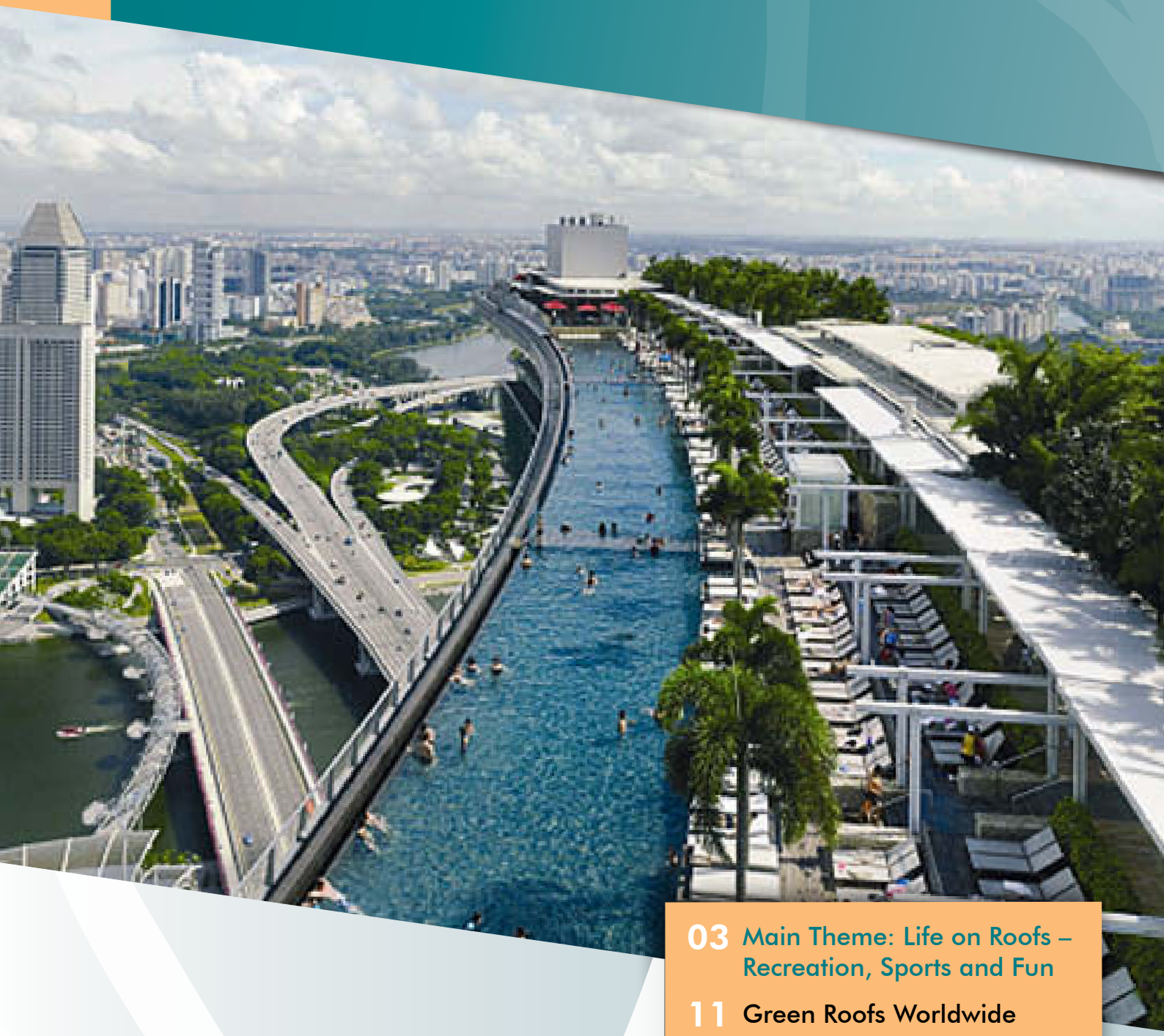
GREEN ROOF NEWS



IGRA
International Green Roof Association

International Green Roof Association
Global Networking for Green Roofs

Issue 1|2014

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Title image: SkyPark at Marina Bay Sands, Singapore
Copyright: Timothy Hursley

Dear Reader

Green Roof technologies not only provide the owners of buildings with a proven return on investment, but also represent opportunities for significant social, economic and environmental benefits, particularly in cities.

Find out more about the private and public benefits of Green Roof technologies in this issue of the Green Roof News with a focus on recreation, sports and fun on urban roofscapes.

If we change the colour from green to white: There have been many discussions about white roofs to respond to the challenges of climate change and the urban heat island effect. Let us take a look on a scientific study and the results to be prepared for further debates. A second study, on the cost evaluation of adaption measures for cities provides additional input.

For the first time you will find a research review with selected articles from the international pool of publication – IGRAs´ unique service for you!

Have fun reading!

Sabine Frueh
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The International Green Roof Association (IGRA) is a global network for the promotion and dissemination of Green Roof topics and Green Roof technology.

MAIN THEME Life on Roofs:

Recreation, Sports and Fun

Environmental topics normally spring to mind when you think of Green Roofs. They retain water, improve the microclimate, encourage biodiversity, save energy and protect the roof waterproofing. One design option is, however, often underrated – shaping the urban roof area as a useable free space for townspeople. This is the main theme in the current issue of Green Roof News and we'll be showcasing the manifold design possibilities with examples from Singapore, Istanbul, Berlin and Copenhagen. Ski slopes, golf courses, swimming pools or playgrounds on roofs – all of these examples follow the tradition of the Swiss-French architectural theorist Le Corbusier. Le Corbusier was already putting forward the roof area as a central feature of a new kind of architecture in the 1920s, making roof gardens preferred gathering places in buildings.

Special moments with friends on a privat Green Roof in Munich/Germany. Copyright: ZinCo

Golf course on a company roof near Berlin/Germany

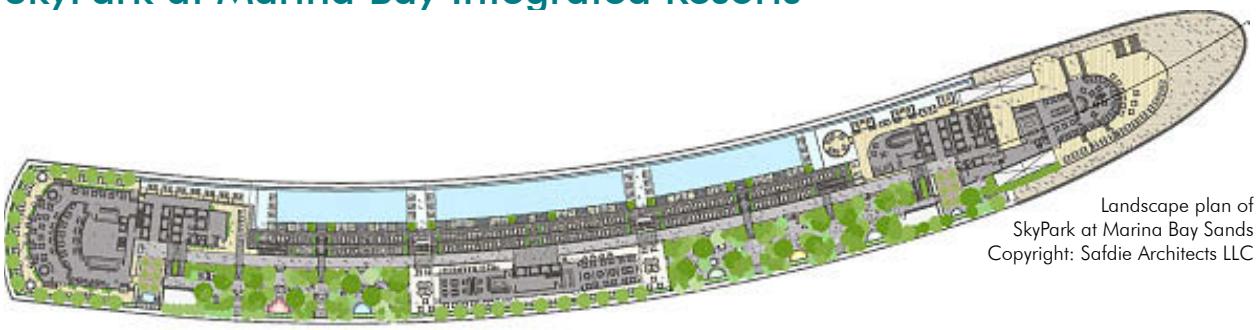
Oase of recreation on the Green Roof of Marmara Forum in Istanbul/Turkey

Ski Slope in Copenhagen: Amager Ressource Center
Copyright: BIG-Bjarke Ingels Group

Swimming pool high above Singapore – SkyPark at Marina Bay Sands

MAIN THEME Swimming High above Singapore:

SkyPark at Marina Bay Integrated Resorts



Landscape plan of
SkyPark at Marina Bay Sands
Copyright: Safdie Architects LLC

Marina Bay Sands, located on the Marina Bay waterfront, is a 16-hectare mixed-use integrated resort combining more than 121,000 m² of convention and exhibition facilities, three 55-storey hotel towers, an iconic ArtScience Museum, entertainment and gaming venues, a wide array of shopping and dining outlets, an outdoor event plaza along a public promenade, and the 1.2-hectare SkyPark. A series of layered gardens provide ample green space throughout Marina Bay Sands, extending the tropical garden landscape from Marina City Park towards the bay front. The crown of the landscape is the SkyPark located at 200 m above sea level. The SkyPark, an engineering marvel, spans the three towers of the Marina Bay Sands and cantilevers 65 m beyond the tower at the eastern end. It accommodates a public observatory, gardens, a 151-metre-long infinity pool, restaurants and jogging paths, and offers sweeping panoramic views of the city.

