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Chapter 2

Reviewing Ecosystem Services in Urban Plans



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2.1 Introduction

The incorporation of ecosystem services (ES) in urban plans is considered an indicator of their quality (Woodruff and BenDor 2016) and, ultimately, of their capacity to put in place strategic actions towards more sustainable and resilient cities (Frantzeskaki et al. 2016). Using Italy as a case study, this chapter explores how urban plans integrate knowledge on ES to secure or improve ES provision by conserving, restoring, and enhancing urban ecosystems. The ultimate objective is to shed light on what ES information is already included in current urban plans to support planning actions, and what is still needed to improve their content and decisions.

Scientists have monitored the uptake of ES in planning practices mainly following two approaches. The first approach investigates how practitioners, policy-makers, and stakeholders understand the concept of ES. Perceived opportunities and limitations in the use of ES in planning are usually elicited from key informants through interviews (see examples in Beery et al. (2016); Hauck et al. (2013a); Niemelä et al. (2010)). The results of similar studies are useful to understand the mechanisms through which the uptake of ES can occur. However, being based on self-reported perceptions and opinions, these studies do not measure the actual level of implementation of the ES concept into planning practices. The second approach reviews the content of documents, including strategic plans (Piwowarczyk et al. 2013), environmental policies (Bauler and Pipart 2013; Maczka et al. 2016), and urban plans (Hansen et al. 2015; Kabisch 2015) using content or keyword analysis.

Investigating the uptake of ES as a new planning paradigm may lead to overlook the fact that urban plans have a tradition of accounting for - at least some - ES. ES-inclusive approaches have routinely been used in planning, even though under different names, as it clearly emerges from both planners opinions (Beery et al. 2016), and historical analyses of planning documents (Wilkinson et al. 2013). To understand how the ES approach can contribute to improve the current planning practices, it is necessary to identify which urban ES are addressed and how, and to what extent the conceptual framework of ES is already integrated in urban plans. To this aim, this chapter investigates the contents of plans by searching for explicit but also implicit references to ES, and classifying the information based on their use within the plan, as described in the next Section.

2.2 Methods to Analyse ES Inclusion in Urban Plans

We selected a sample of 22 recent urban plans of Italian cities (see Annex 1). Urban plans in Italy are comprehensive spatial planning documents drafted at the municipal level, fairly similar in content to analogous documents around the world. Their main tasks are: defining land-use zoning; designing and coordinating the system of public spaces and public services; detailing and integrating regulations and provisions set by higher administrative levels. The plans were analysed through a directed qualitative content analysis composed of the three steps described next.

2.2.1 Assessing the Breadth of Inclusion

We considered the following urban ES: food supply, water flow regulation and run-off mitigation, urban temperature regulation, noise reduction, air purification, moderation of environmental extremes, waste treatment, climate regulation, and recreation. Following previous content analyses of urban plans (Geneletti and Zardo 2016; Woodruff and BenDor 2016), we identified three main plan components: information base, vision and objectives, and actions. The *information base* component illustrates the background knowledge that supports planning decisions. The *vision and objectives* component states the long-term vision of the plan and the targets that the plan pursues. The *actions* component illustrates decisions taken by the plan, including strategies and policies (projects, regulations, etc.) that are envisioned to achieve the objectives. Urban ES and plan components are cross-tabulated in a table, which is filled for each plan under investigation by analysing both its textual and cartographic documents, and reporting the relevant content. The number of filled cells in the table allows measuring the overall breadth of inclusion of the analysed ES. We adopted the formulation of the breadth score indicator proposed by Tang et al. (2010) and later applied by Kumar and Geneletti (2015). We calculated the breadth score both for the whole plans and for each component individually.

2.2.2 Assessing the Quality of Inclusion

Quality is conceptualized as the presence of desired characteristics, described through criteria that high-quality plans are expected to meet (Berke and Godschalk 2009). We built on the scoring protocol developed by Baker et al. (2012), and adopted a 5-point scale, with scores ranging from 0 (no inclusion) to 4 (high-quality inclusion). A plan is awarded the highest score in the *information base* component when it acknowledges the links between ecosystems and human wellbeing, identifies functions and processes that determine the provision of ES, and applies this knowledge to a quantitative assessment of the local provision that also includes an analysis of demand and beneficiaries (Table 2.1).

