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FUNCTIONS OF URBAN GREENSPACE AND ECOSYSTEM SERVICES

Abstract: The concept of ecosystems services has become an important model for linking the functions of ecosystems to human welfare. The aim of this paper is to identify ecosystem services generated by green areas within the urban area, classify and value them. „Ecosystem services" refers to *components of nature, directly enjoyed, consumed, or used to yield human well-being* (Boyd, Banzhaf 2007). This definition advances the ability to use ecosystem services as a practical measurement tool.

Key words: urban greenspace, functions, urban ecosystems, ecosystem services

INTRODUCTION

The dynamics of urban ecosystems (parks, lawns, forests, cultivated land, street trees, streams, lakes, wetlands) requires appropriate tools for planning and management to provide high quality of inhabitants' life (Bolund, Hunhammar 1999). The concept of ecosystem services might be one of such tools. According to Solon (2008, p.26) "it enables a synthetic presentation of the relationships between basic ecological and economic concepts and a combined analysis of the two subsystems, which finally leads to standardisation of ecological and economic assessments". The concept of ecosystem services is thus a platform of co-operation for naturalists, landscape architects, planners and economists.

The aim of this study was the typology of ecosystem services of urban greenspace in relation to their functions and an attempt to indicate the measures of their value.

FUNCTIONS OF THE URBAN GREENSPACE

Nature Protection Act of 16. April 2004 established that urban greenspace are "the areas together with technical infrastructure and functionally associated buildings covered by vegetation which grows within the town or village limits and plays aesthetic, recreational, health and protective functions, including parks, squares, promenades, boulevards, botanical and zoological gardens, Jordan's and historical gardens, cemeteries and the green lands accompanying streets, squares, fortifications, buildings, stores, airports, railway and industrial objects".

The literature on urban greenspace distinguishes, apart from social functions (aesthetic, recreational, leisure and didactic), also the ecological functions. Authors who adopt the term "ecological function" do not agree as to its scope. Zimny (1978) and Hejmanowski (1989) understand "ecological function" as a regulation of ecological conditions of a city through decreasing air dustiness, noise, volatiles, air ionization and the effect on the town microclimate. Chmielewski (1996) described these functions as "phytosanitary" ones. Matuszkiewicz A. J. (1993) understands ecological functions as an appropriate shaping of the urban ecological system. She is of the opinion, that the main criteria of these functions are the species diversity, the richness of vertical vegetation structure and species composition with special reference to native species. Czerwieniec and Lewińska (1996) attribute modification of climatic conditions in urban habitat, shaping community relationships and the influence on water relations in soils to the main functions of urban greens.

Kaliszuk (2005) adopted biotic, climatic and hydrological functions as the superior functions of the urban biological system.

Based on the literature data one may distinguish the following ecological functions:

- those associated with climate and air quality (control of bio-climatic conditions, mitigation of noxious city climate, improvement of aerosanitary conditions through the absorption of dust, gaseous and microbiological pollutants, improvement of air quality through the absorption of carbon dioxide and the release of oxygen to the atmosphere),
- those associated with waters (counteracting water degradation),
- those associated with soils (counteracting soil degradation),
- those associated with vegetation and animals (providing life conditions for organisms, supporting the protection of genetic richness and species diversity, with special reference to native species of plants and animals),
- those associated with humans (supporting physical regeneration through favourable air ionisation and excretion of volatile substances, supporting psychological regeneration through fulfilment of aesthetic demands and contacts with nature).

The functions mentioned above may be divided into 5 types: biotic, ecological function of soils, climatic, hydrologic and the function of absorbing pollutants (Szumacher 2005).

FUNCTION AND ECOSYSTEM SERVICES

Ecological function of urban greenspace, understood here as a relation between organisms (plants, animals, people) and the environment, depends on preserved structure and functioning of the natural environment (Szumacher 2005). The terms "function" and "functioning" are often used as synonyms. Function has, however, more anthropocentric dimension and depends directly on ecosystem functioning (de Groot et al. 2002, 2010, Fisher et al. 2008). In landscape ecology, the term "functioning" is reserved for a set of all processes of exchange and transformation of matter, energy and information (Richling, Solon 2002). So, how ecosystem services become part of these relationships? To answer this question, one has to define ecosystem services.

The concept of ecosystem services still has not a consistent definition and, consequently, a classification of ecosystem services (de Groot et al. 2002, 2010, *Millennium Ecosystem Assessment* 2005, Wallace 2007, Costanza 2008, Boyd and Banzhaf 2007, Fisher and Turner 2008, Fisher et al. 2008). There is no agreement on what this service is: a component of the ecosystem (e.g. water), a process (nutrient cycling), a benefit (clean water) or a function.

In this paper it was assumed, that ecosystem services are "components of nature, directly enjoyed, consumed, or used to yield human well-being (Solon 2008 p. 30 after Boyd and Banzhaf 2007). Hence, the ecosystem service is "a final product" of ecosystem and not the natural process, that creates such product. Thanks to such approach one may propose a measure for any service and perform its economic evaluation.

The functions mentioned above should not thus be automatically dealt with as ecosystem services since there is a series of connections between ecosystem and human welfare where the service is a kind of a "bridge" (de Groot et al. 2010).

