COST Action FP1206 (EuMIXFOR)
European Mixed Forests: Integrating Scientific Knowledge in Sustainable Forest Management

Species diversity of urban forests across Europe versus their efficiency in providing the expected ecosystem services

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URBAN FORESTS (UF)

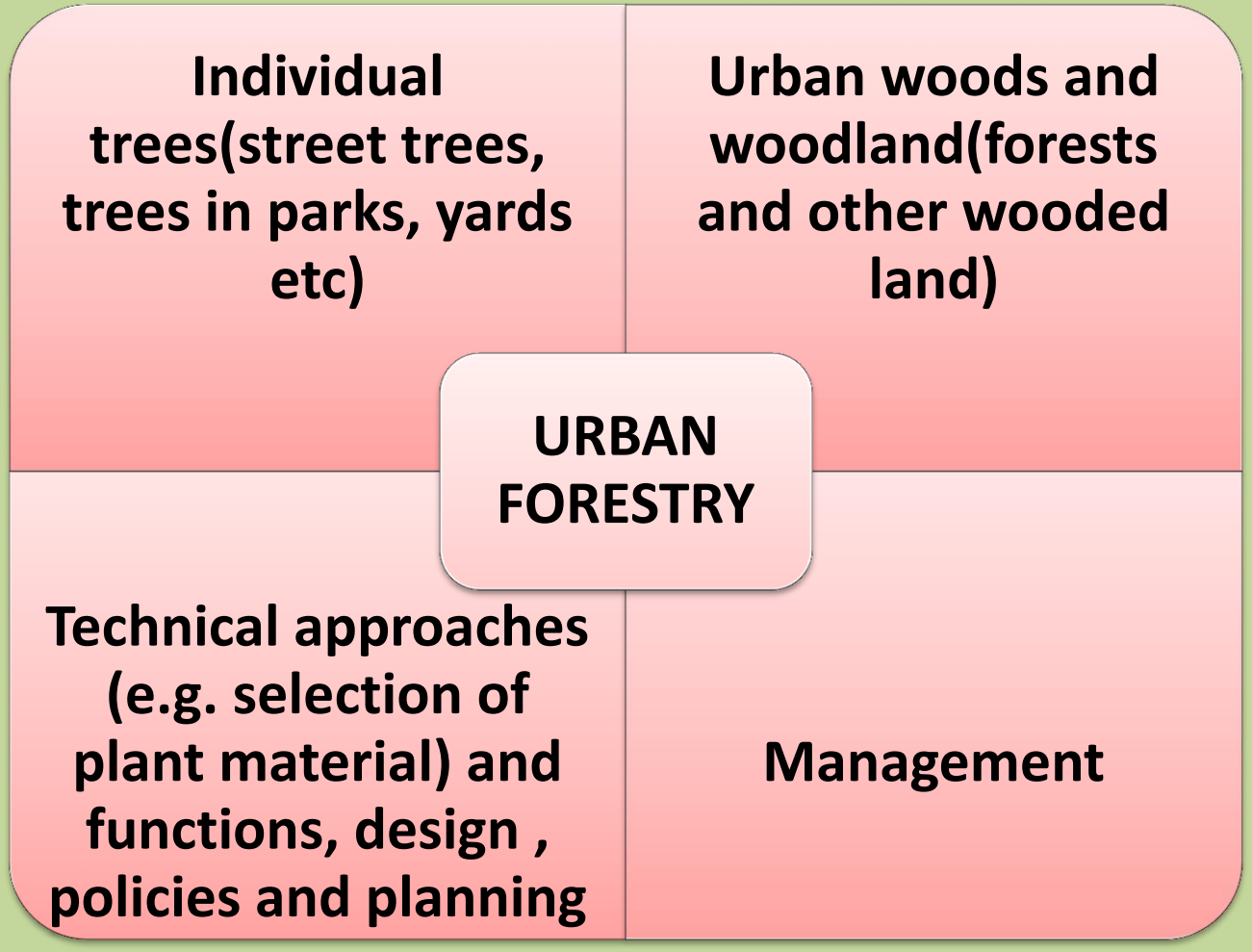
- **Sustainable Urban Forests Coalition (SUFC) views UF as the aggregate of all vegetation and green spaces that provide many environmental, health and economic benefits for a community**

- **UF are integral parts of urban ecosystems**

- **Whether planted intentionally or left by default, UF appeared even in the earliest settlements**

