Commentary on systematic reviews

MISTRA EviEM
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# To what extent do urban greenspaces contribute to ecosystem services?

*Sweden is becoming increasingly urbanised. The urban green areas that remain are in competition with other urban needs, including housing and infrastructure. What significance does such urban nature have for people living in urban areas? Do urban greenspaces contribute to human well-being, and if so, how? Here EviEM summarises and comments on eight systematic reviews published between 2010 and 2015.*

## Summary

Today, more than half of the world's population lives in cities. In 2050 the proportion will have increased to 75 percent. According to Eurostat, Sweden has the fastest level of urbanisation, and in larger cities, the pressure to build in urban greenspace is very large. Such greenspace can, however, contribute to 'ecosystem services', which can be roughly defined as the ecosystem's direct and indirect contribution to human welfare [1]. Research interest in urban greenspace has increased dramatically, and presented here is an overview of the results from eight systematic reviews of the topic, published between 2010 and 2015.

These evaluations focus on the non-material benefits of ecosystem services, such as recreation, health and aesthetic value, as well as the regulatory services of air purification, water treatment, and noise reduction. Only three evaluations met the requirements of the Collaboration for Environmental Evidence (CEE) for a systematic review [5, 6, 10]. There was clear evidence in the literature that greenspaces contribute to increased physical activity in urban inhabitants, thus reducing obesity, and increasing mental wellbeing. There was some support for urban green areas having a regulatory function, including through maintenance of lower temperatures, but these ecosystem services are mainly localised and do not have impacts outside the boundaries of the greenspaces. Several evaluations urge scientists in future studies to clearly define what type of greenspaces are investigated. As a result, here it is difficult to synthesise results from different studies, which are often unclear about what kind of environments were examined.

### Discussed evaluations

Discussed evaluations: Konijnendijk CC, Annerstedt M, Nielsen AB, Maruthaveeran S: **Benefits of Urban Parks: A systematic review.** 2013. A report for IPFRA.

Bowler DE, Knight TM, Buyung-Ali L Pullin AS: **How Effective Ice greening of urban areas in Reducing human exposure to Ground Level Ozone Concentrations, UV exposure and the urban heat island effect?** 2010b. CEE UK 08-004.

**Also tabulated:**

Bowler et al 2010a [5], Dzhambov & Dimitrova 2014 [7], Gascon et al 2015 [8], Kabisch Others 2015 [9], Korth and others 2014 [10] and Roy et al 2012 [3].

## A Swedish perspective

The Swedish Department of Environment and Energy published an investigation in 2013 of how ecosystem services could be valued [2]. The inquiry sought to consider ecosystem services as a natural part of city planning and business development. One of the study's conclusions, however, was that the knowledge base was insufficient to assess which measures should be prioritised. The Swedish Environmental Protection Agency was therefore commissioned by the government to implement a communication project focusing on ecosystem services (final report due in 2018).

In Sweden's major cities, the pressure to build in green areas is currently very high. Greenspaces compete with urban needs, in particular housing and infrastructure. For several reasons, it is important to emphasise the benefits of greenspaces in relation to other social interests. Parks and greenspaces can provide multiple ecosystem services, for example; vegetation can attenuate traffic and industrial noise, whilst also acting as a filter for some air pollutants. Access to greenspace also promotes physical activity, which is often considered to be fundamental to our health and mental wellbeing. Urban greenspaces often contain a surprisingly large biodiversity that may indirectly contribute ecosystem services, including through increasing interest in outdoor activities. More examples of urban ecosystem services are given in Table 1. Many agencies working on issues related to urban greenspace at national, regional and local levels, for example the Swedish Environmental Protection Agency, the Forest Agency, the National Board of Housing, the National Heritage Board,

**Table 1. Categorization of ecosystem services based on the Millennium Ecosystem Assessment [2]**

| *Category* | *Description* | *Examples of ecosystem service* | *Systematic evaluation* |
|---|---|---|---|
| Responding services | Goods from ecosystems | Food, drinking water, fiber, bioenergy | Korth et al 2014 |
| Regulatory services | Services from the regulation of ecosystem processes | Air and water purification, climate regulation, erosion control, noise reduction | Bowler et al 2010b, and Dzhambov Dimitrova 2015 Konijnendijk Others 2013, Roy and others 2012 |
| Culture Services | Non Tangible benefits generated from ecosystems | Recreation, aesthetic values, health, resource | Bowler et al 2010a, Gascon et al 2015 Kabisch Others 2015 Others Konijnendijk 2013, Roy and others 2012 |
| Supporting Services | Services necessary for the production of all other ecosystem services 1 | Primary production, photosynthesis, soil formation | |

and the Public Health Agency, along with regional and local administrative boards and municipalities.

