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)*

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Second Year Data Collected and Documented

Heikki Setälä, Marjo Valtanen, Tiina Helkavaara, Maija Taka,
Piia Lundberg, Olli Ruth, Vesa Yli-Pelkonen, Jussi Kulonpalo

Preface

This report “*Second year data collected and documented*” builds on the VACCIA Action 6 (Urban Environments) report “*First year data collected and reported*” by Setälä et al. (2010) and on the literature review published in August 2009 (Setälä et al. 2009). In the latter we addressed 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. In that literature review we also outlined 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 Second year report we continue examining the common research setup and present the data collected and documented during the second year of the VACCIA Action 6 (Urban Environments). The three catchment areas both in Lahti and Helsinki serve as the socio-ecological theatre within which the research has been conducted. These catchment areas differ in their population density and in the intensity that land is used for various purposes. The collected natural scientific data so far consists of detailed, but not yet complete, storm water measurement data and ecological data on pervious and impervious surfaces and soil samples in three different catchment areas in the Cities of Lahti and Helsinki.

As the first-year report included wide discussion about the concept “*ecosystem services*” and the impacts of urbanization on the services, we refer to this report (http://www.environment.fi/download.asp?contentid=115338&lan=en) for further material. No socioeconomic data were collected in 2010. This report is part of the work of the VACCIA consortium supported by the LIFE financial instrument of the European Community.

Contents

1. The Common Research Setup

In the VACCIA Action 6 (Urban Environments) project we aim at finding 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 are using a novel multidisciplinary perspective and research setup, where we aim 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).

In this project, we focus 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 is 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 have, this hypothesis can be verified, falsified or specified. Through the analysis, specific planning solutions could be identified as the best or as the worst – and this information could be used to guide future city planning of the area.

The socioeconomic development of the City of Helsinki and Helsinki region in general has been studied 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 is 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. Observations so far 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 have collected and reported (Setälä et al. 2010) 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. In this report we present some new ecological data from year 2010 to better link the results from these catchment areas to the socioeconomic and ecological development on the municipal and regional scales. We will then aim at performing an integrated analysis based on all the data gathered.

The rationale behind the research setup is also practical: we are searching for planning and construction solutions that could be sustainable both from the perspective of local ecosystems and economically and socially.

As we get more data and the project proceeds, we will assess the proper ways to make the integrated analysis. Furthermore, we will attempt to. Based on the results of the analysis, we aim at opening new discussions on the future development of urban planning.

2. Results and Discussion

2.1. Data Collected in the Catchment Areas

Description of the catchment areas and their location is given in our previous report. Here we report new data that accurately describes the variation in land use between the catchment sites.

Briefly, MapInfo software was used to define the amount and distribution of pervious and impervious surfaces in the three different catchment areas in the Cities of Helsinki and Lahti. The data were then verified by field observations.

2.1.1. Land Use of the Catchment Areas in Lahti and Helsinki

Overview maps of the Cities of Lahti and Helsinki with their three sub-catchment areas marked are presented in Figs. 1 and 2 respectively.

Figure 1. Aerial photograph of the northern part of the City of Lahti. The three study sites (catchment areas) are shown: the uppermost area = Kilpiäinen (low-density), the lowermost = Paavola (medium-density) and the area in between = Taapelipolku (high-density). The city centre is located to the west of Paavola catchment (the lowest one in the middle and at the bottom of the aerial map).

<u>Fig. 2.</u> Aerial photograph of the catchment areas (marked in green line) in Helsinki. The uppermost area = Veräjämäki (low-density), the lowermost = Itäpasila (high-density) and the area in between = Pihlajamäki (medium-density). The city centre is located ca. 5 km to the south of Itä-Pasila catchment.

The proportion of land in each catchment area in the two cities that is pervious or impervious to water is presented in Fig 3.