Prior to the installation of the landscapes, wind tunnel studies were conducted to understand the possible effects of periodic wind gusts for both human comfort and the plants. Plants were selected for their ability to tolerate the wind. The use of stone, timber and plant materials found in the region aims to create a grounded feeling for SkyPark visitors.

Infinity pool and landscaped roof garden of SkyPark at Marina Bay Sands, with the built-up milieu of Singapore in the background.
Copyright: Timothy Hursley

From afar, with the maturing plants, the SkyPark is increasingly looking like an urban forest nested at 200 m above sea level. (excerpt from Tan, P.Y. (2013). A Vertical Garden City, Singapore. Straits Times Press, Singapore. 192 pp.)

SkyPark at Marina Bay Sands and the skyline of Singapore's central business district.
Copyright: Urban Redevelopment Authority of Singapore

Project Data

Location: Singapore, Marina Bay

Total area: 12,000 m²

Architects/Design: Safdie Architects LLC

Author: Dr. Tan Puay Yok, National Universtity of Singapore

MAIN THEME Family Recreation from Everyday Life:

Shopping at Marmara Forum, Istanbul

A mixed use with pedestrian ways, outdoor seating, playgrounds and ponds.

Today, shopping is arguably the fastest growing family-orientated activity in the world. Shopping malls are no longer simply a collection of retail outlets but a meeting point with many other attractions. In short they have become a major recreational focus and the means to regenerate urban communities. As an alternative to frequency of shopping centres and existing characteristics of trade areas in the region, Marmara Forum is a unique and compact festival market place, which would grab the imagination of citizens of all age and style, not only shoppers'. The new image is not only offering the goods to buy but also it becomes a new gathering zone for social motives.

Marmara Forum was implemented in Bakirköy, by the Investment of Multi Development Turkiye, under the scope of its shopping mall concept "Forum". The project is located in the very densely populated region of European side of Istanbul, which has a construction area of 375,000 m^2. The project has two main buildings: Shopping Mall and Garden Offices. The Green Roof located on the roof of the shopping mall (4,500 m^2), serves a significant social area requirement in the region, by including outdoor seating of cafes, pedestrian ways, playgrounds for children, ponds, water ducts. It provides also a nice atmosphere with different species of plants and with the view of the Marmara Sea.

In Garden Offices (2,500 m^2), all offices open out onto the several verdant courtyards, applied with the Green Roof concept. There are also two outside terraces in front of the offices. The project aims with its huge Green Roof area, to provide natural surroundings for the shopping mall visitors and the office occupants, as the green areas in the region were mostly replaced by concrete buildings and motorways because of the dense housing and population.

As to the interior of the mall, the landscaped public space is surrounded by cafes and restaurants and is designed to attract families and to extend the appeal of a shopping trip. The roof terrace above the shopping facility provides an elevated viewing platform with a wide panorama of Sea of Marmara and the cityscape.

The Green Roof offers a natural atmosphere for the city residents, which is hard to find in the neighbourhood.

Project Data

Location: Istanbul, Bakirköy

Total area: 7,000 m^2

Architects/Design: Tabanlioglu Architects, Istanbul

Landscape architect: DS Mimarlik, Istanbul

Author: Ayse Miray Sen, Onduline Avrasya AS

MAIN THEME An Interview with Maria Auböck and János Kárász:

Community Roof Gardens

Maria Auböck and János Kárász jointly run the Atelier Auböck + Kárász in Vienna (http://www.auboeck-karasz.at/). The core areas of this interdisciplinary office are landscape architecture, urban design, housing and health landscapes, home gardens and art & education. The Atelier carried out an extensive study for the city of Munich on the potential of community roof gardens in the Bavarian capital.

János Kárász and Maria Auböck jointly run the Atelier Auböck + Kárász in Vienna/Austria. Copyright: Peter Reischer, Vienna

You collected examples from around the world for your report "Roofscapes – Community Use". Which projects impressed you the most?

"Michel Desvigne designed an accessible roof landscape for students at Keio University in Tokyo in 2004–2005 and his intelligent incorporation of prefabricated components appeals to us. The temporary installations in Linz by the architects Bow Wow and Riepl for the 'Höhenrausch' project offer townspeople attractive views over their city! The roof landscape of the residential neighbourhood 'Jean Hachette' in Ivry sur Seine, France is still as fascinating as ever. Jean Renaudie and Reneé Gaillaustet created diverse and versatile roof gardens there back in 1969–1975!"

Is there any one city which is particularly active in the area of Green Roofs, or which is a role model for this concept?

"Our research on municipal Green Roof promotion for the city of Munich in 2011 showed, for example, interesting initiatives in Portland, Oregon. Building owners receive up to 100 % exemption from storm water fees for their property if they install Green Roofs. What is more, investors in the 'Central City Plan District' receive a bonus on the Floor Area Ratio (FAR) if they install an ecoroof. The city of Linz in Austria is also supporting Green Roofs by helping to cover the additional static and construction costs and the costs for Green Roof installation. The rate for the Green Roof subsidy is 5 % and each building project is eligible for a maximum of 7,500 Euro support."

The report "Roofscapes – Community Use" (in German language) explores the potential for roof gardens in Munich/Germany.

What are the major barriers/obstacles to converting roof areas in the city?

"Barriers are the extra costs which need to be calculated in the construction budget early on. Responsibility for the care and upkeep of the garden also has to be decided on before construction starts. A roof garden can only be kept dynamic and usable by active residents."

One of the latest projects of the Atelier Auböck + Kárász: the "Joseph-Pschorr building" in Munich/Germany (architect office Kuehn Malvezzi, Berlin). Copyright: Atelier Auböck + Kárász

Which points would you clarify with the constructor at the start of planning talks about roof use?

"We ask if the client wants to use the roof area him or herself – or if creative concepts for collective use by residents or employees are needed. We ask 'How do you want to use the area? What kind of natural image are you expecting?' The often surprising answers can influence the outline planning significantly."

What role could the increasingly aging population play?

"Community roofscapes are meeting places for all generations! There are many activities which would be of interest to the whole household – from child care to senior home-sharing."

Keyword: "Urban Rooftop Farming". Is this a lasting trend, or is the interest being flamed by, for example, the number of articles in the press?

"This buzz word describes a lasting trend. Our professional experience has shown a long-term improvement in quality, especially in multi-storey buildings and we support it fully!"

What is your general opinion on the collective use of roof areas in densely populated cities?