Table 2.1 Scoring protocol for the *information base* component. The examples are taken from the analysed plans (own translation). Plan ID codes are reported in Annex 1

Score	Description	Example
0	The plan contains no evidence of the ES concept.	–
1	The plan acknowledges the link between ecosystems and ES supply, either explicitly as part of the information base, or implicitly in the description of objectives and actions.	<p>“Urban green areas [...] guarantee protection of biodiversity inside the city as well as recreation and compensation of anthropogenic impacts.” [explicit] (Source: P12)</p> <p>“Acoustic green belts with a minimum length of 50 m [...] must be composed of evergreen broadleaves hedges or trees, with preference for fast growing, indigenous species with large crowns”. [implicit in the description of actions] (Source: P21)</p>
2	The plan mentions functions and processes on which ES provision depends, and identifies the elements that define ES potential. However, it lacks local application and analysis.	“Urban micro-climate [...] can be enhanced by the presence of vegetation [...]. A continuous green network that crosses the city, linked to the countryside, constitutes a ventilation corridor that enhance urban micro-climate. The most relevant biophysical process that determines the effects of vegetation on urban climate is the transpiration (...).” (Source: P06)
3	The plan shows a limited level of locally specific application of the ES concept. A basic qualitative assessment of the current state of ES is performed, but detailed analysis, quantitative measurements, and clear identification of demand and beneficiaries are lacking.	“Land-use changes determine an increase in soil sealing with higher storm water run-off. [...] The increase in soil sealing and, consequently, in the flow rates produced by the reference rain event were quantified based on the distribution of sealed surfaces (e.g. streets, roofs) and permeable surfaces (e.g. parks) in each transformation area, as proposed by the draft masterplan”. (Source: P20)
4	The plan shows an in-depth application of the ES concept in the analysis of the local provision of urban ES, including quantitative measurements, detailed assessment, and identification of demand and beneficiaries.	Spatially explicit mapping of the accessibility to recreational areas (5 classes of accessibility), and quantification of beneficiaries broken down by age group (< 3; between 4 and 7; between 8 and 14; > 64 years). (Source: P04)

Table 2.2 presents the scoring protocol used for the *vision and objectives* component. A plan is awarded the highest score when it defines locally specific principles and quantitative targets for the enhancement of ES provision. A high-quality *vision and objectives* component is expected to coordinate public and private land-use decisions to achieve the defined goals (Berke and Godschalk 2009), and, more specifically, to guide the choice of the best planning alternatives in terms of both “what” and “where” (Kremer and Hamstead 2016). For the *actions* component, we assigned a binary score to record the presence, for each urban ES, of at least one action (as in Wilkinson et al. (2013)). We then defined the overall quality of the component as the share of ES addressed by at least one action in the plan. To measure the overall quality of inclusion in the sample, we adopted the depth indicator proposed by Tang et al. (2010), which calculates the average score considering only the plans with a non-zero score in the component. We calculated the indicator for each urban ES for the *information base* and for the *vision and objectives* components.

Table 2.2 Scoring protocol for the *vision and objectives* component. The examples are taken from the analysed plans (own translation). Plan ID codes are reported in Annex 1

Score	Description	Example
0	The plan contains no evidence of objectives related to the ES.	–
1	The plan defines objectives of ecosystem conservation/enhancement, which are expected to affect positively ES provision, but does not directly refer to ES.	“Allow the restoration of river sides, particularly of potential flooding risk areas and retention areas that control overflows”. (Source: P11)
2	The plan defines objectives directly related to ES provision. However, they are entirely descriptive, and lack local application and analysis.	“Tree planting, enlargement of existing green areas, and hedge planting must be encouraged to enhance the local micro-climate (including air purification, noise abatement, and mitigation of the heat island caused by impermeable surfaces)”. (Source: P07)
3	The plan defines qualitative objectives directly related to ES provision through a locally specific analysis and application of the ES concept.	[In the peri-urban areas] “the municipal administration envisions the drafting of a specific plan [...] for the safeguard and enhancement of green recreational areas and green belts, aimed at increasing the absorption of particulate matter and the reduction of the urban heat island effect.” (Source: P10)
4	The plan defines objectives and quantitative targets related to ES provision through a locally specific analysis and application of the ES concept.	“The objective of increasing the amount of public green areas up to three times the existing can also be reached by making the 22% of the actual inaccessible green areas accessible and usable. This way, the green area per inhabitant doubles and exceeds the 30 Km ² /inhabit..”. (Source: P09)

