VACCIA

Vulnerability Assessment of Ecosystem Services for Climate Change Impacts and Adaptation

Action 6: *Assessment of Climate Change and Land Use Impacts in Urban Environments (short name: Urban Environments)*

Date: 31.12.2011

Main Findings and Recommendations

Heikki Setälä (University of Helsinki), Jussi Kulonpalo (University of Helsinki), Jari Niemelä (University of Helsinki), Heikki Loikkanen (University of Helsinki), Mari Vaattovaara (University of Helsinki), Matti Kortteinen (University of Helsinki), Olli Ruth (University of Helsinki), Vesa Yli-Pelkonen (University of Helsinki).

Preface

This final report "*Presentation of Main Findings and Recommendations*" is based on all the research work done in the Work Package VACCIA Action 6 (Urban Environments) during the years 2009 to 2011 and draws from the two previously delivered and published yearly reports "*Second Year Data Collected and Documented*" by Setälä et al. (2011) (http://www.ymparisto.fi/download.asp?contentid=126623&lan=fi) and "*First year data collected and reported*" by Setälä et al. (2010) (http://www.ymparisto.fi/download.asp?contentid=115338&lan=fi) as well as on the literature review published in August 2009, "*How to Construct Ecologically and Socially Sustainable Urban Environments? - a Literature Review on Climate Change, Runoff Waters and Land-use Impacts in Urban Environment*" (Setälä et al. 2009) (http://www.ymparisto.fi/download.asp?contentid=108087&lan=fi).

In the two previous reports the ways to construct ecologically and socially sustainable urban environments with keeping the interactions between climate change, runoff waters and land-use and land-cover change in mind were addressed. The literature review also outlined the potentials and challenges of the common research setup, where ecological, economic and social issues are brought together in studying the interplay between urbanization, climate change and hydrological cycles.

In this final report we simply report, in rather brief form, the main findings with some policy and action recommendations of the VACCIA Action 6 (Urban Environments) collected and presented in the full final report of the VACCIA project "Ecosystem services and livelihoods – vulnerability and adaptation to a changing climate" (SY26/2011) edited and published by Finnish Environment Institute (SYKE).

The 5th stakeholder meeting and 2nd stakeholder seminar were organized together as final common seminar of the Vulnerability Assessment of Ecosystem Services for Climate Change Impacts and Adaptation VACCIA project and consortium on November 29th 2011 at the Tieteiden talo, Helsinki. For program and more information please refer to: http://www.ymparisto.fi/download.asp?contentid=130861&lan=fi

This report is part of the work of the VACCIA consortium supported by the LIFE financial instrument of the European Community.

Contents

Preface 3
1. The Common Research Setup 5
2. Main Findings 7
    2.1 Transformations in the Ecosystem Services of Urban Environments 7
    2.2 Denser Urban Structure as a Future Challenge 8
    2.3 The Main Challenges and Adaptation Options of Urban Environments 11
    2.4 Necessary Additional Research 11
3. Conclusion 12
4. VACCIA/Action 6 Working Group Members and their Contributions to the Work Package 13
5. References 14
Summary in Finnish 15

1. The Common Research Setup

In the VACCIA Action 6 (Urban Environments) project we aimed at examining ecologically, economically and socially sustainable ways of planning and building urban areas while simultaneously addressing the interactions between climate change, runoff water and land-use and cover change. To complete this challenging assignment we used a novel multidisciplinary perspective and research setup, where we aimed at integrating new, innovative and accurate hydrological and socioeconomic measurements and ecological research.

As it was noted in the VACCIA Action 6 literature review (Setälä et al. 2009), the aims of building sustainable urban environment in ecological, economic and social terms produce paradoxes both in their own fields and also when integrating those terms in planning and decision-making. For instance, it is not sufficient to address urban environmental development in the face of climate change solely from the perspective of minimizing carbon emissions. Discussion from such perspective bypasses important questions related to state and function of local ecosystems in urban regions. As described in the literature review (Setälä et al. 2009), urban ecosystems (based on their biological diversity and ecosystem functions) provide important ecosystem services essential for the well-being of inhabitants of urban regions. Even though it is advisable to design compact urban areas to minimize carbon emissions produced by transportation, it is also essential to make sure that local green areas and waterways are preserved for the maintenance of biodiversity that forms the basis for ecosystem services vital for residents (Yli-Pelkonen 2009).