"These are new compensation possibilities, especially when community roofscapes are intensively planted. Cities need more overall green for atmospheric humidity, ventilation and ecological diversity. Sealed areas at street level cannot be compensated for alone by Green Roofs, but nature on top of homes already improves the cityscape."

A prime example of community roof gardens – the public playground on top of a shopping centre in Geislingen/Germany. Copyright: ZinCo

MAIN THEME After the Meeting Up on the Roof:

High Flying Balls

It's sporty up on the fifteen meter high roof of the administrative centre of a company in Brandenburg. This businessman's love of golf inspired the architect's design which ultimately also managed to impress the constructor. That is why there is a putting green directly in front of the management's conference rooms, enticing you to swing your club during your lunch break – either alone to relax, or together with your business partners. The bunker at the back of the course near the second hole makes the game on the roof a bit more challenging and exciting. Clubs and balls lie ready and normally find players quickly in this relaxed atmosphere.

The golf course is flanked by a colourful border made up of forsythia, weigelia, butterfly bushes and juneberries which makes the area fairly wind still. The bushes have become a chirping bird paradise, probably in part because natural predators, such as cats, martens and squirrels cannot get up here. The two pools with fountains edged with granite are not only symbols of a flourishing company, but also provide a flowing transition between the terrace and the grass. The background vegetation is made up of yew, maple, rhododendron and ferns. The terrace is decked with a large awning and is a popular place for meetings in nice weather. The intensely greened roof areas are rigged up with underground irrigation. Another part of the roof area was simultaneously extensively greened with various stonecrops (sedums).

The pools – flowing transition between terrace and garden

Sporty roof on an administration building in Brandenburg/Germany

Putting green in front of the conference room

The roof substrate was made lean with a large portion of river sand to increase the water permeability and to prevent any form of soil wetness. Very specific grass mixtures were used for the greens. The decision to bring in a green keeper to train the caretaker proved a good one. The quality of the grass can only be kept up with detailed care, such as regular cutting, scarifying, aeration and proper fertilization.

Project Data

Location: Brandenburg, Germany

Total area: approx. 300 m^2

Architects/Design: GIESE + GIESE Dipl.-Ing. Architects, Bremen

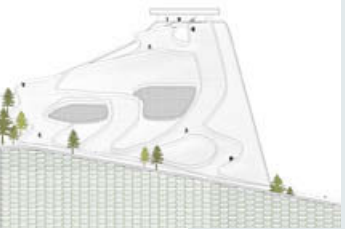
Author: Sabine Frueh, IGRA

MAIN THEME Amager Ressource Center Copenhagen:

Sports, Fun and Education on a Waste-To-Energy Power Plant

Mountain sports in a flat city

Because Copenhagen is completely flat, there is no landscape for skiing or other alpine leisure activities. BIG is going to turn the roof of the new Amager Ressource Center into an artificial ski slope open all year. The slope will be ecological, upending the convention of the energy intensive indoor alpine ski resorts. Like a real mountain with green forest areas, hike trails, climbing walls and a viewing plateau and a little café on the top it is an enrichment for the citiziens of Copenhagen.



Smoke rings for visualising CO_2 output

While sustainable energy has become increasingly important in media and politics, the understanding of the issue itself is still very abstract. Does anybody know what a ton of CO_2 looks like? BIG propose a simple modification to the smokestack which will allow it to puff smoke rings whenever 1 ton of fossil CO_2 is released. This will serve a communication function as a gentle reminder of the impact of consumption.

Photo credits: BIG-Bjarke Ingels Group

Green walls

The bricks on the facade functions as planters, creating a green façade and tuning the building into a green mountain from afar with a white mountain top.

Project Data

Location: Copenhagen, Denmark

Total area: 95,000 m^2

Architects/Design: BIG – Bjarke Ingels Group, Denmark

MAIN THEME Reflections on the Main Theme:

Bjarke Ingels – Turn It Into Something Playful

The general perception of sustainability is this idea of a moral code: How much of our existing quality of life are we prepared to sacrifice to afford being sustainable. It is the protestant perception that it has to hurt to be good and that the sustainable life is less than the normal life.

But we are looking at how sustainable cities, or sustainable buildings, can increase the quality of life – to finds ways of designing cities and buildings as double ecosystems that are both ecologically but also economically profitable and where the outcome that doesn't actually force people to alter their lifestyle to have a better conscience. They can live exactly the way they want, or even better, because the world and the city are designed in such a way, that they can actually do so. Essentially it is to approach the question of sustainability not as a moral dilemma but as a design challenge. In our current project the Waste-To-Energy Power plant the mass of the building serves as a ski slope for the citizens of Copenhagen. It is economically profitable because it turns waste into heat and energy. It is environmentally profitable because it disposes of waster eliminating landfill.

And in Denmark only 4 % of waste ends up in landfills, the rest is either turned into energy or recycled. And finally it is socially profitable because it actually creates social activity – skiing – which would otherwise be impossible. We have the climate. We have the cold. We don't have the topography. So now Copenhagen will get its first ski mountain. Right now people commute eight hours to go southern Sweden where the slope is only a third higher than what we can provide on this building. It has a black slope, a blue slope, and a green slope. And they loop around. There is even a mogul slope. And the lower part is a slope for the kids. And they end up at the elevator for the chimney.

In the brief they were asking for a visitor's center, this thing where you take the school kids to tell them this is where the waster turns into power. But then we thought you are only going to go once, and when your teacher tells you to. What if it actually becomes a destination where by accident you discover. Why do we have this ski slope here? Ah, it's because it is on top of a waste-to-energy power plant. So somehow it is the ultimate example of sustainability.

Bjarke Ingels, founder BIG, Bjarke Ingels Group. Copyright: Jakob Glatt

And finally as a sort of art installation we are asked to … In the brief all of the competitors were given the machines, some were low, some were bigger, and somehow we had to make a building around it, to make it look beautiful, the beautification of a factory. So we thought OK we add a social program. And they asked to make an illumination of the factory so it looks beautiful. And we thought OK maybe it is more interesting to play, instead of adding light to it. If you are cynical adding lights is just wasting energy. And we have the chimney, it pans out, a thirty diameter disk that fills up with smoke. There is actually a piston with 200 kilos of smoke, the piston collapses which blows a giant smoke ring. And of course, the idea is artistically it is a symbol of hedonistic sustainability that you can blow smoke rings with a factory. But the idea is that smoke is also uncountable. You know one of the main drivers of behavioural change is knowledge. And right know you can't really see what is coming out of the chimney.

Whereas you can tell your kids, just like when I was a kid and you saw a light flash and my parents would tell me you count one case of beer, two cases of beer, and it is two kilometres away … I can tell my kids OK five smoke rings and it is one tone of CO_2.

How do you take the ultimate symbol of work, production, and pollution and turn it into something playful?

Author: Bjarke Ingels, founder BIG, Bjarke Ingels Group and authore of Yes is More

Diadema de Luxe Club House:
Unique Living Concept in St. Petersburg

"Diadema de Luxe Club House" is a residential complex situated in St. Petersburg. The complex consists of four residential towers which are connected to each other via a central conservatory area.

In the top floors of the towers there are penthouses with large terraces and accessible Green Roof areas. Even the residents in the first and second floor have their terraces on rooftops. The Green Roofs were realized on inverted roofs, therefore the separation membrane was laid on top of the XSP insulation boards instead of a water retaining protection mat.

The roof greenery underlines the high quality of the project and emphasizes its uniqueness. From the roof terrace of the penthouse apartments one has a beautiful view on a tributary of the Neva River and the surrounding area. The building was nominated for the award in the category "Elitist Residential Complex of the Year".