2.2.3 Analysing Planning Actions

We investigated three action properties, namely typology, target area, and implementation tool. The typology describes the type of intervention on urban ecosystems, i.e. conservation, restoration, enhancement, or new ecosystem. The target area describes the scale of the planning action and the spatial distribution of the interventions within the city, i.e. widespread over the whole territory, targeting specific areas, or limited to specific sites. The implementation tool describes the type of legal instruments provided to implement the action, i.e. regulatory tools, design-based tools, incentive-based tools, land acquisition programs, or other tools (Table 2.3). A list of planning actions addressing each of the nine urban ES was compiled for each plan. Then, actions were classified with respect to the three properties, and recurrent combinations were identified both in the whole sample and for each urban ES.

Table 2.3 Categories and sub-categories adopted for classifying planning action properties

Typology	Description
Conservation	Action aimed at preserving the current state of urban ecosystems in order to secure the provision of ES. (<i>e.g. preserving existing wetlands</i>)
Restoration	Action aimed at recovering the health and functionality of urban ecosystems in order to get back to a level of ES provision offered in the past. (<i>e.g. de-paving sealed surfaces</i>)
Enhancement	Action aimed at improving the state of existing urban ecosystems in order to enhance the provision of ES. (<i>e.g. enlarging existing urban parks</i>)
New ecosystem	Action aimed at creating new urban ecosystems in order to provide new ES in an area. (<i>e.g. planting street trees</i>)
Target area	Description
Widespread	The action targets all the future interventions of a certain typology. (<i>e.g. new building interventions, demolitions and reconstructions, large urban transformations</i>)
Specific areas	The action targets one or more zones in which the plan divides the city, or areas in the city identified by the presence of a specific issue. (<i>e.g. industrial sites, agricultural fragments</i>)
Specific sites	The action targets a specific project site or transformation area envisioned by the plan (<i>e.g. a specific urban park, a specific brownfield to be re-developed</i>)
Implementation tool	Description
Regulatory tools	
Building code standard or requirement	Definition of a standard or a requirement in the building code that must be met when developing or re-developing an area.
Compensation measure	Definition of a compensation measure (e.g. payments for realizations, mandatory land property transfers), including its rationale and quantification.

(continued)

Table 2.3 (continued)

Conservation zone or protected area	Definition of a boundary for a conservation zone or a protected area, and of the rules (restrictions and limitations) that must be respected within this area.
Other regulatory tools	All the other types of actions undertaken through regulatory tools (e.g. density regulations, permitted and forbidden uses related to zoning).
Design-based tools	Definition of specific design solutions to implement either in public projects or in privately lead urban developments.
Incentive-based tools	
Preferential tax treatment	Definition of a financial incentive in the form of a preferential tax treatment (usually a reduction in planning fees).
Density bonus	Definition of a non-financial incentive in the form of an increase in the surface (or volume) that is allowed in the area.
Transfer of development rights	Definition of a “transfer of development rights” mechanism: the development right is assigned to an area as a compensation for the placement of a conservation easement that prevents further development, and can be applied in other areas or sold. Participation is on a voluntary basis.
Other incentive-based tools	This category includes all the other types of incentive-based tools, such as the possibility of realizing specific interventions under certain conditions.
Land acquisition programs	Definition of a program for land acquisition by the public administration, with the aim of realizing a public project.
Other tools	
Principles for public space design	Definition of design principles and guidelines (non-compulsory) that should be applied in the realization of public spaces.
Principles for territorial management	Declaration of principles that the municipal administration will follow in the management of the territory (e.g. commitment in administrative processes or in the implementation of future planning documents). It also includes assessment criteria for proposed interventions, when no incentive is envisioned.
Promotion of good practices	Suggestion of principles, good practices, best available techniques, etc. (non-compulsory) to apply in private areas.

