RESEARCH REPORT VTT-R-02444-13

Climate Adaptive Surfaces
CLASS workshop, 8.4.2013

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Confidentiality: Public

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Summary

This report is a summary of the "Climate Adaptive Surfaces (CLASS)" project workshop that took place at VTT on 08.04.2013. The workshop included 7 speakers from various industries associated with the development and implementation of permeable surfacing solutions for improving stormwater management in urban environments. The speakers and workshop participants were from within the project consortium as well as guest speakers from Belgium, Sweden and SYKE in Finland.

Confidentiality	Public

Espoo, 11 April 2013

Edited by	Accepted by
Erika Holt Principal Scientist	Eila Lehmus Technology Manager

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Distribution (customer and VTT)

Contents

1. Press release

Finnish project to identify solutions for flooding in cities

08.04.2013

New generation of water-permeable surfacing materials to be developed

Extreme weather conditions will occur more often in the future because of climate change. In Northern Europe, this means an increasing trend of heavy rainfall, particularly during the autumn and winter months. Flooding causes problems in dense urban environments where the water often cannot penetrate into the ground and rainwater collection systems lack the capacity for large volumes of water. VTT Technical Research Centre of Finland is leading a project that is seeking to identify flood water management solutions suitable for northern conditions through development of surfacing materials, technical design, and other means.

As cities grow and become more densely populated, an increasing portion of their surface becomes covered by hard, impermeable materials, such as asphalt and concrete. Together with the increase in rainfall, hard surface materials make urban flood management more challenging. New environmental regulations also require municipalities to find new ways of reducing the environmental load caused by pollutants in runoff water.

The two-year project develops new kinds of water-permeable surface materials to facilitate flood water management. These new materials can replace traditional dense asphalt, concrete and stone surfaces and reduce the accumulation of rainwater in areas such as streets and plazas. Flooding can also be prevented by developing sub-base structures, such as aggregate, pipes, geotextiles and water storage tanks.

The CLASS project is partly funded by Tekes, the Finnish Funding Agency for Technology and Innovation. In addition to VTT, project participants include the cities of Helsinki, Espoo, Vantaa and Oulu, as well as 12 industrial partners and associations.

There is close cooperation with the parallel Swedish project that focuses on sustainable urban development of solutions for green and grey surfaces. This project is coordinated by CBI and financed by the Swedish Governmental Agency for Innovation Systems VINNOVA. There are 22 project partners.

In both projects, the Finnish and Swedish cities that participate in the projects plan to pilot the permeable materials developed in the project, as well as the sub-base and water management systems.

Further information:

Project web page: http://www.vtt.fi/sites/class/index.jsp?lang=en

Tutkimushanke: Tulvavedet hallintaan kaupungeissa

08.04.2013

Ratkaisu uuden sukupolven vettä läpäisevät pintamateriaalit

Äärimmäiset sääilmiöt ovat lisääntymässä ilmastonmuutoksen seurauksena. Suomessa tämä tarkoittaa muun muassa lisääntyviä rankkasateita etenkin syksyisin ja talvisin. Tulvavedet aiheuttavat ongelmia tiheästi asutuissa kaupungeissa, joissa vesi ei usein pääse imeytymään maaperään ja sadevesiviemärien kapasiteetit eivät riitä suurille vesimassoille. VTT:n vetämässä hankkeessa etsitään Suomen oloihin sopivia ratkaisuja tulvavesien hallintaan muun muassa pintamateriaaleja ja teknistä suunnittelua kehittämällä.

Kaupunkien kasvaessa ja tiivistyessä yhä suurempi osa niiden pinta-alasta on kovien vettä läpäisemättömien materiaalien, kuten asfaltin ja betonin peittämää. Kovat materiaalit tuovat sademäärien lisääntyessä kaupungeille kasvavia haasteita tulvien hallintaan. Myös uudet ympäristösäännökset edellyttävät kunnilta uusia keinoja valumavesien ympäristölle aiheuttaman kemikaalikuorman pienentämiseksi.

VTT:n johtamassa kaksivuotisessa hankkeessa tulvavesien hallintaan kehitetään muun muassa uudenlaisia, vettä läpäiseviä pintamateriaaleja. Uusilla materiaaleilla voitaisiin korvata tiiviitä asfaltti-, betoni- ja kivipäällysteitä ja vähentää näin sadevesien kertymistä esimerkiksi kaduille ja toreille. Tulvimista voidaan ehkäistä myös kehittämällä pinnan alla olevia rakenteita, kuten betonisoraa, putkistoja, suodatinkankaita ja vesisäiliöitä.

CLASS-hanke on Tekesin osarahoittama. VTT:n lisäksi hankkeessa ovat mukana Helsingin, Espoon, Vantaan ja Oulun kaupungit sekä Rudus Oy, Lemminkäinen Infra Oy, Saint Gobain Weber Oy, Kaitos Oy, Pipelife Finland Oy, Puutarha Tahvoset Oy, HSY, FCG Suunnittelu ja tekniikka Oy, SITO, Ramboll Finland Oy, Rakennusteollisuus ja Kiviteollisuusliitto.

CLASS-hankkeessa tehdään tiivistä yhteistyötä ruotsalaisen ”Kaupunkiympäristöjen kestävän kehityksen mukaiset harmaat ja vihreät päällysrakenneratkaisut” -projektin kanssa. Ruotsalaisen betoni-instituutin CBI:n koordinoimaa hanketta rahoittaa Vinnova ja siinä on 22 partneria. Hankkeissa kehitettyjä vettä läpäiseviä pintoja ja niiden alla olevia kuivatus- ja vedenhallintajärjestelmiä on tarkoitus pilotoida projektiin osallistuvissa kaupungeissa.

CLASS-hankkeen verkkosivut: http://www.vtt.fi/sites/class/

2. Agenda

CLASS - "CLimate Adaptive SurfaceS" Workshop

Monday, April 8, 2013

VTT, Digitalo, Vuorimiehentie 3, Espoo

Invited: About 30 industrial parties, related to permeable surfacing, stormwater management including 16 project partners.

Goal: Overview of R&D related to developing permeable surfacing solutions for urban stormwater management. Identifying goals to be achieved for Finland's implementation of CLASS project results (2012 - 14). Event language is both Finnish & English.

CLASS project information: http://www.vtt.fi/sites/class/index.jsp?lang=en

* * * *

12.00	Opening Welcome Address (Matti Kokkala, Vice President, VTT, Built Environment)
12.10	Introduction (all participants)
12.15	CLASS Project Overview (Erika Holt, VTT)
12.35	Tekes "Smart Cities" Perspective for CLASS (Angelica Roschier, Tekes)
12.45	Swedish "Green-Grey" Project Overview (Björn Schouenborg, CBI Sweden)
13.15	International Perspective of Past & Future Permeable Surfacing (Anne Beeldens, BBRC, Belgium)
13.45	Coffee break
14.10	Urban Needs perspective for CLASS (Pirjo Siren, City of Espoo)
14.30	Material Development perspective for CLASS (Pia Rämö, Rudus Oy)
14.50	Urban & Stormwater Design perspective for CLASS (Perttu Hyöty, FCG)
15.10	Choices of Permeable Materials in Landscape Architecture (Jukka Jormola, SYKE - Finnish Environment Institute)
15.30	Panel: Question and Answers regarding R&D needs
16.00	Summary & Adjourning

3. List of participants

CLASS Workshop, 8.4.2013
Vuorimiehentie 3, Espoo

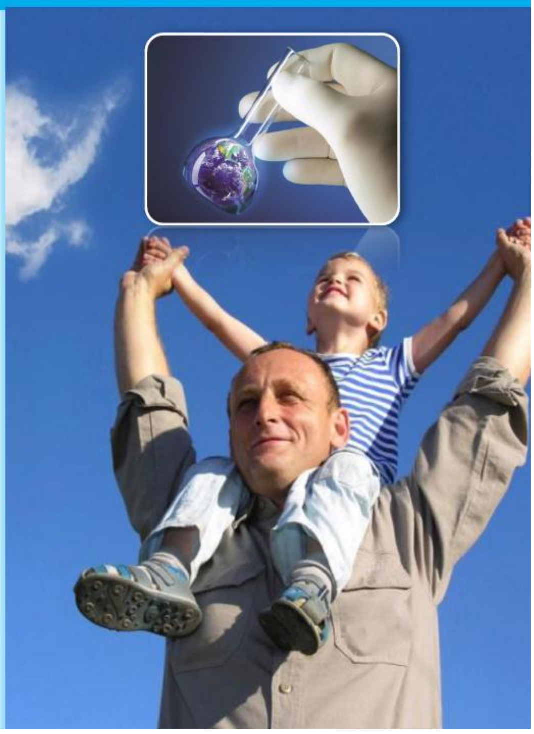
1.	Laura	Aaltonen	HSY Vesihuolto	Helsinki
2.	Mona	Arnold	VTT	Espoo
3.	Antti	Auvinen	City of Vantaa	Vantaa
4.	Anne	Beeldens	Belgian Road Research Centre	Brussels
5.	Henrik	Bodin-Sköld	Sweco	Gothenburg
6.	Olli	Böök	Kaitos Oy	Espoo
7.	Juha	Forsman	Ramboll Finland Oy	Espoo
8.	Marko	Heikkinen	Pipelife Finland Oy	Oulu
9.	Erika	Holt	VTT	Espoo
10.	Perttu	Hyöty	FCG Suunnittelu ja tekniikka Oy	Helsinki
11.	Ismo	Häkkinen	SITO	Espoo
12.	Jukka	Jormola	SYKE	Helsinki
13.	Perttu	Juntunen	Kaitos Oy	Espoo
14.	Terhi	Kling	VTT	Espoo
15.	Matti	Kokkala	VTT	Espoo
16.	Juhani	Korkealaakso	VTT	Espoo
17.	Gerald	Krebs	Aalto University	Espoo
18.	Kimmo	Kuisma	Helsingin kaupunki/Talous- ja suunnittelukeskus	Helsinki
19.	Hannele	Kuosa	VTT	Espoo
20.	Jari	Lahtinen	Kaitos Oy	Espoo
21.	Eila	Lehmus	VTT	Espoo
22.	Kalle	Loimula	VTT	Espoo
23.	Ari	Mantila	Rakennustuoteteollisuus RTT	Helsinki
24.	Pasi	Marjamaa	Espoon kaupunki, Tekninen keskus	Espoo
25.	Anniina	Määttänen	Lemminkäinen Infra Oy / Keskuslaboratorio	Tuusula
26.	Aino-Kaisa	Nuotio	Ramboll Finland Oy	Espoo
27.	Angelica	Roschier	Tekes	Helsinki
28.	Pia	Rämö	Rudus Oy	Helsinki
29.	Harri	Sara	Oy ViaPipe Ab	Vantaa
30.	Björn	Schouenborg	CBI Betonginstitutet	Borås
31.	Jouko	Selkämaa	RUMTEC Oy	Vantaa
32.	Nora	Sillanpää	Aalto University	Espoo
33.	Pirjo	Siren	Espoon kaupunki	Espoo
34.	Tiina	Suonio	Rakennustuoteteollisuus RTT ry	Helsinki
35.	Maria	Tikanmäki	VTT	Espoo
36.	Jouko	Törnqvist	VTT	Espoo
37.	Irmeli	Wahlgren	VTT	Espoo

4. Slides

WELCOMING WORDS:
Matti Kokkala, VTT Vice President,
Services & Built Environment
(matti.kokkala@vtt.fi)

VTT's mission

- VTT produces **research and innovation services that enhance the international competitiveness** of companies, society and other customers.
- VTT creates the **prerequisites for society's sustainable development, employment and wellbeing.**