Project Data

Location: Sankt-Petersburg, Konstantinovskij p. dom 23

Total area: approx. 6,500 m²

Architects/Design: ZAO Architekturbüro "Zemtsov, Kondiayn & Partners", St. Petersburg

Developer: UK "Credo-Invest"

Author: Ivan Christ, ZinCo GmbH

Green at all levels: even the lower roof areas and inner courtyards were planted.
Copyright: ZinCo

Modern apartment complex in St. Petersburg: Diadema de Luxe Club House

Educational Activities in Israel:

Green Roofs as School Subject

Since 2010 a number of Green Roofs have been installed on Israeli schools. Most of the cases were at the initiative of the relevant municipality, as part of the city's policy to enhance the "environmental friendliness profile" of existing structures or "green" construction of new schools. Examples for municipalities that promote Green Roofs in their schools are Jerusalem, Rishon Le'Zion, Petach Tikva, Shoham and Hod Hasharon. It is also interesting to take note of the case in many other municipalities where Green Roofs have not been installed; significant support can be found among city officials, school principals and parents, but the project failed to make headway, primarily because of budgetary constraints or incompatibility of the roof in question (e.g., sealant defects, student safety issues, stress load limitations and/or inaccessibility). This year, Dr. Noam Austerlitz from Tel Aviv University initiated research with a grant from Israel's Office of the Chief Scientist to investigate the roots and means for overcoming the obstacles facing decision-makers concerning the issue.

Green Roofs in schools offer a variety of benefits and objectives, e.g., an enriched biodiversity, improved energy efficiency, landscaping and recreation, promote urban agriculture, educational and research activities, and contribute to the environment. The Green Roofs in which we played a role in their construction were developed primarily for landscaping and agricultural-educational activities as well as illustrating their energy efficiency and contributing to a 'green lung' effect in the particular city. One of the more crucial obstacles we faced was a limited budget that delayed construction of a safety guardrail and thereby prevented student activities on the roof. Another difficulty is the transfer of professional responsibility to the school following the Green Roof's installation, for example, dealing with the various costs pertaining to irrigation, plants, equipment and maintenance.

A Green Roof at the Ehud Manor Elementary School for the Sciences and the Environment in Petach Tikva was designed as an "outdoor" classroom to study the subject of sustainability. Students are responsible, inter-alia, for maintenance of the garden, composed of herbs and succulents.

The fact of the matter is that the educational activities planned for the roof are not always executed. Consequently, it is our conclusion that in some of the cases it is best to forego access to the Green Roof; thereby facilitating savings in a whole range of expenses pertaining to safety, access, shade and construction and choose a roof that can be viewed from a variety of sites throughout the school. Furthermore, a roof installed primarily for biodiversity, requires very little in the way of maintenance and still remains "educational" by serving as an example of nature. Herein is a summary of two successful projects implemented in Israel during recent years.

A Green Roof at the Tzuriel Elementary School in Rishon Le'Zion was designed with the objective of decorating the environment of the school's second-floor classrooms. Landscape architecture: Zur-Wolf.

The Ohr Torah Stone School in Jerusalem was the first school in Israel in which a Green Roof was installed. The selection was made as part of the city pilot project aimed at landscaping the roofs of four city schools. From the outset the students were active partners in the Green Roof's construction. Eleventh grade students working under the guidance of architecture students from "Bezalel Academy of Arts and Design" and architect Ayal Ronen prepared a series of proposed designs for the roof. The roof's architect, Arie Kutz from "Studio Landscape Architecture", integrated the various proposals in the final design. Accompanied by their teachers, the students were also involved in construction of the deck. Kutz designed a three part garden over an area of 340 square meters. The first part of the roof is a "living roof" – natural soil in which the students planted storage organs (geophytes), without any additional artificial irrigation. The second section is semi-extensive and comprised of drought tolerant plants in a Perlite substrate, adjacent to the additional section – a Tuff substrate intended for student experimentation and study.

The Mosenson Youth Village in Hod Hasharon is a school dedicated to promoting and educating ecology. As part of the school's Urban Argo-Ecology Learning Track, students study in an academic, practical and experiential manner how best to utilize the sources of life in a sustainable manner, congruent with progress and development. One can find at the school a variety of devices and facilities for experimentation and study, such as a device for water recycling, a shaded vegetable garden and composters that serve as growth beds, etc. The installation of a Green Roof was but an additional aspect in the school's activity and vision, the objective of which is to conduct a full range of botanical, agricultural, hydrological and climatic experiments on the roof and in its environment. After installation of the roof's guardrail, the students in this specific track go up onto the roof to conduct a series of annual experiments. Moreover, the roof is a prominent landmark throughout the school's campus and enables other students at the school to give consideration to environmental subjects as well.

Authors: Hagit Nol and Yifath Halperin, Rov Noy

Studying and experimenting on the Green Roof, Mosenson Youth Village.
Copyright: Ido Harpaz

Studying and experimenting on the Green Roof, Mosenson Youth Village.
Copyright: Ido Harpaz

Rosemary, Thyme and Oregano:

Mediterranean Garden on a Hellenic Roof

The country house is located in Vourkari, in Kea Island, Greece and the Green Roof expands to a flat area of 55 m². The site is exposed to sea winds and drought conditions are prevailing. Microclimatic conditions including water salinity and exposure to sea wind, were among the factors that determined the plants species' selection. High summer temperatures and continuous exposure to solar radiation were among the significant factors for creating a Green Roof to account for bioclimatic, ecological and economical benefits.

The implementation of the extensive Green Roof aims to improve:

a) the microclimate of the house,

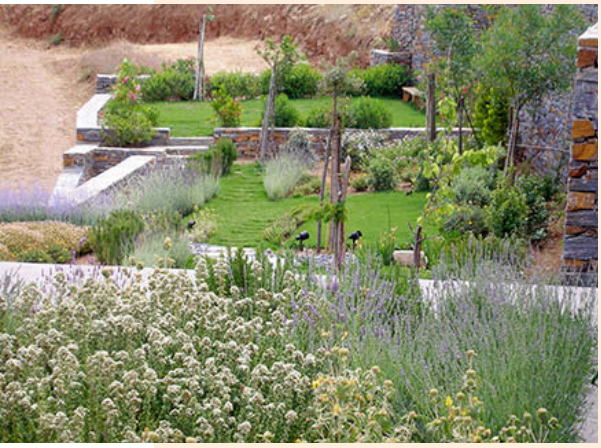
b) the energy performance of the building in order to decrease the use of air-conditioning systems,

c) the life expectancy of the waterproofing and its maintenance,

d) the natural habitat for wildlife.

The main goal of the landscape design was to reintroduce nature on the built areas, to create a harmonious relation and integration of the house into the landscape.

One of the design tools was the creation of the extensive/semi intensive Green Roof, mainly consisting of aromatic culinary herbs and small shrubs such as rosemary, oregano, lavender, Jerusalem sage, thyme, winter savory, cotton lavender and Greek horehound. Plants' selection formed a drought resistant and visually pleasing vegetation. Due to the minimum depth of the Green Roof substrate and the lack of water on a constant basis, and especially during the summer period, a Green Roof system (ZinCo) was selected in order to create a viable environment for the plants and to protect the waterproofing.



The roof- Integrated into the existing environment.

Idyllic country house near the sea

A drip irrigation system was installed, in order to irrigate periodically the plants during the hot summer period.