We focused on urban runoff water (storm water) as an indicator of the stability and sustainable functioning of local urban ecosystems. Retention of storm water absorption is one of the ecosystem services provided by urban ecosystems (Bolund & Hunmammar 1999). Such retention function requires pervious surfaces, such as green areas (park, garden, lawn, forest) or in some cases sand surface. In urban areas, however, the degree of impervious surfaces (such as concrete, asphalt and roofs) usually increases with the degree of urbanization making it increasingly difficult to retain water. Although the impacts of urbanization on urban hydrology are rather well known, the combined impacts of climate change, urbanization, and climate change mitigation efforts (such as very compact building) on hydrology, especially on storm water, are unclear.

A proper scale to address storm water impacts is often only a couple of hectares. Traditionally, the measurements of quantity and quality of storm water have been inaccurate, since the flow measurements have been done and water samples have been taken infrequently – often once a week or even once a month. This has not enabled a precise monitoring of the amount and composition of urban storm water. The new measurement equipment and techniques used in this project make it possible to monitor the quantity and quality of storm water in real time and with great accuracy at the three catchment areas in the Cities of Helsinki and Lahti. The data collected in this project provide completely new insights to the world urban hydrology.

Integrating socioeconomic data with storm water measurements and linking those to the amount and distribution of pervious and impervious surfaces was the aim and challenge in our research setup. The socioeconomic data collected at the six urban catchment areas was presented in the first report.

The paradigms of city planning in Finland (including the Helsinki Metropolitan Area) have overlooked the ecological perspective, and ecological consequences have not been studied to a great extent. The emphasis of aims has been related to socioeconomic development, where the perspective has also been part of the building project of a Nordic welfare state. The goal of urban planning has been to construct as mixed and evenly-constructed city as possible. All areas have been meant equally for everyone. Statistical follow-ups and international comparisons have shown that this goal has been for a long time met exceptionally successfully. Only recently, the supra-municipal housing markets born to region during last two decades have led to a situation where differences between various housing areas have begun to grow (Vaattovaara & Kortteinen 2003).

With the research setting we had, this hypothesis could be verified, falsified or specified. Through the analysis, specific planning solutions could be identified as the best or as the worst – and this information can eventually be used to guide future city planning of the area.

On general level the socioeconomic development of the City of Helsinki and the wider Helsinki metropolitan region has generally been studied rather well, but data on the City of Lahti and Lahti region are so far scarce, since there has not been much proper research conducted on the development of urban structure there. During this project the aim was also to study and understand the development of the Lahti region, so that comparisons could be made to Helsinki region and other similar sized regions in Finland. Our observations indicate that the development situation in Lahti region is perhaps more open than in other similar regions. This is a positive sign and means that the socioeconomic structure of the population in the area has not been disintegrated so clearly and strongly as in the regions of Helsinki, Tampere and Oulu.

In practice, we collected and reported (Setälä et al. 2010; 2011) some detailed socioeconomic data on the developments of the socioeconomic structures and the prices of housing from the same catchment areas in which the urban runoff data and other ecological data are collected from in the City of Lahti and in the City of Helsinki.

The rationale behind the research setup was also a practical one: we were looking for planning and construction solutions that could be sustainable both from the perspective of local ecosystems and economically and socially.

As we collected more data and the project proceeded towards its conclusion, we have assessed certain ways to make the integrated analysis. Based on the results of the analysis, we aim at opening new discussions on the future development of urban planning.

The research work started in the project also continues in form of different individual projects with the funding from different sources such as, among others, Helsinki University Centre for Environment (HENVI) (http://www.helsinki.fi/henvi/english/index.htm) and the Helsinki Metropolitan Region Urban Research Program (KATUMETRO) (http://www.helsinki.fi/kaupunkitutkimus/english/index.htm).

