WORLD DESIGN CAPITAL HELSINKI 2012

UNIVERSITY OF HELSINKI

HENVI SCIENCE DAYS 2012

INTERNATIONAL SCIENTIFIC MEETING FOR GREEN ROOF RESEARCH

Biodiversity & Ecosystem Services

16th April, 2012, Helsinki, Finland

Photo: Niina Ala-Fossi

VENUE

Helsinki University Main Building, Small Festive Hall

THE AIM

The aim of the scientific meeting was to discuss the possibilities of inter- and transdisciplinary research on green roofs and to introduce the current international green roof research to the Finnish audience, with the focus on biodiversity and ecosystem service promotion on urban green roofs. How to combine the studies and theories of different disciplines and multifaceted perspectives to fruitful outcomes?

COOPERATING ORGANIZERS University of Helsinki

The Fifth Dimension – Green Roofs in Urban Areas -research program &
Finnish Museum of Natural History & The Urban Ecology Research Group
in cooperation with Helsinki University Centre for Environment (HENVI)

GREEN DESIGN

The Fifth Dimension – Green Roofs in Urban Areas -research program is part of the World Design Capital Helsinki 2012 curriculum. The cities of Helsinki, Espoo, Vantaa, Kauniainen and Lahti together form the World Design Capital 2012. This International Scientific Meeting for Green Roof Research was one of the events arranged by the Fifth Dimension during the design year. The goal of the Fifth Dimension –research program is to find out the best solutions and practices for sustainable green roofs, which is hard to achieve without combining expertise from different fields.

Presentation slides available:

http://www.helsinki.fi/henvi/societalinteraction/Scienceday2012_greenroof_program.htm

Writers

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Fifth Dimension – Green roofs in Urban Areas -research program

Reviewer

PhD, Adjunct Professor Susanna Lehvävirta (leader of the Fifth Dimension -program)

Photos

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Program

*Chair: **Research Director Laura Höijer**, Ministry of the Environment*

8:30-9:00	Registration and coffee	
9:00-9:15	Opening words Welcome and introduction	**Director Leif Schulman** Finnish Museum of Natural History Adjunct Professor **Susanna Lehvävirta** Program leader
9:15- 10:15	Green roof research at Michigan State University – Plants, carbon sequestration, energy and biodiversity Comments by **Dr. Eeva-Maria Tuhkanen**, MTT Agrifood Research Finland	**Professor Brad Rowe** Michigan State University, Department of Horticulture
10:15-11:15	Ecosystem services, biodiversity and aestethic delight – A research agenda for green roof vegetation Comments by **Kaisa Hauru**, UH, Urban Ecology Research Group	**Dr. Nigel Dunnett** Green Roof Centre, University of Sheffield
11:15-12:30	Lunch	

*Chair: **Sustainability Practice Leader Mari Puoskari,** Logica and Member of Helsinki City Council (Greens of Finland)*

12:30- 13:30	How to maximize biodiversity benefits of green roofs? Comments and discussion	**Professor Manfred Köhler** Green Roof Centre of Excellence, University of Applied Sciences Neubrandenburg
13.30-14:00	Coffee	
14:00- 15:00	Key factors in green roof habitat design – Substrates, light weight solutions, species groups and diversity Comments by **Manager Jouko Hannonen**, Puutarhapalvelu Hannonen Oy	**Professor Stephan Brenneisen** University of Applied Sciences Wädenswil
15:00- 16:00	The role of green roofs in urban drainage – A review and the case of Augustenborg eco-city Comments by **Landscape Architect Jukka Jormola**, SYKE	**Dr. Justyna Berndtsson** University of Lund
16.00-16:30	Summing up & final discussion	

MEMO


DESIGNING SOCIETY THROUGH THINKING
GREEN ZONE
Rethinking our environment into a more sustainable place to live.
UNIVERSITY OF HELSINKI

Opening and introduction

OPENING WORDS
Director Leif Schulman, Finnish Museum of Natural History

WELCOME AND INTRODUCTION
Adjunct Professor Susanna Lehvävirta, Program leader,
Fifth Dimension – Green Roofs in Urban Areas -research program

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Green roof research at Michigan State University – Plants, carbon sequestration, energy and biodiversity

Professor Brad Rowe, Michigan State University, Department of Horticulture

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At Michigan State University there has been 12 years of green roof research. The research begun from questions like: *what is a green roof?* Now their research includes, for example, plant evaluation, carbon sequestration, energy, storm water, urban agriculture, biodiversity (plants, insects, birds) and irrigation methods.