This article outlines the results from eight systematic reviews of ecosystem services of urban greenspace, published between 2010 and 2015.

## The scientific evidence

Researchers' interest in urban green spaces and their importance for human populations has increased dramatically in the 20th century. The number of published scientific articles has increased exponentially, from around 10 in 1998 to just over 600 in 2014. As a result, it is now possible to systematically compare and analyse the results of such studies. One of the eight systematic reviews focused on individual trees in public spaces [3], another on public parks dominated by open grassy areas and waterbodies. [4] Most articles, however, focused on a broad definition of urban greenspaces [5-9], a concept which includes all parks with varying degrees of forestation in urban environments.

We found only one systematic review of the extent to which urban greenspaces contribute in physical products [10] and no systematic reviews of indirect ecosystem services (e.g. photosynthesis, soil formation). Instead, the focus was typically on the non-material benefits, such as recreation, health, aesthetic values and regulating services such as air and water purification, and noise reduction (Table 1).

Only three of the evaluations [5, 6, 10] met the requirements for systematic review in terms of the literature search, study selection, data extraction and data analysis set out by CEE (the Collaboration for Environmental Evidence). Five evaluations [3, 4, 7, 8, 9] did not include meta-analyses. Two studies [3, 9] performed no assessment at all of the quality of included articles. Instead, they described how the number articles was distributed across geographical regions, methods, ecosystem services and more (Table 2).

## Review results

In the following, we present only the results from two of the systematic reviews [4, 6] since these studies largely follow the CEE's guidelines and include quantitative analyses of the results of included articles.

The International Federation of Parks and Recreation Administration (www.ifpra.org) evaluated a total of 201 studies of how urban parks[1] contribute to people's physical and mental wellbeing [4]. Researchers found strong support in the literature for indirect health benefits, thanks to increased opportunities for physical activity, and thus a reduced risk of obesity. Only 8 of the 35 studies failed to demonstrate an increase in physical activity as a result of access to parks. Opportunities for recreation and outdoor experiences can also be increased as a result of higher biodiversity in parks than in other urban green spaces[2]. There was less support in the literature for other possible health effects of urban greenspaces, most likely because the number of studies was too small. The same finding was observed for effects on tourism and social cohesion (Table 3).

Cities are significantly warmer than surrounding areas as a result of hard surfaces and residual heat from buildings, traffic and people [6]. A meta-analysis showed that urban greenspaces on average were 0.94°C cooler than the surrounding urban environments during the day and 1.15°C cooler at night (based on 16 and 7 studies, respectively). Larger greenspaces (> 3 hectares) had clearly greater cooling power than smaller areas (<3 ha), and the more trees, the greater the cooling effect. There was a strong to moderate support in the literature for these conclusions (Table 3). For other regulating ecosystem services - reduced air pollution, increased sequestration of carbon, improved water runoff after rain - there was only weak supported in the literature.

1 Defined mostly open areas dominated by vegetation and water. They are freely accessible to the public and are usually termed 'Parks' by local authorities. The size of the areas varies greatly.

2 Includes urban and peri-urban woodlands, gardens, green roofs, roadside vegetation, residential areas, unused land and managed grasslands.

