Ökosystemleistungen der Bäumen in der Stadt von der klimatischen Hinsicht (Szeged,Ungarn)

Ecosystemservices of trees from the point of view of urban climate (Szeged, Hungary)

Ágnes Gulyás*, Márton Kiss, János Unger
agulyas@geo.u-szeged.hu
Department of Climatology and Landscape Ecology, University of Szeged, Hungary

Introduction

Environmental policy and urban planning is more and more influenced by the methodology of valuing ecosystem services (EU Biodiversity Strategy 2020, Intergovernmental Platform on Biodiversity and Ecosystem Services, UN Rio+20 Conference – Green Economy). Coping with consequences of climate change is a big challenge for urban planning in the 21st century, and an important possibility would be the maintenance and improvement of urban green infrastructure [1]. In big cities with considerable heat excess and air pollution, trees may provide regulating and cultural services that can exceed the planting and management investments in economic value as well.

Methods and study area

The UFORE model

We evaluated ecosystem services of urban trees with i-Tree Eco 4.1.0 (software implementation of the UFORE (Urban Forest Effects) model) [2].

UFORE-A: Urban Forest Structure
Structural attributes of the stand (e.g. species distribution, tree density, health, leaf area)

UFORE-B: Biogenic Emissions
Volatile organic compounds (VOCs) can contribute to the formation of O3 and CO.

UFORE-C: Carbon sequestration and storage
Sequestration of carbon dioxide, resulting in biomass growth, can be calculated with the help of allometric equations.

UFORE-D: Air Pollution Removal
The most complicated submodel, the economic calculations are based on median externality values for the USA.

UFORE-E: Building Energy Effects
Trees, owing to their shading effect, can reduce air conditioning and thus contribute to energy saving, but as the buildings are significantly different in this aspect, we ignored this component of the model.

Model cities in this first implementation: Lincoln (Nebraska), Goodland (Kansas)