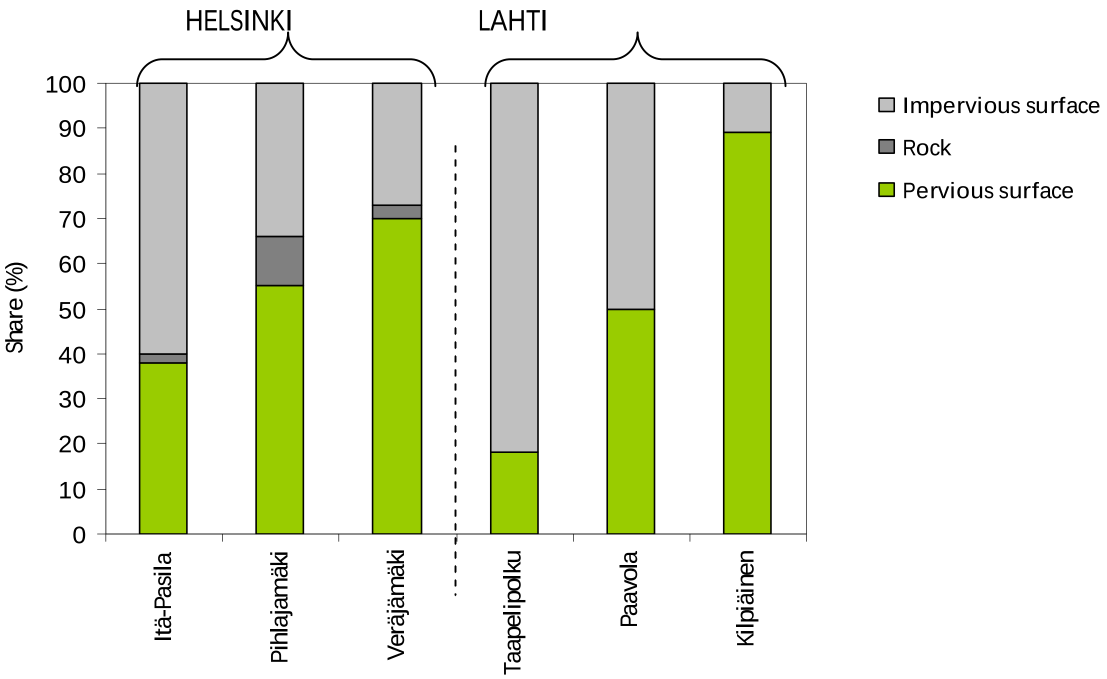

Fig. 3. The proportion of impervious and pervious soils in the sub-catchment areas in Helsinki and Lahti. The proportion of rock surface (impermeable to water) is also presented. Itä-Pasila & Taapelipolku = high density, Pihlajamäki & Paavola = medium density, Veräjämäki & Kilpiäinen = low density areas.

It is evident that our *a priori* categorization (low, medium and high land use intensity) of the study sites based on visual observation proved to be correct. In both cities there was a clear gradient in the proportion of sealed/impervious soils from the urbanized areas towards the less urbanized areas. This trend was more conspicuous in Lahti than in Helsinki. Further, while each of the catchment areas in Helsinki had ca. 2 to 10% of rock cover, no rocky outcrops were detected in Lahti (Fig.3).

A more detailed description of the various types of pervious and impervious surfaces of the catchment areas is given in Fig. 4. Of the pervious surfaces areas growing trees (parks and forests) were clearly more abundant as compared to sites with lawn. This was the case in both cities. The proportion of areas with distinct sand cover was generally less than 5% of the total catchment area, with Paavola catchment in Lahti making an exception (Fig 4).