They have done long-term studies (e.g. Durhman et al. 2007 HortScience; Rowe et al. 2011 Landscape Urban Planning). Long-term studies are needed for example to find out the dominant species in different substrates and substrate depths. Rowe argues that in deeper substrates the growth is faster (for the calculations and figures, see the slides). Rowe introduced studies considering carbon sequestration, energy and biodiversity issues.

Rowe and his team have quantified the carbon storage potential of extensive green roofs and evaluated species effects on carbon sequestration. To find out the carbon storage potential they sampled above ground biomass, below ground (roots) and soil carbon content. The carbon sequestration depends on carbon embedded in the green roof, green roof design (plants with greater biomass), management techniques, climate and carbon emissions avoided. Rowe argues that the more there is biomass on the roof the more the green roof sequestrates carbon.

Rowe has also studied the energy issues on green roofs. According to Rowe temperature differences during seasons stay smaller and due to this the roof lasts longer. During summer, the experimental green roof was 20 degrees (Celsius) cooler than a gravel ballasted roof due to substrate, shade from plant canopy and evapotranspiration. During cooler periods, the heat flux out of the building was much smaller from the green roof than from the reference roof. Reduced heat flux was 13% out of the building in winter and 167% into the building in summer.

Rowe and his team studied what effects roof characteristics have on insect presence and composition. Vegetation cover and substrate affect the amount of insects. The more there is vegetation the more there are insects on green roofs (depending on substrates). Rowe also found that the lowest rates of insects were on an intensive roof (one of the experimental roofs) and he thinks that this is because of maintenance and visitors on the roof. He also found significant differences between vegetation coverage, species richness and abundance (see more for the ppt slides).

Rowe states that green roofs are expanding in USA, and Chicago is seen as the number one city of roof greening. However, the cost is seen as a barrier for roof greening. On Rowe's opinion, the future of green roofs is a bright one. Benefits are obvious and overall green roofs are expanding in the USA.

Lot of research has to be done in different areas of USA because climate is different in different parts of the country. Same applications do not work in every area: for example sedum doesn't survive in Florida because the climate is too hot. Rowe argues that funding is easier for energy and storm water studies than for studies considering plants. For the future, the valuing of benefits is important: are energy savings and storm water issues important part of future cities? Considering the aesthetic values of green roofs, Rowe says that some like green roofs some don't.

Commentary speech

Dr.Eeva-Maria Tuhkanen (MTT Agrifood Research Finland)

Dr. Tuhkanen stated on her commentary speech that long-term experiments are a good idea because of varying climate during seasons. The changes are stressful for plants and they also affect biodiversity and carbon fluxes. Dr. Tuhkanen thought that the main problem in long-term experiments is funding: they are hard to get funded. She also argued that we must convince the public and study the policy and policy tools. The policy tools are the most important thing through which we can increase roof greening in cities. One may also ponder whether green roofs are a good investment or not?

She suggested that taxes and fees could be introduced as policy instruments for roof greening, for example related to the storm water management. Dr. Tuhkanen also stated that people can be convinced through the positive effects that green roofs have. There is a need for more discussion, and the way of thinking in Finland needs to be changed.

Comments

The question about exotic versus native species was raised. Why Rowe is using so many non-native species in his green roofs and green roof experiments? Rowe argued that the native species didn't survive without water, and sedums survived better on shallow substrates. He also argued that natives need a lot more maintenance (weeding, watering) than exotics (in this case) and are also too expensive. There was an argument that exotics, like sedums, aren't that bad because they have a rich biodiversity (insects etc.). And how do we define native species? What is native and what is not? The shallowness of the growing medium is seen as a strong argument for this matter. If there is a will for roof greening and no other species than non-native sedums survive on shallower depths, what else can be done?

One suggestion was that green roofs' negative effects on biodiversity should also be born in mind when performing economic calculations. Connectivity with surrounding areas is an important issue. Birds may be able to use green roofs with greater isolation from the surrounding green areas than many insects. How can one weigh different positives and negatives?

