Lesn. Cas. For. J. 61 (2015) 52–57 DOI: 10.1515/forj-2015-0014

REFERÁT – DISSCUSSION PAPER

Lesnícky časopis - Forestry Journal
http://www.nlcsk.sk/fj/

Evaluation of ecosystem services from urban forests in the City of Prague

Ocenění ekosystémových služeb městských lesů Hlavního města Prahy

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Abstract

Municipal forests primarily provide ecosystem services which are in demand by residents. If they are to meet the demands of Prague's citizens, managers need good quality information and appropriate financial resources. One important piece of data is a valuation of all ecosystem services. The aim of this paper is to assess the current level of organisation and funding of forest management, estimate the value of forest functions and contribute to improvements in annual reporting by the Forests of the City of Prague. The results of the valuation could potentially be used for the improvement of decision making processes. The organisational structure (Centre of Forests, Watercourses and Reservoirs, Ornamental Nursery Management and Environmental Education) has been effective in delivering sustainable forest management in the City. In addition, forest management of the City of Prague has been independently certified under the Forest Stewardship Council (FSC) International Standard since May 2007.
Key words: outsourcing; forestry services market; transaction cost; timber harvesting

Abstrakt

Obecní lesy poskytují především ekosystémové služby, které jsou požadovány obyvateli. Aby splňovaly požadavky pražských občanů, potřebují manažeři kvalitní informace a odpovídající finanční prostředky. Jedním z důležitých údajů je ocenění všech ekosystémových služeb. Cílem této práce je zhodnotit současnou úroveň organizace a financování lesního hospodářství, odhad hodnoty funkcí lesů, ale také přispět ke zlepšení výroční zprávy o Lesích hlavního města Prahy. Výsledky ocenění by mohly být použity pro zlepšení rozhodovacích procesů. Organizační struktura (středisko lesů, vodních toků a nádrží, městské zeleně a ekologické výchovy) byla účinná při zajištění udržitelného hospodaření v lesích na území Hlavního města Prahy. Kromě toho hospodaří Hlavní město Praha od května 2007 ve svých lesích na základě certifikátu dle mezinárodní normy Forest Stewardship Council (FSC).
Klíčová slova: outsourcing; trh s lesnickými službami; transakční náklady; těžba dřeva

1. Introduction and problems

Urban forests are an important urban ecosystems (Bolund & Hunhammar 1999). Urban forests generate a range of ecosystem services which are in demand by residents (Constanza et al. 2014; Deng et al. 2011) and have an influence on sustainable development in cities (Konijnendijk et al. 2005; Jim & Cheng 2009). The valuation of these ecosystem services provides information and insight for humans to contemplate alternatives and make decisions relating to urban forests (Carreiro et al. 2007).

Forest ecosystem services can be divided into two categories; market and non-market forest services. Traditional valuation methods include opportunity costs, estimation of maintenance costs and the production value of forests (Konijnendijk et al. 2005). Valuation of non-market benefits brings a lot of methodological problems. However monetary valuation of ecosystem services is very important because most people understand values expressed in monetary units (Constanza et al. 2014). Monetary units are very often a convenient denominator and can assist the process of communication.

The particularity of urban forests, and hence, the goal of their owners (usually municipalities), is to satisfy needs of residents (Hájek 2013; Matsuoka & Kaplan 2008). These goals determine the approach of financing and support for all important non-market forest services.

The aim of this article is to assess the current level of organisation and funding of forest management, and to estimate the value of forest functions as a basis for forest management improvement. Examples were taken from the city of Prague in the Czech Republic. It is difficult to generalise results because the actual services and their values are site-specific. On the other hand, this methodological approach is applicable in all cities.

The identification and valuation of forest ecosystem services could be viewed as an input to a cost-benefit analysis (CBA), e.g. aiming at more efficient land-use in urban areas. The benefits of ecosystems are often neglected and, if included, the results of CBAs on new infrastructure or conservation projects could change (Bolund & Hunhammar 1999). The valuation of forest ecosystem services can also support the management of urban forests and increase awareness

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about them. For example if all forest services are included in environmental management accounting, this approach can support the operation of the sector and provide useful indications for policy decision making (Papaspyropoulos et al. 2012).