Erika Holt, VTT

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PROJECT OVERVIEW:
Erika Holt, Project Manager

(erika.holt@vtt.fi)

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WORKSHOP GOALS

Gain suggestions about past experiences related to CLASS project, also from non-partner participants

Educate Finnish community about upcoming improved practices (expected project outcomes)

Provide community the opportunity to influence direction of CLASS project R&D actions

Encourage active dialogue about needs for permeable surfacing, design and stormwater management

Networking among interested parties, both in Finland and abroad

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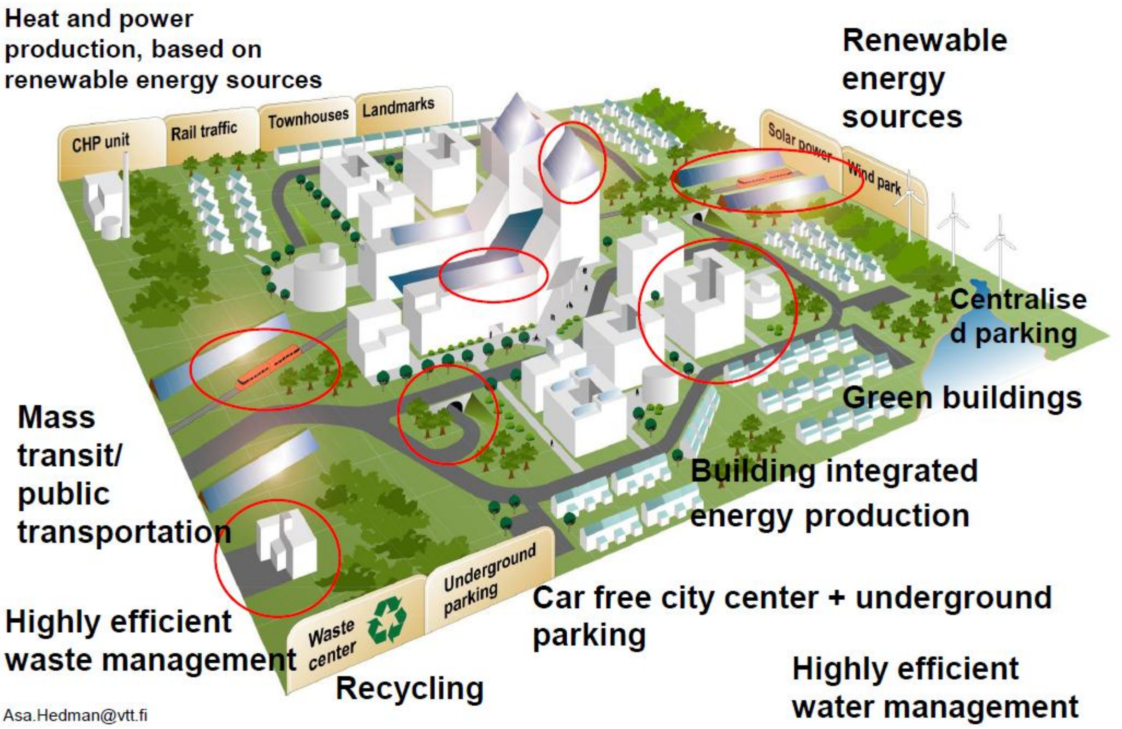
Eco-efficient district solutions



Project Example:
Uncertainty in the inference of climate data

Scientific and technological outcome

- Targe was: Assessing the impacts of climate variability and prediction uncertainty on the adaptation to climate change. VTT studied the prediction uncertainty of extreme weather events related to the statistical methodology, and develop an objective extreme value analysis method.
- Main results: Errors in the previous probabilistic methods have been revealed. A new optimal extreme value analysis method has been developed and demonstrated in the EWENT-project (EU).
- Exploitation potential: Planning of adaptation measures, improving design codes, decision making for future investments to infrastructure

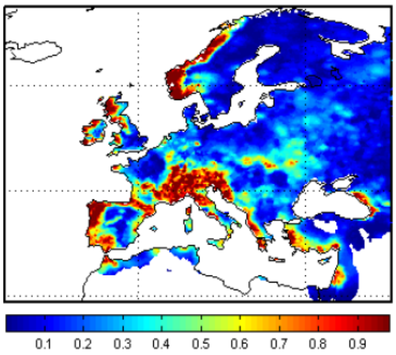
Impact in numbers (VTT)

- 3 journal papers, 3 conference presentations

Additional information

- Total volume: (Academy 354 k€ / VTT 453 k€)
- International co-operation: SMHI, Sweden
- Duration of the project: 01.01.2012-31.12.2014

- Contact person: Lasse Makkonen (VTT)



Probability of five-day precipitation exceeding 100 mm.

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Climate change adaptation in urban planning

Prediction of climate change
- Local climate in present situation: wind conditions...
- Predicted changes, extremes: temperature, precipitation, wind, snow

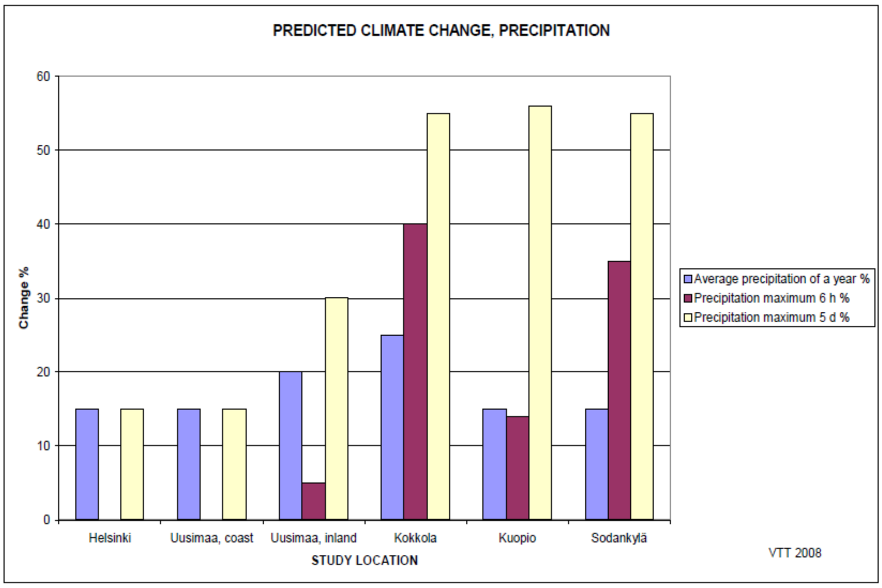
Regional plan, master plan
- On coasts and near water systems consideration of flood risk areas
  - Restrictions for location of functions
  - Lowest safe building heights
- Building areas, green areas and networks, agriculture and forestry…
- Complete existing urban form
- Rainwater management

Detailed plan
- Micro climate analyses
  - Present situation, situation after implementing plan
- Location and charasteristics of structures
  - Sun, wind, topography, soil, vegetation
- Rainwater management, drainage

Climate change mitigation at the same time

Climate change in urban planning

Predictions for study localities – changes in about 100 years



Extremes or maxima and minima describe on average once in a 50 year period exceeding (or going below) values

(Wahlgren, Kuismanen & Makkonen 2008)

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Ten golden rules for planner

1. Find out local climate conditions and predictions of their changes, especially extremes.
2. Find out possible flood risk areas. Don't locate building on them, if it is not safe and reasonable. Define lowest safe building heights.
3. Complete existing urban form. Don't locate new areas detached from existing structure. Avoid formation of new dispersed settlement.
4. Plan building areas and green areas and networks at the same time.
5. Form good micro climate by taking into account especially impacts of windiness.
6. Plan and make sure rainwater management also when precipitation increases strongly. Reduce surface water runoff to water system.
7. Form areas with combinations of row houses, low rise houses and blocks of flats rather than areas with loose big detached houses. Aspire to relatively dense structure. Promote district heating and use of renewable energy sources.
8. Find out prerequisites for public transport. Form area or structure so that it supports development of public transport. Form good walking and cycling environment.
9. Locate different functions near each other. Mix functions, don't separate.
10. Assess impacts on greenhouse gas emissions, choose best alternatives and solutions. Take into account also other views of sustainable development.

(Wahlgren, Kuismanagen & Makkonen 2008)

Project Example: Urban Flood Alarm System for Real Estates

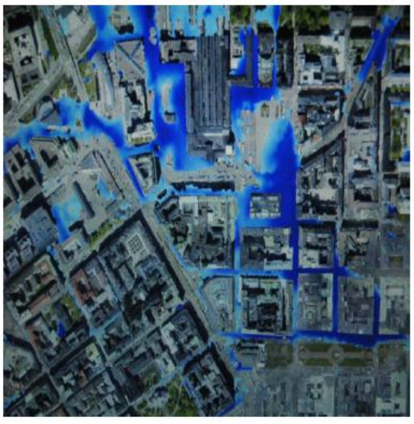
2009-2011: Research Project in Tekes Safety & Security Programme

Security challenge

- How to minimize the damages for people, property and business caused by heavy rain floods
- How to forecast where and when the flood is coming
- How and who should be informed beforehand and what is the information content

The solution: The prototype of a local early warning system for urban floods caused by heavy rains

1. **Heavy rain data collection** (measurements, weather forecast)



2. **Flood forecast simulations** (10 min, 20 min, 30 min, 1 h, etc.)

3. **Alarming + instructions** (Critical points analysis -> alarm)

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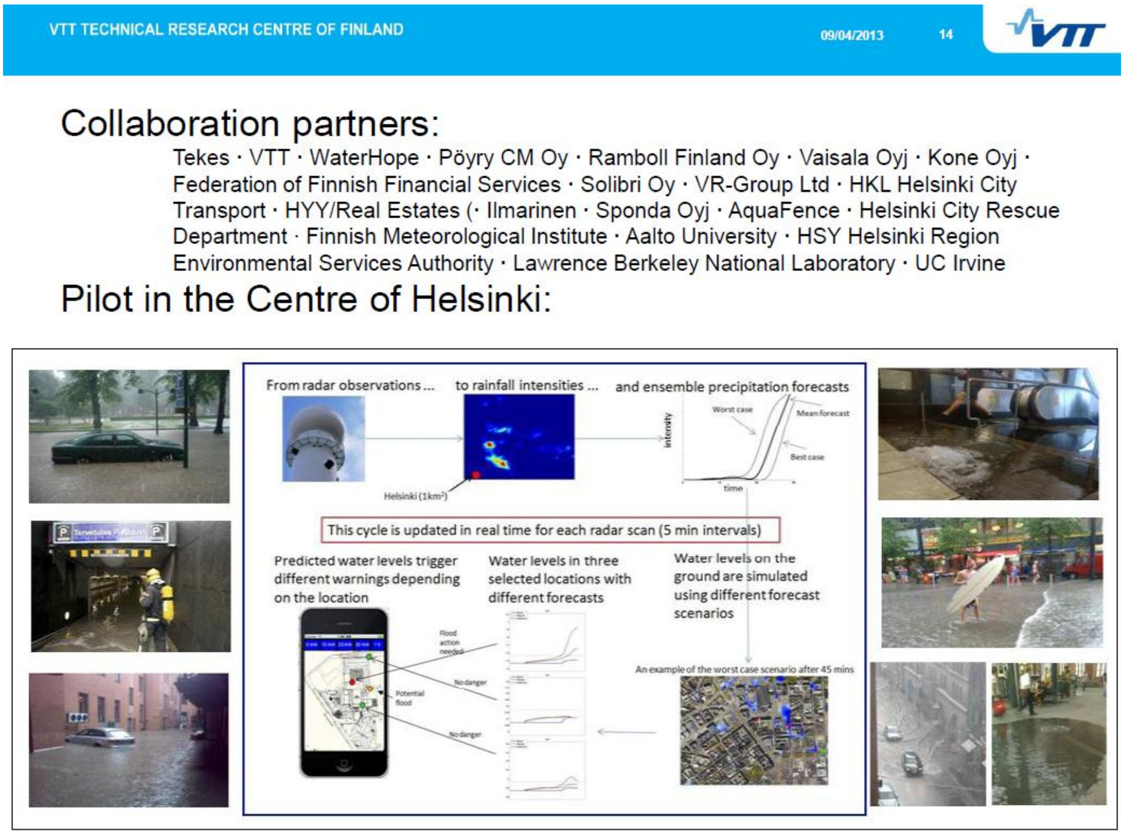