Chairs of the seminar (from the left):

***Research Director Laura Höijer**, Ministry of the Environment*

***Sustainability Practice Leader Mari Puoskari,** Logica and Member of Helsinki City Council (Greens of Finland)*

Ecosystem services, biodiversity and aesthetic delight – A research agenda for green roof vegetation

Dr. Nigel Dunnett, Green Roof Centre, University of Sheffield

Presentation slides available:
http://www.helsinki.fi/henvi/societalinteraction/Scienceday2012_greenroof_program.htm

Dunnett stressed that there is no single right way to design green roofs, and that the diversity is an important point of view in roof greening. He sees that green roofs make landscapes more interesting as they can be visible from the ground level and also from taller buildings. There are many different solutions and they can vary a lot. Different approaches all aim to the same goal: making the city greener.

For Dunnett the leading principle is sustainability: low resource inputs, no or minimal irrigation, high biodiversity value and high aesthetic appeal (this refers also to social sustainability because people cannot be ignored). These arguments apply to both extensive and intensive contexts. Dunnett also argues that we should focus on vegetation selection and designed plant communities, because vegetation works as a system. On Dunnett's point of view one aim is to create flower-rich green roofs with dramatic aesthetic appeal. He argues that non-native plant species have value to native invertebrates and birds. Dunnett states that there should be an aesthetic approach with ecology which incorporates social perception.

Dunnett states that there should be a diversity of approaches to green roof design, depending on context, to create diverse green roof ecosystems. Dunnett argues that green roofs should be

seen as habitat mosaics to maximize ecological opportunities within an ecosystem. A whole range of green roof types should be used in cities and we shouldn't stick only to one solution. Dunnett argues that especially diverse flower-rich green roofs increase biodiversity because pollinators love colorful flowers. Flower-rich green roofs are a combination of *water issues* (water management & conservation, and climate change), *biodiversity* (pollinators, ecosystem services, nature conservation) and *well-being* (beauty, health, community).

The species chosen to green roofs create a distinctive composition in cities. Dunnett argues that species should form a mixture of native and non-native species. In vegetation selection we should consider species from local and regional habitats with similar environmental conditions to the rooftop scenario in the region. This includes also urban habitats. Dunnett states that habitats and sceneries that are possible in the ground might be possible on the roofs also: beautiful, colorful scenery can be possible also on very shallow substrates. Why not use "countryside" species in the cities? Dunnett also states that we should reckon all the habitats in the world with similar conditions. The climate on roofs is different than on the ground so we must look at habitats that have similar conditions compared to our roof climate. What species really survive on the roofs?

Dunnett and his team have made experiments and trials with small movable plots. These plots can be moved from place to place on the roof. This allows for example controlling for rainfall to measure the water quantity precisely. These experiments are part of the EU Marie Curie "Green roof system" program (see more in ppt). Their objective is to develop and implement a rigorous and standardized plant screening program for green roofs. They want to build a comprehensive database on green roof plants. They also want to evaluate new potential species and cultivars. Experiments have been run in three substrate depths (50, 100 and 150 mm), three irrigation regimes (high, moderate and low water stress) and on standardized growing medium (crushed brick, composted park). These are built on cross-gradient design, varying depth and moisture supply.

Dunnett concludes his presentation to four points about green roofs and biodiversity. Firstly, green roofs should be seen as part of the green infrastructure. Green roof can be a link in an interconnected network of green elements and they can enable movement and flow of species. Secondly, green roofs can be *biodiversity hotspots* and resource-rich, so called service stations. For example Dunnett introduced a case in Sheffield where a green roof is nowadays a *Local Nature Reserve*.

Thirdly, green roofs can be seen as target habitats. Dunnett argues that we could create specific habitats and plant communities (including key plant species) mimicking local geology and habitats. The fourth part of biodiversity also refers to this. Dunnett states that through roof greening we can include restoration ecology to this matter.

Commentary speech

PhD student Kaisa Hauru (urban ecology)

Hauru discussed aesthetic and social sustainability in her commentary speech. Visual diversity is important within the landscape scale and on a single green roof. She stated that visual pleasure and restorativeness is reached also with very common sceneries that are close. Visually accessible green roofs are in this case very important and physical access should also be enhanced. Maximizing only the visual activity is not the whole story but we should create stimulating and functional ecosystems. Hauru states that there should be a diversity of green roofs for several purposes.