2.3 Results

2.3.1 Breadth of ES Inclusion in Urban Plans

Figure 2.1 shows the breadth score indicator measuring the overall inclusion in plans (i.e. inclusion in at least one component). Urban ES are clearly divided into two groups: five urban ES are included in almost all plans in the sample (breadth score > 85%), whereas around half of the plans consider the other four urban ES (breadth score between 45% and 55%). Figure 2.2 breaks down the breadth score by plan component. The frequency of mention in the *information base* and in the *actions* components is similar across ES, although values for the latter are slightly

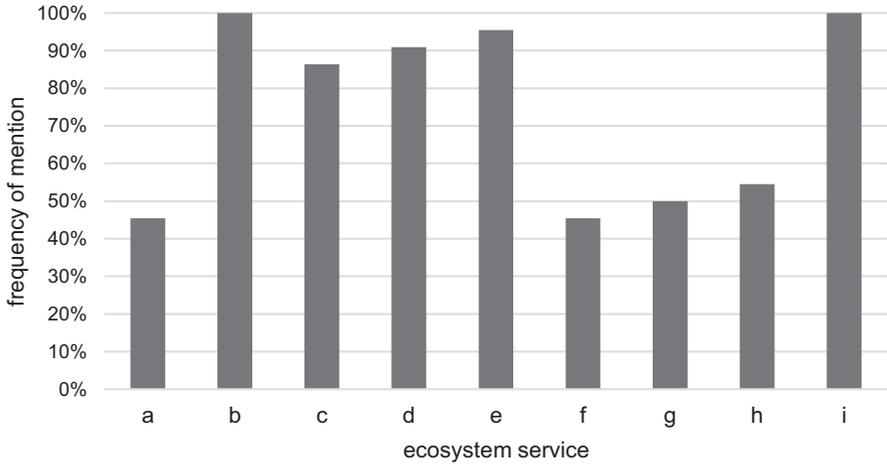


Fig. 2.1 Breadth score indicator measuring the inclusion of urban ES in at least one component of plans. ES are named as follows: (a) food supply, (b) water flow regulation and runoff mitigation, (c) urban temperature regulation, (d) noise reduction, (e) air purification, (f) moderation of environmental extremes, (g) waste treatment, (h) climate regulation, (i) recreation

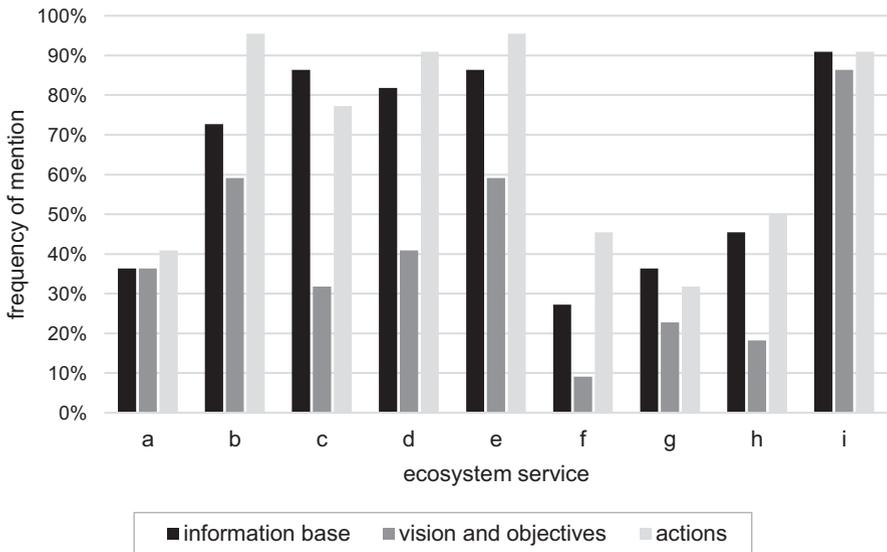


Fig. 2.2 Breadth score indicator measuring the inclusion of urban ES in the three plan components. ES are named as follows: (a) food supply, (b) water flow regulation and runoff mitigation, (c) urban temperature regulation, (d) noise reduction, (e) air purification, (f) moderation of environmental extremes, (g) waste treatment, (h) climate regulation, (i) recreation