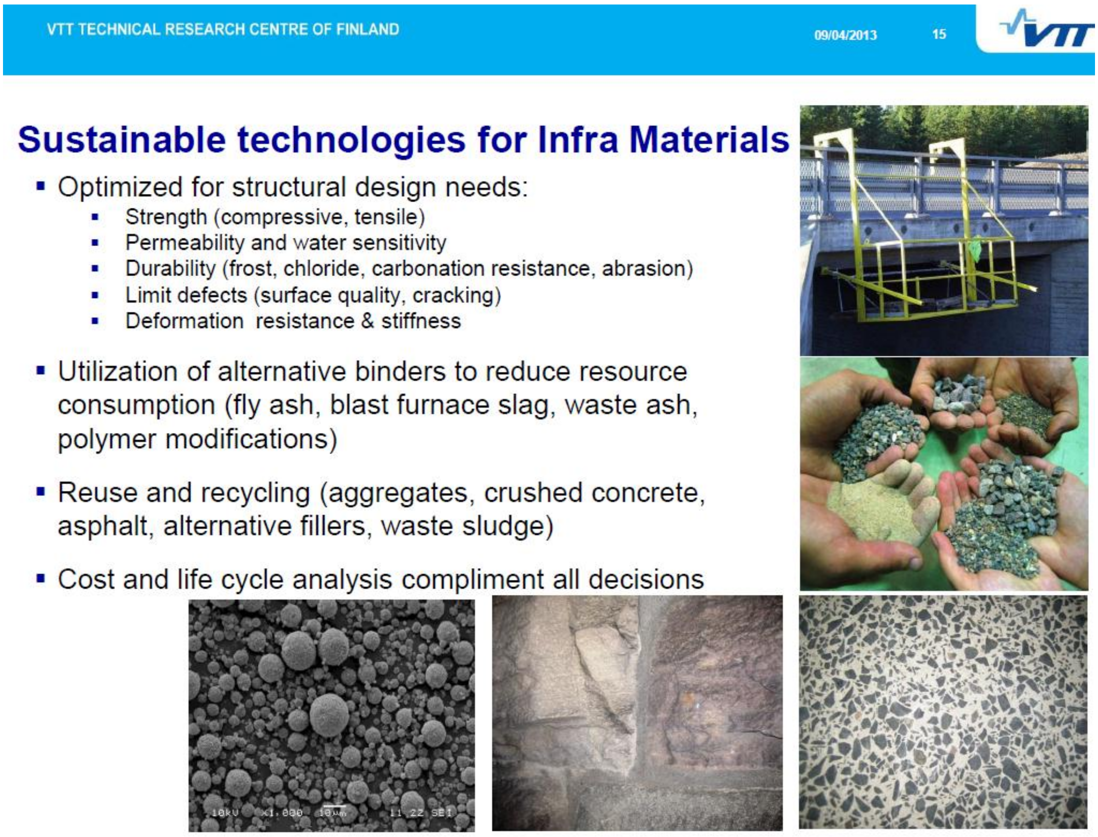

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VTT's knowledge on bituminous materials & asphalt pavements

- **Background**
  - **Asphalt Pavement Research Project (ASTO 1987-92)**
  - **Road Structures Research Programme (TPPT 1994-2001)**
    - **These programmes provided new durable asphalt pavement recipes, more intelligent mix design procedures, better construction and testing methods. They were also base for new improved Asphalt Pavement Specifications of PANK**
- **Recent Asphalt Research**
  - **Base course stabilization development project (TEKES/ INFRA-STABIL 2004-07).**
  - **Resistance of asphalt mixture to freeze-thaw cycles and combined effect of water and loadings (ASFADUR 2008-11)**
  - **A new way to improve accuracy of asphalt mixture testing methods e.g. water sensitive or freeze-thaw test (SATUR 2012-13)**
- **Present situation**
  - **VTT still has knowledge to carry out many kind of asphalt studies using its asphalt testing devices and methods**
  - **Today no one research laboratory in Finland can maintain all asphalt pavement testing methods and devices.**
  - **Co-operating with other laboratories and asphalt industry is the VTT's solution to answer to these challenges**

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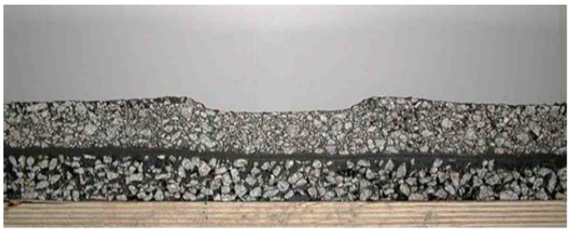
Project Example: Deformation resistance study of porous asphalt in multi-layered structures

The test was carried out for a bridge deck surface structure research project (report: VTT/ YKI 481/ 1998)

Composition of porous asphalt
- **Crushed aggregate 0/12 mm (Teisko granodioriitti),**
- **Bitumen type B80, content 5,1 m-%**
- **Voids content 26 %**

Porous asphalt layer
- **was easy compact**
- **had good horisontal water-carrying capacity in permeability test**
- **had high resistance to deformation in wheel-track deformation test**

Figure. Deformation rut of asphalt slab after the Wheel-track test



VTT laboratory wheel-track deformation test 1998
- **top layer of asphalt concrete AC 12, (30 mm)**
- **two-layered polymer modified bitumen sheet membrane waterproofing system (between two asphalt layers)**
- **bottom layer of porous asphalt PA 12, (30 mm)**

After 14000 loadings of 10 kN at +30 °C:
Results of deformation test:
No damages in layers of the waterproofing system
Permanent deformation of
- **Asphalt concrete layer 6,9 mm**
- **Porous asphalt layer 2,0 mm**

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Project Example:
Composite pavements of bitumen, cement and aggregate

VTT carried out in the TPPT-programme studies on five different types of composite pavements. The mixing method of bitumen, cement and aggregate, was different for every composite type:

A. Bitumen coated aggregate was mixed with cement mortar

B. Milled asphalt was mixed with cement mortar

C. Cement mortar was grouted into porous asphalt

D. Bitumen emulsion was grouted into porous concrete

G. Aggregate, cement mortar and bitumen emulsion were mixed with each other

The reference pavement type was the conventional base course asphalt concrete (type E)

The aim of composite studies was to develop road pavements or other infra structures, which are more flexible than cement stabilizations and have a better deformation resistance than asphalt pavements (during warm seasons).

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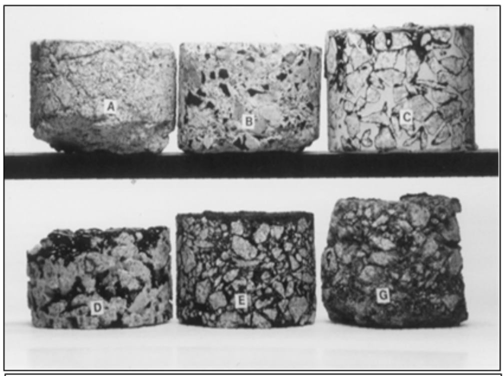

The best composite product was the cement mortar grouted porous asphalt.

Currently every big asphalt pavement contractor has an own brand product of this type.

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Project Examples: Concrete material durability

DuraInt project (2008 - 11) Effect of interacted deterioration parameters on service life of concrete structures in cold environments

- Laboratory studies on interacted deterioration
- Service life design (SLD) including interacted deterioration (freeze thaw + carbonation/chloride penetration)

Concrete durability field testing (2001 – on going)

- Excels database with testing results for different projects & field stations

TEKES-FiDiPro (2012 - on going - 2015)

- Addressing chloride penetration of concrete subject to frost attack, transport properties and service life design

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Examples of Recent Material Public Projects & Publications

- Nanotechnology in concrete technology
- Internal surfaces of mineral based materials
- Modelling of air structure based on mix design
- Guideline for selection of concrete aggregates
- Development of self-compacting concrete
- Development of self-cleaning concrete
- Development of foam concrete
- Aesthetic and durable design for optimal concrete bridge surfaces
- Building code for concrete construction quality
- Environmentally-friendly and durable concrete
- “BERTTA” LCA tool for cement and concrete manufacturers
- Effect of interacting deterioration on service life of concrete structures in cold environments
- Impact resistance of concrete structures
- Service life design of concrete structures
- Repair and restoration manual for concrete infrastructure

CLASS PROJECT: INNOVATION GOALS

- Develop new infrastructure surfaces for improved safety for future climate change, through improved handling of excess water associated with flooding.
    - Products (concrete, asphalt, stone) that are better and quicker draining or higher water holding capacity
    - Sub-base systems (aggregate, pipes, geotextiles, tanks) for high level of water inflow in short period
- Reduce risks to society and infrastructure owners
- Better prediction of water handling (modeling floods, alarm systems, maintenance etc.)
- Create new business opportunities with products and systems that lower flooding risks
- New adaptation solutions for urban planning

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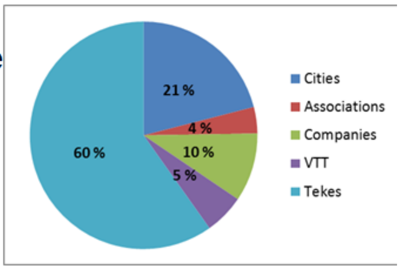
CLASS: PROJECT STATISTICS

- Project born in cooperation discussions with Swedish Cement and Concrete Research Institute (CBI)
- Finnish Project funding applied from Tekes "Intelligent Urban Built Environment"
- Project duration 2 years (Oct. 2012 – Oct. 2014), budget ~700 k€



- Demonstrations in urban environments expected 2015, separate project to be prepared
- Parallel 2-year project in Sweden: "Green-Grey" (summer 2012-14), funded by Vinnova and coordinated by CBI
- Considering joint EU and/or Nordic parallel studies, i.e. in EU 7th Framework 2013 Environmental call (submitted 2013) and future

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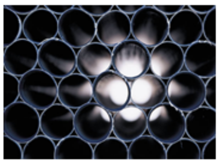
CLASS INDUSTRIAL PARTICIPANTS (Steering Committee)

- Cities of Espoo, Helsinki, Oulu, Vantaa
- HSY Vesihuolto
- Rudus Oy (aggregates & concrete products)
- Lemminkäinen Infra Oy
- Rakennusteollisuus (products side)
- Finnish Natural Stone Association
- Pipelife Ltd (drainage control)
- Saint-Gobain Weber /Leca (porous sub-base products)
- Kaitos Oy (geotextiles)
- Puutarha Tahvoset (landscaping/horticulture)
- Finnish Consulting Group
- Ramboll
- SITO