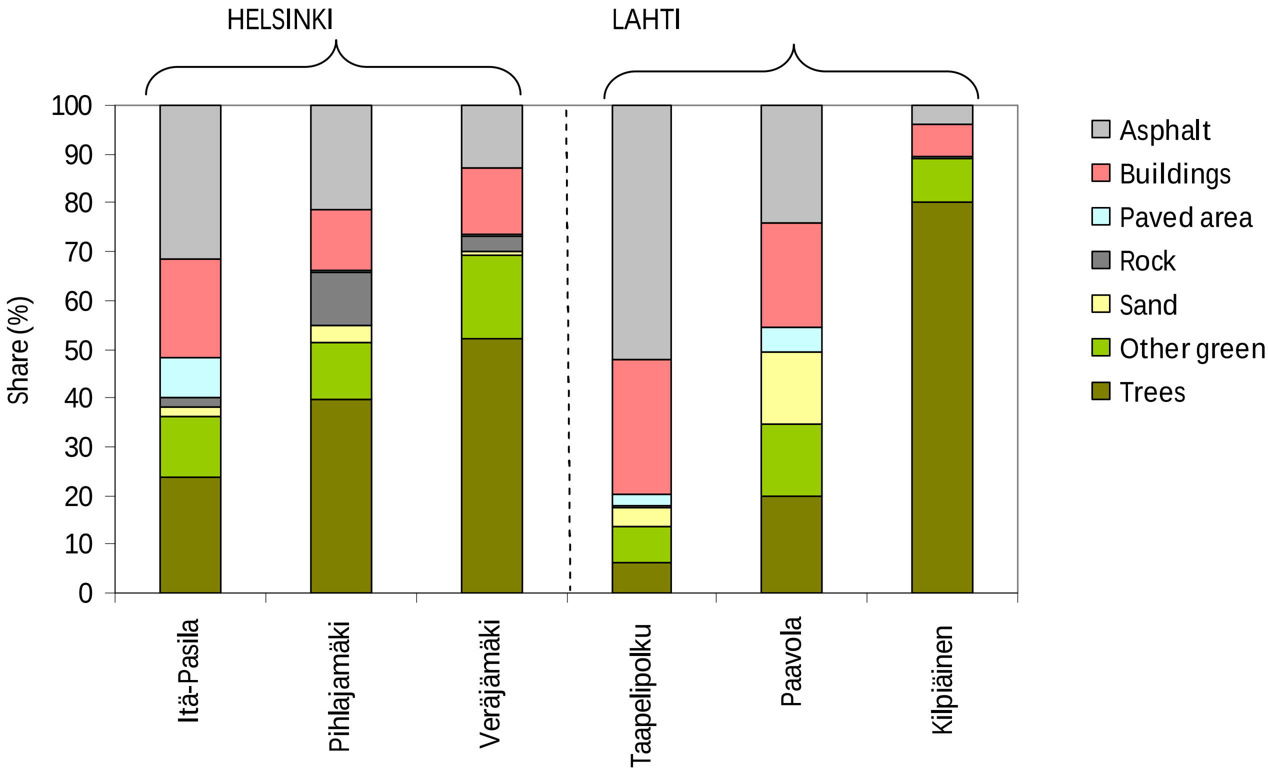

Fig. 4. The proportion of impervious (Asphalt, Buildings, Paved (such as tiled surfaces) area and Rock cover) and pervious (Trees, Other green and Sand) surfaces in the sub-catchment areas in Helsinki and Lahti. Itä-Pasila & Taapelipolku = high density, Pihlajamäki & Paavola = medium density, Veräjämäki & Kilpiäinen = low density areas.

The impervious surfaces were split to: asphalt, buildings, paved area and rock. In general, irrespective of the land use intensity asphalt and buildings had a similar share of the surface cover. In high-intensity areas over 50% (52 to 90%) of the land is covered by asphalt and buildings, while in the low-intensity areas 10 – 25% was covered with these two surfaces. The soils in Lahti proved to be more sealed than those in Helsinki. However, the low-intensity site Kilpiäinen in Lahti was clearly the most pervious study site (Fig 4.),

The pervious areas of the catchment sites were further divided to 11 "habitat classes" (Fig. 5.). In general, "yard" (urban green area closely associated with houses/buildings), "park" (urban green areas with planted, scattered trees and lawn as understory vegetation) and "forest" (relatively natural habitat) occupied the largest area in the two cities. However, only "yard" and "lawn" existed in each catchment site. In Helsinki catchment sites the diversity of habitat types was greater than in Lahti. Pihlajamäki (Helsinki; medium-density site) was represented by the highest number of habitats (10 classes), while Paavola (Lahti; medium-density site) had the lowest diversity of habitats (4 classes). The forest habitat was lacking in the most urbanized areas. Dry meadows on rocky outcrops ("Meadow" in Fig. 5) existed only in the most urbanized areas in Helsinki. Parks typified the landscape especially in the urbanized sites in the two cities (Fig. 5).