2. Main Findings

2.1 Transformations in the Ecosystem Services of Urban Environments

The goal of the multidisciplinary research project titled '*Assessment of Climate Change and Land Use Impacts in Urban Environments*' has been to study the combined effects of the land-use and climate change for the ecosystem services in the designated urban areas in the cities of Lahti and Helsinki.

Ecosystem services have a particularly important role in the cities. Green areas such as parks provide the majority of the ecosystem services in urban areas, cleansing the air, filtering the water, removing urban pollution, binding carbon dioxide into the soil, reducing the risks of flooding, and addressing other storm-water-related issues. Urban green areas, in a wider sense, also present aesthetic value and serve as an asset by being an important part of the local cultural heritage in the form of the historical built environment.

One of the focal changes foreseen in the future of urban ecosystem services is the increasing precipitation level and the 'urban heat island' phenomenon accompanying rapidly advancing urbanisation all over the world. Prior research has demonstrated that a denser urban structure decreases the quantity of urban green areas providing local ecosystem services and weakens their quality as well as the urban hydrology. In many cases, the decreasing quality of groundwater, as well as various anomalies of the surface waters, can be attributed to the lack of living 'freely breathing' surfaces.

These transformations have direct effects in the increasing amount of runoff and its declining quality, especially in areas in which the proportion of impervious surfaces is high. Negative effects linked with the

runoff water are both local, in the form of the flow areas, and regional, contributing to the pollution of surface waters and the erosion of riverbeds.

The role of ecosystem services, especially in northern climes, raises many essential questions, such as:

- Which urban ecosystem services are the most important?
- What is the real capacity and capability of cities to provide ecosystem services for their inhabitants?
- How can ecosystem services be incorporated into urban planning processes and as tools for the planners?

2.2 Denser Urban Structure as a Future Challenge

Dense urban structure presents a serious challenge of adaptation for ecosystem services as well as for urban green areas in a broader sense. As urbanisation advances rapidly all over the world, climate change forces metropolitan areas and large cities to consolidate their urban structures. New developments such as residential neighbourhoods are often planned to be denser than previously, and older neighbourhoods too are being made more compact, through filling in of previously unused lots.

The most common argument for a relatively more dense urban structure is that a more compact city is a more ecological one, decreasing the need for longer commutes by car, enabling development of the public transport networks, and providing services closer to the people and more economically, all of which help to reduce the local carbon footprint. Although new and more environment-friendly technical solutions in urban planning and in construction engineering are constantly emerging, more compact urban areas inevitably have less green space, which amounts to reduction in urban ecosystem services.

With the annual rainfall predicted to increase 15–20% in consequence of climate change, the growing area covered by impermeable surfaces inevitably increases the risk of flooding in urban areas. Yet different approaches to planning could enable increasing the proportion of permeable surfaces in areas with a large population and construction density. Allowing storm waters to soak in by increasing the amount of permeable surfaces offers a solution to the runoff problem in urban environments (see Figure 12).