Hauru also argues that the landscapes that people prefer on a ground level may not be the same in a roof context. There should be more research on the preferences and experiences related to green roofs. Hauru stated some future research questions: How people react to native compared to non-native species planted on roofs? What are the aesthetic responses to flower-rich but exotic versus ordinary but familiar plant species? What is a public acceptance of wild versus horticultural vegetation? Could we use “cues to care” to increase public acceptance of wild, nature-like but somewhat messy vegetation types? How does the knowledge of why and to what purposes the roof is established for, affect the experiences, and furthermore, can knowledge affect the public acceptance of these specific green roof types?

Comments

There was a lot of discussion about the possible negative aspects concerning exotic species on green roofs. There are three kinds of exotic species: familiar/safe to use (may increase the local benefits), species we do not know of and species we know are hazardous. The latter two are to be avoided, especially as the climate is changing and may increase the invasion potential of species. The importance of local species was raised: we should use local species. What is the value of them for the local fauna? The usage of exotic species in botanic gardens cannot be used as a reference here as species potentially invasive are controlled carefully there.

The question of species is multidimensional. Should we be strict and at the same time refuse using some species? The processes in nature are very complicated. The problem of invasive species was seen as a serious threat and a lot of money is put in fighting with invasive species. “Species are guilty until proven innocent” because species may innocently persist even for centuries before problems occur.

How to maximize biodiversity benefits of green roofs?

Professor Manfred Köhler, Green Roof Centre of Excellence, University of Applied Sciences Neubrandenburg

Professor Köhler is one of the first green roof researchers and has done green roof research since 1980's. In 1986-1990 Köhler and his team used experimental plots for simple initial testing. Since 1999 there has been much more research and accurate measurements. For example, they studied what happens to the green roof with snow load: what is the temperature under the snow, situation on the roof in winter, what happens to the soil when it is wet/dry etc. They have also formed the FLL standard for green roofs and another standard for indoor greening and green facades. Köhler states that long-term research is necessary because each year is different. Köhler and his team are doing annual monitoring to green roofs and they have included green roofs to an environmental mapping system.

Köhler argues that if old and new green roofs are compared to each other the newer ones are better in biodiversity (see more Köhler, M. & Poll, P. 2010). In the case of vegetation selection Köhler argues that we should do some research on lichens and mosses in Finland. It is important to test mosses and sedums in different climates. For example some may grow in Japan but cannot be adopted anywhere else. He also suggests that we should test different plants from different ecosystems, for example from meadows and gardens we could get different plants to different kinds of green roofs.

Köhler sees green roofs as habitats and as technical areas. For example in Hamburg on a campus area there is a green roof that is a specific type of technical area. It is planned like a machine and it isn't merely seen as landscape. Köhler also wants to remind us that greening doesn't only mean roofs but also facades and indoor areas. The research should be stretched out also to these fields of study here in Finland.

The green roof is seen as a concept of enhancing biodiversity. Köhler inspires us to do biodiversity research on green roofs in Finland differently. He asks could the lichens/mosses be used for lightweight solutions in Finland. How much greenery is possible in Finland? Köhler states that these questions are tasks for researchers and students to find out.

Comments

The cost of roof greening is a big issue. Money is needed for roof greening in cities and also for the studies concerning LCC & LCA of green roofs, to find out the investment and payback time of green roofs. How to get public support? Some coercive regulation may be needed.

Mosses and lichens are under investigation in the Fifth dimension -research program in Finland. On the other hand historical green roofs haven't yet been investigated and the need for their investigation is noticed. The question of ecosystem disservices was raised. The building of green roofs has to be done well: no leakages, follow good standards, process documentation is needed for construction, develop specific green roof construction security. Companies play a key role in developing these issues.

In Finland the question of fire issues and hazards is often raised when discussing about the advantages/disadvantages of green roofs. Köhler stated that they have made a test in Germany in the 1980's. They found out that a green roof is like a hot roof and the gravel barriers should follow the standards and certifications. Köhler suggested that dry materials should be tested and that the testing must be done by a fire protection agency. Köhler also stated that green roof technology is not too difficult; it is just connection between buildings and plants.