2. Material and methods

The methodological approach is divided in two parts. The first part is focused on management and financing systems, the second part deals with the valuation of the forest ecosystem services.

First, it is important to describe the organisation and governance system. The concept of comprehensive management of urban forests involves visualising the total urban area and understanding the complexities of location, ownership, and condition of the urban forest (Grey 1996). In the city urban forest, management is based on an organisation with responsibility, authority, and effective leadership. Description of the organisation and governance of the management in the urban forest is important because it has a basic influence on the support for forest ecosystem services. For example in Canada, the experience in urban forest management indicates that management practices would be significantly improved by overcoming the lack of detail in ecological, social, and economic management themes, which refer to components such as nativeness, naturalness, climate change, community stewardship, public participation, and use of economic incentives (Ordonez & Duinker 2013). The role of managing institutions must be well-defined if they are to understand the dynamics of urban environments affecting resource decision-making (Mincey et al. 2013).

A precondition for effective urban forest governance is financial support for all forest ecosystem services or, preferably, a limited number of services that are seen as being most important (i.e. for which there is greatest demand). Basically, public forest services should be financed from the state budget or municipal budget (Golos 2013). Nevertheless, it is important to describe the type of organisation and details of the financing system. Financing of the non-market ecosystem services from forests is very important.

The second part of this paper is focused on the valuation of ecosystem services from forests in the city of Prague. There are no widely accepted methods for quantification and valuation of the ecosystem services offered by urban forests (Jim & Chen 2009). The most frequently applied method is contingent valuation (Tyrväinen & Väänänen 1998). The method used in this paper is based on the methodological approaches of the Czech University of Life Sciences, Prague, to the valuation of ecosystem services that are based on societal demand for forest functions. The valuation processes use direct relationships, i.e. costs and revenues in the case of market functions, and, in the case of indirect market functions, prevention and compensation costs are also used. Valuation of non-market functions uses expert procedures which are specific in comparison with methods used in other countries based on consumer surplus or willingness to pay. Forest ecosystem services are differentiated by their socio-economic content (Šišák 2013). According to this methodological approach, the following services are considered:

- timber production service
- hunting and game management service
- soil-protection services
- hydrological services
- air protection services
- non-wood production services
- health-hygienic services
- cultural-educational services.

The value of forest ecosystem services is compared with the costs of these services. It is very important to compare product and non-product ecosystem services in order to place a value on non-product ecosystem services.

The chosen specific valuation procedure follows the Methodology for evaluating social socio-economic significance of forest functions (Šišák et al. 2010). The calculation was performed in CZK and converted to EUR.

The value of timber production service was set on the basis of actual sales of wood in 2013. The value of hunting and game management service was set at the level of 170 CZK per hectare of hunting area. The value of soil protection function of the forests in the studied area is negligible, because there is no risk of surface and introskeletal erosion or silting of water reservoirs and streams. The value of hydrological forest services was derived from individual qualitative characteristics, i.e. maximum flow, minimum flow and water quality. The basis for maximum flows is a rate of 910 CZK per hectare of forest area, corrected by soil texture, altitude, age, density and quality of a forest stand. For minimum flows, the rate depends on the type of substitution of forests, in the case of the change to permanent grassland a rate of 540 CZK/ha corrected by the quality of a forest stand is applied. For water quality, a rate of 9,300 CZK/ha is applied and corrected by the forest vegetation zones and nitrate content in the protection areas of drinking water and groundwater accumulation. Beyond these areas, the coefficient of 0.4 is applied.

The value of air protection forest services is derived from carbon fixation. It is set to the average annual level in the Czech Republic at a rate of 1,000 CZK/ha of forest land. To calculate the value of non-wood production services, a rate of 1,315 CZK/ha for major forest fruits is used. The rate applies to average production conditions and the intensity of berry and mushroom picking in the Czech Republic. The value of health-hygienic services was calculated using a rate of 7,521 CZK/ha for the increased numbers of visitors that are expected in suburban forests. The value of cultural-educational services was calculated as follows: For national nature reserves a rate of 7,095 CZK/ha and for the remaining areas a rate of 2,183 CZK/ha were used.