TYPOLOGY OF URBAN GREENSPACE SERVICES

The typology of the urban greenspace services should, according to adopted definition, consider these features and properties of urban ecosystems which are directly used by man for better living conditions. Such typology of ecosystem services in view of the functions played by city greenspace is presented in table 1. An attempt was undertaken to present the relationships between natural processes, functions, services and benefits. Finally, the measures are proposed that would help evaluate a given service.

Table 1. Functions, processes, services and benefits from the ecosystems of urban greenspace and the measures of services

Functions of urban greenspace	Natural processes	Ecosystem service	Benefits	Measures
BIOTIC				
1. Food production (plant crops, breeding)	1. Biomass production	1. Food delivery	1 and 2. Fulfilment of nutritive demands	1 and 2. Yields in t/ha/y Number of animals per ha and their market value
2. Raw materials (e. g, timber)	2. Biomass production	2. Delivery of raw materials		
3. Providing living conditions for organisms (plants animals, humans)	3. Biomass production	3. Habitat protection	3. Recreation, aesthetics, health (psychic regeneration through fulfilment of aesthetic needs and a contact with nature)	3. Trophic status, costs that should be born for its maintenance
4.Protection of genetic richness and valuable (mainly native) species of flora and fauna	4. Trophic webs, biodiversity	4. Resources of plant and animal species	4. Recreational, aesthetic, educational, cultural	4. Number of species
5. Noise absorption	5. Absorption and reflection of sound waves by vegetation	5. Noise mitigation	5. Health, recreation	5. Decibel
CLIMATIC				
1. Regulation of bioclimatic conditions	1. Absorption and reflection of light, retention, evapotranspiration	1. Decreasing thermal and moisture contrasts	1. Thermal comfort	1. Cost of heating and air-conditioning
2. Regulation of air quality through CO_2 absorption and O_2 release	2. Cycling of elements, photosynthesis, respiration	2. Improvement of air quality	2. Health (physical regeneration through e.g. favourable ionization of the air and release of volatiles)	2. Content of gases in the air

Functions of urban greenspace	Natural processes	Ecosystem service	Benefits	Measures
HYDROLOGIC				
1. „Small" water cycle	1.Water cycling	1. Permeable surface, ground and surface waters, hydrogenic grounds	1. Flood control, recreation	1. Percentage share of permeable surfaces, surface area of water reservoirs, bogs
2. Counteracting water degradation (filtration, self-purification in water reservoirs)	2. Filtration, self-purification	2. Increased water quality (naturally purified water)	2.Drinking water	2. Cost of potable water treatment, water intake and sewerage
ECOLOGICAL FUNCTION OF SOILS				
1.Counteracting physical and chemical soil degradation	1. Buffering	1. Non-degraded soils	1. Limitation of soil degradation	1. Costs born for counteracting soil degradation e.g. liming
2. Physical and chemical soil properties determine living conditions for organisms	2. Soil processes	2. Habitat for organisms	2. Decreased costs of care	2. Cost of fertilisers, watering, agro-technical measures
3. Detoxication of pollutants	3.Biogeochemical cycles, buffering	3. Soil	3.Pollution control	3. Heavy metals ppm
ABSORPTION OF PARTICULATE AND GASEOUS POLLUTANTS				
– by vegetation – by soils	Biogeochemical cycles, accumulation, decomposition, sorption	Increasing air quality	Health, pollution control and self-purification	– forested area – sorption and buffering soil capacity

Own elaboration based on Boyd and Banzhaf 2007, Solon 2008, Fisher et al. 2008, de Groot et al. 2002, Bolund and Hunhammar 1999

Presented typology (Table 1) shows that ecosystem functions are not equivalent to ecosystem services and hence, they should not be used as synonyms. Precise description of services allows for proposing their measures. Benefits perceived or experienced by humans increase the quality of social functions (recreational, leisure, educational). Public awareness in town inhabitants of benefits arising from the urban greens will undoubtedly result in positive approach to their presence in the town.

Finally, one should put a question: can the cost of maintaining urban greenspace be dealt with as a measure of their function and services? It is known, that the share of urban greenspace in the town's surface area is treated as one of determinants of life quality in a town. Hence, maybe the cost of maintenance green areas should be equated with the cost of ecosystem services? For example, the annual cost of maintenance urban greens in Warsaw varies from 5000 to 7500 euro/ha for parks and other greenery and from 2500 to 5000 euro/ha for street green. In the year 2008, over 11 million euros was spent for the maintenance and conservation of parks and other greenery (885 ha in total) and c. 9 million euros for street greenspace (600 ha). Moreover, 10 million euro donation from ecological funds of Warsaw were used for the management and maintenance of urban greens in the years 2007-2009 (Terek 2010). Can thus the ecosystem services of urban greens in Warsaw be estimated at 25 million euros? Similar way of reasoning may pertain to the reconstruction of „Różanka Garden" (an area of 20 thousand m^2) in Szczecin for a total sum of 550 000 euros. The annual cost of maintenance of this garden is at maximum 100 000 euro (Haas-Nogal 2010). Maybe the costs borne can be treated as a measure of benefits (e.g. aesthetic) resulting from the presence of this garden? Such questions seems to be legitimate in view of the management of urban greenspace and optimisation of their use.

SUMMARY

Functions of urban greenspace are not equivalent to ecosystem services. Proposed here typology of ecosystem services of urban greenspace pertains to their ecological functions, natural processes and benefits obtained from the presence of urban greenspace by urban community. A measure that could be a helpful tool for further evaluation of a given service was attributed to each of the services. Such evaluation is necessary for planning and management of urban greens.

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