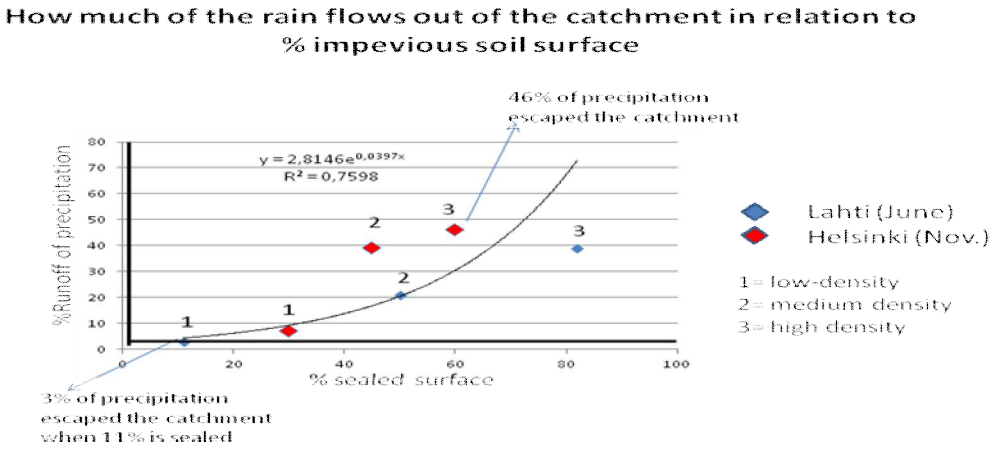

Figure 12. The amount of storm waters against the area of impermeable surfaces at the measurement points in Lahti and Helsinki. The fewer permeable surfaces there are, the less precipitation will soak in, with more running off as storm water.

As an example of a different solution, making urban structure more compact does not necessarily mean that all non-built lots and other areas will be built up and ultimately covered with sealed surfaces. The question is also one of how much the city can be consolidated both upward and downward. Numerous examples, from all over the world, show that new types of innovative solutions in planning, architecture, and construction technology enable building of a vertically denser city.

Even if dense urban structure can be an effective means of decreasing the local carbon footprint, there are other serious environmental challenges in the cities, which are easily pushed aside when public debate concentrates on one issue at a time. Adaptation to climate change demands a holistic view and understanding that emphasis on certain aspects of the phenomena can make the situation simultaneously worse elsewhere.

Since not all ecosystem services can be replaced with technical solutions, we should consider whether the direct advantages and benefits that a dense urban structure offers are greater than the long-term harm that denser cities cause in the end. This issue is challenging, as it involves political values and the necessity of making 'hard decisions'. Does the worry about carbon end up undermining other measures aimed at sustainable long-term development of the urban environment? As the argument is now framed, consolidation of urban structure leads increasingly often to a trade-off between cities' basic infrastructure and green areas.

A slightly different, yet equally important, potentially negative development trajectory is that of diminishing urban green space eventually reducing the general well-being and happiness of the residents. Parks and other recreational green areas in cities offer not only benefits to citizens' health but important aesthetic and cultural values.

One major challenge is related to the difficulty of assessing ecosystem services in monetary terms. This problem is especially topical in growing metropolitan areas and cities such as Helsinki, where the local geography and history make buildable zoned land a relatively scarce resource today and the demand for housing is constantly high. Such situations force many cities to prioritise maximal efficiency of land use in planning, often at the cost of green areas.

On the other hand, cities' planning departments are aware of the threats posed to ecosystem services and green areas in general. Urban planning in Finland is highly regulated by international standards, and, in the case of Helsinki, the city itself is a powerful landowner within its own borders. From this perspective, the public sector has all the necessary tools and means to react.

Key points from the Work Package's research work:

- Increasing levels of rainfall caused by climate change and rapidly advancing urbanization lead to increased amount of storm water of deteriorating quality especially in areas where level of impenetrable surfaces is high.

- Transforming rainfall patterns and the increasing levels of built impermeable surfaces in urban areas means increasing the risk of urban flooding.

- In many urban areas variety of surface water problems can be attributed to the diminishing living, or "freely breathing", soil due to lower groundwater levels and its deteriorating general quality.

- Adapting to climate change requires a holistic view. It should be understood that overemphasis in climate change mitigation on certain issues may make the situation worse in other areas. Scientific research is the key to understanding the consequences of these phenomena.

2.3 The Main Challenges and Adaptation Options of Urban Environments

- From the perspective of ecosystem services and urban green areas, condensing urban structures (one of the main future challenges) – innovative and new types of infrastructure designs and technical solutions are needed to optimise ecosystem services in the urban environment

- Artificial recharge of storm waters via use of more permeable surfaces, a viable solution to the challenge in the urban environment

2.4 Necessary Additional Research

Further research should examine the following questions:

- Can cities and urban environments in general serve as real-world laboratories for the research of consequences of climate change?