Study area

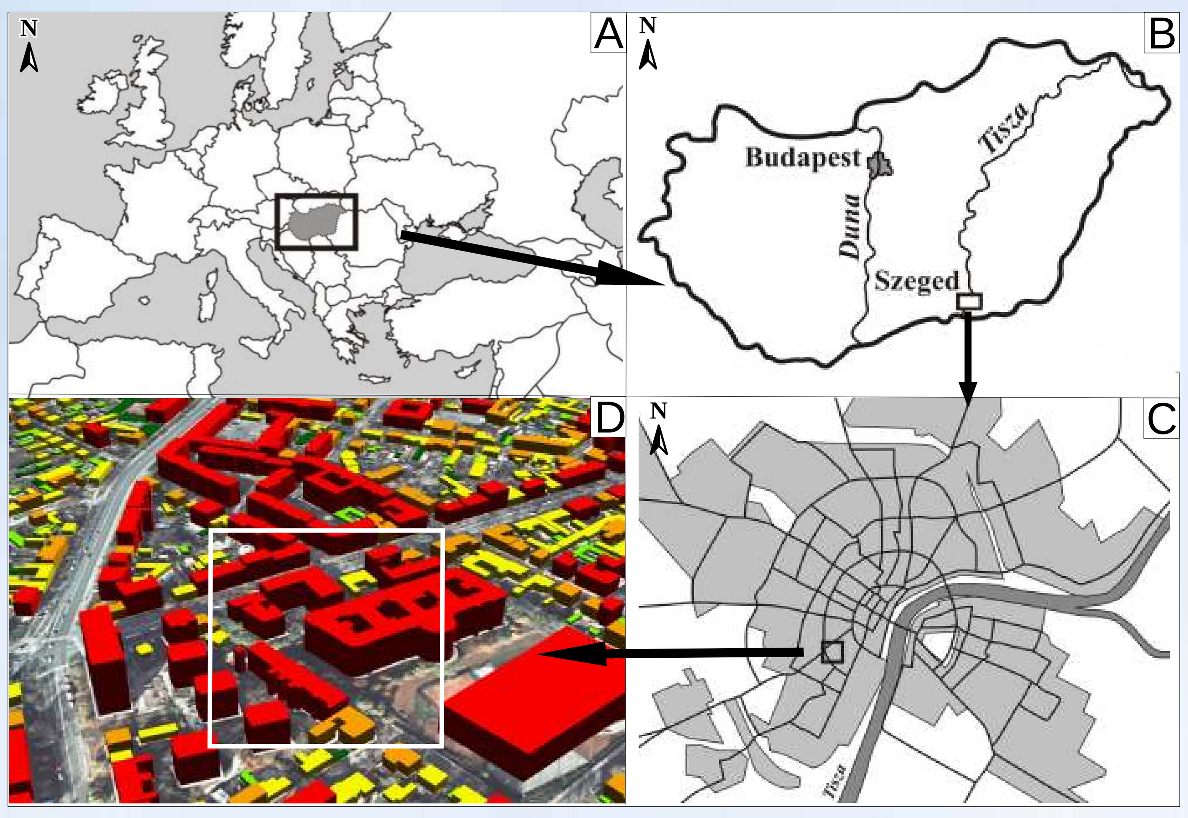

Fig. 1 Geographical location of Hungary in Europe (A), of Szeged in Hungary (B), built-up area and road network of the city (C) and the location of the 200 x 200 m sample area in the city (white frame) (D) Colours: green: 0-2.5 m, light green: 2.5-10 m, yellow: 10.1-15 m, orange: 15.1-20 m, red: above 20.1 m

Szeged (South-Hungary - 46° N, 20° E, population: 160 000, continental climate with a long warm season, annual mean temperature: 10.4 °C, precipitation: 497 mm). For our case study a 200 x200 m sample area was selected in the densely built up city centre characterised by predominantly narrow street canyons bordered by 2-3 storey houses and trees. (*Fig. 1*)
Air pollution in the city is influenced manly by traffic emission (high CO and PM10 concentrations) [3].

Aknowledgement

The publication/presentation is supported by the European Union and co-funded by the European Social Fund.Project title: "Broadening the knowledge base and supporting the long term professional sustainability of the Research University Center of Excellence at the University of Szeged by ensuring the rising generation of excellent scientists."
Project number: TÁMOP-4.2.2/B-10/1-2010-0012

HUNGARY'S RENEWAL
The project is supported by the European Union and co-financed by the European Social Fund.