**Table 2. Summary of eight systematic reviews of ecosystem services of urban green areas**

| *Systematic review* | *Focus on* | *Final number of analysed articles* | *Article databases searched* | *Restrictions* | *Analyses* | *Method of review* |
|---|---|---|---|---|---|---|
| Bowler et al. 2010a | Psychological health (self-perceived) and nature | 25 | Nineteen different databases | None given | Meta analysis | Followed CEE guidelines |
| Bowler et al. 2010b | Temperature, ozone, UV radiation, and urban green areas | 212 | Twelve different databases | None given | Meta analysis | Followed CEE guidelines |
| Konijnendijk et al. 2013 | Eight different ecosystem services from urban parks | 201 | Web of Science, Scopus | Articles published from January 2000 to April 2010. Only in English. | Ranking of study quality (3 groups) based on 6 criteria | Partly follows CEE guidelines |
| Dzhambov & Dimitrova 2014 | Noise reduction and urban green areas | 5 | MEDLINE, Embase | None given | Ranking of study quality (3 groups) based on 13 criteria | Followed CONSORT* and Cochrane |
| Gascon et al. 2015 | Psychological health and urban green areas (also "blue spaces") | 28 | MEDLINE, Scopus | Only publications in English | Ranking of study quality (5 groups) based on 11 criteria | Followed PRISMA guidelines |
| Kabisch et al. 2015 | Social values and urban green areas | 219 | Web of Science, Scopus | Articles published from January 2000 to October 2013. Grey literature excluded. | Only qualitative | Closest to a "systematic map" according to CEE terminology, however, without assessment of study quality |
| Korth et al. 2014 | Urban agriculture | 0** | 28 different databases | Only low- and middle income countries according to the World Bank | None | Followed CEE guidelines |
| Roy et al. 2012 | Trees in the urban environment | 115 | Web of Knowledge, Scopus and five more | None given | Only qualitative | Closest to a "systematic map" according to CEE terminology, however, without assessment of study quality |

* Consolidated Standards of Reporting Trials (CONSORT) for critical appraisal of studies.

** 198 full text articles reviewed in total, but none of these fulfilled the inclusion criteria that had been set up.

## Review conclusions

Today, more than half of the world's population lives in cities. By the year 2050 this will have increased to 75 percent. The pressure to build on urban greenspaces is often strong. Greenspaces compete with other urban needs, namely housing and infrastructure. However, there is clear support in the literature that greenspaces contribute to increased physical activity, and thereby reduced obesity, and increased mental well-being. It is thus important to emphasise the importance of urban greenspaces in relation to other societal interests. In order to maintain existing parks, the focus should be on increasing opportunities for physical activity and/or recreation [4]. There is some evidence in the literature that these urban greenspaces have regulatory functions (temperature, air pollution, water regulation), but these ecosystem services considered mainly have localised effects that do not extend outside park boundaries [6]. Several reviews called on authors of future studies to clearly define the type of greenspaces they investigate. As a result it is difficult to synthesise results from different studies as it is often unclear what kind of environments were examined.

## EviEM's assessment of the reviews

There were large differences in quality among the eight systematic reviews listed in Table 2. Only three of the eight reviews followed CEE guidelines; in particular, missing meta-analyses of the quality-appraised studies. The studies included in the systematic reviews were characterised in general by a low level of replication and a lack of proper experimental design. The number of published articles per year has increased dramatically between 2000 and 2010. It is hoped that the quality of studies on ecosystem services in urban areas will continue to increase in the future, enabling better systematic reviews.

**Table 3. Summary of support in the literature of how urban parks and green areas contribute to ecosystem services.**

| | *Number of studies* | *Results* | *Support in the literature (evidence)* | *Reference studies* |
|---|---|---|---|---|
| Mental health and well-being | 86 | Parks contribute to increased physical activity and reduction in obesity | Strong (moderate to strong for obesity) | Konijnendijk et al. 2013 |
| | | Parks contribute to reduced stress and improved (self-perceived) health | Moderate | |
| | | Parks indirectly improve health by providing opportunities for recreation and psychological well-being | Weak to moderate | |
| | | Parks indirectly improve health by reducing noise and by cooling | Moderate | |
| Biodiversity | 62 | Parks have a higher species richness than other urban green areas | Strong | Konijnendijk et al. 2013 |
| Tourism | 8 | Parks are attractive to tourists and motivate visits to cities | Weak | Konijnendijk et al. 2013 |
| Social cohesion | 5 | Parks contribute to increased social inclusion and cohesion | Weak | Konijnendijk et al. 2013 |
| Temperature regulation | 24 | Parks contribute to cooling both day and night compared to surrounding areas | Moderate to strong | Bowler et al. 2010b |
| Air quality and carbon sequestration | 11 | Parks contribute to reduced air pollution and increased sequestration of carbon | Weak to moderate | Konijnendijk et al. 2013 |
| Water regulation | 6 | Parks contribute to improved run-off after rain | Weak | Konijnendijk et al. 2013 |

## References


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### EviEM

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