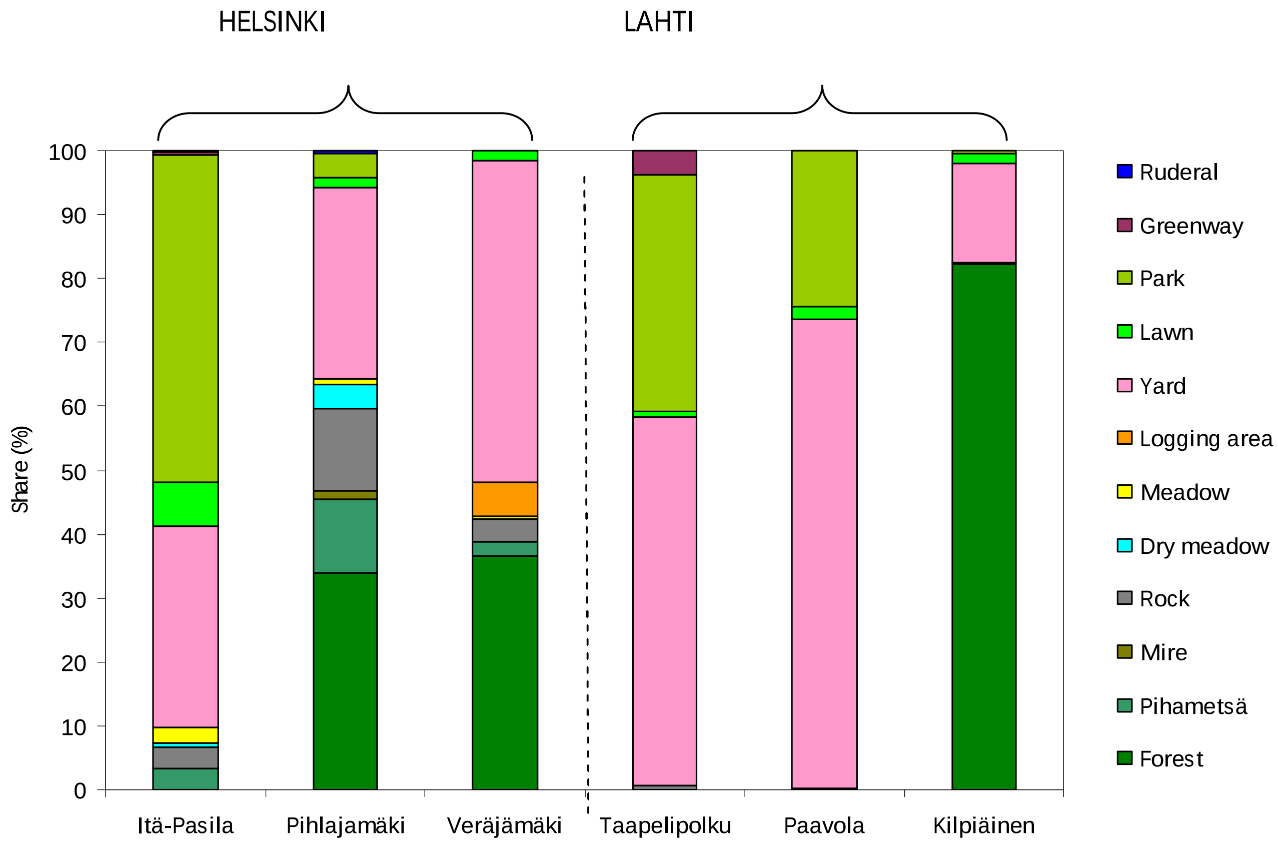

Figure 5. Habitat classes in the catchment areas in Helsinki and Lahti. ”Pihametsä” = isolated forest patch close to buildings/houses with visible human influence. Itä-Pasila & Taapelipolku = high density, Pihlajamäki & Paavola = medium density, Veräjämäki & Kilpiäinen = low density areas.

It is notable that non-vegetated rock surfaces existed only in the Helsinki catchment areas. Based on the data from these catchment areas, it appears that the higher the population density is the lower is the amount of pervious surface. This is not surprising, but if the high-density area was designed differently, it would be possible to increase the amount of pervious surfaces even when maintaining the same population density. It is also interesting to observe how the quality of pervious surfaces varies in the different catchment areas (such as the amount of pervious sand surfaces and different types of green surfaces).

2.1.2. Ecological Data of Soils in Lahti and Helsinki

The soil at each catchment area in the two cities representing “lawn”, “park” and “forest” was analyzed for % organic matter, depth of the organic soil layer, pH, moisture, heavy metals, microbial activity, water-holding capacity, N-mineralization rate, C:N-ratio and earthworms. At this stage only data on the abundance of earthworms in the catchment sites are available (Fig 6).