Results and Discussion

Urban Forest Structure

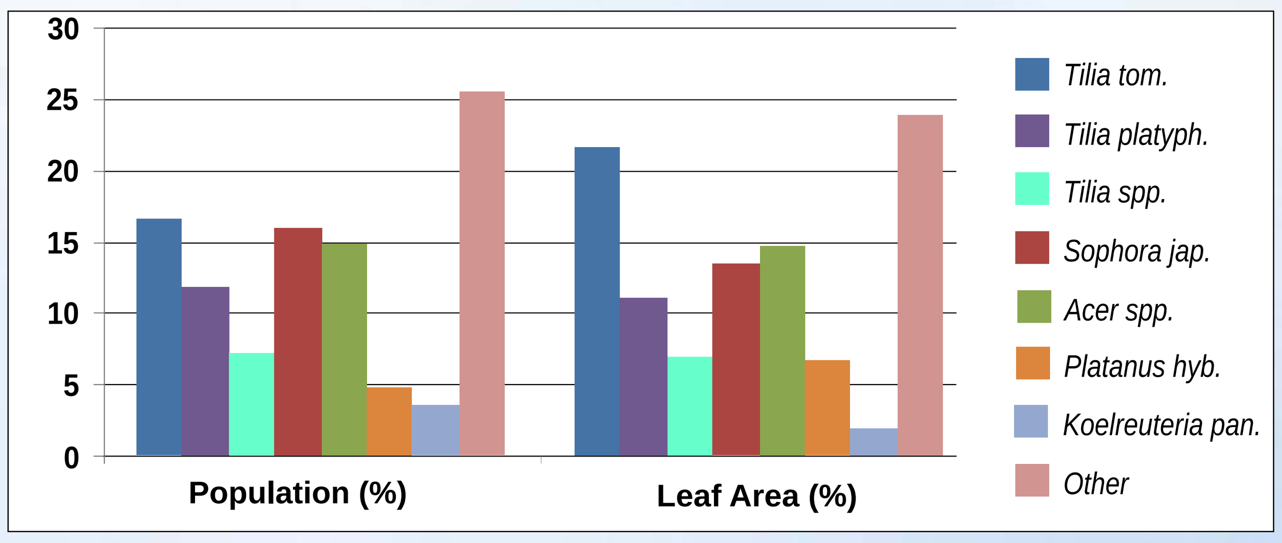

Fig. 2 The percentage of the most common species and their share in the whole leaf area

169 decidious trees from plantation, mainly older than 30 years, most common species: Large-leaved and Silver Linden (*Tilia platyphyllos* and *Tilia tomentosa*) and Japanese Pagodatree (*Sophora japonica*).
Size distribution: most of the trees have DBH between 20 and 40 cm, and height between 10 and 20 m. *Sophora japonica* has bigger individuals (average DBH: 162.9 cm, height: 19.6 m).(*Fig. 2*)

The tree populations of rows of trees in the narrow street canyons can be homogenous or heterogenous. *(Fig. 3A-C)* Health status (based on the crown dieback data, collected during the field survey): the stand's general state is good with many trees categorized as „excellent". (Critical: 1.18%, Poor: 4.73%, Fair: 31.95%, Good: 30.18%, Excellent: 31.95%). Species with better health state are over represented in total leaf area (compared to their share in the species distribution), though several species shows dead branches at the top of their crowns and *Tilia platyphyllos* trees are severely damaged (*Fig. 3D*)