- Are ecosystem services sensitive in different ways to climate change and temperature changes, construction work, transformation of neighbourhoods' socio-economic structures, or other such phenomena?

- How could ecosystem services be appraised and assessed with indicators compatible with the economic indicators used in urban planning?

3. Conclusion

In all, despite the fact that the two consecutive years (2009 and 2010) were clearly different as regards to the temperature, precipitation and snow accumulation, the dynamics of urban runoff water were surprisingly similar in the catchments. However, the predicted increase in precipitation in cities due to climate warming seems to be particularly harmful in the most urbanized settings, simply because of the high percentage of impervious surfaces in the heavily constructed areas. Furthermore, our results indicate that the correlation between the proportion of impervious surfaces and the quantity/quality of storm water is rather weak. In other words, increasing the proportion of pervious soils has disproportionally large influence on reducing the amount/quality of storm water. This is likely to bring an important message to the urban planners: leaving relatively small-sized fragments with pervious soils (such as parks, lawns and road sides) un-built can bring about clear benefits as reduced costs in flood prevention and improved surface and groundwater quality.

Measurements in the Lahti catchment areas were finished in the autumn of 2011 with full two years of urban runoff water measurements completed. During the third year of the project we will continue measuring urban run-off in the three catchments in Helsinki. The collecting of the further in-depth socio-economic data was temporarily stalled in mid – 2010 due to the researcher in charge of data collecting resigning from the University of Helsinki. This was not critical as the socio-economic data collected so far presents a satisfactory dataset from the perspective of reaching the set goals of the project in this respect.

To sum up, the project has advanced as planned. During the third and final year of the project all the data collected during the project will be analyzed and writing publications will start. We also aim at performing an integrated analysis based on all the data gathered. Furthermore, we will attempt to link the results from these catchment areas to the socioeconomic and ecological development on the municipal and regional scales. Based on the results of the analysis, we aim at opening new discussions on the future development of urban planning.

In addition, as stated above the research work started in the project will continue in form of different individual projects and publications by the individuals involved tin he Work Package with the funding from different sources.

4. VACCIA/Action 6 Working Group Members and their Contributions to the Work Package

- Prof. Heikki Setälä (University of Helsinki, Department of Environmental Sciences): ecological issues, runoff data
- Prof. Jari Niemelä (University of Helsinki, Department of Environmental Sciences): ecological issues
- Prof. Heikki A. Loikkanen (University of Helsinki, Department of Political and Economic Studies): socioeconomic issues
- Prof. Matti Kortteinen (University of Helsinki, Department of Sociology): socioeconomic issues
- Prof. Mari Vaattovaara (University of Helsinki, Department of Geography): socioeconomic issues
- Dr. Vesa Yli-Pelkonen (University of Helsinki, Department of Environmental Sciences): social-ecological linkages, compiling and editing the report
- Dr. Olli Ruth (University of Helsinki, Department of Geography): ecological issues, runoff data
- Dr. Kimmo Kurunmäki (Joint Authority of Tampere Central Region): socio-political outlines, coordination of the work group in 2009
- M. Sc. Jussi Kulonpalo (University of Helsinki, Department of Social Studies): compiling and editing the report
- MSc Hanna Ristisuo (University of Helsinki, Department of Geography): socioeconomic patterns
- MSc Marjo Valtanen (University of Helsinki, Department of Environmental Sciences): ecological issues, runoff data
- B.Sc. Tiina Helkavaara (University of Helsinki, Department of Environmental Sciences): ecological issues, runoff data
- B.Sc. Piia Lundberg (University of Helsinki, Department of Environmental Sciences): ecological issues, runoff data
- B.Sc. Maija Taka (University of Helsinki, Department of Geography): ecological issues, runoff data
- MSc (Tech.) Nora Sillanpää (University of Helsinki, Department of Environmental Sciences): ecological issues, runoff data

5. References

Bolund, P. & Hunhammar, S. (1999) Ecosystem services in urban areas. Ecological Economics 29: 293-301.