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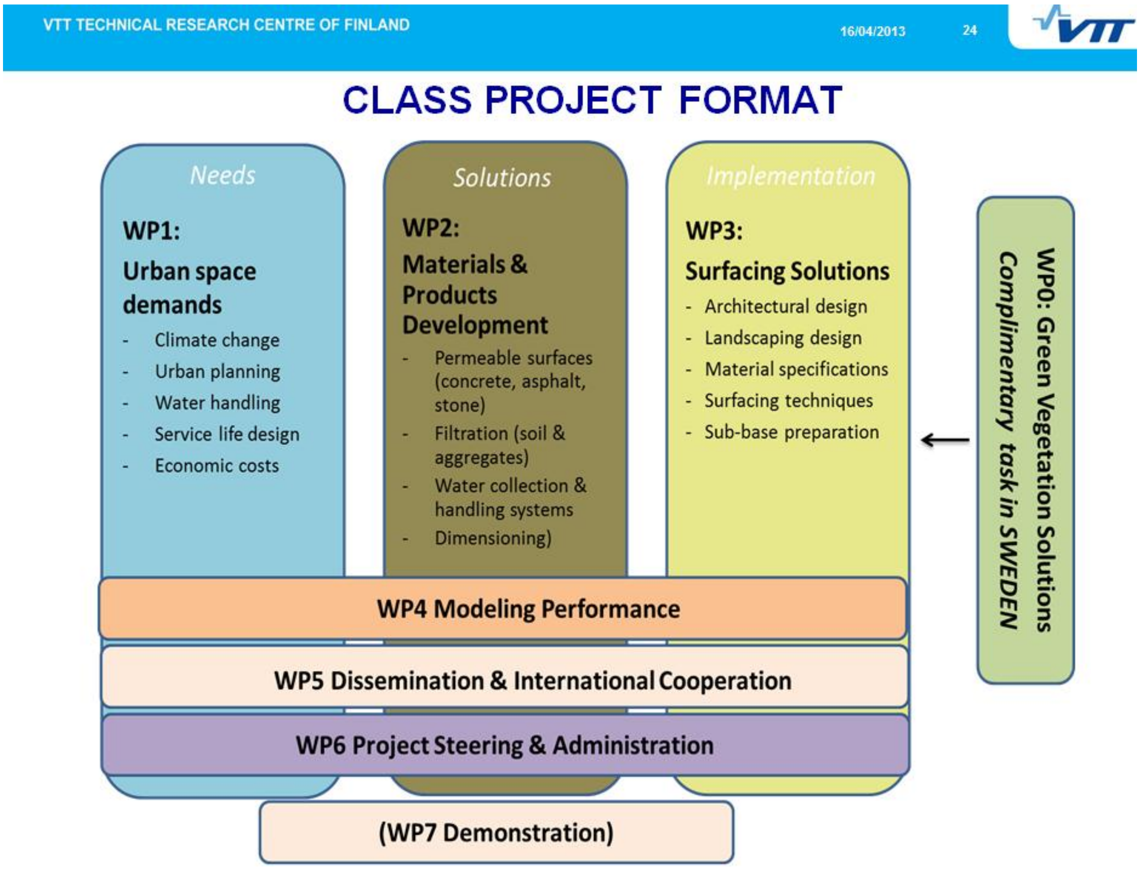

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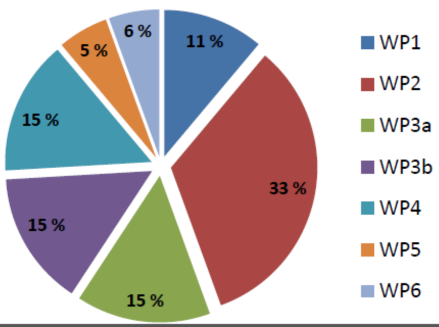
CLASS: WORK DISTRIBUTION

Work Packages	VTT Responsible Person	Person-Months
WP1: Urban Demands	Irmeli Wahlgren (+ Espoo)	6
WP2: Material Development	Hannele Kuosa	18
WP3a: Implementation (R&D)	Terhi Kling	8
WP3b: Implementation (design)	(Pipelife)	8
WP4: Modeling	Juhani Korkealaakso	8
WP5: Dissemination/Cooperation	Erika Holt	3
WP6: Projet Management	Erika Holt	3
TOTAL		54



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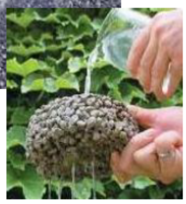
WORKPACKAGES & SUB-TASKS (1/2)

1. **Urban Space Demands**
    - 1.1 Evaluating urban planning & architectural implementation
    - 1.2 Evaluating water handling demands & capacities
    - 1.3 Evaluating surfacing solutions' service life & costs
2. **Materials and Product Development**
    - 2.1 Detailed Literature Review of existing technologies, especially for winter conditions
    - 2.2a Development of permeable concrete surfacing
    - 2.2b Development of permeable asphalt surfacing
    - 2.2c Development of permeable stone surfacing
    - 2.2d Evaluating permeable materials' performance
    - 2.3 Modifying filtration and soil for handling water inflow
    - 2.4 Adapting water collection systems for permeable surfaces



3. **Surfacing Solutions**
    - 3.1 Design (engineering & dimensioning) of landscaping top surfaces
    - 3.2 Design (engineering & dimensioning) of sub-base filtration/drainage
    - 3.3 Developing methods for construction & maintenance with permeable systems
    - 3.4 Developing guideline for permeable surfacing (design, construction, maintenance)

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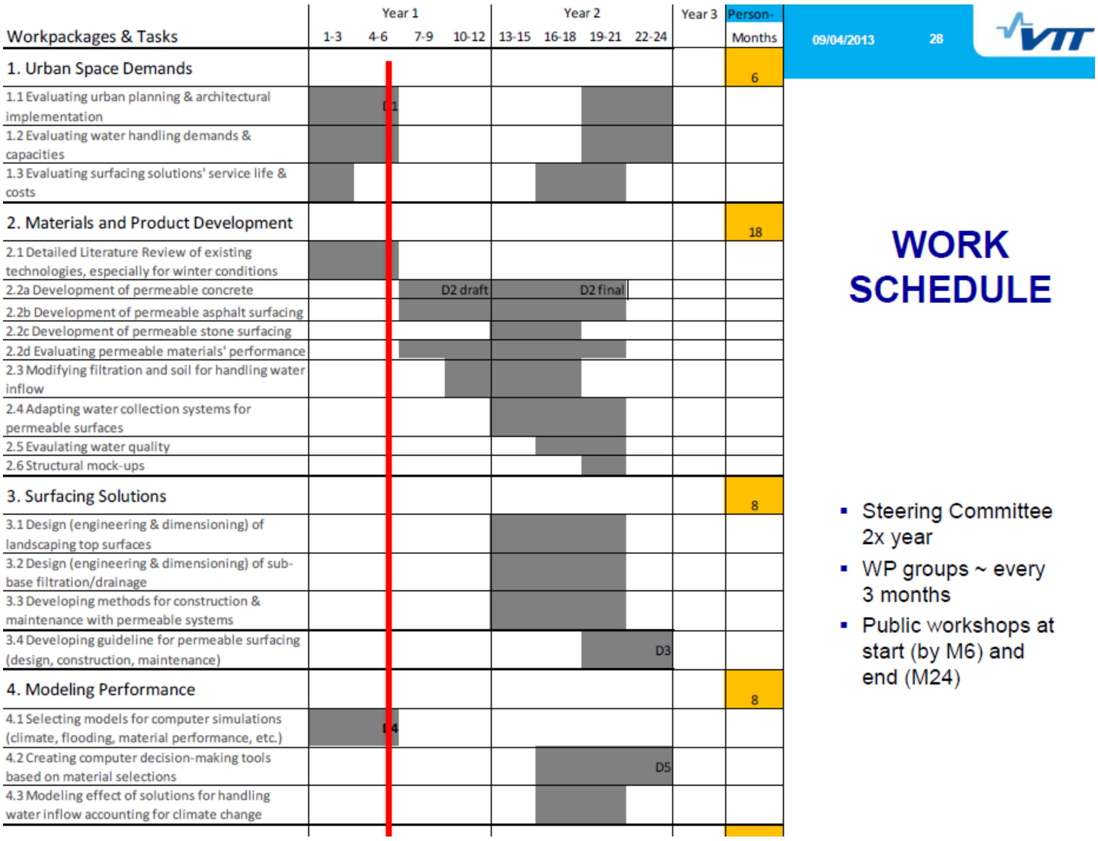
SUGGESTED WORKPACKAGES & SUB-TASKS (2/2)

4. Modeling Performance
    - 4.1 Selecting models for computer simulations (climate, flooding, material performance, etc.)
    - 4.2 Creating computer decision-making tools based on material selections
    - 4.3 Modeling effect of solutions for handling water inflow accounting for climate change

5. International Coop & Dissemination
    - 5.1 International Cooperation
    - 5.2 Project Dissemination & Workshops (WS)
6. Administration

7. Demonstrations (in year 3 – separate project)

Erika Holt, VTT



VTT TECHNICAL RESEARCH CENTRE OF FINLAND 16/04/2013 29

REPORTING & PUBLICITY

Follow project events & news via web: http://www.vtt.fi/sites/class/

Also for Swedish project: http://www.greenurbansystems.eu

2 public workshops planned, as well as press and trade journal "news"

Many Deliverable Reports to be publically available:

WP	Number	Deliverable Reports	Timing (Draft/Final)
WP1	D1	State-of-Art: Finnish needs & requirements for permeable materials & Water handling.	Month 6
WP2	D2	Material surfacing solutions performance, including cost effectiveness, winter durability, service life	Month 12/20
WP3	D3	Guidelines for design, use, construction, maintanence	Month 22/24
WP4	D4	Impact of permeable materials: water handling capacity, filtration & polutant control	Month 6
WP4	D5	Computer-based calcuation tools to support design & decision making	Month 22
WP5	D6/D7	Education and Dissemination plan (draft/final)	Month 6/26
WP5	-	Establish Project Web page	Month 1
WP5	-	2 Project Workshops	Months 3 & 24

Björn Schouenborg, CBI

Grey-green system solutions for sustainable cities
CLASS Workshop 8th April, 2013

A Vinnova project

(Sweden's Innovation Agency)

CBI Betonginstitutet
bjorn.schouenborg@cbi.se & henrik.bodin-skold@sweco.se
SP

Urbanisation - Million programme (65 – 75)*

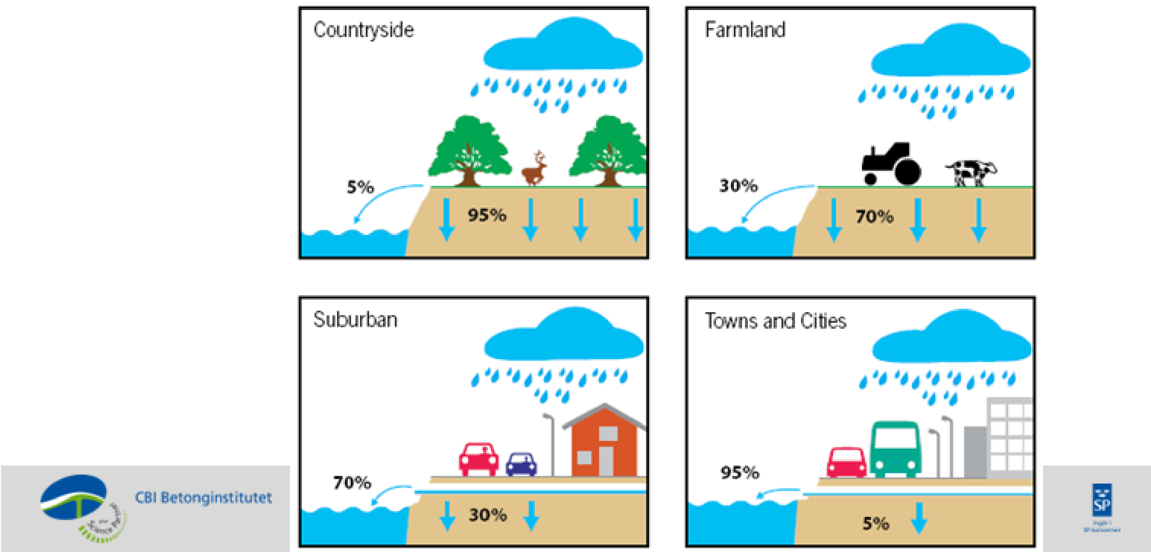
CBI Betonginstitutet

"One million new homes"

Björn Schouenborg, CBI

Consequences

Continued economic growth with increased urbanization creates problems due to increased use of paved surfaces i.e. **flooding**, less water filtration, declining city trees, even an Urban Heat Island effect.