What about adding green roofs to historical buildings? For them, there may be difficulties with policies, and extra roof support may be needed which may make it expensive. Furthermore, maintenance may be hard if access is limited or difficult and if proper safety structures are lacking. Köhler suggested that one shouldn't start with the most difficult historical buildings because for example in Helsinki there are plenty of choices.

Key factors in green roof habitat design – Substrates, light weight solutions, species groups and diversity

Professor Stephan Brenneisen, University of Applied Sciences Wädenswil

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http://www.helsinki.fi/henvi/societalinteraction/Scienceday2012_greenroof_program.htm

Professor Brenneisen started his green roof studies in 1995. They built a small test site and did an experimental green roof with small plots with different substrates and substrate thicknesses. They found out that annual water retention in the best plot was 76.5%, and that the water retention capacity increased with increasing biomass on the roof.

Brenneisen stated that for studying biodiversity a special design is needed. The depth of the growing medium should vary through a roof. Brenneisen sees that we could build habitats on the roofs which support red-book-listed species, and from the conservation point of view native species should be used. What comes to the animal species on roofs, Brenneisen wants to remind us that some animal species come and go but some can only stay up on the roof and cannot escape. So there should be for example green facades for certain species to be able to move from roof to the ground and back.

Brenneisen also argued that architects do not often care for the roofs and are more interested in facades. This situation calls for changing of perspectives: biodiversity and ecosystem services should count even when a roof is not visible or accessible. Brenneisen suggests that green roofs could be designed for biodiversity and conservation reasons also. Brenneisen introduced an example from a water treatment plant in Zürich. The roof was built in 1914 and it is an orchid meadow. This meadow works like a source nowadays and the orchids have spread to the surrounding area. Around this area there is no such species richness anywhere else than on this roof.

In Basel, Switzerland, there is a green roof building code that states that all flat roofs must have a green roof. Nowadays 10% of the city's flat roofs are green. The roof greening doesn't happen by itself and different steps need to be taken. For example in the city of Basel the first pilot project was at the University Hospital at the late 1970's. After this there was a green roof campaign at the late 1990's, then a new building code was established and a new campaign was held in 2000. After this, also a habitat guideline for green roofs has been established in the city of Basel.

Brenneisen suggests that the planners have to be taken into account. Who does the planning for the roofs at the city level if they are required in a building-code for example? There has to be someone who has the authority to say what to do and why.

Brenneisen has also developed new techniques: for example he uses direct seeding. This means that dried or freshly cut plants, e.g. hay, can be lifted straight up onto the roof to create a green roof.

Brenneisen also discussed the issue of solar panels and green roofs. Are they alternative or simultaneous solutions? He argues that solar panels and green roofs on the same roof is a good planning solution. Sedums and other low plants with a shallow medium can be grown near solar panels where for example tall plants could bother the panels. On these kinds of roofs different substrate layers can be used in different parts, but then an accurate plan is required. Brenneisen has also studied biodiversity and nature conservation on roofs. He has found out that green roofs can be a permanent living space for e.g. birds.

The extra demand for the supporting structures that green roofs require was discussed. Brenneisen suggests we should study also the very light-weight concepts. Of course a meadow on a roof needs a deeper media, but a roof can be designed for different purposes from different materials. For example hemp - wood fiber mat may weigh only 30kg/m².

Commentary speech

Manager Jouko Hannonen (Puutarhapalvelu Hannonen Oy)

Hannonen agreed with Brenneisen that the thickness of soil is an important point to be considered. Hannonen also stressed that the green roof research in Finland is not cross-disciplinary enough at the moment and that we need engineers to take part in the research. Hannonen feels that there may be problems with leakages in new buildings. The fire department in Finland isn't ok with green roofs at the moment and a single person can prevent a whole green roof project.

Hannonen also argued that there are not any proper soil substrates available for green roofs yet in Finland. The situation in Finland is that landscape architects cannot design green roofs because they do not have the knowhow, and landscape contractors do not know enough about green roofs. Hannonen stressed that landscape contractors and developers don't do anything that costs more than usual. He didn't understand why all the researchers and people in the seminar were discussing about whether the species on the roof were native or non-native. There should be more discussion about the possibilities of green roofs in Finland in general.

