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Green Infrastructure approach: linking environmental with social aspects in studying and managing urban forests

STSM Scientific Report

Environment and urban forests, mobility, transport and infrastructure - compromises for sustainability

by

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Summary

The short-term scientific mission (STSM) at Kaunas University of Technology has successfully completed according to the work plan defined before.

The main purpose of STSM has been reached - the information for providing researches in the field of „Environment and urban forests, mobility, transport and infrastructure - compromises for sustainability" based on world literature, scientific publication and experience obtained by Kaunas University of Technology has been collected.

All main activities was successfully completed, such as:

- The expirience of Kaunas University of Technology in the field of „Environment and urban forests, mobility, transport and infrastructure - compromises for sustainability" has been obtained; Qualitative and quantitative data on the environmental services (such as climate change, water control, energy saving, microclimatic improvement) has been researched.
- Has acquainted with researches implemented by Kaunas University of Technology in the area of urban transport, planning, modelling, environment, mobility and technologies in transport systems in urban area; Defining the threats represented by urban transport system on urban forests.
- Has acquainted with targets and research area of Department of Transport Engineering, Faculty of Mechanical Engineering and Mechatronics, Kaunas University of Technology;
- Has acquainted with scientific literature in the field and expirience of Kaunas University of Technology;
- Has planned a preliminary research agenda for preparing scientific publication.
- The 17-th international scientific conference "TRANSPORT MEANS", organised by Kaunas University of Technology has been participated.
- Possible further cooperation between Riga Technical University and Kaunas University of Technology has been discussed.

Description of the work carried out during the STSM.

Main activities taken during the STSM.

Kaunas University of Technology continues long tradition and reflects the most relevant scientific and practical problems of transport engineering. KTU has shared the latest information on the issues of transport means engineering and transportation technologies.

The expirience of Kaunas University of Technology in the field of „Environment and urban forests, mobility, transport and infrastructure - compromises for sustainability" has been obtained; Qualitative and quantitative data on the environmental services (such as climate change, water control, energy saving, microclimatic improvement) has been discussed. Environmental, mobility, transport and infrastructure problems have also been discussed with collegues from Kaunas University of Technology (fig.1.).

Fig.1. A.Patlins with A.Kersys discussing work plan of STSM in october 2013.

The literature in library and e-libraries cover a vide variety of topics related to the most pressing issues of todays environment, mobility, transport and infrastructure sustainable development.

A lot of (more then 200) literature sources have been studied during STSM (including original scientific papers and PhD thesis) (fig.2.).

Fig.2. A.Patlins working in library with literature during STSM in Kaunas.

The Library of KTU stores and continously replenishes one of the richest collection on science, technology and engineering, provides access to e-resources. Archives of KTU Library has also been studied during STSM.

During the STSM the Transport Laboratory of KTU also has been visited. So, the expirience of Kaunas University of Technology has been also studied in this way. (fig.3.)

Fig.3. Visiting Transport Laboratory of KTU.

The researches implemented by Kaunas University of Technology in the area of urban transport, planning, modelling, environment, mobility and technologies in transport systems in urban area has been discussed. Threats represented by urban transport system on urban forests has also been discussed.

Has acquainted with targets and research area of Department of Transport Engineering, Faculty of Mechanical Engineering and Mechatronics, Kaunas University of Technology. Has been planned a preliminary research agenda for preparing scientific publication.

Fig.4. A.Patlins in the process of discussions with collegues from Kaunas University of Technology.

Lithuania are situated near Baltic sea and it is interesting that without transport and infrastructure threats to urban forests there are some other threats which has been studied during STSM. Much more significant and interesting from them are - sea threat - the erosion of coastal dunes by the sea and the destruction of forests in the border regions the coastal cities; and the extinction of of trees in the coastal cities because of the large number of cormorants and their metabolic products. Corrosive bird droppings literally burns the leaves and bark of trees (Fig.5 and 6).

Fig.5. Corrosive bird droppings literally burns the leaves and bark of trees.

Fig.6. Corrosive cormorants droppings literally burns the leaves and bark of trees.

During the STSM I have also been participating the scientific boat-trip in Klaipeda city (Lithuania) to see and study more about threats to urban forests from sea and from cormorants.

Fig.7. A.Patlins and scientists from Lithuania during the scientific boat-trip.

There were a lot of cormorants finded near the Klaipeda and it is a real threat for near the coast located trees and forests (fig.8).