Björn Schouenborg, CBI

City trees live a hard life

Several headlines show that cities have to spend millions of Swedish crowns on planting new trees since the existing ones die. In general their roots don't manage to grow where they should. They don't get water and they don't get the equally important gas exchange

Stockholm has approximately 12 000 trees in the inner city. 8 000 of them don't feel very well.

Trees die slowly and we often don't realise it before it is too late!

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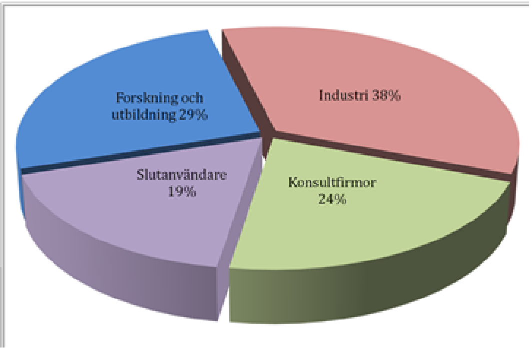
Björn Schouenborg, CBI

Short facts

- 2-year project, starting August 2012
- Possible 2-years extension for Demonstration
- Ca 20 M SEK (presently 2,2 M €)
- Funding 50 % Vinnova and 50% from partners and external projects
- More than 20 partners. No. of end users growing



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The consortium

- **Industry partners**: Stone Industry Federation, Starka, Benders, NCC, Sh Bygg, Cementa, Pipelife, Hasselfors Garden
- **Research organisations**: CBI, SLU Alnarp, VTI, SP, JTI, MinBaS.
- **Consulting companies**: SWECO, CEC Design, VIÖS. *Thorbjörn Andersson (land scape archit.)*
- **Purchasers and specifiers**: Cities and Municipalities (Stockholm, Malmö, Jönköping & Växjö). Several cities have joined

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WP 1 Social aspects and regulations

WP2 Hard made surfaces

- Dimensioning of hard made surfaces is not always easy.
- Permeable surfaces require permeable construction/subsurfaces.
- What traffic loads can a permeable construction cope with when wet
- Evironmental loads (contaminants) can be dealt with more efficiently
- Natural filtering and purification of stormwater

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Dimensioning of surfaces

- Most surfaces/pavings are dimensioned to cope with the **static loads**
- The **dynamic loads** are difficult to deal with
- The **interaction** of paving stones, jointing materials and beds below are all important for the performance
- The **standardised test methods** do not help much
- **Purchasers, specifiers and designers need concrete guidance and figures to work with**

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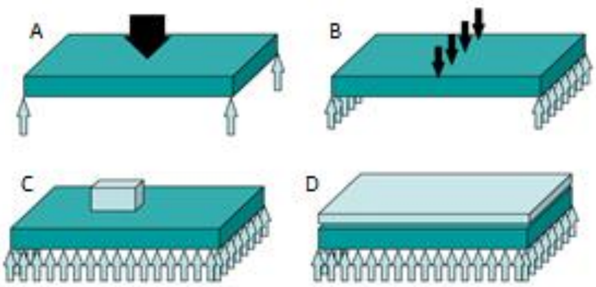
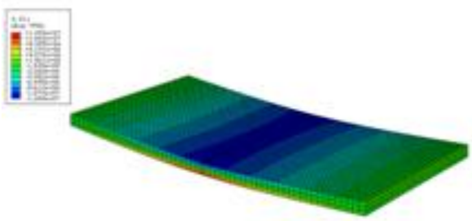
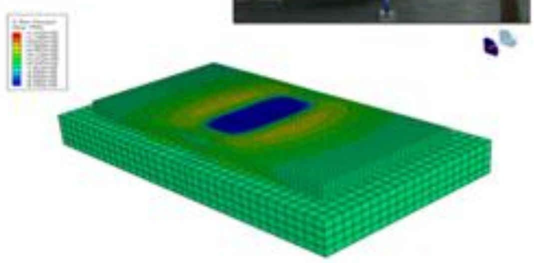
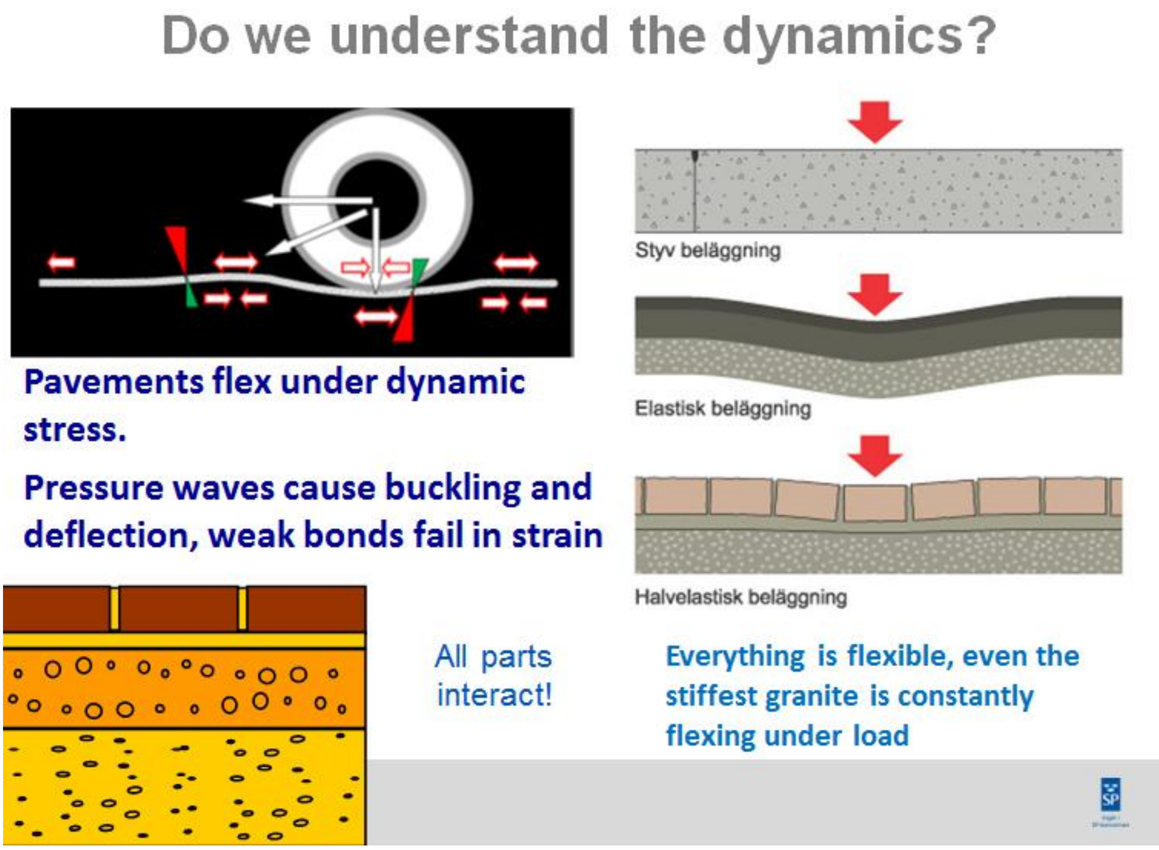
Testing in laboratory scale and simulation in full scale with different static loads







Björn Schouenborg, CBI



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Permeable surface solutions

Many varieties

Grid plate

Siena grass armour

Uni Ecoloc

Siena Eco

Challenges

Load bearing capacity VS plants

Maintenance

Acessibility

Aesthetics

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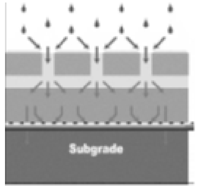
Permeable surfaces

Depending on ground properties



		System A Full infiltration	System B Partial infiltration	System C No infiltration
Permeability in the ground, k (m/s)	10^{-6} till 10^{-3}	Y	Y	Y
	10^{-8} till 10^{-6}	N	Y	Y
	10^{-10} till 10^{-8}	N	N	Y
Ground water level closer to 1 m from the terrasse		N	N	Y
Contamination risk in the ground		N	N	Y

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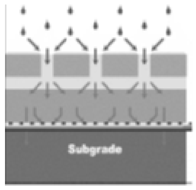
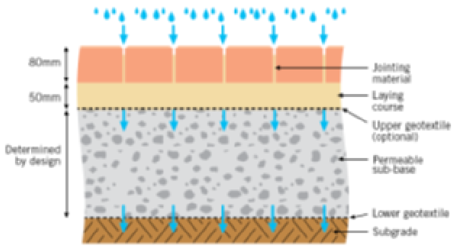
Permeable surfaces

Three types – Stormwater handling

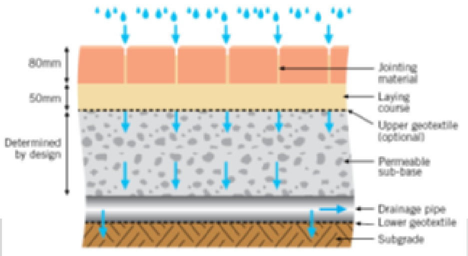




Type A: Full infiltration

Prevents contribution to stormwater systems. Relatively high infiltration capacity to the subgrade and nearby areas.

Very cost efficient.- Draining pipes are normally not necessary .



Type B: Partial infiltration

Similar to type A, but used when the subgrade has a lower infiltration capacity. Remained stablity in the subgrade. Provides a low contribution and a long detention to the stormwater system.