Sources: Rowntree, 1986; Ulrich, 1986; Dwyer et al., 1992; Bolund and Hunhammar, 1999; Tyrväinen and Miettinen, 2000

URBAN FORESTRY MATRIX



Randrup et al, 2005

SPECIES DIVERSITY OF UF

❖The survey of European tree selection and establishment practice showed that the range of **different tree species** planted varied from one city to another

❖The most urban forests' **tree species composition** reflect natural vegetation types typical of respective biogeographical region

❖Their composition is partly modified mostly by various **invasive species**

Sources: Pauleit et al., 2002

SPECIES DIVERSITY OF UF

❖**Northern Europeans cities have a low diversity of species due to**

a. **the harsh climatic conditions and**
b. **a traditionally narrow choice of species**

- **In Reykjavik, over 90% of newly planted street trees were *Populus trichocarpa* while *tilia sp* account for 40-70% in Norwegian cities**
- **In urban woodlands, species from the natural flora predominate with a high percentage of coniferous species such as *Picea abies* and *Pinus Sylvestris***

SPECIES DIVERSITY OF UF

- **In Central and North –West European countries, a broad choice is used.**

- **167 species were recorded in a survey in the city of Cologne (22 of which natural flora)**

- **154 species were recorded in Riga urban pine forests**

- **Species in urban woodlands reflect the natural range of decidious tree species such as *Quercus sp* and *Fagus sylvatica* but plantations of locally non-native species can also be common**

Sources:Kunick 1987; Straupe et al.

SPECIES DIVERSITY OF UF

❖**A great range of species are used in the Mediterranean.**

➢***Platanus sp* often predominates in public open space. However this species is increasingly threatened by pests and diseases and in Marseille are now largely replaced by *celtis australis***

➢**Urban woodlands are often characterized by native *Quercus sp***

URBAN FORESTS (UF)

Broad range of benefits:

❖ **Opportunities for residents to have daily contact with nature and to enjoy attractive landscapes and recreational activities**

❖**UF contribute to an improved quality of urban life in many ways and play a paramount role in stabilizing and sustaining urban ecosystems**

Source: Whitford et al., 2001

ES IN URBAN AREAS

- **All the benefits that the human population can derive, directly or indirectly from ecosystems are known as ES**

- **Due to the different types of ecosystems, the types of ES are different as well**

- **The diversified benefits generated by UF could be more instrumental in solving local environmental problems**

Sources: Costanza et al., 1997; Chen, W. Y., & Jim, C. Y. (2008); Gomez-Baggethum et al, 2013;

ES IN URBAN AREAS

- However, such ecosystem services are not generally well understood or appreciated

- A more direct interpretation of these benefits could promote their preservation and enhancement

IDENTIFICATION OF ES PROVIDED BY URBAN FORESTS

- **Most services are indirect and intangible, however play important roles in the sustainable operation of local ecosystems, and contribute notably to the welfare of society**

- **These services have long been recognized, and a large body of literature has attempted to identify and quantify them**