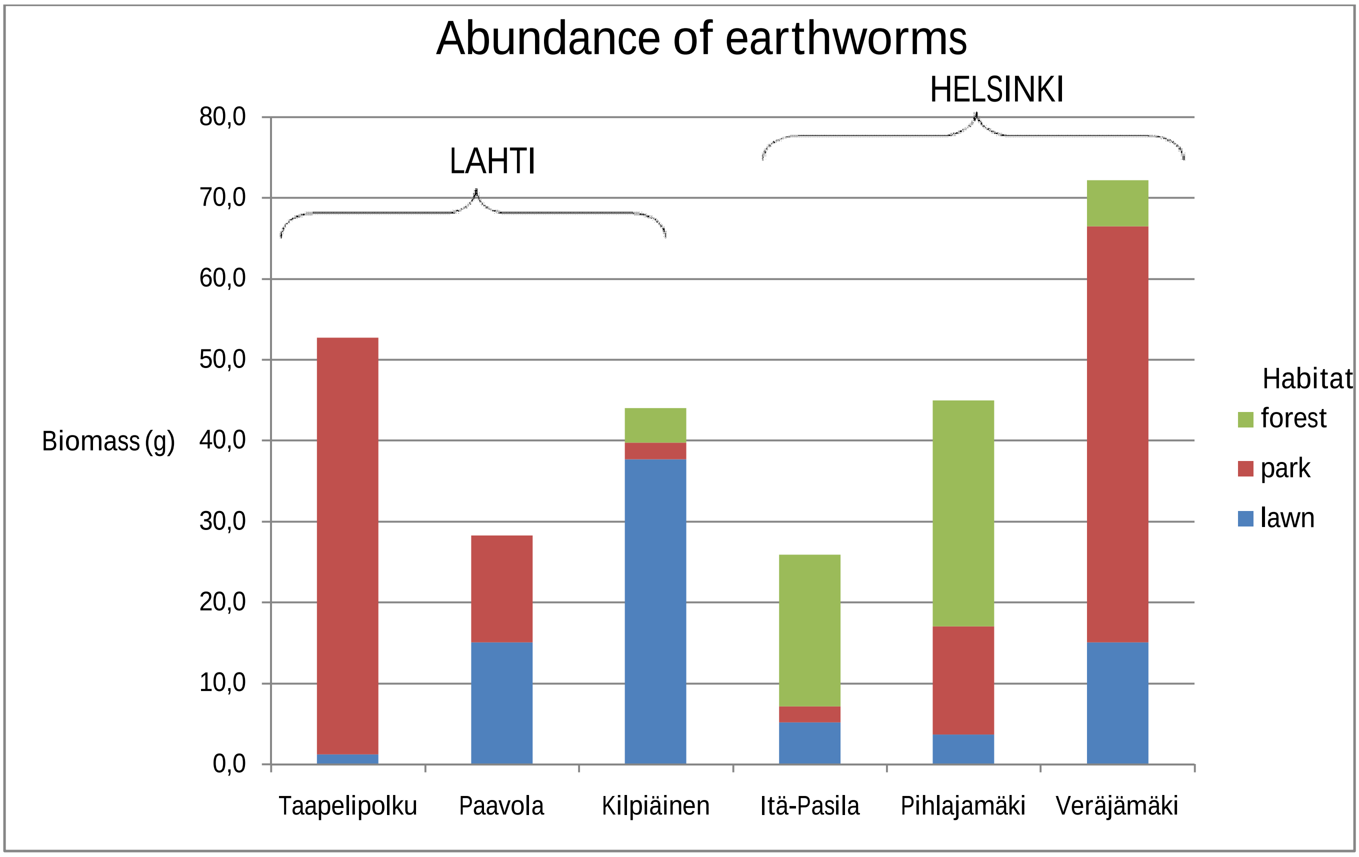

Figure 6. The biomass (fresh mass/m^2) of earthworms (Lumbricidae and *Allolopohora* spp combined) in the three habitats (forest, park and lawn) at the catchment areas in Lahti and Helsinki. Itä-Pasila & Taapelipolku = high density, Pihlajamäki & Paavola = medium density, Veräjämäki & Kilpiäinen = low density areas.

The abundance of earthworms seemed to be related to land use intensity but only in Helsinki, where the biomass of earthworms was negatively correlated with land use intensity. In Lahti, however, the catchment area with the highest land use intensity appears to favor earthworms. Here urban parks were strongly favored by earthworms over to urban lawns. Interestingly, forests – completely lacking in the two urbanized areas in Lahti – harbored an abundant earthworm population in the urbanized catchments in Helsinki.

2.2. Urban Runoff Data

The quantity of urban runoff i.e. storm water data for the entire year 2010 are available but not yet fully analyzed from the catchment areas in Lahti. In Helsinki automatic data collection started in September/October 2010. Some water samples were collected by hand during the summer season (data not presented). Concentrations of nutrients, heavy metals and carbon in the storm water are largely analyzed in Lahti but the data is not presented. Below we present the runoff data from period of one month; June 2010 in Lahti and November 2010 in Helsinki

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2.2.1. Urban Runoff Quantity and Wuality – Case Lahti

As before (2009) the amount of runoff differed clearly between the three study sites (Fig. 6). The high- and medium-density sites leaked substantially more of the rain water out of the system as compared to the low-density area. During most of the rain events the high-density site had clearly the highest storm water recharge, and even during very small rain events storm water was generated at this most urbanized site (low peaks (red) in Fig 6) .