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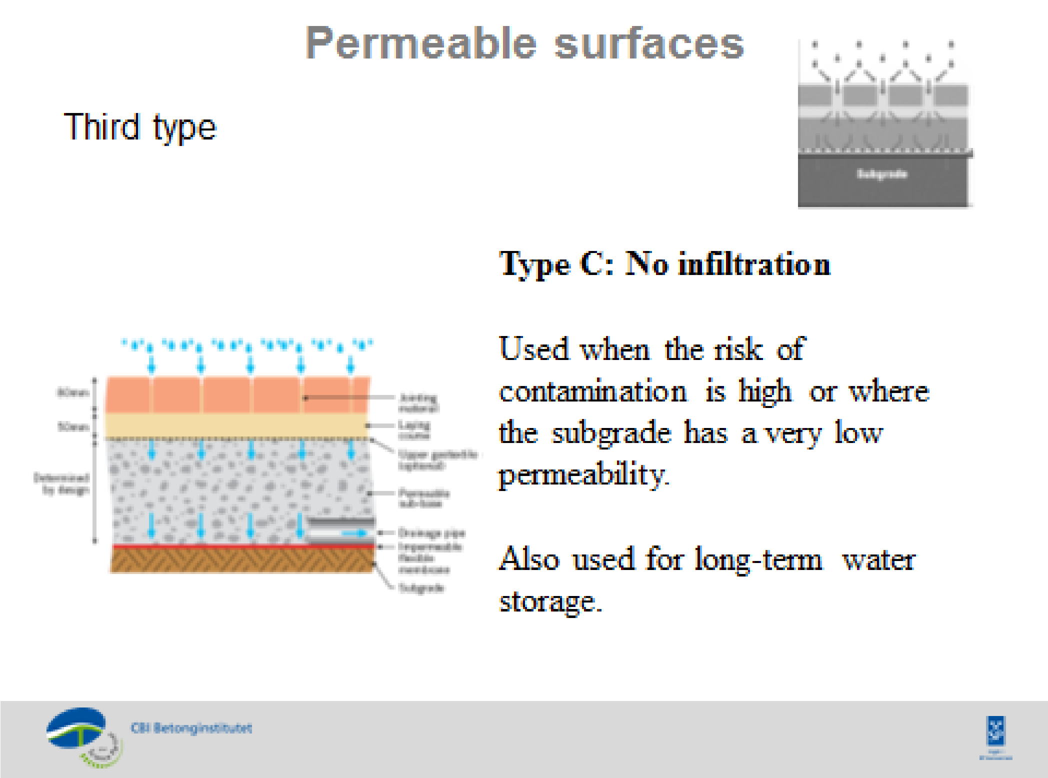

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Traffic loads

- Now we've got a permeable or semi-permeable construction.
- We have to check that it can cope with the traffick loads
- Testing of existing surfaces
- Testing in field laboratory of new construction design in dry and wet condition

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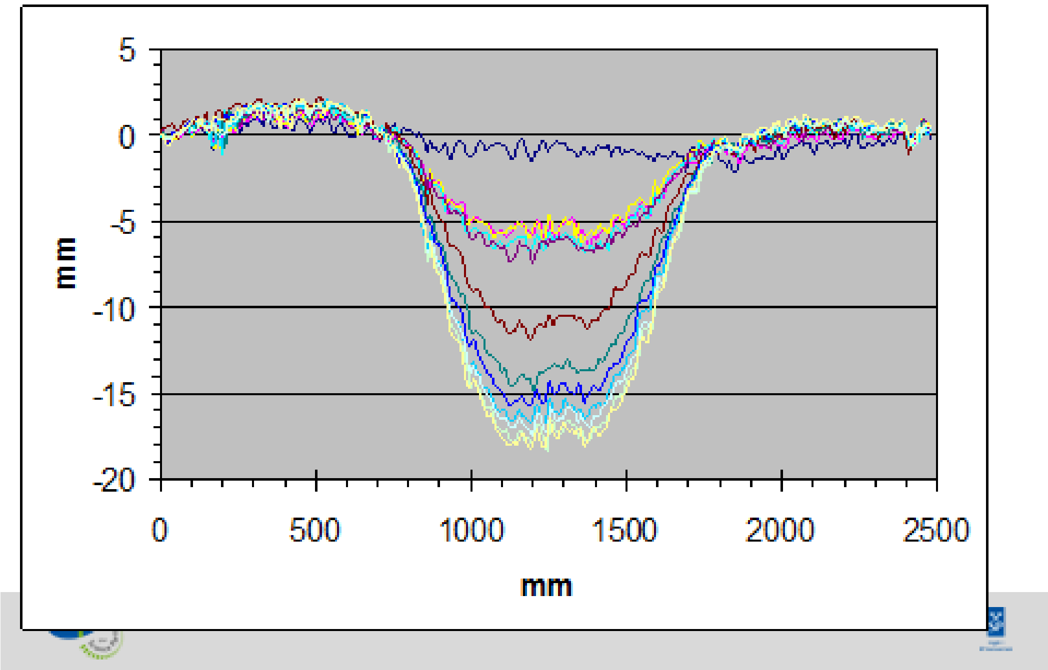
Heavy Vehicle Simulator (HVS)

Surface Laser Profile Measurements



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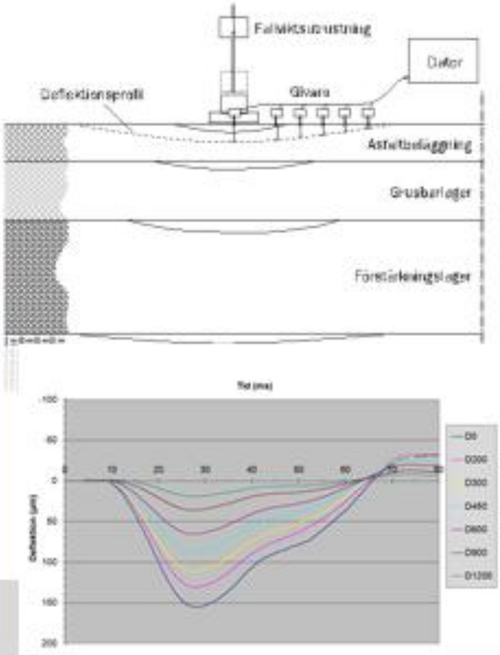
"Falling Weight Deflectometer"

Simulates the passage of a heavy vehicle.



WP 3 THE GREEN – Trees and other green surfaces

- Trees need healthy roots to survive
- The roots need **nutrition, water and oxygen**. The possibility for gas excange is as important as water!
- Roots that don't get water will try to find it elsewhere, often damaging pipes etc
- **One tree** is a very expensive investment; several thousands to more than ten thousand euros!
- Trees can deal with large amounts of water in a small area – retaining storm water
- Trees provide coolness by shadowing and evaporation

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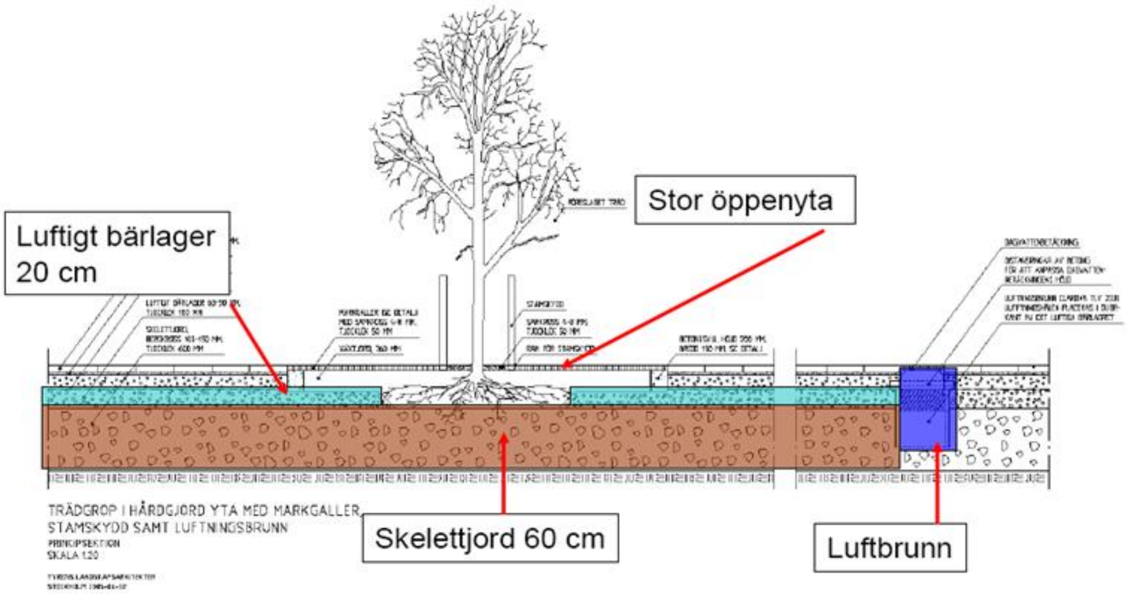
The vitality of a tree is enormous

Planting a tree is not to be taken lightly

Björn Schouenborg, CBI

Björn Schouenborg, CBI

Present solutions are good but very expensive and sensitive to construction errors



Construction of a ”structual soil”

Björn Schouenborg, CBI

Control after three seasons

Thriving trees!!

Björn Schouenborg, CBI

WP4 Storm water

- Storm water is often directed to the sea, lakes etc. In cases, also directly to water treatment plants and overloading them
- Climate change leads to more frequent flooding.
- We want the storm water to be filtered through the soil and cleaned at the same time
- A challenge is to work on drainage and make sure that the base court and subgrade are stable and not full of water. Too much water will make the construction unstable and may also drown the trees

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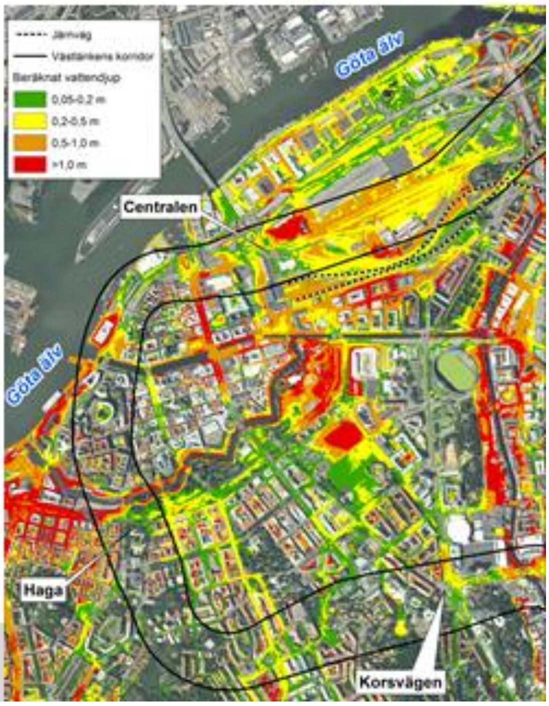
Simulation of stormwater consequences

Simulation of cloudburst shows where measures are needed most!

Here, the same amount of rain as in Copenhagen, 2011, but simulated for Gothenburg city:
130-150 mm in 1-3 hours



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WP4. Stages of the project

1. **Inventory and compilation** of solutions for level spreading and purification of stormwater in urban environments incl. management, sustainability, material selection, demands, regulations. **Evaluation. WP3, WP5, WP6**

2. **Selection of test sites,** for example Öringevägen (Tyresö) and Malmö (city park). Compilation of measurement data and analysis. If needed, flow measurements, samples and pollution analysis could be implemented. **WP3, WP5**

3. **Selection of materials** incl. plants and required depths for the effectiveness of stormwater purification and level spreading (pore volume). Propose new, innovative and improved solutions for managing stormwater in urban envionments. WP1,WP3

4. **Suggestion of solutions** for water conveyence to and from the stormwater solutions. **Transport** (gutters, channels, wells), inflow and connections to stormwater systems. **WP2**

5. Integration of grey-green system solutions in the process of renewing municipal water and sewer pipe systems. Evaluation of impact on climate changes. **WP1, WP2, WP5**

6. Producing in data to WP5, WP6 and to different models. **WP3, WP5**

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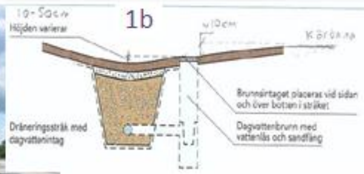
1a. Curb Extensions (green streets, biofilter)	Below-ground level plant beds with plants and/or trees for water level spreading and quality improvement of stormwater from streets. Gravel layers with underlying drain pipes. Data from 2012/2013 samples in Tyresö, Sweden.
1b. Swales with makadam magasines (bio filter)	Flat ditches with makadam magasines for water level spreading, conveyence and quality improvment of stormwater from streets. Svenskt vatten, publication P105
1c. Rain gardens (biofilter)	Below street-level green spaces for improvement of stormwater quality and spreading of water levels at school areas parking lots, crossroads etc.



