out that local policy makers lack practical guidance related to the promotion of green roofs. The authors performed a spatial screening (or mapping) through a Multicriteria Decision Analysis (MCDA) tool to figure out: (i) where the green roofs should be built as a priority in Barcelona and (ii) which type of green roof would potentially optimize the provision of ecosystem services in such areas. Therefore, Langemeyer et al. (2019) proposed a spatial screening model that can be easily adapted to steer municipalities in GI planning. Lennon et al. (2015) focused on the integration of GIs in planning processes, which require the involvement of different stakeholders.

2.2 Scrutiny of the Grey Literature

Qualitative analysis of documents -such as guidelines or guidance documents- have been applied in other studies and proved to be useful (see Mascarenhas et al., 2015 and De Montis et al., 2016). Given the relevant role of public administrations, we have scrutinized the so-called grey literature. The research was performed by filtering the world wide web through the Google search engine and the keywords "guidelines", "green infrastructures", and "Italy". We considered: explicit guidelines or guidance documents, guidelines for designing GI or their potential components (such as urban green, ecological networks), and current and adopted guidelines in the Italian local contexts, i.e., cities or provinces. We selected and scrutinized documents eliciting: the geographical context, the objectives of the project, and the guidance to the design of a GI. Figure 1 shows the Italian metropolitan areas that released guidelines aimed at the design of GI.

In 2007, the Provincial Council of Novara adopted the guidelines for implementing the ecological network; the guidelines are considered a tool for the implementation of the Provincial Territorial Plan (Provincial Council of Novara, 2007). The guidelines address the planning of the ecological network by developing five points: (i) why implement an ecological network (objectives); (ii) where to implement the ecological network; (iii) instruments to be used; (iv) definition of time schedule; (v) identification of the actors to be involved; (vi) drafting

of technical actions on the types of ecological networks to be created.

In 2010, the Council of the Province of Turin adopted the guidelines for the Green System, which include a part attaining “guidelines for Ecological Networks”. Such guidelines are mainly intended as support to the municipal administrations for the design of an ecological network that involves 35 municipalities (Council of the Province of Turin, 2010). The guidelines for Ecological Networks include: (i) descriptive analysis of the ecological network; (ii) prioritizing implementation objectives; (iii) planning and design of the requalification of the current ecological network; (iv) definition of the operational guidance for implementing the actions in practice; (v) maintenance of the ecological network.

In 2015, the Italian Institute for Environmental Protection and Research (ISPRA, 2015) released the guidelines for the Sustainable Urban Forestry in Rome. The document aims at providing a technical support to local administration decisions regarding

the design and construction of new forests in urban and peri-urban areas (ISPRA, 2015). The guidelines are designed in compliance with ecological, environmental, social, and economic sustainability issues, and are divided into two main parts: (i) design phase, which includes the description of objectives, choice of the geographical area of project destination, definition of the design guidance, and choice of target and vector species and of the propagation material; (ii) implementation phase, which includes the preparatory activities, plant, and first maintenance plan.

In 2018, in the context of a meeting organized by the Green City Network (Italy), guidelines for Green Cities were published to encourage the green development of Italian cities. The guidelines are divided into four general objectives concerning policies and measures aimed at promoting sustainable cities. For each objective, guidelines have been defined that contain policies and measures (Green City Network, 2018).