The role of green roofs in urban drainage – A review and the case of Augustenborg eco-city

Dr. Justyna Berndtsson, University of Lund

Presentation slides available:
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Dr. Berndtsson discussed green roofs in urban drainage and their role in water management. A lot of money is put in preventing the nutrient flow from cities, so we should not put more nutrients up on the roofs. Berndtsson stressed that water issues could be an asset to start building more green roofs in Finland. She stated that green roof solutions should be combined with the existing infrastructure.

The Augustenborg project started in 2000 and its aim was to develop an unpopular and problematic area to a new and attractive neighborhood. Green roofs and storm-water management were only on part of the development project. An open rainwater sewage system with green roofs was built to Augustenborg. Green roofs were especially built to reduce storm water runoff and other benefits weren't seen at that time.

The result from Augustenborg was that there is almost no runoff at all and flooding has stopped. There has been some reconstruction of the roofs over the years, for example some grasses have been added. She stressed that the perspective on the investigation has to be decided: how deep into details the study wants to dive? Delaying the water is an important phenomenon related to green roofs. Berndtsson stated that one small green roof in a city has no effect on delaying water and that there has to be a lot of green roofs to gain these goals.

Berndtsson argued that green roofs affect water quality. More long-term studies are needed because the quality of water changes over time. For example the experimental roofs were fertilized only in the beginning, so waters collected first may be more polluted. Berndtsson argued that roofs store nitrogen, and phosphates decrease over time (if the roof isn't fertilized). The runoff water has to be compared with rainwater because the roof and the construction of the roof affect the quality of the water. She also stated that the first runoff from a new roof is more polluted than the next ones. Berndtsson also stressed that the substrate plays a role in the quality of the runoff water, and that all the materials of the green roof have to be tested to be sure that they don't leak anything dangerous - especially when considering the recycled materials as substrates.

Berndtsson concluded that the water reduction quantity of a green roof is 30% of the soil volume on the roof. The other main point is that the green roof shouldn't be fertilized.

Commentary speech

Landscape Architect Jukka Jormola, (Finnish Environment Institute, SYKE)

Presentation slides available:
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Jormola stated that the Finnish national storm water guide is being published soon and he was especially interested in the study on biochar which was presented in the papers before the seminar. Jormola agreed that floods are an increasing problem in Finnish cities and that the sewage system is overloading. Usually the sewage water is mixed with storm waters which can cause problems to surrounding waters.

Jormola raised a question about the layers of green roofs. What kinds of layers are there and what kind of layers do we need? Jormola also stated that the runoff from green roofs should be compared to the runoff from other green areas. He also stressed that there has to be more extensive promotion of green roofs and the benefits of green roofs have to be brought to public.

Summing up and final discussion

All in all *the local circumstances are important and local solutions are always good*. One question is how many green roofs do we need? If we think about the storm water issues, green roofs can't totally fulfill the requirements that are set to storm water management. Green roofs have to work with other open storm water systems.

Regulations were also raised up as an important issue. How suitable are different regulations to different situations? The role of the authorities is important because they make the decisions about the regulations. But who does the preliminary decisions and on what basis? Discussion about benefits, aims, goals, values and attitudes is needed. What is important research, how should we proceed?

The main theme of the day was biodiversity and ecosystem services. There is not yet a proper understanding about the potential of green roofs to ecosystem services. This matter has to be measured and studied from different points of views in the future. What kind of ecosystem services green roofs provide?

In California, USA, there has been some discussion about the water that green roofs consume and retain. Water is highly political in dry areas. This situation raises a question: who owns the water? Someone who builds a green roof can be accused of stealing the water for example from rivers. The authorities want the water to the rivers and they don't want to retain rainfall in green roofs.

The diffusion of green roofs is highly dependent on people's attitudes and values. How much construction industry, developers and ordinary people value the green roofs? For example, a hotel in Vancouver charges more from the room with a view to a green roof and people are willing to pay for it. Green roofs could also have an effect on learning etc. Dr. Dunnett gave an example from a business building project. The people behind the project were interested in affecting their company's public image through roof greening. What about green roofs and property value - do green roofs increase property value?

The value of a green roof that can be seen or accessed is more easily understood. What is the value of a green roof that cannot be seen? How to measure or prove the benefits? The quantification of the economic value of clean air and other ecosystem services is needed. Certificates like LEED could be one tool
to add value to green roofs.