higher. The frequency of mention in the *vision and objectives* component is generally lower, with the only two exceptions of food supply and recreation, which are mentioned evenly in the three components.

2.3.2 Quality of ES Inclusion in Urban Plans

The overall quality of ES inclusion (Fig. 2.3) is generally low, with only two plans in the sample reaching the score of 1.5 in the 0–3 range obtained by summing the normalized scores in the three components. The *actions* component receives the highest average normalized score (0.65), while normalized scores for the *information base* and the *vision and objectives* components are lower than 0.5 in all plans. When looking at the distribution of quality scores for the different urban ES in the different plan components, it emerges that the most common quality score in the *information base* component is equal to 1. However, the same pattern discussed for the breadth indicator emerge with respect to the different ES. Although the overall performance is quite poor, five ES (water flow regulation and runoff mitigation, recreation, air purification, noise reduction, and urban temperature regulation) are addressed in this component more often and with a higher quality compared to the others. Water flow regulation and run-off mitigation and recreation are the only ones for which some of the plans were given the highest scores. However, only analyses

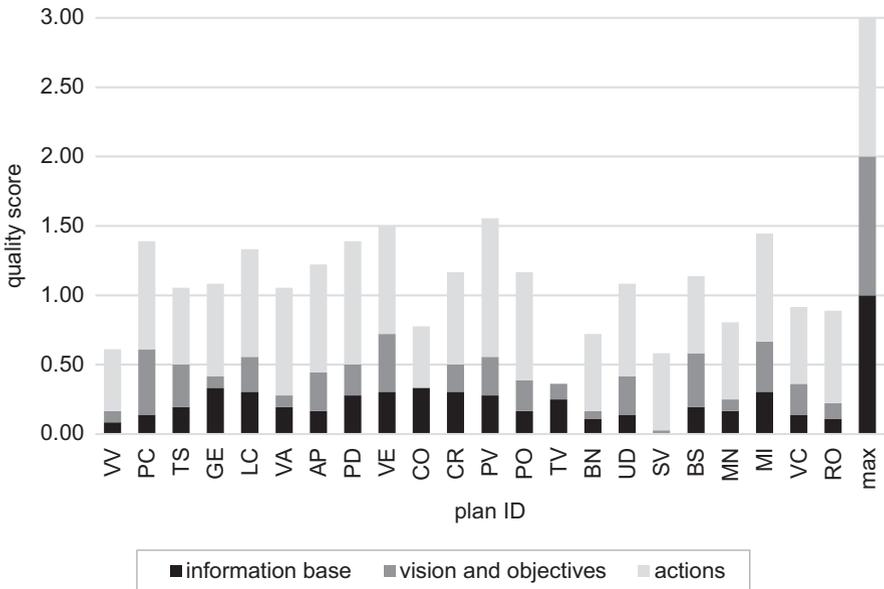


Fig. 2.3 Overall quality of ES inclusion calculated as the sum of the normalized scores obtained in the three components. Plan IDs can be found in Annex I

of recreation show, in some cases (around 30%), consideration for demand and beneficiaries. In the *vision and objectives* component, the pattern is less clear. Here, the most common quality score is 0, which indicates the absence of any reference to ES. However, the highest scores (3 and 4) are more frequent than in the *information base* component, and are found at least in one plan for almost all ES, even though a quality score of 4 is again obtained only by water flow regulation and runoff mitigation and recreation. The depth score indicator (Fig. 2.4) confirms that, when ES are considered, the average quality of the *vision and objectives* component is higher compared to the *information base* component.