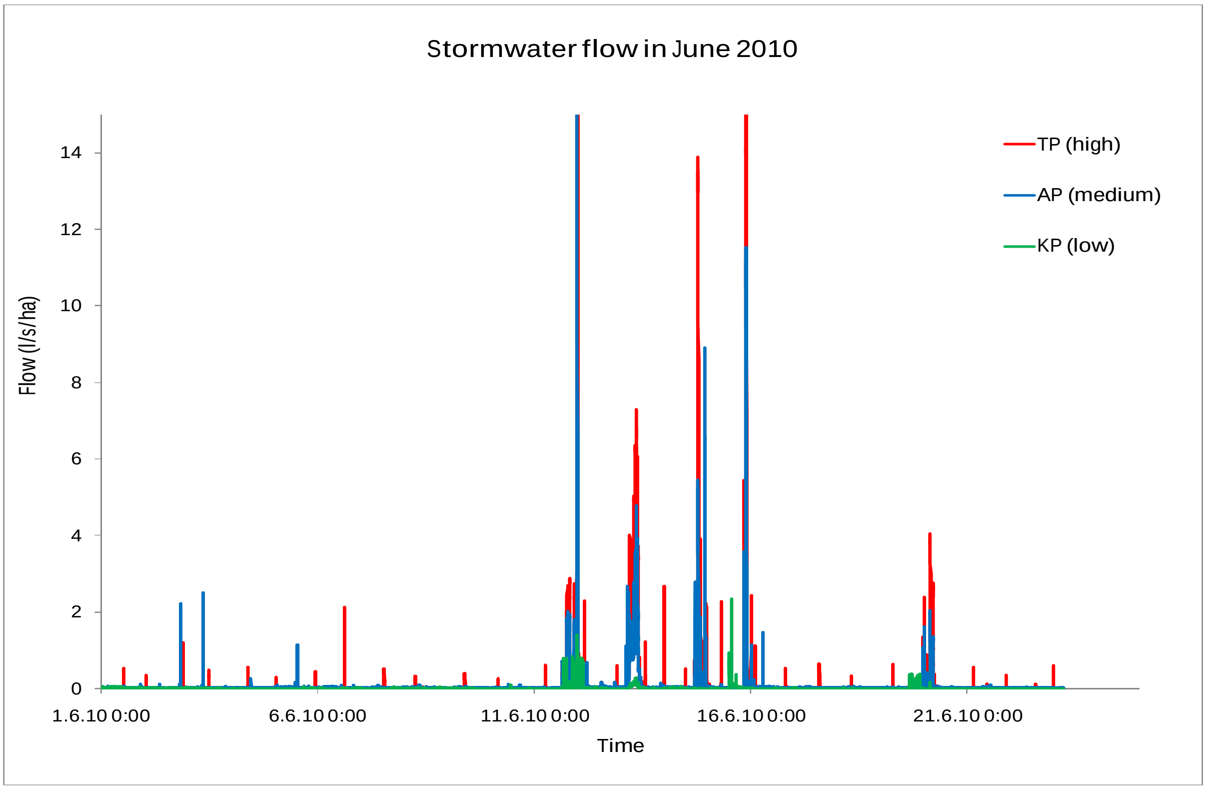

Figure 6. Storm water flow (l/s/ha) at the three catchments in June 2010 in Lahti. TP = Taapelipolku; high-density area (red line), AP =Paavola; medium density area (blue) and KP = Kilpiäinen; low density area (green). The highest peak flows (24 l/s/ha in TP and 36 l/s/ha in AP) do not appear in the figure.

The monthly total (cumulative) runoff was more than ten-fold in the high-density area as compared to the low-density area. At the low-density site 3% of the precipitation in June escaped the system as storm water runoff, while in the medium-density and high-density areas the numbers were 21% and 40%, respectively (Table 1).

Runoff seemed to correlate positively with precipitation leading to e.g. high runoff volumes during heavy rain events. Only in low-density area no runoff was generated during small rain events. The runoff flow peaks were high and sharp in city centre areas and low and wide in low-density area indicating that runoff events are shorter but more intensive in city centre areas (Figure 6).

At this stage of our project only a limited set of runoff quality data is available. However, the conductivity data described below can be applied as an indicator for the concentrations of soluble nutrients (e.g. nitrate and phosphate), metals, and chlorides in the water.

The conductivity of the runoff water was measured at 60 second intervals during the whole study period (2010) using a conductivity sensor. However, data collected in June will only be presented. As with the quantity of the urban runoff, conductivity of the storm water was clearly reduced in the low-density area as compared to the more urban sites (Table 1). In most rain events the conductivity of the water was less than 10% of that in the urban catchment areas. Interestingly, of the two urban sites, the conductivity of storm water did not differ between the medium-density site and the high-density site. Similarly, turbidity of storm water at the low-intensity catchment was just a fraction of those in the more urbanized areas (Table 1).

The low conductivity of storm water runoff at the low-density urban site is likely due to (i) a lower deposition of urban-borne pollutants and (ii) the much higher proportion of pervious, living soils that purify the storm water.

Table 1: Precipitation and the amount and quality (conductivity and turbidity) of storm water in June in the Lahti catchment sites. TP = Taapelipolku; high-density area, AP =Paavola; medium density area and KP = Kilpiäinen; low density area.

June 2010		measurement site (land use intensity)		
		TP (high)	AP (medium)	KP (low)
Precipitation (mm)		53	53	53
Stormwater runoff (mm)		20,9	11,3	1,6
Runoff conductivity (mS/m)	*mediaan*	25,0	24,9	1,5
	average	29,1	28,1	1,4
Runoff turbidity (FTU)	*mediaan*	616	641	3,4
	average	633	643	17,6

2.3.1. Urban Runoff Quantity and Quality – Case Helsinki

Due to difficulties with getting electricity to power the storm water-stations, the automatic measurement started not until September/October 2010. Therefore data from November 2010 only have this far been analyzed and can be presented.

As in Lahti, the amount of runoff differed clearly between the three catchment areas (Fig. 7). Especially the high-density site showed extensive storm water flows – even at times when the precipitation was low.

The monthly total (cumulative) runoff was about seven times larger in the high-density area as compared to the low-density area. At the low-density site 7% of the precipitation in June escaped the system via runoff, while in the medium-density and high-density areas the numbers were 38% and 46 %, respectively.