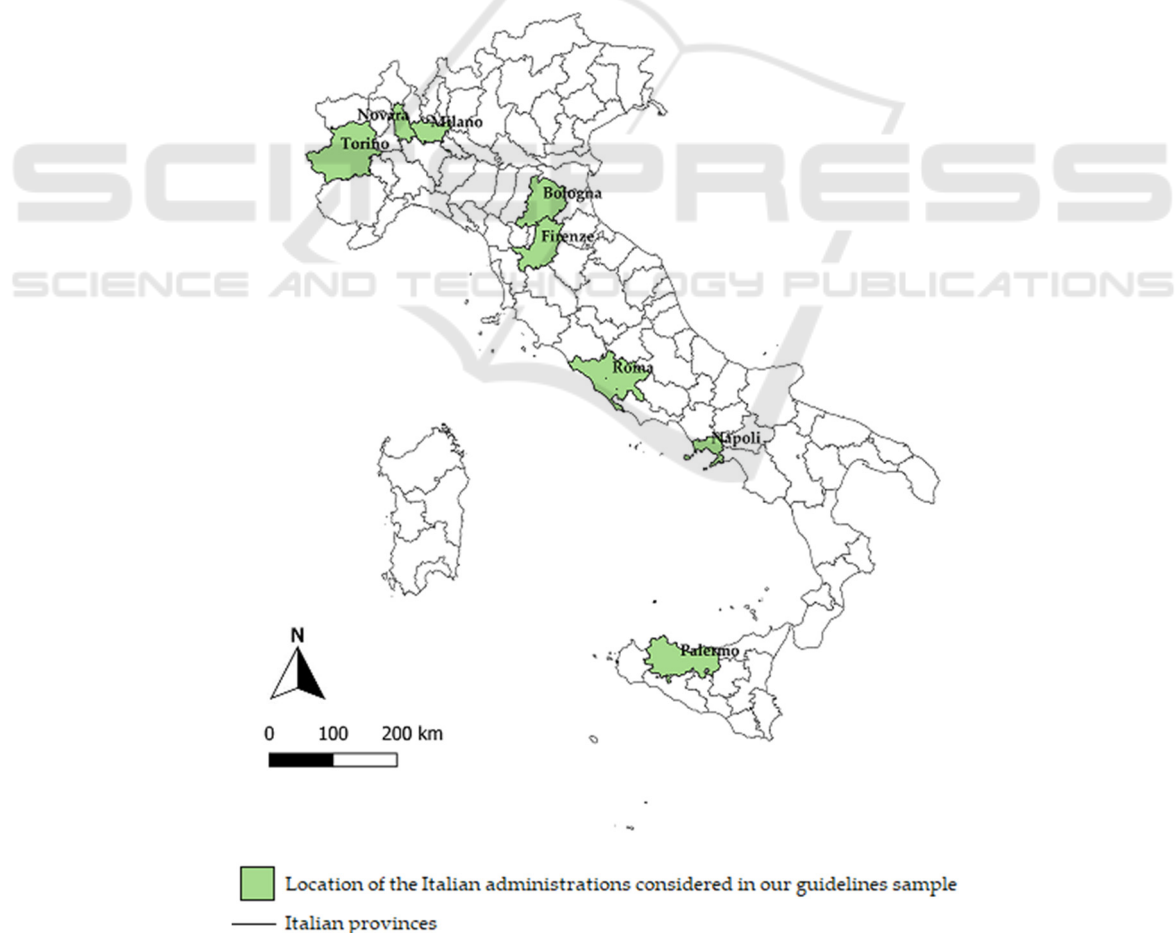


Figure 1: Italian metropolitan areas that released guidelines aimed at the design of GI.

Table 1: Proposed method for the drafting of GI guidelines.

N	Phase	Description	References
i	State of the art	Analysis and summary of the scientific and grey literature	Ibáñez Gutiérrez and Ramos-Mejía (2019)
ii	Context analysis	SWOT analysis on a specific context to define objectives and actions	Ibáñez Gutiérrez and Ramos-Mejía (2019); Langemeyer et al. (2019)
iii	Consistency check	Assessment of the consistency with respect to sustainability objectives	UN (2015); European Commission (2020); MATTM (2017)
iv	Draft of GI guidelines	Draft of guidelines tailored to the specific geographical and institutional context	Ibáñez Gutiérrez and Ramos-Mejía (2019); Klemm et al. (2018); Langemeyer et al. (2019)
v	Sharing the draft with the stakeholders	Presentation of the draft to acquire views and comments from interested parties	Ibáñez Gutiérrez and Ramos-Mejía (2019); Klemm et al. (2018); Langemeyer et al. (2019)
vi	Approval of GI guidelines	Institutional verification on the final contents of the GI guidelines	Ibáñez Gutiérrez and Ramos-Mejía (2019)