IDENTIFICATION OF ES PROVIDED BY UF

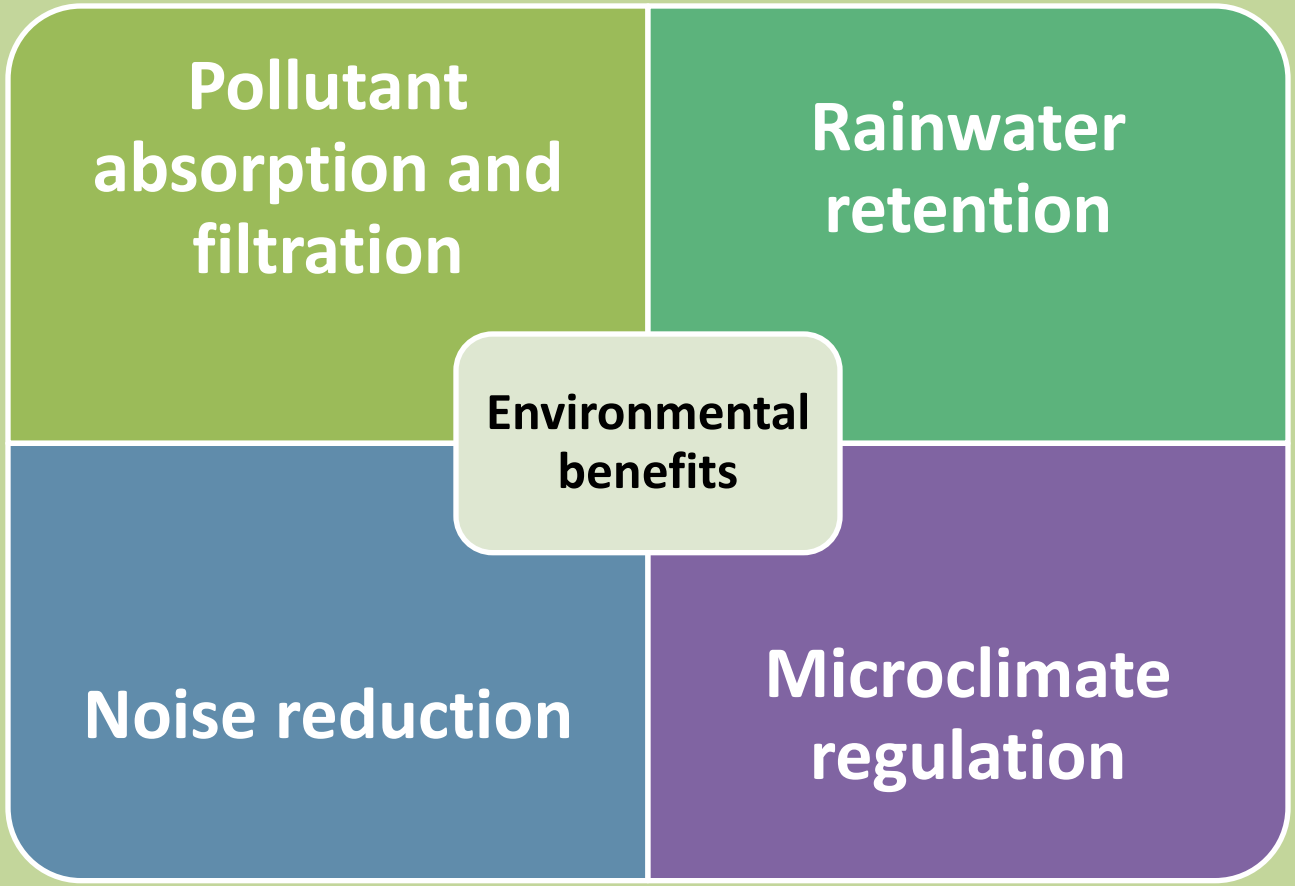
Environmental benefits

Recreation and aesthetic services

Biomass functions

Other ES

Environmental benefits



Microclimate regulation

UF can effectively modify the microclimate and improve thermal comfort

- **Heisler (1986a,b, 1990) investigated the impact of trees in reducing wind speed and the impact of tree location around a house on energy use**

- **Akbari and Taha (1992) used Heisler's data to simulate energy use of typical houses in cold climates. They found that in cold climates, a 30% increase in urban tree cover can reduce winter heating energy use by 10%, and evergreen trees planted on the north side of buildings can effectively protect the buildings from the cold north wind**

Noise reduction

❖Noise may be potential sources of physical and psychological stress to humans

❖Some studies suggest that when planted with enough width and density, vegetation can noticeably reduce noise

❖Trees also mask noise by generating pleasant sounds as wind moves tree leaves or as birds sing in the canopy

❖A 30-m-wide tree belt combined with soft ground surfaces can reduce loud noise by 50% or more

Sources: Harris and Cohn, 1985 ;Miller, 1997; Nowak and Dwyer, 2000

Rainwater retention

❖**UF play important roles in rainwater retention and runoff avoidance**

❖**The potential retention capability of UF is related to vegetation type and degree of impervious cover**

❖**Rainwater retention by urban vegetation can reduce the size and density of drains needed in a city, and hence the costs of constructing and maintaining a city's drainage infrastructure**

Sources: Nowak and Dwyer, 2000; Girling and Kellett, 2002

Pollutant absorption and filtration

- The effectiveness of this ES varies by plant species, canopy area, type and characteristics of air pollutants, and local meteorological environment

- Urban tree canopies are more effective in capturing particles than other vegetation types due to their greater surface

- In Frankfurt, Germany, a street with trees had 3000 dust particles per liter of air, whereas streets without trees in the same neighborhood had 10,000 to 30,000 particles per liter of air