Forests in the City of Prague

Forests in the City of Prague are categorised as special purpose forests; suburban forests with an increased recreational role. There are about 4,950 hectares of forests within the administrative territory of the City**.** A total of 2,696 hectares of forests are owned by the City of Prague. They are mainly deciduous forests dominated by oak (Table 1). Their species composition supports recreational forest services (Hobbs 1998).

Table 1. Tree species composition of forests owned by the City of Prague.

Tree species	Percentage [%]
Quercus robur, Quercus petraea, Quercus rubra	33
Pinus sylvestris	12
Robinia pseudoakacia	11
Abies alba	8
Pinus nigra	6
Tilia cordata	6
Larix decidua	5
Carpinus betulus	4
Fraxinus excelsior	4
Other	11

Source: Forests of the City of Prague.

Organisational structure and responsibility

Responsibility for the management and maintenance of city forests is delegated to an organisation called the Forests of the City of Prague. City forests are administrated by the City of Prague's Department of City Green Waste Management. The management of state forests within the city is administrated by the Government's Department of Environment (third subject). This leads to inefficient overlap of activities and competencies. At present it is unclear when and under what conditions these inefficiencies will be addressed.

According to its founding charter, the main functions of the organisation Forests of the city of Prague are:

- administration and maintenance of urban forests, including the assessment of the health of vegetation on land owned by the City of Prague
- administration and maintenance of small watercourses
- administration and maintenance of water works
- environmental education and awareness
- production of plant material
- administration and maintenance of protected areas
- management and maintenance of important parks
- management and maintenance of alleys.

One of the primary objectives is to ensure a high level of recreational forest service combined with other high priority functions; cultural-educational and hydrological and water management.

The organizational structure of the Forests of the City of Prague (Fig. 1) has been effective in delivering sustainable urban forest management in the City.

From the financial point of view, the Forests of the City of Prague is a non-profit organisation. The organisation's activities are funded from two main financial sources: a contribution from the City of Prague, which is not sufficient to cover all costs; and from its own trading activities (timber production, horticultural products, game activities, environmental education etc.). The basic economic requirement from the founding organisation (City of Prague) is not to lose money. Annually the Forests of the City of Prague break-even or make a small surplus.

In addition, since May 2007, the City of Prague has had its forest management independently certified under the Forest Stewardship Council (FSC) International Standard. Certification supports marketing efforts and it has been possible to achieve price premium for certified timber.

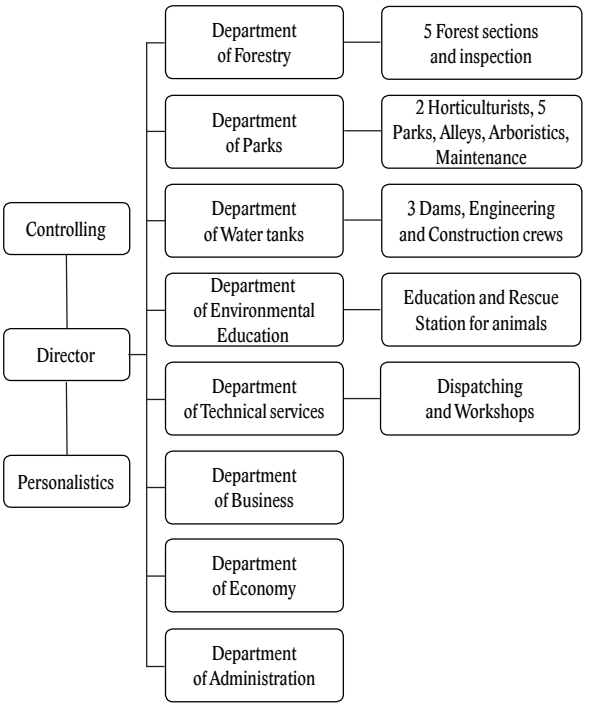

Fig. 1. Structure of organisation in 2014.
Source: Forests of the City of Prague.

3. Results

This study revealed that the most highly valued services are health-hygienic and cultural-educational forest services. The comparison with other services can be found in Table 2.

Table 2. The annual value of forest services in 2013.

Forest ecosystem services	Value in EUR	Share in the total value in %
Health-hygienic forest services	741,000	38
Cultural-educational services	675,000	35
Hydrological forest services	173,220	9
Timber production service	136,364	7
Air protection forest services	98,036	5
Non-wood forest production services	96,762	5
Hunting and game management service	16,666	1

Source: Authors.