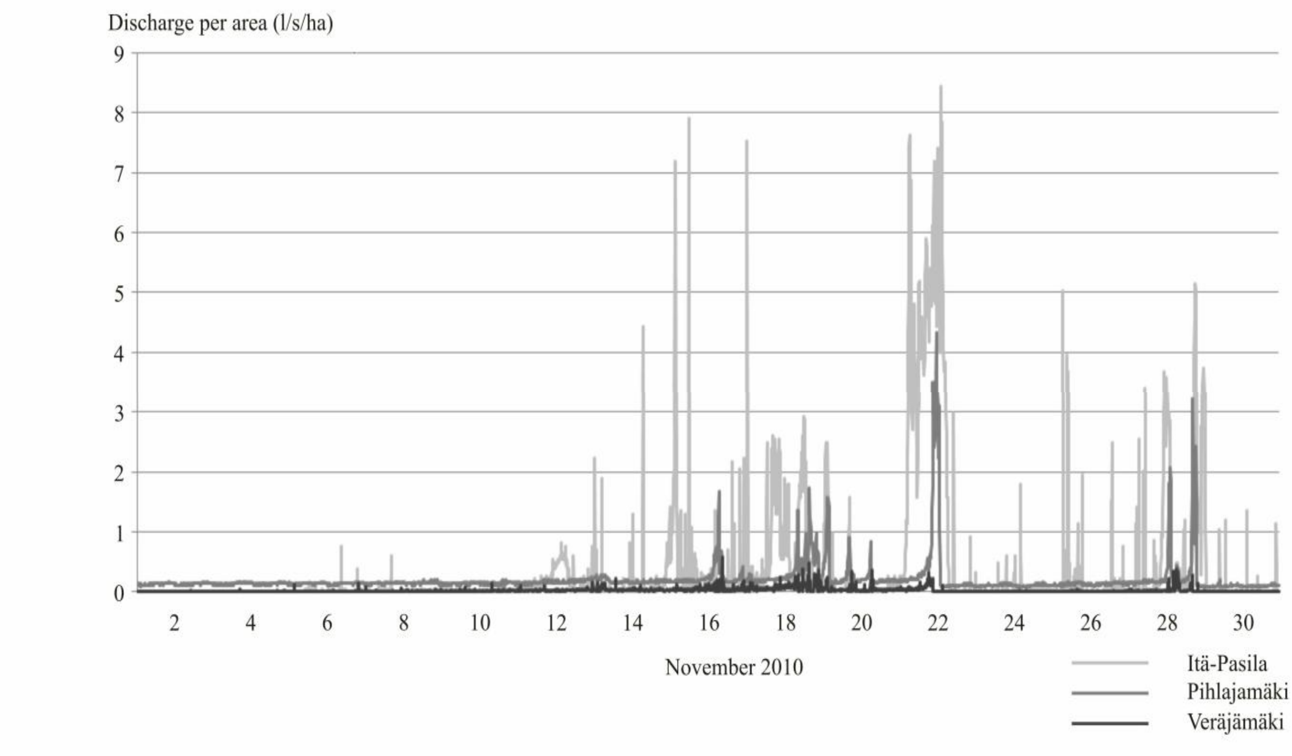

Figure 7. Stormwater flow (l/s/ha) at the three catchment sites in November 2010 in Helsinki. Itä-Pasila = high-density area (light grey line), Pihlajamäki = medium density area (medium-grey line) and Veräjämäki = low density area (dark line).

Table 2: Precipitation and the amount and quality (conductivity, mS/cm and turbidity, NTU) of stormwater in November in the Helsinki catchment sites.

November 2010	SITE		
	Itä-Pasila (high-intensity)	Pihlajamäki (medium-intensity)	Veräjämäki (low-intensity)
Precipitation (mm)	76*	76*	76*
Stormwater runoff (mm)	35,1	30,2	5,1
Runoff conductivity *mediaan* *average*	0,5	1,9	0,2
Runoff turbidity *mediaan* *average*	195,7	9,4	1,4

*) Precipitation value taken from the Kumpula weather station (Finnish Meteorological Institute data) ca. 5 km south of the Itä-Pasila catchment.

Conductivity, an indicator of e.g. dissolved salts and metals in storm water, was lowest in the low-density Veräjämäki catchment and clearly highest in the medium-density area (Table 2). The storm water was clearly most turbid in the high-intensity area, followed by medium-intensity area and clearly cleanest in the low-intensity catchment.

When comparing the two cities it becomes evident that storm water runoff was less intense in Helsinki catchments than in Lahti catchments. This may be due to the relatively greater proportion of pervious surface in Helsinki study sites - especially in the two most urbanized catchments.

3. Seminars and Symposiums Organized in 2010

Four separate open public events were organized during the second year of the project by the Action 6 Working Group research team in order to discuss, debate and disseminate the projects data collected, findings and proceedings with and or for the stakeholders and other public.

VACCIA (Vulnerability assessment of ecosystem services for climate change impacts and adaptation) Action 6: Urban Environments Second Stakeholder meeting in conjunction with Argumenta Symposium "Ecological City" took place between 28. – 29.1.2010 in Lahti, Finland.