3 RESULTS: A METHOD FOR DRAFTING UP GUIDELINES FOR THE DESIGN OF GI

Based on the scientific contribution of Klemm et al. (2017), Langemeyer et al. (2019) and Ibáñez Gutiérrez and Ramos-Mejía (2019), and considering key strategies released at international, European, and Italian level (UN, 2015; European Commission, 2020; MATTM, 2017), we proposed the method described in Table 1 for drafting up guidelines concerning the design of GI in the context of spatial planning. The method consists of six steps: (i) analysis and summary of the scientific and grey literature; (ii) SWOT analysis concerning a specific geographical context to define objectives and actions useful for implementing a GI; (iii) assessment of the consistency among the guidelines and strategies concerning GI and/or sustainability principia to achieve (at least) national and European objectives; (iv) draft of guidelines tailored to the specific geographical and institutional context; (v) public display of the draft to acquire views and comments from interested parties; (vi) institutional verification on the final contents of the GI guidelines.

The first phase addresses the inclusion of references to previous scientific and guidance (guidelines) documents (Ibáñez Gutiérrez and Ramos-Mejía, 2019). The bibliographic analysis is useful to define a state-of-the-art summary concerning GI in European and -specifically-Mediterranean contexts. Such a summary contains scientific information about GI, i.e., relevance, types, ecosystem services provided by GI, and governance issues. On the one hand, the state-of-the-art summary provides a reference framework on GI. On the other hand, the scrutiny of grey literature regards the

analysis of published documents such as guidelines for the design of GI. The scrutiny of guidelines allows planners to acquire information on document structure, focus, main objectives, and actions.

The second phase concerns the analysis of the territorial context, where the GI project will be implemented (Ibáñez Gutiérrez and Ramos-Mejía, 2019). Context analysis describes factors related to the GIs (environmental, economic, social, political elements, etc.) that will be assessed in a SWOT analysis in order to highlight the territorial critical issues to be addressed through GI, by focusing on its strength, and highlighting the opportunities and threats of the area. The context analysis can be more specific by following the method proposed by Langemeyer et al. (2019) who suggest the identification of priority areas in respect to critical issues, by mapping the areas where certain ecosystem services are required. The context analysis is a descriptive approach and the first step to define the areas that need to be included in a GI network.

The third phase concerns a consistency check. GIs are considered a strategic tool for biodiversity conservation and, therefore, for achieving sustainability objectives (European Commission 2020). GI guidelines should be consistent with objectives and actions set in international and national programs and strategies published by UN (2015), European Commission (2020), and MATTM (2017). The analysis must highlight the sustainability objectives that can be achieved through the implementation of GI, in coherence with the highest-level objectives, principia, and guidance (at European scale at least). The GI project should meet the objectives of Agenda 2030 and the European objectives. Finally, the guidelines should be coherent with regional plans and programs to be applied in practice.

The fourth phase regards the drafting of the preliminary GI guidelines. In this phase, the findings obtained from the scrutiny of the grey literature are a core element in terms of objectives, annexes, in-depth boxes, and regulatory tools.

The fifth phase concerns sharing the draft of guidelines with different stakeholders (i.e., environmental engineers, architects, agronomists, botanists, ecologists, etc.) to modify the technical parts of the document, if it is required. Local authorities must be involved to assess the consistency of the draft guidelines with the current regulations. Seminars and meetings with the public (citizens, entrepreneurs, etc.) will also be useful to collect opinions regarding the draft guidelines. Finally, the inclusion of any changes aimed at improving the guidelines will lead at the definitive version of the document. In the last phase, the final version of the guidelines is brought to the attention of the competent institutional body for the approval process.

4 DISCUSSION

Outdated grey infrastructure characterize several modern cities and “refurbishing these elements and systems will provide an opportunity to incorporate smart green components” (Kaluvarachchi, 2021).

The importance of guidelines such as policy tools for encouraging the promotion of GI at local and regional scale has been stated in previous studies (Irga et al., 2017). Italy lacks policy and legislation concerning the design and planning of GI (Progetto Interreg Central Europe MaGICLandscapes, 2019).