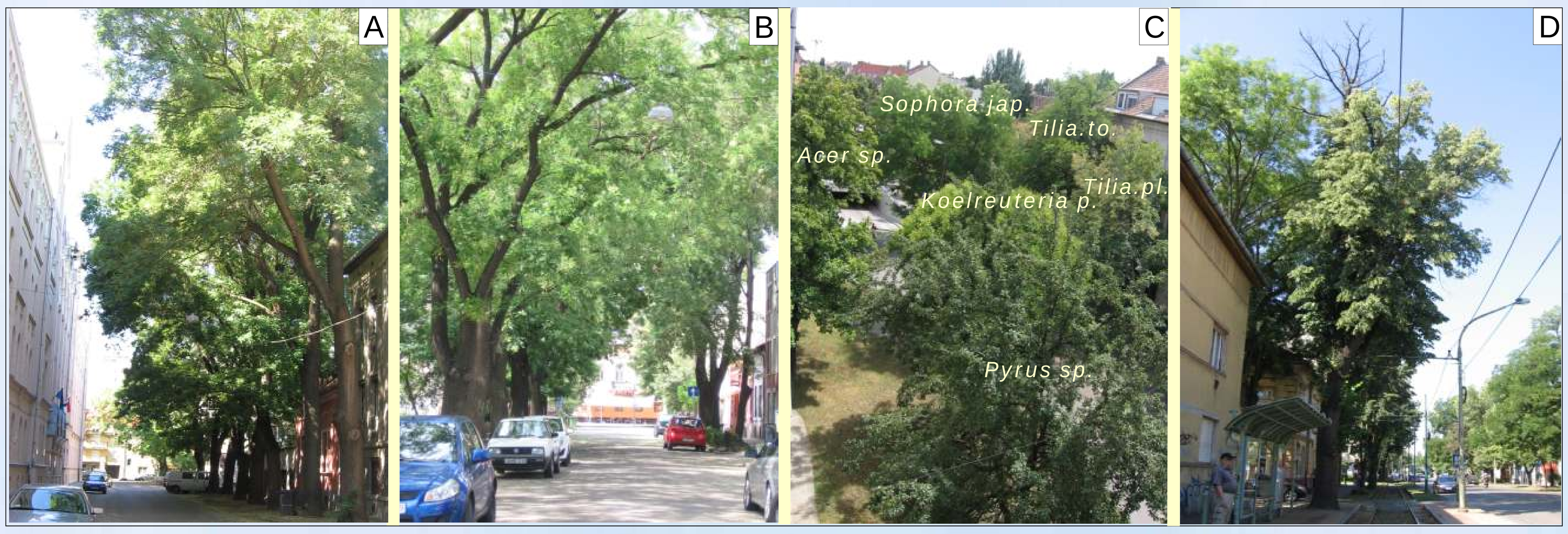

Fig. 3 Street canyon with homogenous, old *Sophora japonica* row of trees (A-B), street with different species (C),damaged canopy of *Tilia platyphyllos* with removed branches in the lower third (D)

Air pollution removal

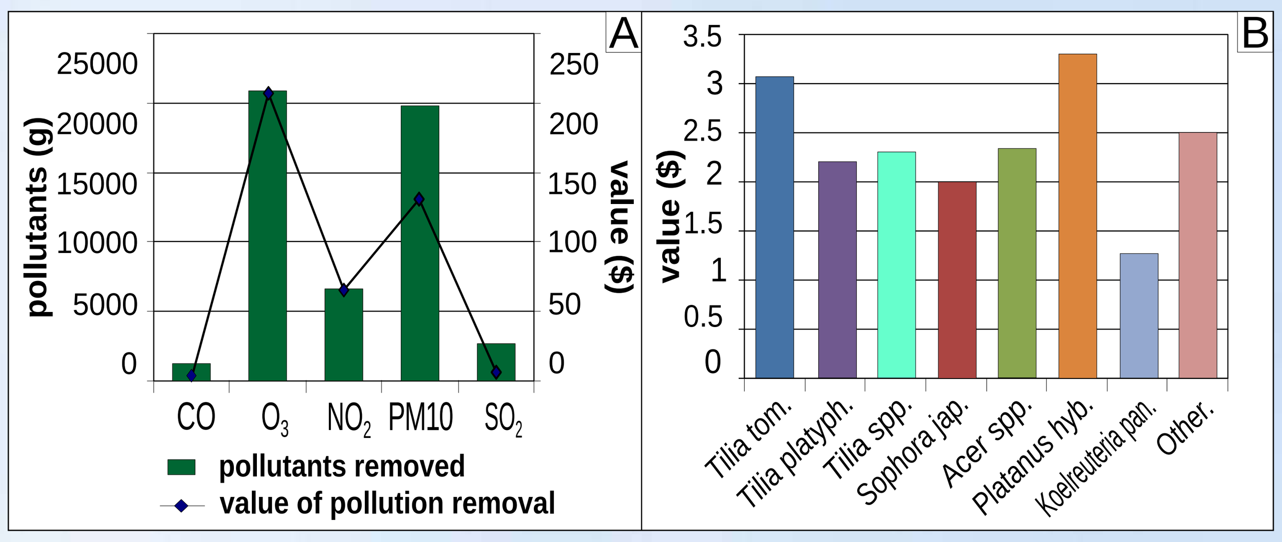

Fig. 4 The amount of the main pollutants removed and the economic value of pollutants (A) and economic value of pollutants removal per species (B)

The biggest quantity was removed from O_3 and PM10, their amounts reaching or even exceeding 20000 g and 100 $, respectively *(Fig. 4A)*. The distribution between the species follows that of the leaf area. The distribution is relatively even, only *Platanus hybrida* has a quite high and *Koelreuteria paniculata* a quite low value *(Fig. 4B)*.