Despite the fact, that this Green Roof was constructed during summer, with high temperatures (36–38 °C), it performs perfectly and it is now transformed into a natural mediterranean garden. The most resistant plants proved to be oregano, lavender, Jerusalem sage and rosemary.

Project Data

Location: Vourkari, Kea Island/Greece

Total area: 55 m²

Architects/Design: Katerina Gkoltsiou, Landscape Architect and Agricultural Engineer

Author: Grigoris Kotopoulis, egreen

Riga Supermarket Collapse:
Who's To Blame?

At about 17:45 on 21 November 2013 part of the roof of a supermarket in the Latvian capital Riga collapsed, burying more than 100 people who were inside near the check out area. Another part of the roof collapsed at about 19:00 and two days later the third and last part also collapsed. A total of 54 people were killed in this tragic accident and more than 40 others were injured. Television news reports said that a garden was being constructed on the supermarket roof and that this could have caused the roof to collapse.

The supermarket roof was built on three rows of steel lattice girders, each 16 meters long. These girders complied with the expected vegetation loads, traffic loads and snow loads as well as with the respective safety allowances. However, probably for transportation reasons, these girders were not made out of one piece of steel as originally planned. They were each made of two 8 meter pieces which were bolted together on site. It has subsequently emerged that the bolting on the underside of the girders, where the highest tensile forces occur, failed. Whether too few bolts were used, whether they were too weak or whether they were of inferior quality was not made public information. Independent structural engineers have since established beyond doubt that the faulty girder connections were responsible for the nearly simultaneous collapse of the first two girders and then, later, of the third.

Faulty girder connections could have caused the collapse
Copyright: Roman Koksarov

The Green Roof was already part of the original design
Copyright: The Lativa Associaton of Architects

I extend my sincere sympathy to the relatives and friends of any person whose death may have been associated with this disaster. As this kind of news could prove to be a major setback for the entire Green Roof branch, so I also decided to investigate.

It is true that, at the time of the collapse, the two year old flat roof was being converted into a roof garden to give the residents of the newly erected neighbouring apartment block a place to relax and play. The Green Roof had been planned right from the start and had been included in the drafts, the plans and in the static calculations. The planting work should have been completed by the end of November and an inspection had been carried out just a few days before the collapse to make sure that the works were being carried out properly and to check that the installation heights, etc. were being respected. No flaws were found – and yet the roof collapsed a few days later. Why?

It is unfortunately impossible to undo this tragedy. I do, however, sincerely hope that this accident will help make roof planners, constructors and those who work on roofs with loads more aware of what can happen when work is carried out recklessly and irresponsibly.

Author: Roland Appl, Building Physics Engineer
President IGRA; Technical Director ZinCo GmbH

A Review:

Green Roof Research in 2013

Climate protection and adapting to climate change are amongst the most pressing environmental challenges of the 21st century. Green Roof technology offers interesting approaches to reacting to both aspects. City roofs also offer space usage potential which has yet to be properly tapped into and which can be put to good use for the urban ecology. It should therefore come as no surprise that scientists around the globe are researching the many scopes of Green Roof application and design. What the current focus research areas are, and which countries are doing the most research can be seen in the following short research overview for the Green Roof year 2013. The scientific database Scopus was used as a reference. Its analysis of 21,000 titles covers most scientific publications (peer reviewed journals, trade publications and book series) in the field of science, technology, medicine, social sciences and arts & humanities.

Areal view of the city of Stuttgart
Copyright: Landeshauptstadt Stuttgart / DLR

Focus on Stormwater Management, Energy Balance and City Climate

Green Roof research reached a new high in 2013 with 162 publications referring to the search term "Green Roof". The number of publications grew by 10 % compared to the year before. More than 900 research reports in the area have been published since 1984. An analysis of the year's publications showed a significant focus on stormwater management, energy balance and city climate. Detailed measurements taken in laboratories and on buildings served as the basis for computing and simulation models which can be used for many applications. Seeing as Green Roofs span both urban ecological and energetic effects, many individual articles dealt with a number of aspects at the same time. The particular advantage of Green Roofs over other purely technical environmental procedures (e.g. white roofs, solar power generation, insulation), which often only address one problem, was highlighted. Even though some publications dealt with the basic issues of roof and vegetation techniques (e.g. wind forces, care and maintenance, fall protection), it is clear that these research areas are losing importance thanks to the development of national standards. Adapting Green Roof systems to local climate and location conditions was still a focal point, including the design of individual functional layers, substrate components and plant selection.

The USA takes the lead

In 2013 scientists from 34 countries contributed to Green Roof research. The most active countries were the USA, followed by China and the UK. A regional focus was the Mediterranean area with publications from Spain, France, Italy, Greece, Turkey, Israel, and Egypt. One limiting factor to be taken into account is that Scopus only covers articles in peer reviewed journals, trade publications and book series. Studies and research papers as well as institute reports which were only published internally were not evaluated.

IGRA supports research networks

Scientific investigations are still an important reference point for the development and support of the Green Roof market. In order to put the available financial and personnel resources to best use, exchanges between research groups and continual comparison of research areas is advisable. The International Green Roof Association IGRA, as an international knowledge platform, will put special emphasis on this subject in the future. In the following issues of "Green Roof News" we will present selected articles from the international pool of publications. For more information on Green Roof research around the world, please contact the IGRA office: info@igra-world.com.

Author: Wolfgang Ansel, IGRA

A few articles from the many interesting and innovative approaches are listed below:

Green Roof Policies

Mees, H.L.P., Driessen, P. P. J., Runhaar, H. A. C., Stamatelos, J.: Who governs climate adaptation? Getting Green Roofs for stormwater retention off the ground; (2013) Journal of Environmental Planning and Management, 56 (6), pp. 802–825.

Mullen, J.D., Lamsal, M., Colson, G.: Green Roof adoption in Atlanta, Georgia: The effects of building characteristics and subsidies on net private, public, and social benefits; (2013) Environmental Science and Technology, 47 (19), pp. 10824–10831.

Plant selection and Biodiversity

Caneva, G., Kumbaric, A., Savo, V., Casalini, R.: Ecological approach in selecting extensive Green Roof plants: A data-set of Mediterranean plants; (2013) Plant Biosystems

Farrell, C., Szota, C., Williams, N.S.G., Arndt, S.K.: High water users can be drought tolerant: Using physiological traits for Green Roof plant selection; (2013) Plant and Soil, 372 (1-2), pp. 177–193.

Madre, F., Vergnes, A., Machon, N., Clergeau, P.: A comparison of 3 types of Green Roof as habitats for arthropods; (2013) Ecological Engineering, 57, pp. 109–117.

Stormwater Management

Deng, Y., Cardin, M.-A., Babovic, V., Santhanakrishnan, D., Schmitter, P., Meshgi, A.: Valuing flexibilities in the design of urban water management systems; (2013) Water Research

Stovin, V., Poë, S., Berretta, C.: A modelling study of long term Green Roof retention performance, (2013) Journal of Environmental Management, 131, pp. 206–215.

Yio, M.H.N., Stovin, V., Werdin, J., Vesuviano, G.: Experimental analysis of Green Roof substrate detention characteristics; (2013) Water Science and Technology, 68 (7), pp. 1477–1486.

Song, U., Kim, E., Bang, J.H., Son, D.J., Waldman, B., Lee, E.J.: Wetlands are an effective Green Roof system; (2013) Building and Environment, 66, pp. 141–147.