Health-hygienic services (recreational functions) in the forests managed by the Forests of the City of Prague had an annual value of 741 thousand EUR, a capitalised value of 37,000 thousand EUR, and annual costs of 653 thousand EUR in 2013. A large part of the expenditure is used for construction and maintenance of recreation infrastructure. The Forests of the City of Prague currently deploy more than 2,600 items of recreation infrastructure (including 54 playgrounds, 51 pavilions, 45 sandboxes, 1,300 benches, etc.).

Furthermore, the value of the recreational function is influenced by the number of visitors to forests. The numbers of visitors to Prague's forests are very high, especially in the locations that are easily accessible to the public. For example, in 2004 (the last survey), Hvězda preserve was visited by more than a half million of visitors, and Kunratický forest by even a higher number of 670,000 visitors.

Cultural-educational forest services had an annual value of 675 thousand EUR, a capitalised value of 27,615 thousand EUR, and associated annual costs of 120 thousand EUR. The value of this function is influenced by the numerous protected areas occurring in the area, and environmental education activities organised by the Forests of the City of Prague.

The Forests of the City of Prague want to expand reporting about their activities and the state of forests and the environment. The organisation received new competencies in 2014, which will facilitate an expansion of its reporting. The importance of non-market forest services is increasing in the eyes of visitors to Prague's city forests, and the Forests of the City of Prague want to improve their communications by reporting on the value of these services periodically.

4. Discussion

The realisation of owners´ interests is characterised by the strained relationship between individual freedom and involvement in society (Krott 2005). Public forest owners have a very high potential to support all ecosystem forest services, preferably non-market forest services (Carreiro 2007; Álvarez et al. 2013; Mincey et al. 2013). The management goals in urban forests are a good example.

Specific problems for urban forests arise from the influence of the city on forests, parks and trees. On one side urban forests provide ecosystem services, and on the other side high population density has a negative impact on urban forests, for example through soil compaction due to the increased number of visitors (Christopoulou et al. 2007). This is a complexity of problems, which includes direct pressure on land for building purposes at the edge of forests, and increasing vandalism, which is directed not only towards recreational facilities, but also towards young stands of trees, et**c.**

Governance of urban forests

Governance of urban forests differs widely among countries. A set of different criteria may be used if we want to compare different approaches, e.g. institutional framework, actors and coalitions, resources, processes (Lawrence et al. 2013). The governance activity of the City of Prague is focused mainly on organising, financing and management improvement.

The City of Prague founded an organisation called the Forests of the City of Prague and delegated the management of urban forests to them. This could be seen as a form of out--sourcing where the city would distance itself from day-to--day management activities. However, the efficiencies which this model could yield seem to be unrealised because two other organisations continue to be active in the administration of the city forests.

The communication with stakeholders is a priority area of sustainable urban forest management. In the City of Prague, decision-making is mainly performed by the city council and only to a limited extent by residents, civic associations and individual property owners. This situation differs from other cities (Lawrence et al. 2013). For example, in the National Urban Park in Stockholm, state bodies and other organisations have substantial influence on decision making. In Camden, London urban woodlands and street trees are managed by Camden Borough Council. In Scotland it is possible to find strong influence of local non-profit organisations, such as the Central Scotland Forest Trust and the Edinburgh Green Belt Trust, which are autonomous but funded and governed as a collaboration between local government national agencies, and local communities.

Collaboration with NGOs appears to be an inevitable part of future organisational change and the management of Prague's city forests. This approach has been very productive for urban forests in other locations (Wright & Andersson 2013) and provides an opportunity for strengthening sustainable development.

Financing of the urban forests in the City of Prague differs a lot from other cities. The organisation's activities are funded from two main sources: the City of Prague, which is not able to cover all costs, and from the commercial activities of the urban forests. In the case of the Ghent Park Forest, National Urban Park Stockholm and Camden Borough London, governments (national, regional or city) support urban forests, whereas Bosco della Giretta Milan is supported only by private donations and membership fees (Lawrence et al. 2013).