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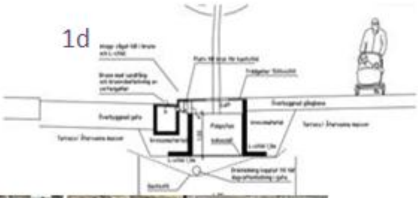
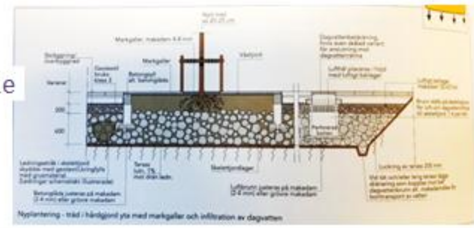
1d. Green beds for "street trees"	Below-ground plant beds for city trees in urban environments. Usage of special soil materials. The solution is currently implemented in Norra djurgårdsstaden, Stockholm.
1e. "Structual soil" according to AMA 2010, DCL.131	Plant beds for trees in urban environments. Stormwater input by air wells. Commonly used for sidewalks or walking/bicycle streets and therefore do not receive stormwater from street runoff.

1d

1d



1e



1e

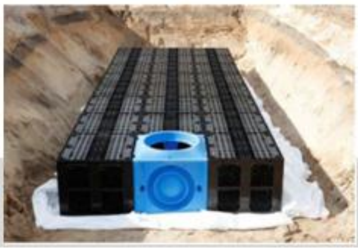
2a. Raster surface and permeable pavements	Draining surface of concrete raster (grass or gravel) or permeable pavements. Below-ground with drain pipes. Parking lots. Management is important for life lentgh of the systems. Svenskt vatten, publication P105.

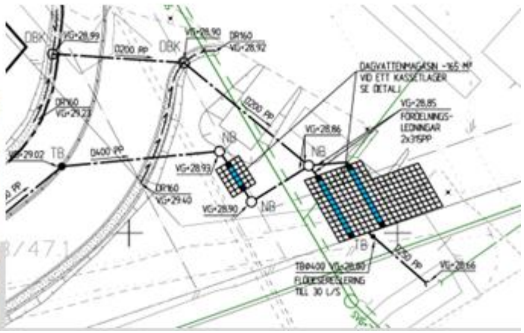
Björn Schouenborg, CBI

3. Stormwater boxes to handle the most severe flooding problems

- Retaining and detaining storm water
- Plastic boxes with 95 % open/efficient volume
- Dense or permeable
- 0,5 m above ground water level
- How do they cope with traffic loads?
- What is the mechanical performance when stacked on top of each other?
- **We lack quality requirements!**

Thomas Larm, Sweco





8a. Dry ponds	Below-ground green areas with bottom outflow for reglating of water flows, but also improvement of waterquality.

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WP 5 Climate effect

- Present situation: Case study from Malmö, Sweden. Results
- More green components in the city:
- Decrease the temperature fluctuations
- Preserve air moisture
- Provide shadow
- Retain storm water
- Increase peoples satisfaction

- Which improvements are possible? →
- How can we visualise our achievements?

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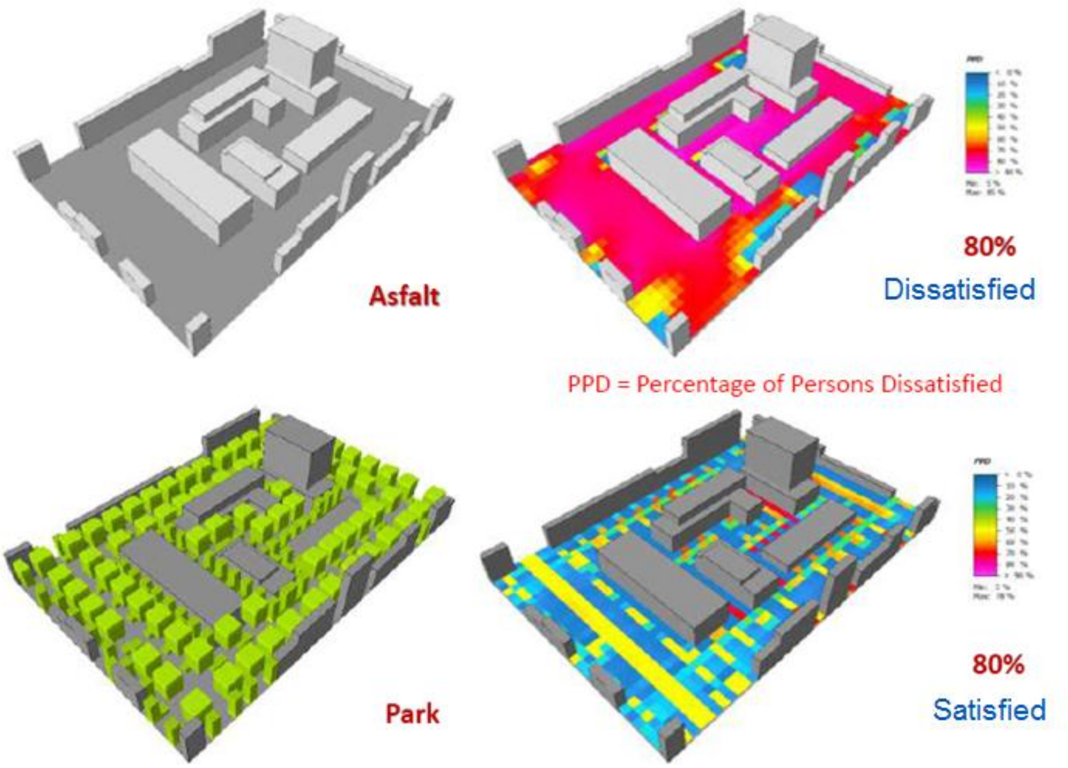
Climate change and influence



Björn Schouenborg, CBI

WP 6 Sustainable choises of materials, products and systems

Green procurement is more common today, but do the tools exist to compare different offers/solutions?

- Our solutions shall be sustainable
- Our solutions shall have as small negative impact on the environment as possible. Nothing wrong in recycling: We'll investigate crushed concrete as an alternative to rocks for the structural soils, whole crushed rock instead of natural gravel in the soils
- We include **LCA** to enable an unbiased comparison
- We want the planners and purchasers to look on the costs in short and long term. **LCC** is therefore included

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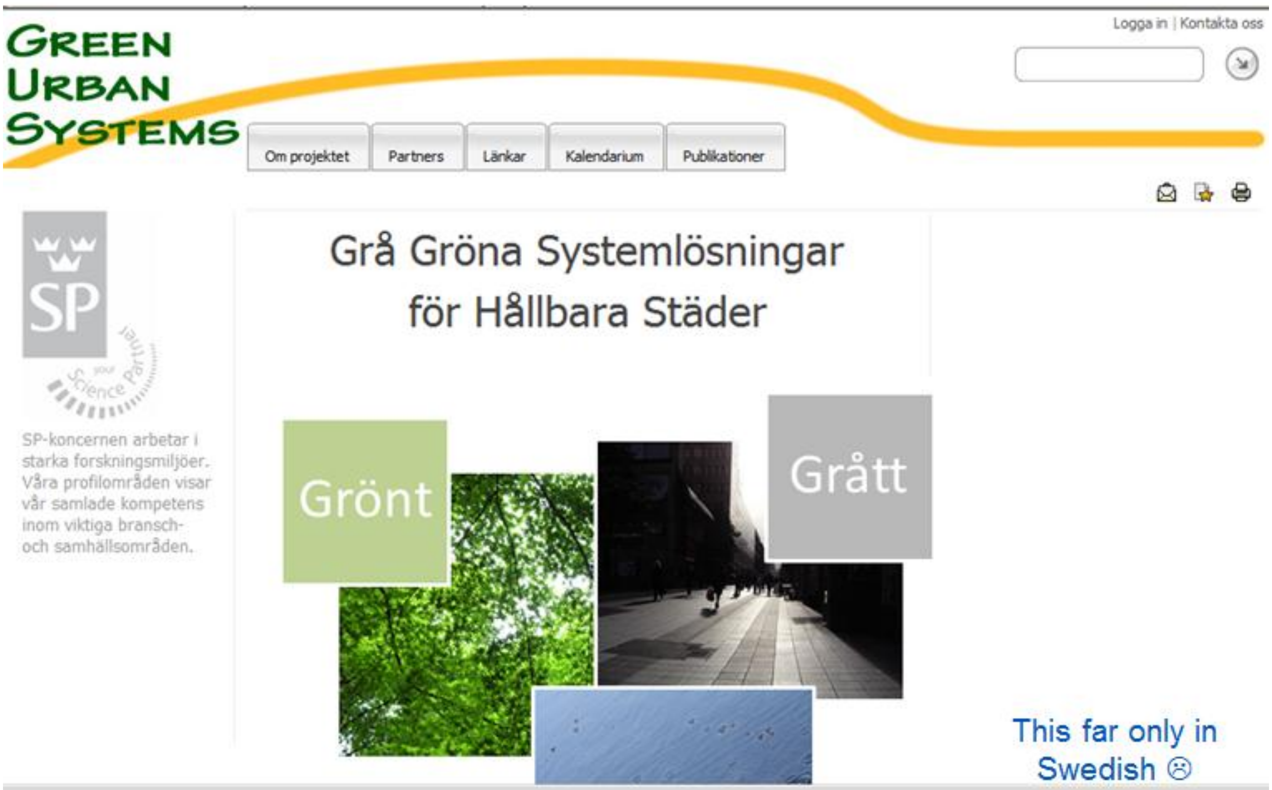
www.greenurbansystems.eu



Anne Beeldens, BBRC

Anne Beeldens, BBRC

Why do we apply permeable pavement blocks?

- *To optimize water management (storage and infiltration) by a minimum of investment*
- *To comply with legislations: new legislation in Flanders encourages and enforces in some cases the use of permeable surfaces as storage and/or infiltration system*
- *To combine an environmental friendly structure with traffic: combination of bearing capacity and water permeability, taking into account the necessary frost protection of the soil*

CLASS workshop, ESPOO, April 8th, 2013

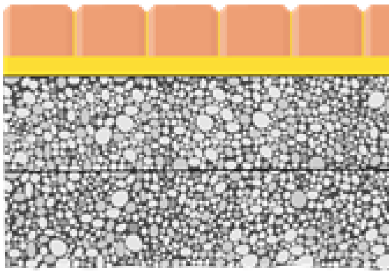
How does the application of water permeable pavement blocks develops in Belgium?