Energy and City Climate

De Munck, C.S., Lemonsu, A., Bouzouidja, R., Masson, V., Claverie, R.: The GREENROOF module (v7.3) for modelling Green Roof hydrological and energetic performances within TEB; (2013) Geoscientific Model Development, 6 (6), pp. 1941–1960.

Saadatian, O., Sopian, K., Salleh, E., Lim, C.H., Riffat, S., Saadatian, E., Toudeshki, A., Sulaiman, M.Y.: A review of energy aspects of Green Roofs; (2013) Renewable and Sustainable Energy Reviews, 23, pp. 155–168.

Ignatieva, M., Ahrné, K.: Biodiverse green infra-structure for the 21st century: From "green desert" of lawns to biophilic cities; (2013) Journal of Architecture and Urbanism, 37 (1), pp. 1–9.

Public Awareness

Jungels, J., Rakow, D.A., Allred, S.B., Skelly, S.M.: Attitudes and aesthetic reactions toward green roofs in the Northeastern United States; (2013) Landscape and Urban Planning, 117, pp. 13–21.

Fernandez-Cañero, R., Emilsson, T., Fernandez-Barba, C., Herrera Machuca, M.T.: Green Roof systems: A study of public attitudes and preferences in southern Spain; (2013) Journal of Environmental Management, 128, pp. 106–115.

Sound Transmission

Connelly, M., Hodgson, M.: Experimental investigation of the sound transmission of vegetated roofs; (2013) Applied Acoustics, 74 (10), pp. 1136–1143.

Van Renterghem, T., Hornikx, M., Forssen, J., Botteldooren, D.: The potential of building envelope greening to achieve quietness; (2013) Building and Environment, 61, pp. 34–44.

Cost Evaluation of Adaptation Measures for Cities and Municipalities:

Green Roofs to Fight Heat

Climate research has shown that heat waves, floods and heavy rains will occur with increasing frequency in Germany and can incur enormous economic damage. The costs and benefits of countermeasures have been difficult to measure in a systematic way up to now. A new study by the German Federal Environment Agency (UBA) has corrected this. It is a first-time cost-benefit analysis of concrete climate change adaptation measures. The greening of roofs to combat summer heat in cities proves to be a measure that is particularly promising and beneficial.

Other efficient measures include the renaturalisation of floodplain forests to protect against flooding and the use of heat-resistant surfacing to counter road damage. "Although our climate policy has been successful, some of the consequences of climate change cannot be avoided. We must now therefore adapt to its consequences", said UBA President Jochen Flasbarth. "As the cost-benefit analysis by the Federal Environment Agency shows, there are a number of measures which the Federal Government, Länder (Federal States) and local governments can already initiate today at relatively low cost."

The Federal Government, Länder and local governments increasingly find themselves facing the issue of how to adapt to the unavoidable consequences of climate change. The new UBA study analyses the costs and benefits of adaptation measures that are appropriate as a reaction to climate change. Measures in urban and spatial planning, health protection and civil protection are especially effective. The greening of roofs, for example, reduces the city temperatures on hot summer days. A system of heat warnings at the local level and corresponding cooling measures – especially in hospitals and nursing facilities – are possible at relatively low-cost and incur great benefit. In contrast, the cost-benefit ratio of comprehensive infrastructure measures is poorer. These measures might include new flood protection dams or the expansion of the sewerage system.

Länder and local governments should keep in mind that a scheduled renewal of roads, buildings or other infrastructure must already factor in climate change. It may be worthwhile to invest in especially weather-proof asphalt, for example, a scenario for which the study also does a cost-benefit analysis. "We must be better prepared for extreme weather events in particular, perhaps by maintaining flood plain areas as a means of flood protection", said UBA President Flasbarth. "The study serves as a guide to identifying effective and cost-efficient adaptation measures. In these times of tighter budgets in particular, we simply cannot afford to make investments that later prove to be ineffective."

The UBA study introduces criteria for a standardised evaluation of the costs and benefits of adaptation measures. The study presents 28 case studies in the areas of agriculture, urban planning and infrastructure investment.

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http://www.umweltbundesamt.de/sites/default/files/medien/515/dokumente/4298.pdf

The study "Cost Evaluation of Adaption Measures for cities and municipalities (in German language)

Adapting to Climate Change:

A Question of Colour?

Researchers around the world are looking for the best environmental technology to respond to the challenges of climate change and the urban heat island effect in growing cities. One focus of attention is the roof area. Apart from installing Green Roofs, other "cool roof" options are being discussed. These include using white waterproofings or painting dark roof surfaces white. White roofs are a cost effective means of significantly reducing the urban heat island effect and building heat in the summer by reflecting the sunlight. Apart from the health aspects, the lower temperatures mean substantial energy savings on air conditioning in buildings. The study titled "Urban adaptation can roll back warming of emerging megapolitan regions" which was carried out by an American research group is providing a lot of material for discussion. It compares Green Roofs and white roofs with regard to the city climate and the indoor temperatures. It is worth examining the article more closely to better assess the results.

The approach

Researchers looked at how Green Roofs, white roofs and a hypothetical combination of the two could reduce climate warming in various regions of the USA. To provide a more aggravated situation for the climate simulation, urban expansion in different scenarios was included together with the anticipated global warming. The prognosis was projected as far as the year 2100.

The results

White roofs performed slightly better than Green Roofs across the country. There were varying degrees of differences in the cooling effect depending on the region though. While the difference between both "cool roof" options was 1.2 °C in dry California, it was only 0.2 °C in hot and humid Florida. The best cooling values were achieved with the hypothetical combination of both techniques where more light was reflected by the white roof and the Green Roof gave evaporative cooling. However, negatives also came with the positives of the white roofs in the simulation.

Not a panacea for climate change adaption – white roofs

Green Roofs are ecological all-rounders

The researchers claimed that the increased reflection from white roofs would mean higher heating costs during the winter months. Even more importantly, the white roofs could have a negative impact on the precipitation. The researchers believe that widespread white roofs could lead to a 2–4 mm reduction in rain per day, depending on the region. Over the year, this could mean a reduction of 700–1400 mm, which would have a massive effect on the city climate and the water supply of the ecosystems.

Conclusion

It is not surprising, therefore, that the researchers do not want to generally recommend white roofs and stress the point that the choice of environmental technique should always match the local situation. They further recommended unsealing land as a further measure to reinstate natural water cycles.

Critical assessment

Painting roofs white as a quick and cheap step towards active climate protection is not a new idea. The American Nobel Prize winner and Secretary of Energy Steven Chu already put the idea forward at the beginning of Obama's presidency. Painting a roof surface white is easier and cheaper than installing a Green Roof, that´s true. But it is important to point out, though, that the whiting only addresses the energy aspect of climate protection and adapting to climate change. White roofs, unlike Green Roofs, do not store rainwater. There is no relief for the drainage and sewage systems during periods of heavy rainfall. The humidification of the ambient atmosphere from subsequent evaporation would also be missing.

Further shortfalls include biodiversity, filtering air pollution and protecting the roof waterproofing from extreme weather conditions. Not to mention the aesthetics. The two techniques are not interchangeable. If one decides to paint his roof white, he will get a lot less ecology for his money.

Author: Wolfgang Ansel, IGRA

Source or Sink:

Runoff Water Quality from Green Roofs

A study carried out by the Universities of Manchester and Leicester (UK) caused quite a stir last year. The quality of the runoff water from a Green Roof and a conventional roof surface was compared and presented in a paper titled "Metal and nutrient dynamics on an aged intensive Green Roof". The elevated lead content found in the runoff water from the Green Roof gave way to a host of press articles with headlines like "Do Green Roofs do more harm than good?" which challenged the ecological usefulness of Green Roofs. On closer examination of the study report, it is clear to see that individual points were taken and then simplified and misrepresented by the press.