Valuation of ecosystem forest services

The results of this study show that the monetary benefits of urban forests are significantly higher than the present maintenance costs (Tyrväinen & Väänänen 1998). But the ratio of benefits to costs varies according to the different services provided. It is necessary to take into account that costs and revenues related to non-production ecosystem functions are commonly included in financial statements, but the value of these services is not reflected there (Hájek 2013).

In financial statements we should provide the data on ecosystem services that are produced spontaneously (wake theory) as a component which is fixed, and unchanging (Dietrich 1941). On the other hand, we should also report any changes which we specifically provide for the purpose of intensification of non-production ecosystem services (Kovalčík et al. 2012). Monetary value of health-hygienic forest services was 741 thousand EUR, and their costs were 653 thousand EUR in 2013, while monetary value of cultural educational forest services was 675 thousand EUR and costs 120 thousand EUR. We can conclude that the value is not directly dependent on the amount of management expenditure.

The use of valuation

The estimation of economic values of goods and services can improve the effectiveness of policy instruments in forest management and protection (Cubbage et al. 2006). It is possible to use these data when management organisations introduce sustainable management accounting, sustainable reporting or use cost benefit analysis, analysis of assets, calculation of profitability etc. In this view it is also useful to know the value of all services, not only market services, because of increasing efficiency in public forest management and financing.

In the case of the City of Prague's urban forests it is possible to find a very high potential. For example, sustainable management accounting contains a lot of information that can be used in any enterprise to prepare annual reports focused on sustainable development. Making this information available is important if the ecosystem services in urban areas are to be properly understood and valued by city planners and political decision-makers (Bolund & Hunhammar 1999).

5. Conclusions

The importance of non-production forest services is increasing due to which a new analysis of financial support has become a key issue. Urban forestry represents a special situation because the goal of municipalities is to satisfy the needs of residents. In the case of the city of Prague responsibility for the management of the forests is delegated to an organisation the Forests of the City of Prague. It is a non-profit organisation which gives a high priority to non-market ecosystem services. It is possible to increase the effectiveness of urban forest management and to use the valuation of all forest ecosystem services in the processes of decision making. It is possible to use ecosystem services valuation in the process of investment, management accounting and reporting, too. Reporting is important because of the opportunity to influence the awareness of the public and other stakeholders.

We can conclude that urban forest management creates favourable conditions for the successful support of ecosystem forest services and sustainable development in cities. In comparison with private owners, municipalities want to satisfy needs of residents and can rationalise support mainly for non-production forest services.

Acknowledgments

The paper is one of outputs of the project National Agency for Agriculture Research No QJ1220313 Differentiation of management intensities and procedures in relation to the assurance of biological diversity of forests and economic viability of forestry.

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Summary

Urban forests generate a lot of ecosystem services which are demanded by residents and have influence on sustainable development in cities. The particularity of urban forests is that the goal of cities is to satisfy needs of inhabitants. These goals determine the approach to financing and support of all important non-market forest services.

The aim of this article is to assess the current level of organisation and funding of forest management and to estimate the value of forest ecosystem services as a basis for forest management improvement. An example was taken from the Forests of the City of Prague in the Czech Republic. It is difficult to generalise the results because of political conditions and site-specific actual services and their values. On the other side, the methodological approach is applicable in all cities.

The methodological approach is divided into two parts. The first part is focused on the management and financing system, the second part deals with the valuation of forest ecosystem services. An important feature is to describe organisation and governance system. The concept of comprehensive management of urban forests is based on visualising the total urban area and understanding the complexities of location, ownership, and condition of the urban forest. The description of the organisation and governance of the urban forest is important because it has a basic influence on the support of forest ecosystem services. The used method of valuation of ecosystem services is based on the methodological approaches of the Czech University of Life Sciences, Prague. The valuation method is based on societal demand for forest functions.

The City of Prague delegated the responsibility for the management of the forests to an organisation called the Forests of the City of Prague. It is a non-profit organisation with a high priority in non-market ecosystem services. The described organisational and governance system is convenient for support of all ecosystem services, primarily for non-production forest services.

The Forests of the City of Prague could find a very high potential for improving management efficiency. For example, sustainable management accounting contains a lot of information that can be used in any enterprise to prepare annual reports focused on sustainable development. It is important that the ecosystem services in urban areas are understood and valued by city planners and political decision-makers.