2.3.3 Actions Related to ES in Urban Plans

In total, 526 actions addressing urban ES were identified, distributed as shown in Fig. 2.5. Recreation is by far the most commonly address ES, with an average of more than eight actions per plan. An average of three to four actions per plan address water flow regulation and runoff mitigation, noise reduction, and air purification, with implicit acknowledgement of the demand for mitigation of these common urban environmental problems. The other services are addressed on average by less than two actions per plan. Table 2.4 lists the most frequent actions for each urban ES, based on the type of intervention proposed.

Figure 2.6 describes the distribution of actions according to the three properties (typology, target area, and implementation tool). New interventions, such as the

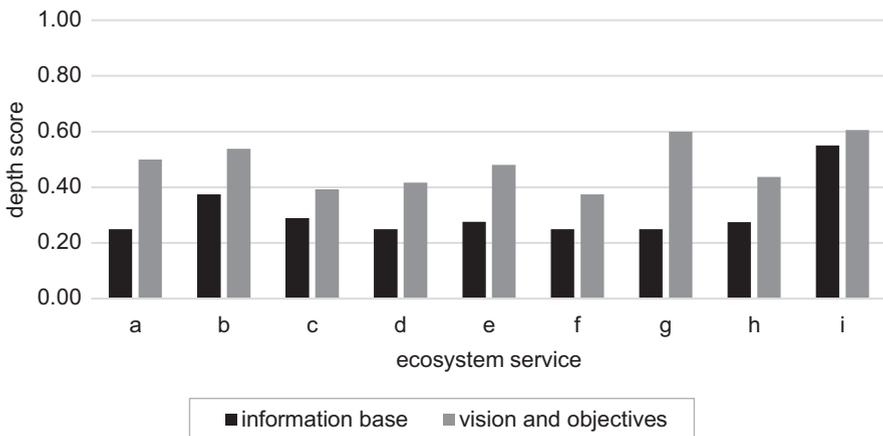


Fig. 2.4 Depth score indicator measuring the quality of inclusion of urban ES in the *information base* and in the *vision and objectives* components. ES are named as follows: (a) food supply, (b) water flow regulation and runoff mitigation, (c) urban temperature regulation, (d) noise reduction, (e) air purification, (f) moderation of environmental extremes, (g) waste treatment, (h) climate regulation, (i) recreation

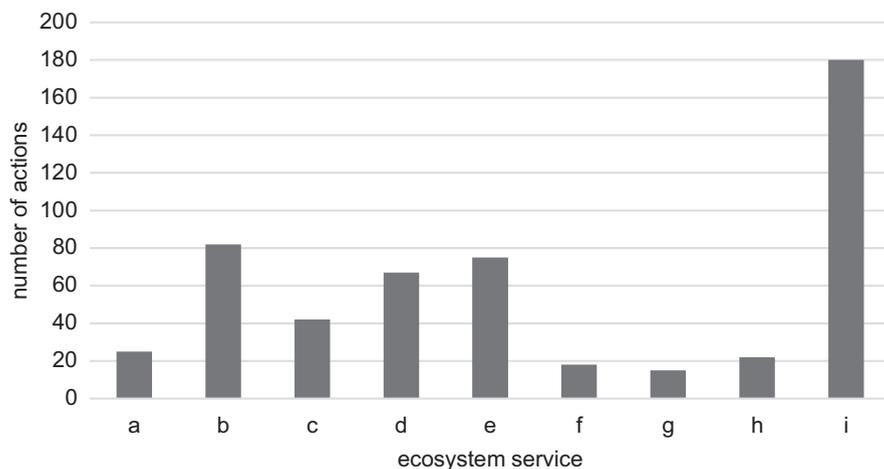


Fig. 2.5 Number of actions addressing each ES in the whole sample of plans. ES are named as follows: (a) food supply, (b) water flow regulation and runoff mitigation, (c) urban temperature regulation, (d) noise reduction, (e) air purification, (f) moderation of environmental extremes, (g) waste treatment, (h) climate regulation, (i) recreation