Recreation and aesthetic services

❖For the general public, recreational possibilities and aesthetic enjoyment may be the most readily appreciated benefits of UF

❖Vegetation creates different colors, shapes, dimensions, textures, sounds, and feels, and these attributes vary with season, time of day, and weather conditions

❖Vegetation is key to making cities pleasant and livable. Using engineering and landscape skills, and integrating grass, shrubs and trees, UF can be created as landscaped spaces where people can gather

❖Clear views with low-density understorey vegetation are associated with increased pleasure and are preferred by visitors

Biomass functions

- The capacity of trees to capture carbon has varied

- The annual rate of O_2 release and CO_2 sequestration depends on photosynthetic capacity of plants, which in turns depends on species composition and age structure of urban vegetation

- Tree species, age, health condition, weather, and environmental conditions could influence the amount of CO_2 uptake and carbon storage

- For a given city, selecting species with large final dimensions, and permitting them reaching their biological potentials in terms of size and physiology could raise the cost-effectiveness of the UF in terms of carbon sequestration and carbon emissions

Other ES

- Health and Psychological Services
- Wildlife Habitats
- Biodiversity Conservation
- Education and Sites for Scientific Research

VALUATION OF ES PROVIDED BY UF

❖Various approaches have been employed to assess the value of ES generated by UF, such as replacement cost, hedonic pricing, externality cost, travel cost and contingent valuation

❖Some studies focus on special ES rather than a holistic analysis of UF benefits

Sources: McPherson, 1994c; Tyrväinen, 1997 ;Price, 2003; Jim and Chen, 2006a

EMPIRICAL VALUATION OF ES OF UF

- In Salo, Finland, buyers were willing to pay 4.9% more to obtain a dwelling with a forest view. In addition, an increase of 1 km to a green space was found to reduce the house price by 5.9%

- Some examples of the value of the urban forest include an annual yield from the sustainably managed Stadtwald forest, in Bonn of 2,200 cubic meters of roundwood with an income of about € 80,000; water-retention services that provide significant; flood protection is of economic importance and in addition, an estimated 1.5 million visitors enjoy the forest each year

Sources: Tyrväinen and Miettinen, 2000; Patrickson, , 2014

EMPIRICAL VALUATION OF ES OF UF

❖**These empirical studies indicate that the value of various ES provided by UF is very high, and often greatly exceeds the cost of tree planting and maintenance. Longer-term public benefits could be raised by increasing tree cover, by planting the right kinds of trees in proper locations, and by providing sound tree management**

Source: Nowak and Dwyer, 2000

THE VALUE OF ES IN THE MANAGEMENT OF UF

❖**Capturing all ES into conventional, market based economic analyses, urban planning that encompasses the wide range of benefits and values provided by UF could help to create special landscapes in a multifunctional, productive, and sustainable way**

❖ **Therefore, a realization of the worth of urban vegetation together with construction of more resource-efficient city structures and designs could advance our goal of creating workable eco-cities that align with the spirit of smart growth**

Sources: Gatrell and Jensen, 2002; de Groot, 2006

THE VALUE OF ES IN THE MANAGEMENT OF DIVERSE UF

❖The benefits of managing for a diverse UF are also increasingly recognized. In general, higher levels of biodiversity support more complex ecosystem functioning, greater overall productivity, and more opportunities

❖Higher species diversity in an UF is thought to provide greater security against environmental changes

❖Urban biodiversity is also associated with social and health benefits

THE VALUE OF ES IN THE MANAGEMENT OF DIVERSE UF

- **Living, working and visiting areas high in biodiversity provides a range of positive psychological and physiological effects**

- **Additionally, exposure to a diversity of species is an important element in stimulating people's desire to support conservation efforts**

- **Given the benefits, species diversity is recognized as a key component of strategic UF management**

CONCLUSIONS

- **UF provide numerous ES and substantial value to the majority of the people in the world and these services are critical to maintaining the health and well-being of the urban environment and its human population.**

- **These services and values are directly dependent upon forest structure and species composition/diversity within urban areas**

CONCLUSIONS

- **Some ES have been quantified and valuated as monetary units to facilitate benefit-cost analyses, to inform public policies, and to integrate UF into projects for the enhancement of urban and rural sustainability**

- **More in-depth research is necessary to explore how urban forests provide ES through complicated interactions among ecological elements within urban ecosystems.**

THANK YOU