Setälä, H., Niemelä, J., Loikkanen, H.A., Kortteinen, M., Vaattovaara, M., Yli-Pelkonen, V., Kurunmäki, K., Ristisuo, H., Ruth, O., Immonen, S. & Sillanpää, N. (2009) How to construct ecologically and socially sustainable urban environments? - A literature review on climate change, runoff waters and land-use impacts in urban environments. VACCIA (Vulnerability assessment of ecosystem services for climate change impacts and adaptation) Action 6: Urban Environments, literature review. (http://www.ymparisto.fi/default.asp?contentid=333217&lan=FI)

Setälä, H., Niemelä, J., Loikkanen, H.A., Kortteinen, M., Vaattovaara, M., Yli-Pelkonen, V., Kurunmäki, K.,Ristisuo, H., Ruth, O., Immonen, S. & Sillanpää, N. (2010) First year data collected and documented. VACCIA (Vulnerability assessment of ecosystem services for climate change impacts and adaptation) Action 6: Urban Environments, report. (http://www.ymparisto.fi/download.asp?contentid=115338&lan=fi)

Setälä, H., Valtanen, M., Helkavaara, T., Taka, M., Lundberg, P., Ruth, O., Yli-Pelkonen, V., Kulonpalo, J. (2011) Second year data collected and documented. VACCIA (Vulnerability assessment of ecosystem services for climate change impacts and adaptation) Action 6: Urban Environments, report. (http://www.ymparisto.fi/download.asp?contentid=126623&lan=fi)

Vaattovaara, M. & Kortteinen, M. (2003) Beyond polarisation versus professionalisation? A case study of the developments of the Helsinki Region, Finland. Urban Studies 40:11, 2127-2147.

Yli-Pelkonen, V. (2009) Luontoalueiden ja ekosysteemipalveluiden säilyttäminen kasvavassa kaupunkirakenteessa ja ilmaston muuttuessa (Preserving nature areas and ecosystem services in growing urban structure and in the changing climate). In: Faehnle, M., Bäcklund, P. & Laine, M. (eds.)Kaupunkiluontoa kaikille? Ekologinen ja kokemuksellinen luontotieto kaupungin suunnittelussa (Urban nature for all? Ecological and social nature information in urban planning). Helsingin kaupungin tietokeskus, Tutkimuksia 2009/6, ss. 73-81, Helsinki, Finland (in Finnish).

Summary in Finnish

Tiivistelmä: keskeiset tulokset ja suositukset

Heikki Setälä, Jari Niemelä, Heikki Loikkanen, Mari Vaattovaara, Matti Kortteinen, Olli Ruth, Vesa Yli-Pelkonen, Jussi Kulonpalo

Tässä raportissa on esitetty tiivistetyssä muodossa VACCIA Action 6. ('Urban Environments') -hankkeen aikana toteutetun tutkimustyön keskeiset tulokset yleisellä tasolla sekä esitetty valikoituja yleisiä toiminta- ja politiikkasuosituksia kyseisten tutkimustulosten pohjalta ja suhteessa hankkeen kysymyksenasetteluihin.

Työpaketin tulokset ja suosituksen on julkaistu hankkeen yhteenvetoraportissa "*Ekosysteemipalvelut ja elinkeinot — haavoittuvuus ja sopeutuminen muuttuvaan ilmastoon. VACCIA-hankkeen yhteenvetoraportti*" (Bergström Irina, Mattsson Tuija, Niemelä Eerika, Vuorenmaa Jussi, Forsius Martin (toim.) 2011) (SY26/2011). Suomen ympäristö 26/2011, Ympäristönsuojelu, 74 s., Suomen ympäristökeskus (SYKE). URN:ISBN:978-952-11-3933-8. ISBN978-952-11-3933-8 (PDF). Julkaisu on saatavana myös painettuna 978-952-11-3932-1 (nid.).
http://www.ymparisto.fi/default.asp?contentid=398857&lan=fi&clan=fi