The approach

An approximately 400 m², 43 year old roof on the Manchester University campus which carries an intensive Green Roof with grass and herbaceous vegetation was chosen as the research object for heavy metal and nutrient fluxes in runoff water. A partial area of the roof only covered with paving slabs served as the non-landscaped reference area. As well as rainwater runoff, Green Roof substrate samples and dust deposit samples from both roof areas were analysed. The heavy metal and nutrient content of the rainfall was also examined. The investigation period lasted 6 months.


Environmental Pollution

Metal and nutrient dynamics on an aged intensive green roof

The report was published in the journal "Environmental Pollution"

The concentration of the following elements was measured in detail:

Nutrients/Anions: chloride (Cl-), nitrate (NO3), phosphate (PO4), sulfate (SO4)

Heavy metals: chrome (Cr), manganese (Mn), iron (Fe), nickel (Ni), copper (Cu), zinc (Zn), lead (Pb) and cadmium (Cd)

The English threshold value for the protection of surface water was used as a reference for the quality of each sample.

The results

The nutrient contents lay below the threshold values for the protection of surface water in all 3 samples (Green Roof, bare roof and rainfall). The median values of heavy metals for zinc and copper (all samples), lead (Green Roof and bare roof) and cadium (rainfall) exceeded the threshold values. If the nutrient and heavy metal input of the rainwater is included in the runoff balance of both roof types (flux model), then it becomes clear that, with the exception of lead and sulfate values, the roof runoff values are almost all lower than the rainwater values. This means that a certain amount of heavy metals and nutrients is retained by the roof and do not, therefore, contaminate the drainage system. There is a simple explanation for the comparatively higher levels of lead found in the roof runoffs compared to those in the rainfall. Lead accumulates in the soil and does not degrade well. The researchers assume that the higher lead concentrations are due to its accumulation on the roof over decades. This was shown in the Green Roof substrate and dust deposit analysis, both of which demonstrated elevated lead values. The study also showed that the research site was in an area of elevated levels of heavy metal pollution at ground-level. One cause of the lead pollution in the area noted by the researchers could be traffic emissions from leaded petrol which was in use until 1985. The Green Roof was installed in 1970, which could account for some of the higher lead content of the substrate. In addition, it could not be ruled out, that lead flashings on the atrium roof contribute to the elevated lead values.

Conclusion

The researchers put forward various suggestions following the results of their investigation. One of these was to refrain from installing Green Roofs in areas where there is high pollution (e.g. along busy streets) because the accumulation of harmful substances could lead to elevated pollutant levels in runoff over time. They also classified the intensive Green Roof a "source" of lead pollution in the runoff in their study. The simplified adoption of this statement led to press articles with headlines like "Green Roofs may be a source of pollution".

Critical assessment

The study and the conclusions reached by the researchers raises the question whether the temporary storage of harmful substances in vegetated areas and its later eventual and reduced release is to be seen as a positive or negative environmental function. It is well known that Green Roofs act as environmental buffers at various levels. They also take on stormwater management functions when runoff peaks are reduced or delayed. Depending on the intensity of the rainfall however, there can still be some residual drainage. Nevertheless, there is no question that they relieve the sewage system in comparison to conventional roofs with direct runoff. Similar arguments can be used for airborne pollutants. The vegetation provides a buffer for negative effects, resulting in lower direct environmental pollution. A certain amount of the harmful substances can then be released over time while the rest remains stored in the substrate. To classify Green Roofs as "sources" of pollution because of this delayed release masks the real story. If the contribution of lead flashings on roofs to the runoff pollution is also factored in, then the real truth becomes even more blurred.

To suggest that Green Roofs should not be used in areas with high pollution is tantamount to suggesting that all ground-level vegetation should be avoided too, because it also filters out, binds and later partially releases pollutants. This is a hard to imagine scenario.

Author: Wolfgang Ansel, IGRA

Green Roofs store and purify rainwater. Copyright: ZinCo

Singapore:

Highlights from the Second International Skyrise Greenery Conference; 07–09 November 2013

Key global trends concerning urban greenery were discussed during the event as part of the second International Skyrise Greenery Conference as well as in companion conferences, workshops and public forums. Themed Density & Greenery: Evolving into Collaborative Cities, renowned international experts covered a broad range of industry-critical topics in keynote speeches and multiple plenary sessions, including Singapore's greening efforts from the government's perspective, greenery from the developer's perspective, and the growing market premium placed on property that incorporates different elements of living architecture. The multiple advances in modern technology that drive safe construction and maintenance of increasingly ambitious green projects were also at the forefront of discussion.

green urbanscape asia

7-9 November 2013

International Exhibition & Conference
On Landscape, Leisure, Greenery
Design, Construction & Technology

The plenary session kicked off with CEOs of Housing Development Board, NParks and Urban Redevelopment Authority sharing their efforts and visions in greening of Singapore. Highlighting prime examples of urban greenery from around the world, keynote speaker and architect Stefano Boeri spoke about his latest project, Bosco Verticale, a development that is poised to become the world's first-ever vertical forest with some 730 trees, 11,000 groundcover plants and 5,000 shrubs. Local industry leading lights also featured strongly in the conference programme with Dr Liu Thai Ker, noted for his instrumental influence on Singapore's urban landscape, and Wong Mun Summ, a leading local architect and founder of WOHA, giving keynote addresses on the first and second days of the conference, respectively. Biodiversity was another key issue at the conference, with delegate dialogue focused on ways that greenery enhances biodiversity of towns and cities, specifically the way urban greening trends allow for re-population of urban environments by insects, vegetation, birds and other animal life.

Mr Poon Hong Yuen, Chief Executive Officer, National Parks Board, said, "The inaugural GreenUrbanScape Asia, held alongside the Second International Skyrise Greenery Conference, presented our international and local participants with many opportunities to share best practices and to work together. This is a testament of Singapore's growing importance as a global hub for landscape and urban design solutions. It also augurs well for the continued expansion of the local landscape industry, which is key to achieving Singapore's vision of a City in a Garden."

Damian Tang, President, SILA said, "With presentations by 43 speakers from across the world, the ISGC conference provided an international perspective, highlighting the values that landscape architecture brings to the world's towns and cities, urban communities, and global economy, as a whole."

Keynote speaker Kathryn Gustafson from the USA, delivered an enthusiastic address to a packed audience of delegates.

Singapore's progress and role as the Asian "hub" for skyrise greenery was exceptionally showcased in the conference's technical tour component."

Maia, Portugal:

International Green Roof Conference in Maia – An Impulse for Green Roofs in Portugal

With more than 250 registrations, including 100 municipal technicians from 26 counties the International Green Roof Conference Maia 2013 (18th of October 2013) was extremely well attended. Speakers from the industrial, municipal and environmental sector provided the visitors with the opportunity to discuss the design and implementation of Green Roofs in all its facets.