Fig.8. Cormorants in Lithuania nea the coast.

During the STSM the 17-th international scientific conference "TRANSPORT MEANS", organised by Kaunas University of Technology has been participated.

Fig.5. A.Patlins in the process of discussions with scientists and researches participatind the 17-th international scientific conference "TRANSPORT MEANS" in Lithuania.

Possible further cooperation between Riga Technical University and Kaunas University of Technology has also been discussed.

Main finding(s) and the perspective in relation to green infrastructure and urban forest.

What the'green infrastructure' is .

One concept that has gained greater interest from scientists and planners during recent years is that of 'green infrastructure', defined as the physical green environment within and between our cities, towns and villages. It is a network of multi-functional open spaces, including formal parks, gardens, woodlands, green corridors, waterways, street trees and open countryside. It comprises all environmental resources, and thus a green infrastructure approach also contributes towards sustainable resource management and highlights the importance of the natural environment in decisions about land use planning (Surma M., 2009)

Green infrastructure is today one of the most important terms when we think about planning the contemporary city. It is an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations (Benedict M.A., McMahon E.T.,2002). It contributes to a very high level of achieving the sustainable urban form (Rafeq Jabareen, Y. , 2006)and supports the natural life system (Benedict M.A., McMahon E.T.,2002). The term 'green infrastructure' relates itself to the meaning of the term 'built infrastructure', which is critical to the continuance and growth of the community as the essential part of the city (Benedict M.A., McMahon E.T.,2002). The 'infrastructure' term referred to greenery helps to promote the importance of green spaces as one of the basic installations for the urban planning system, because it emphasizes the same level of priority as, what we could call, the 'grey infrastructure' (roads, sewage system, utility lines). Moreover, the 'green infrastructure' term underlines the idea of connections between green spaces, which seems necessary in the case of its contribution to sustainable development in a more general scale. As a concept, the planning and management of a green infrastructure network can guide the creation of a system of open space hubs and links that support conservation and associated outdoor recreational and other human values, connect existing and future green space resources, and 'fill in' gaps (Benedict M.A., McMahon E.T.,2006).

Short introduction to the problem of threats to urban forests and green infrastructure

By understanding threats to urban forests (including invasive species, fire, air pollution, lack of management capability, and development pressures), as well as the continued urbanization of rural and exurban forests, management efforts can be directed to help reduce various threats and sustain important urban forest resources. Regional urban forest plans can help improve long-term resource and environmental sustainability by integrating vegetation management issues across a region. Long-term planning and management can reduce the risks associated with various urban forest threats and ensure ecosystem services that will continue to improve urban environmental quality and enhance human quality of life and well-being.

Urban forest and green infrastructure challenges

Throughout the world, urban forests face a myriad of management challenges. Like forests in rural and ex-urban settings, urban forests are exposed to a broad range of human-caused and natural challenges, all of which can be compounded by climate change. However, the proximity of urban forests to relatively high numbers of people and associated development can considerably increase the level and complexity of management challenges. These challenges include:

• **Insects and diseases**—Urban forests across the world are severely affected by numerous insects and diseases, many of them introduced from other places, that have caused or have the potential to cause signifi cant damage. Some invasive species—such as the gypsy moth, emerald ash borer, and the fungi that cause Dutch elm disease and chestnut blight—have caused catastrophic tree mortality that has virtually eliminated dominant tree species in some places (Dozier 2000, Liebhold et al. 1995). Endemic pests such as mountain pine beetle have also caused severe damage to urban forests (Ellig 2008). Numerous insects, endemic pests and diseases can be moved from one place to another by transport using transport infrastructure.

• **Wildfire**—Uncontrolled fires, or wildfires, can cause substantial damage to urban forests and dramatically alter the urban landscape, especially in urban areas adjacent to wildlands (often referred to as the wildland-urban interface) (Spyratos et al. 2007). High population growth and urban expansion in the world, for example, have led to a substantial increase in

fire ignitions in wildland-urban interface areas. Different fires can be also a result of transport crashes and so damage the urban forests.

• **Natural catastrophic events**—Urban forests can be greatly affected by natural catastrophic events such as ice storms, snow, and severe wind, which can result in broken branches or uprooted trees among other impacts (Greenberg and McNab 1998, Irland 2000, Proulx and Greene 2001, Valinger and Fridman 1997). Such events can cause damage to people, transport, infrastructure and other property.