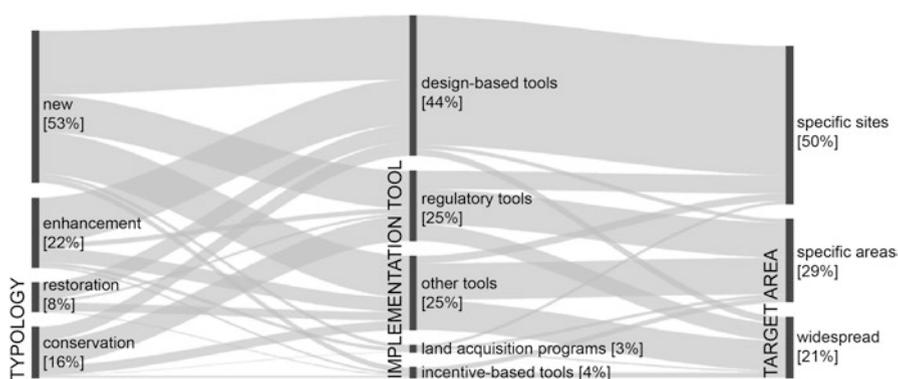
Table 2.4 Groups of actions based on the type of intervention proposed. Only actions recurring in more than three plans are reported

Urban ES and related actions	Number of plans
Food supply	
Realization of new allotment gardens	6
Conservation of existing allotment gardens and residual agricultural patches	4
Water flow regulation and runoff mitigation	
Prescription of a minimum share of unsealed surfaces to maintain in new developments	14
Prescription of permeable pavements for parking areas, cycling paths, etc.	9
Realization of green roofs	6
Realization of bio-retention basins or other ecosystem-based approaches to storm-water management	6
De-paving	5
Urban temperature regulation	
Provision of trees to shade parking areas	10
Creation of new green areas/enlargement of existing green areas	7
Noise reduction	
Realization of green barriers/areas for noise shielding from infrastructures	15
Realization of green barriers/areas for noise shielding from factories and plants	15
Soil modeling for noise protection	4
Generic use of green for noise shielding	4

(continued)

Table 2.4 (continued)

Urban ES and related actions	Number of plans
Air purification	
Realization of green barriers/areas for air purification from traffic emissions	15
Realization of green barriers/areas for air purification from industrial emissions	13
Creation of woodlands and urban forests	5
Generic use of green for air purification	4
Conservation of existing green areas	4
Realization of green roofs and green walls	4
Moderation of environmental extremes	
Enlargement of river areas and conservation/reclamation of floodplains	8
Waste treatment	
Climate regulation	
Realization of Kyoto-forests and new woodlands	8
Increase of public green areas	5
Recreation	
Realization of new public green spaces and urban parks	16
Strengthening walking and cycling accessibility among green areas and with the rest of the city	16
Increasing fruition of green spaces through new walking and cycling paths	14
Restoration of existing green areas aimed at increasing their use	14
Promotion of new functions and uses in the existing green spaces	12
Enlargement of existing green spaces	8
Identification of opportunities for recreation in agricultural areas	8
Realization of peri-urban parks	7
Opening of existing private/unused gardens and green spaces to public use	6

**Fig. 2.6** Distribution of actions per typology, target area, and implementation tool, and recurring combinations in the whole sample of actions

realization of new green areas, represent the most common typology of action (53%). Around 44% of the actions rely on design-based implementation tools (e.g. projects included in the plan), through which the public administration can control action implementation with a quite high level of detail. Regulatory tools, particularly the definition of standards and other specific requirements in building codes, and other tools, such as the suggestion of good practices, are also among the most common, both with 25% of the sample. Incentive-based tools (e.g. density bonuses) and land acquisition programs are the least adopted tools, and accounts for only 4% and 3% respectively. In terms of target areas, specific sites are the most common and represent the target of 50% of the actions. These include, for example, the restoration of specific ecosystems, the identification of conservation areas, and the realization of new urban parks. Around 29% of the actions target specific areas in the municipal territory, such as regulations to be applied in industrial areas or safeguards to protect agricultural patches. Finally, 21% of the actions are widespread. These include requirements for all new building interventions and rules to respect in case of demolitions and reconstruction.