List of Speakers: Maria João Pedrosa (Maia Municipality, Portugal), Ana Teixeira Mesquita (Landlab, Portugal), Wolfgang Ansel (International Green Roof Association, Germany), Edmund Maurer (Linz Municipality, Austria), Dusty Gedge (President of European Federation of Green Roof Associations, United Kingdom), Artur Pereira Fernandez (Green Roof technician, Coberturas Vivas, Spain), Bet Gimeno (Director of Normas Tecnológicas de Jardinería y Paisagismo, Spain), Isabel Castillo (Technical Director ZinCo CE S.L., Spain), Paulo Palha (Green Roof installation company Neoturf, Portugal) and João Nunes / Iñaki Zoilo (PROAP, Portugal)

Special emphasis was laid on strategies and municipal policies to support the local Green Roof market. In this context the conference delivered a kind of kick-off meeting for the development of Green Roof policies in Portugal. The conference was organized by the Portuguese company Landlab, in collaboration with the Municipality of Maia (Oporto).

IGRA member Paulo Palha (Neoturf) was one of the conference hosts

The public interest concerning Green Roofs is very high in Portugal

Videos of the conference are available at YouTube:
https://www.youtube.com/watch?v=il4P8e_ybvM
https://www.youtube.com/watch?v=p8qVv376_R4

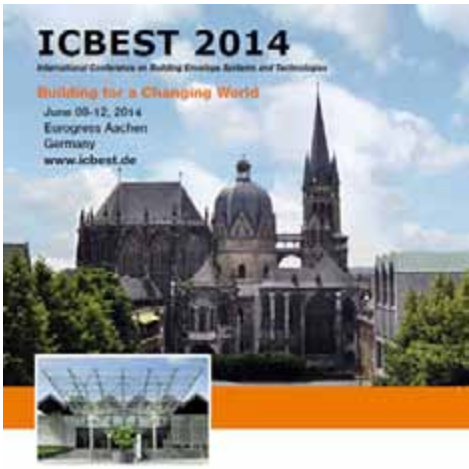
Aachen, Germany:

ICBEST 2014 – Building for a Changing World; 09–12 June 2014

The International Conference on Building Envelope Systems and Technologies (ICBEST) is a worldwide forum for building envelope engineering. It provides information exchange and discussions of recent developments and their application thus bridging the gap between architects, designers, engineers, manufacturers and researchers. The 2014 conference is the 7th ICBEST and the 1st to be held in Continental Europe.

This year's conference will focus on the central theme "Building for a Changing World". With the dynamics of an ever increasing population concentration in cities and high rise buildings, the financial crisis, climate change, peak oil and resource scarcity optimal building envelope systems and technologies will become even more important. Optimal adequate solutions need building up resilience against uncertainties. A radically changing world produces different demands and needs different solutions. So thinking in systems and developing alternatives will be the challenge for the future.

The abstracts which have been submitted cover topics such as new materials, proposals for life cycle assessments, better detailing, zero energy buildings and PV, Green Roofs as well as numerous lessons learnt. They will be discussed in no less than 3 parallel sessions. For further information please visit the website www.icbest.de.



Stoke-on-Trent, United Kingdom:

International Green Wall Conference; 4–5 September 2014

Call for papers and notice of the International Conference on Green Walls "Meeting the Challenge of a sustainable urban future: the contribution of green walls" to be held at the Green Wall Centre, Staffordshire University, Stoke-on-Trent, UK. 4–5 September 2014.

Green walls are an important component of Green Infrastructure – possibly the only cost effective approach to coping with some of the immense challenges currently facing urban areas: climate change (coping with extreme events e.g. heat-waves, flooding), pollution (including health impacts), lack of wildlife habitat, social problems (including mental health) resulting from high-density urban living. The green wall sector is exceptionally dynamic with new product developments and insights constantly emerging. For this reason Staffordshire University has convened this meeting to bring together researchers, manufacturers, installers, planners, architects, consultants, and developers to exchange information and learn of new developments in this exciting technology.

Further information is available at http://www.staffs.ac.uk/research/greenwall/conferences/index.jsp.

Green Islands in the City:

25 Ideas for Urban Gardens

Urban green spaces are gaining significance in our everyday lives and also contribute to our identification with the urban environment. The reclaiming of open spaces in cities has become a political issue that reflects quite different views and ways of dealing with this development. 25 landscape architects based in Germany, as well as an architect, outline in a prescribed form their ideal vision of an urban garden: their "favourite garden". Kamel Louafi asks the contributors about their approaches and visions, their way of working, as well as about issues such as sustainability and urban gardening. The book shows the wide variety of possible interventions of landscape architecture, presented through sketches and texts, which nevertheless have similar aims. Furthermore it proves the extent to which urban gardening influences our socio-cultural and aesthetic understanding. The book delivers a wealth of fascinating reflections about urban gardens – off the beaten track.

http://www.jovis.de/index.php?idcatside=4220&lang=2

Editor: Kamel Louafi

ENGLISH, FRENCH, ARABIC, GERMAN

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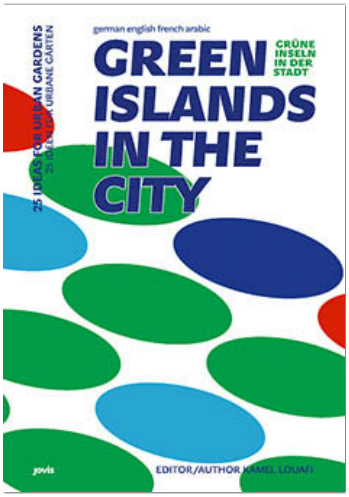

"Vertical Garden City, Singapore":

A New Book on Highrise Greening in Singapore

Launched at the Second International Skyrise Greening Conference in Singapore on 7 November 2013, Vertical Garden City, Singapore takes stock of Singapore's efforts to promote the greening of its highrise environment in recent years. The emphasis on urban greening has been a cornerstone of Singapore's urban development approach over the past five decades through different strategies that reflect the priorities of national development, including balancing development with urban sustainability, liveability and biodiversity conservation. As the city-state continues to develop and claim its place as a global city of the world, the emphasis on urban greening, especially in the use of innovative practices to integrate greenery with the various built elements of the urban fabric continues.

One key strategy it has adopted is to green up its vertical spaces as the new frontier of urban greening. In little more than a decade since the idea of skyrise greening was actively promoted in the city, numerous skyrise greenery installations now dot the city's landscapes. Several are striking architectural marvels, while others help to silently blend the buildings with its environment. How did the groundswell occur? What were the policy considerations and instruments used to promote the concept to the building industry? What more can and should be done? Vertical Garden City, Singapore describes the skyrise greening movement and efforts in Singapore, and profiles selected projects in the city that exemplify innovation, creativity and the boldness to try new ideas. This book also explores how an ecological perspective can help to derive more functions from skyrise greenery. It is a valuable resource to those who want to know more about Singapore's efforts in greening its vertical spaces.

This 192 page book is published by Straits Times Press (Singapore) for the Urban Redevelopment Authority and National Parks Board of Singapore. It is authored and edited by Dr. Tan Puay Yok, Associate Professor in the Department of Architecture in National University of Singapore, and featuring contributions by Prof. Manfred Koehler, Ms Linda Velazquez, Mr Steven Peck, Mr Emilio Ambasz, and Dr. Tan Wee Kiat. Dr. Tan Puay Yok has been active in the promotion of the greening of the vertical spaces of Singapore for the past decade. His research, teaching and professional activities focus on the policies, systems, and practices of urban greening and ecology of the built environment. He publishes widely in journals, books, and technical publications for the landscape industry, and advises on landscape design and planning for projects in the region as means of transferring knowledge from the academia to practice. The book can be purchased online at http://www.ura.gov.sg/uol/publications.aspx.

Editor: Dr. Tan Puay Yok

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