Then, this study aimed at proposing a method for drafting up GI guidelines.

The proposed method allows planners to draw up GI guidelines that can consider issues, such as climate change, reduction of atmospheric pollution, and sustainable cities. The three first phases listed in Table 1 support the assessment of the environmental priorities in each geographical area and the identification of proper GIs, while the two last phases concern the involvement of stakeholders who bring their views into the drafting process. Finally, the GI guidelines are approved by the competent bodies that consider the findings obtained in the previous phases of the drafting process.

Compared to Ibáñez Gutiérrez and Ramos-Mejía (2019), this study does not refer just to a single typology of GI (green roofs) but to the entire set of potential elements (components) of GI (see also phase iii). The proposed method is not limited to the drafting and revision of the first draft guidelines such

as in Klemm et al. (2017). Indeed, it is supplemented by further stages: summary of scientific and grey literature and draft of the state-of-the-art (phase i), SWOT analysis on a specific context to define objectives and actions (ii), consistency check with respect to sustainability objectives (iii), and draft of specific GI guidelines (iv).

While Langemeyer et al. (2019) proposed a method for drafting up a guide to planning just one type (or component) of GIs, we propose a method that include more elements, i.e., references to scientific and grey literature (phase i) and the consistency check (iii).

The findings of this research contribute to the research progress concerning the drafting of GI guidelines in Italy. Furthermore, this study provides a method rooted in scientific basis and best practices, which could be used at local (provincial or municipal) level for the design of GI.

There are research gaps that need to be addressed in future research. The proposed method is currently applied in practice for the development of GI guidelines for the Metropolitan City of Cagliari (Italy). However, we cannot prove its full effectiveness as the stakeholders’ views are missing, and in an ongoing research we are focussing on such an issue to fill this gap.

5 CONCLUSION

Italy lacks important policy tools to promote and support GIs planning. *Ad hoc* guidelines could encourage the diffusion of GI and steer cities towards sustainability. In this study, we propose a method for drafting GI guidelines for implementing GI in Italian sub-regional contexts. We aimed at (i) providing support and guidance to local administrations for drafting up GI guidelines tailored to specific geographical and institutional settings, and (ii) promoting the use of GIs in planning processes.

The proposed method is currently applied to the Metropolitan City of Cagliari, Sardinia (Italy) to assess the effectiveness and implementation of the proposed method in a local Italian context, and the ease of practical implementation of the suggested phases.

This study provides planners and local bodies (i.e., provinces and municipalities) with a method for drafting up GI guidelines. The proposed method is going to be improved in future studies. However, we feel the methodological approach proposed in this study contributes to the scientific panorama as it is one of the first attempt to provide the Italian planners

a method for drafting up GI guidelines rooted in scientific basis.

As a concluding remark, in future research we will investigate the effectiveness of planning and design methodologies apt to integrate the GI guidelines as part of the planning process. An important role in this context can be played by the Strategic Environmental Assessment (SEA), which is often part of the planning process. SEA has potential for integrating the contents of the GI guidelines in planning tools such as regional or local spatial plans. In this regard, SEA can contribute to explicitly consider GI in the design of Green Cities.

ACKNOWLEDGEMENTS

The Authors are supported by the research project “Paesaggi rurali della Sardegna: pianificazione di infrastrutture verdi e blu e di reti territoriali complesse [Rural landscapes of Sardinia: planning green and blue infrastructures and spatial complex networks]”, Regional Law n. 7/2007, Fund for Development and Cohesion, Autonomous Region of Sardinia. Giovanna Calia gratefully acknowledges financial support of her scholarship for the Ph.D. program in Civil Engineering and Architecture (University of Cagliari) by P.O.R., F.S.E. Operative Programme 2014-2020, Autonomous Region of Sardinia. Andrea De Montis and Antonio Ledda are supported by the University of Sassari through the Fondo di Ateneo per la Ricerca [Academic funding for research activities] 2020.

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