• **Invasive plants**—Kudzu (Pueraria lobata), English ivy (Hederal helix), European buckthorn (Rhamnus cathartica), and, in some areas, Norway maple (Acer plantanoides), are among the invasive plants that can degrade or modify urban forests in part by removing and replacing native plants and altering ecosystem structure. English ivy and kudzu have been known to cover acres of canopy trees (Dozier 2000, Webb et al. 2001). Seeds of Invasive plants can be moved from one place to another by wind or by transport using transport infrastructure.

• **Additional development**—Development within and around urban areas in forested regions can lead to decreases in forest area and fragmentation of forest stands, which can signifi cantly affect plant and wildlife populations, forest biodiversity and health (Nowak et al. 2005), and parcelization of forested areas (where stands remains intact but have multiple landowners), which can affect the available timber supply and forest management (Zhang et al. 2005). Huge uncontrolled development of transport infrastructure within and around urban areas in forested regions also can damage urban forests and can lead to decreases in forest area and fragmentation of forest stands.

• **Air pollution**—Forest ecosystems can be substantially affected by air pollution, especially from regional deposition of ozone, nitrogen, sulfur, and hydrogen (Stolte 1996). Ozone has been documented to reduce tree growth (Pye 1988), reduce resistance to bark beetle, and increase susceptibility to drought (Stolte 1996). Beckett et al. (1998) reviewed several reports and surmised that pollutant particles can have a wide variety of effects on trees and that heavy metals and other toxic particles can accumulate in urban soils, causing damage and death in some species. Urban transport is one of the main pollutant of urban air and soils, so uncontrolled air and soils pollution with emissions generated by urban transport, can damage urban forests and green infrastructure.

• **Climate change**—In over the world, climate change is expected to produce warmer air temperatures, altered precipitation patterns, and more extreme temperature and precipitation events (EPA 2009, IPCC 2007), all of which can cause changes in urban forests (Iverson and Prasad 2001, Johnston 2004). Climate change also has the potential to exacerbate all of the other urban forest threats discussed above. Emissions generated by urban transport is a serious part and reason of climate change, so transport emissions can damage urban forests also by participating climate change process.

• **Other changes over time**—Urban forests also are constantly changing through time as a result of land development, ownership changes, tree growth and mortality, natural regeneration, tree planting, and tree maintenance and management activities. These changes present additional challenges for maintaining urban forest cover, health, and benefits.

Urban forest and green infrastructure managenment issues.

Those planning and managing woodland, parks, gardens, street and square trees, and other green areas in urban areas (here collectively identified as urban greenspace) are operating in highly complex environments, facing multiple and rapidly changing urban demands (Miller,1997; Konijnendijk et al., 2005). Urban sites are often harsh, characterized by many pressures and threats, from limited growing space to adverse climatic conditions and air pollution. Greenspace planners and managers are often struggling to keep greenspace issues on the political agenda. In response, comprehensive and integrated land use concepts and approaches have emerged, building on the expertise and skills of various professions.

The management of urban forests typically involves a variety of activities such as inventorying tree populations; enacting tree and land use planning ordinances and policies; developing and implementing long-term management and maintenance plans, annual work plans, and budgets; and promoting community education and participation (Dwyer et al. 1992, Elmendorf et al. 2003). Effective urban forest management nationwide has often been hampered by challenges such as inconsistent management approaches, lack of funding, weak linkages with other resource management programs, and inadequate planning that fails to consider the surrounding ecosystem, the community, and the regional context.

As understanding of the ecological and economic values of trees increases, so does recognition of the importance of urban forest management. A huge ammount of communities in the world have signed a climate protection agreement that includes tree planting and urban forest maintenance as forms of reducing global warming.

For example, in recognition of the importance of urban forestry, the U.S. Conference of Mayors recently conducted an urban forestry survey of 135 U.S. cities with populations of 30,000 or more. Their final report (City Policy Associates 2008) recognizes "the invaluable role of urban forests in the protection of public health and the reduction of harmful greenhouse gases." According to the results, 95 percent of the cities surveyed have adopted tree management ordinances; 47 percent have enlarging tree canopy as a goal; and 70 percent maintain tree inventories (55 percent of which are up to date).

Challenges to Comprehensive Management.