Carbon sequestration and storage

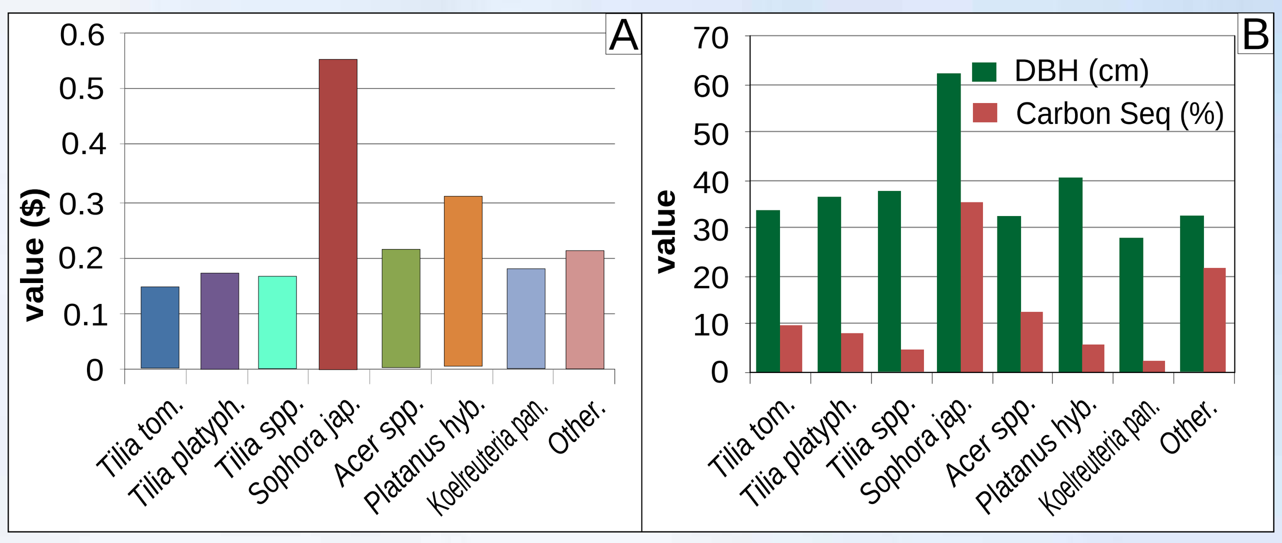

Fig. 5 Value of carbon sequestration per tree (A) and the average DBH of the main species and their share in the carbon sequestration of the stand (B)

The trees of the study area sequester approximately 2 tons of carbon per year in total. The values per trees are scattered around 10kg/year, with an economic value of ~0,2 $/year.*(Fig. 5A)*
From the structural attributes, carbon sequestration correlates mainly with the Diameter Breast Hight (DBH), *Sophora japonica* has extremely high (>25 kg/year), whereas *Tilia tomentosa* has extremely low value (<7 kg/year).
(Fig. 5B)

Conclusions

We demonstrated the importance of the regulating ecosystem services from an economic point of view. From the two services investigated, air pollution removal was found to be more important, its economic value being comparable with the planting and management costs. This conclusion underlines the importance of taking these values into consideration in urban management processes.
In Hungary, there is an indicator system for evaluating urban green spaces, which, however, does not involve direct economic valuation. This valuation system is based on the tree stand's importance for the residents' well-being [4]. This system is also implemented in some municipalities' regulations.

References

1. Georgi, N.J. and Zafiriadis, K., (2006). The impact of trees on microclimate in urban areas. Urban Ecosyst, 9: p. 195-209.
2. Nowak, D.J., Crane, D.E., Stevens, J.C., Hoehn, R.E., Walton, J.T., and Bond, J., (2008). A Ground-Based Method of Assessing Urban Forest Structure and Ecosystem Services. Arboriculture & Urban Forestry, 34(6): p. 347-358.
3. Makra, L., Mayer, H., Béczi, R. and Borsos, E. (2003): Evaluation of the air quality of szeged with some assessment methods. Acta Climatol et Chorolog Univ Szegediensis, 36-37: p. 85-93.
4. Radó, D., (2001). A növényzet szerepe a környezetvédelemben. (The role of vegetation in environmental protection. - in Hungarian) Zöld érdek Alapítvány - Levegő Munkacsoport, Budapest, Hungary