The Second stakeholder meeting of the Action 6 was organized as part of the Argumenta Symposium, funded by the Finnish Cultural Foundation. This was done in order to benefit from the wider publicity and partaking of the Argumenta symposium series and to prevent burdening the stakeholders with several separate seminars on similar themes. Keynote speakers from abroad also gave valuable insights for the research setting of Action 6.

The participants of the event represented varying organizations from a wide geographical area. Especially well represented were the cities and research institutions of the Helsinki Metropolitan Area, which is the research area of Action 6. Full report of the second stakeholder meeting was documented in the report: VACCIA työpaketti 6: 2nd Stakeholder Meeting 280110 Lahti.
(http://www.ymparisto.fi/download.asp?contentid=116009&lan=fi)

The combined third stakeholder meeting and the first stakeholder seminar event of the Action 6 was organized by the project team as an combined effort. The event took place at the Faculty of Social Sciences, University of Helsinki, in the afternoon of Friday 22nd of October 2010. The selected invited participants represented widely varying organizations and institutions from the Helsinki metropolitan region including the City of Lahti, all of which together forms the research area of Action 6. All speakers, most of whom represented University of Helsinki, gave valuable and interesting insights for the research setting of Action 6 from their own specific fields of study, expertise and experiences on the field.

Full report of the second stakeholder meeting was documented in the report: VACCIA työpaketti 6: Third stakeholder meeting and first stakeholder seminar.
(http://www.ymparisto.fi/download.asp?contentid=122197&lan=fi)

Finally the 4th stakeholder was organized as part of the Metropolitan Region Urban Research and Cooperation Program 2010-2014 (acronym: KatuMetro) and the program theme 1. Living Environments and

Urban Structure –seminar on Thursday, December 2nd. in Viikin Infokeskus Korona at University of Helsinki. The 4th stakeholder meeting report will be delivered by the end of Febryary 2011 as scheduled.

4. 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.

4. VACCIA/Action 6 Working Group Members and their Contributions to This Report

- Prof. Heikki Setälä (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
- M.Sc. Marjo Valtanen (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
- M. Sc. Jussi Kulonpalo (University of Helsinki, Department of Social Studies): compiling and editing the report

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Summary in Finnish

Tiivistelmä: Toisena vuonna kerätty ja dokumentoitu aineisto

Heikki Setälä, Jari Niemelä, Heikki A. Loikkanen, Matti Kortteinen, Mari Vaattovaara,
Vesa Yli-Pelkonen, Hanna Ristisuo, Olli Ruth, Marjo Valtanen, Nora Sillanpää, Jussi Kulonpalo

Tässä raportissa on esitetty lyhyesti VACCIA Action 6. ('Urban Environments') -hankkeen toisena vuonna kerätty aineiston. Kerätty biofysikaalinen aineisto koostuu hulevesiaineistosta, vettä läpäisevien ja läpäisemättömien pintojen suhteista ja maaperänäytteistä kolmelta eri valuma-alueelta Lahden ja Helsingin kaupungista.

Tutkitut valuma-alueet molemmissa kaupungeissa eroavat vettä läpäisevien ja läpäisemättömien pintojen määrältään ja laadultaan, ja ovat siten tässä raportissa nimetty matalan tiheyden, keskitiheyden ja korkean tiheyden valuma-alueiksi. Lahden ja Helsingin valuma-alueilta laskettujen läpäisevyysaineistojen perusteella on selvää, että maankäyttömuoto- ja väestöntiheys korreloi vettä läpäisemättömien pintojen määrän kanssa. Vaikka tämä ei olekaan yllätys, niin toisenlaisen suunnittelun avulla saattaisi olla mahdollista nostaa vettä läpäisevien pintojen suhteellista määrää korkean väestöntiheyden alueella.

Hulevesien määrä vaihteli selvästi kolmen tutkitun valuma-alueen kesken niin Lahdessa (esimerkkikuukaudeksi valittu kesäkuu) kuin Helsingissä (marraskuu). Lahdessa kesäkuussa ja Helsingissä marraskuussa huomattavasti suurempi osa sadevedestä valui pois valuma-alueelta hulevetenä korkean ja keskitiheyden valuma-alueilla kuin matalan tiheyden valuma-alueella. Hulevesien laadun osalta vain rajoitettu määrä muuttujia oli kokonaan käytettävissä tässä vaiheessa hanketta. Kuten huleveden määräkin, myös huleveden sähköjohtavuus oli selvästi alhaisempi matalan tiheyden valuma-alueella kuin kaupunkimaisemmilla valuma-alueilla. Myös huleveden sameus noudatti samaa linjaa.

Hankkeen ja aineiston keruun edistyessä tavoitteenamme on tarkastella valuma-alueiden ekologisten ja sosioekonomisten ilmiöiden välisiä yhteyksiä ja pyrkiä 29 testaamaan esittämiämme hypoteeseja. Varsinainen kaiken aineiston yhdistävä analyysi tapahtuu hankkeen myöhemmässä vaiheessa kun kaikki aineisto on kerätty.