Actions on specific sites are usually implemented through design-based tools, while actions on specific areas are generally implemented through regulatory tools or other “soft” tools such as the suggestion of good practices. Soft tools also clearly prevail in the case of widespread measures. Concerning typologies, conservation actions are more often implemented through regulatory tools, while for both enhancement and restoration activities the preferred tools are design-based. For example, new conservation areas are often defined through a boundary in the maps and a set of rules, while restoration measures are often proposed through a more detailed design.

When looking at individual ES, conservation actions are the preferred typology for improving food supply (conservation of agricultural patches) and water flow regulation and runoff mitigation (conservation of existing unsealed surfaces). Recreation is mostly promoted through enhancement interventions on existing green and blue areas. Water flow regulation and runoff mitigation also differs in term of target areas and, consequently, implementation tools, mostly prescriptions related to the share of unsealed surfaces to maintain in new developments. Two other ES do not have design-based as the preferred tools: food supply, for which 40% of the actions consist in principles for territorial management, and waste treatment, which is commonly addressed through the promotion of good practices.

2.4 Conclusions

Our review of 22 urban plans focused on the use of the ES concept as a tool to support decision-making (Mckenzie et al. 2014), as opposed to the explicit uptake of the term “ecosystem services”. Similarly to what has been observed for the concept of sustainable development (Persson 2013), our hypothesis was that an effective integration should build on what is already there, and follow a mechanism of

Table 2.5 Summary of the main findings

What is already there	What is still needed
Urban planning addresses urban ES through a high number and a great variety of actions	Scientific knowledge is only partly transferred to planning practices
A wide range of local problems can be addressed through ES-based actions	There is little guidance on how to incorporate information on ES into planning processes
Urban planners are already equipped with a large set of tools to implement ES-related actions	Usable methods to assess urban ES at a relevant scale while accounting for multi-functionality of ecosystems are still lacking
Recreation provided by urban ecosystems, although not linked to the ES concept, is widely acknowledged and promoted by planning actions	Plans contain no analyses of ES demand and of the existing and expected beneficiaries (with the only exception of recreation)
A set of key regulating ES to address pressing urban environmental problems (i.e. water flow regulation and runoff mitigation, air purification, urban temperature regulation, and noise reduction) are widely acknowledged and addressed	ES are not considered a strategic issue in urban planning

“internalization” that does not necessarily require rethinking or reshaping current practices. Our findings, summarized in Table 2.5, reveal that current urban plans already include a high number of ES-related actions and a variety of tools for their implementation. This indicates that planners have the capacity and the instruments to enhance the future provision of urban ES. Actions in the analysed plans often go beyond those ordinarily mentioned as good practices, and the range of issues that they address is wider. This demonstrates a certain level of creativity that, combined with traditional ecological knowledge and the understanding of local social-ecological systems, enables the design of locally relevant interventions.

However, our study unveils a two-speed integration of urban ES, with a set of services that are widely addressed by urban plans (recreation, above all, but also regulating services linked to environmental problems typical of urban areas), and others that are hardly considered. The least considered (e.g. waste treatment and moderation of environmental extremes) are also the least popular in the scientific literature (Haase et al. 2014), and when they are included in urban plans, their treatment is very shallow (e.g. suggestion of one-fits-all good practices). This can be ascribed, at least partly, to gaps in the scientific literature, which has not produced methods and guidance that fit urban planning practices.

A further understanding and appropriation of the ES approach by urban planning would benefit future practices in many respects. First, it could promote consideration of a larger set of urban ES, at least in the initial phases of planning processes, thus increasing awareness of all values at stake, highlighting co-benefits and trade-offs that may arise from planning actions, and making prioritization more transparent. Second, it could strengthen the consideration of ES as a strategic issue for urban

planning, thus promoting the definition of objectives and targets for ES enhancement, and ensuring long-term commitment in the implementation and monitoring of planning actions. Finally, it could support the explicit identification of ES demand and beneficiaries, thus improving baseline information to address urban environmental equity, and providing planners and decision-makers with stronger arguments against conflicting interests on land-use decisions.



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