Despite such widespread recognition for the importance of comprehensive management, the level of resources allocated to the management of urban forests varies greatly from one urban area to another. The diversity of forest cover types, land uses, population densities, and land ownerships across many urban areas calls for complex, long-term urban forest management plans (Dwyer et al. 2000). However, because of a lack of funding, volunteer time, and information on appropriate management, many urban areas are unable to initiate, complete, or implement even the most basic of urban forest management plans (Dwyer et al. 1992, Elmendorf et al. 2003). Some communities have no urban forestry department; many that do tend to focus on planting and managing trees in public places, particularly along streets and in parks, which account for only a small portion of the overall urban forest canopy. Comprehensive urban forest management considers all trees and associated elements across the entire jurisdiction to adequately address a heterogeneous landscape held by numerous land owners. A fi rst step in developing a proper management plan is to assess the current composition and distribution of a community's trees and their associated ecosystem services. This basic urban forest information, combined with community desires related to forests and ecosystem services, can provide a strong foundation for developing long-term management plans.

Description of the main results obtained.

As a result of STSM a lot of materials for further researches has been collected. Some interesting directions have been defined for further research results publishing in international scientific papers.

For making researches in the field of „Environment and urban forests, mobility, transport and infrastructure - compromises for sustainability" it is important to have an idea of what the problems look like in different cities of over the world. It is necessary to focus on the current problems in a number of cities in a various parts of the world. A case study for concrete city will be also good for better understanding the problem and looking for solving possibilities.

During STSM main interesting directions in the field defined for further researches:

1. ***Development of environmental sustainability patterns, by looking for compromises between environment, urban forests, mobility, transport and infrastructure in city conditions.***

It will be interesting to make researches in the field of development of city transport systems according to environmental sustainability approach. City transport system sustainable development is a part of global sustainability. The global sustainability, in turn, includes the satisfaction of human needs without compromising the ability of future generations to meet their needs in the future.

Researches in this area will help to promote more sustainable city transport system patterns, taking into account the significancy of the question of urban forests. The analysis of chain of causality, between the city transport system and the impacts on the environment, must be described in details. The chain of causalities - from source to destination must be discussed. It is significant to understand what an environmentally sustainable city transport system is. An impacts and indicators, criteria and methods for the assessment - all this must be studied and developed for successful environmentally sustainable city transport system. The definition and formulation of sustainable city transport system indicators for different traffic conditions should be studied and given, as good as monitoring possibilities should be described. Patterns of environmental sustainability of city transport systems must be studied and discussed. As a result some compromises between environment, urban forests, mobility, transport and infrastructure in city conditions will be researched, defined and discussed.

2. ***Computerized monitoring of transport flows and emissions, development of algorythms for managing urban transport using the infrastructure taking into account the ammount and intensity of emissions, simulation of transport infrastructure and its main knots. Alarming system for successfull monitoring also have to be developed***.

There are a lot of researches in this field not only in Kaunas University of Technology, but all over the world, but researches in this field are also actual and there are a lot of unsolved problems in both directions – global and local.

It is interesting to research and compare time spent to reach target-place by public transport, private transport, bycicle or by feet. Making different zones in each city and taking into account multi-criteria dimension of the problem, using criterias with different weights such as: speed, cost, health, enviromental impact, safety, visual quality and others. A lot of gauges and relevant monitoring system need to be developed. As a result it will be possible to make more preferable transport list for each city zone and for travelling between zones. Thinking forward about non-motorized transportation in cities and developing better infrastructure for this purpose. Very significant problem also is motivation for people to walk. Researches in this field are also actually, necessary and interesting. Saving of urban forests and integration them into the urban transport infrastructure for walking and bicycle trips.

3. Specific researches in near-the-coasts-located-cities in the area of threats for urban sea-side forests. As it is studied on Lithuania example, the most actual threats for city forests located near the seaside are: storms (threats of wind and water) and cormorans (corrosive cormorants droppings literally burns the leaves and bark of trees).

This three main directions defined above found during my STSM are preferable for me directions for researches at least in 2014. It was very useful for me to participate STSM and make new scientific contacts with experts from Kaunas University of Technology.

The issues of possible further collaboration between Kaunas University of Technology and Riga Technical University have been also discussed during STSM. The main area of collaboration, which was discussed, is the research activities implemented in common projects and common scientific publications. As potential programs for elaboration of common projects were discussed: the program of scientific cooperation of Latvia, Lithuania and Taiwan.

Literature recomended for study the urban forests and green infrastructure.

Here offered the list of literature which can be highly relevant for readers and for persons who are interested in problem of urban forest and green infrastucture, in threats to urban forests, health and management possibilities.

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