- *Main application on parking lots for cars*
- *Due to new legislation large increase in demand*

CLASS workshop, ESPOO, April 8th, 2013

Anne Beeldens, BBRC

The permeable pavement system in Belgium



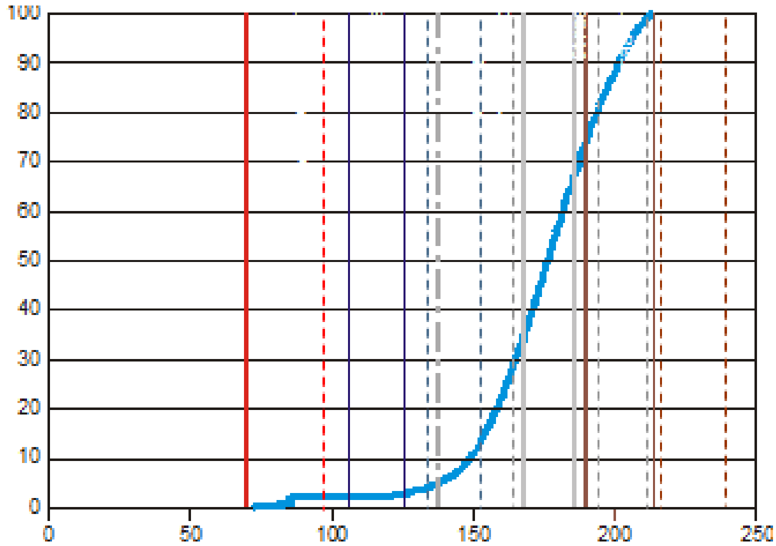
- *Pavement blocks: passing the water*
- *Base layer: bearing capacity*
- *Sub base layer: storage capacity and frost protection*
- *Drainage system: infiltration in the soil or retarded drainage of the water to an infiltration system*

NO gullies needed at the surface – extra security through adjacent green surfaces
NO slope requiered (0,5 % as min by preference – max. 5% - application in terrasses)
NO extra water storage capacity needed: reduced outlet in order to store the water in the structure

CLASS workshop, ESPOO, April 8th, 2013

Storage capacity – influence of the slope

Slope 1 % - 10 m further = 10 cm difference in height
=> Storage in sub base NOT in pavement blocks



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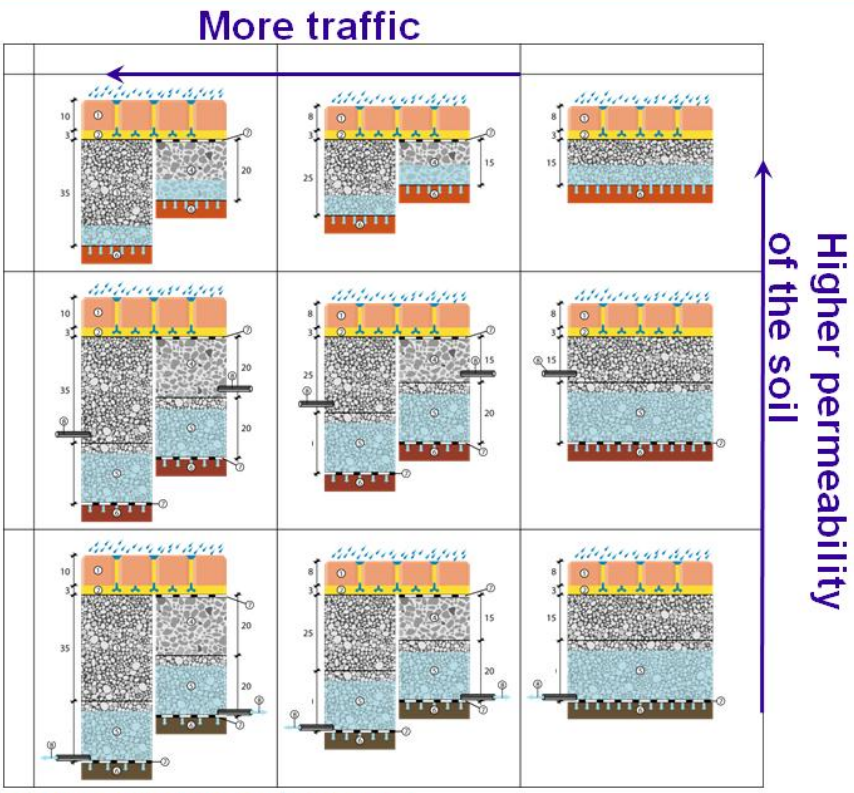
Standard structures in relation to traffic and soil permeability

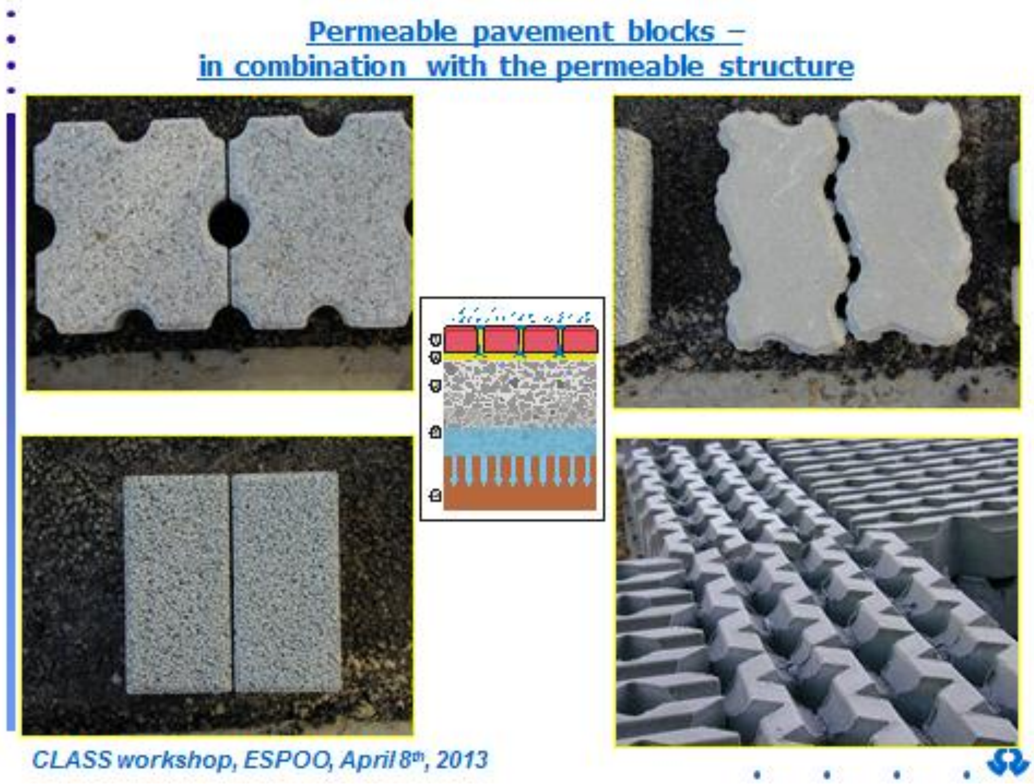


Materials - properties

- *Base and Sub base layer – unbound aggregates 0/32 – 2/32 :*
  - fines (<0.063 mm) < 3%
  - Fraction < 2 mm < 25%
  - If recycled concrete aggregates are used, no aggregates smaller than 2 mm
- *Base layer – bound material*
  - Drainage lean concrete: Permeability of $4 \cdot 10^{-4}$ m/s and strength of 14 MPa
- *Bedding layer*
  - fines (<0.063 mm) < 3%
  - Maximum grain size: 6,3 or 8 mm
  - LA < 20 – MDW < 15: reducing risk on formation of fines
  - Filter stability
- *Joint filling material – in relation to type of pavement block*
  - 0,5/2 sand for pervious pavement blocks
  - 2/4 porphyry aggregates for pavement blocks with enlarged joints or with drainage holes

AT ANY TIME: COMPROMISE BETWEEN MECHANICAL STABILITY AND PERMEABILITY

Anne Beeldens, BBRC



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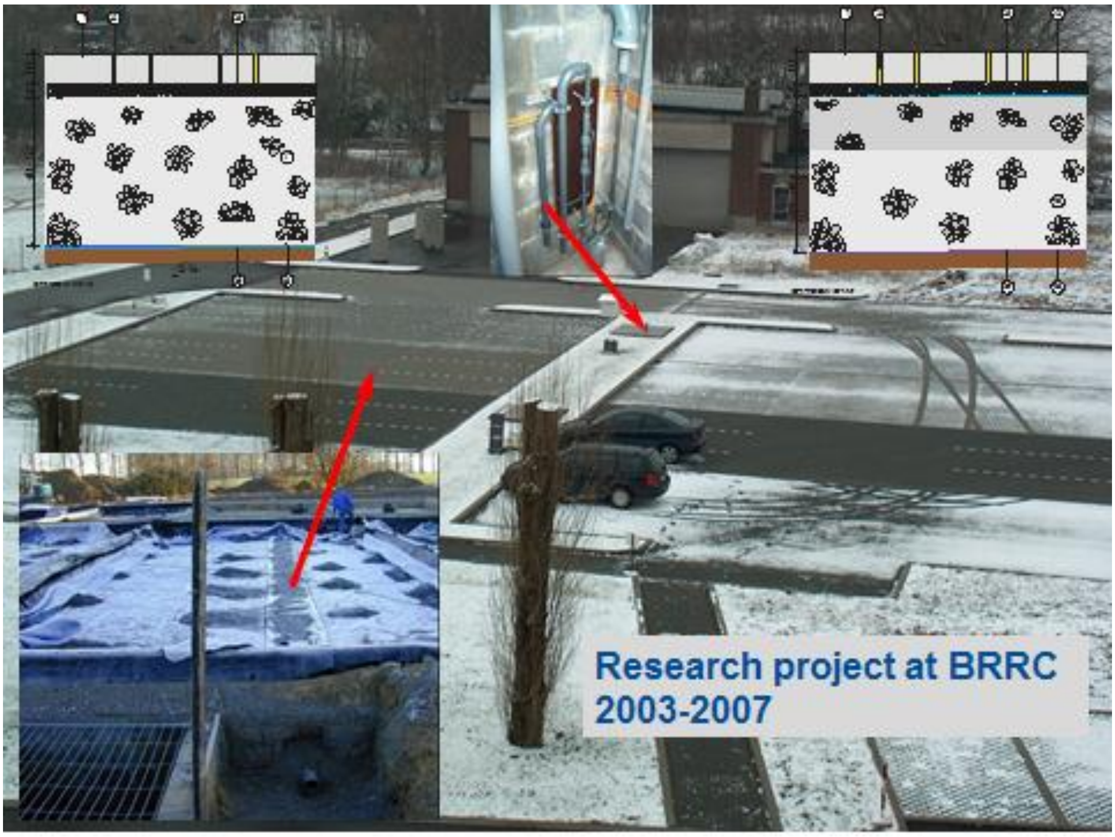
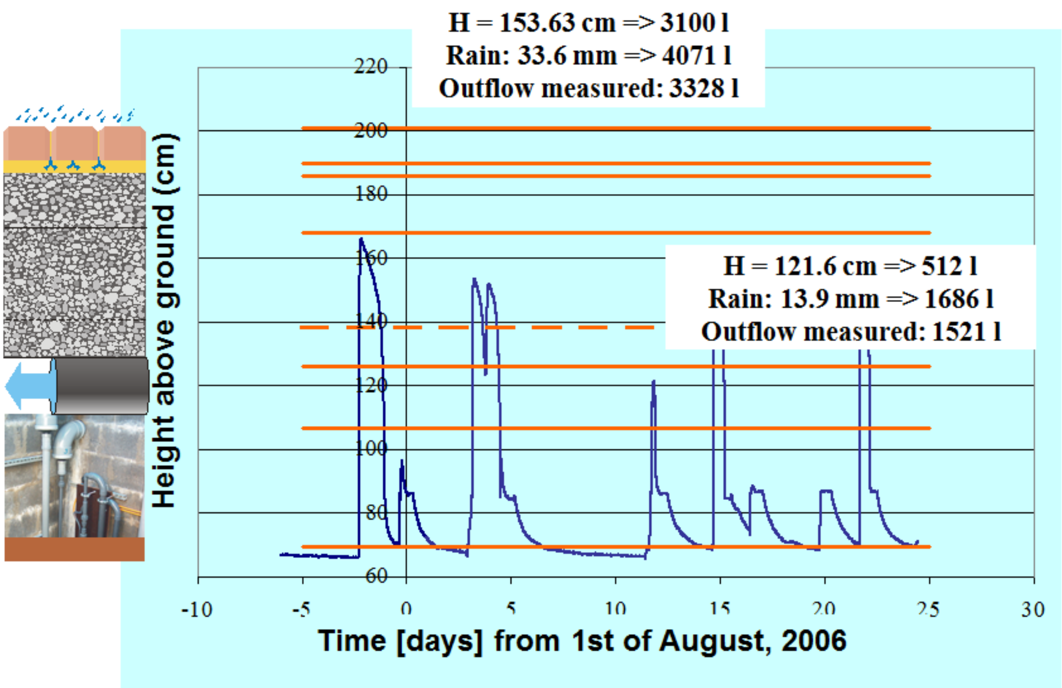


Height of water in the structure



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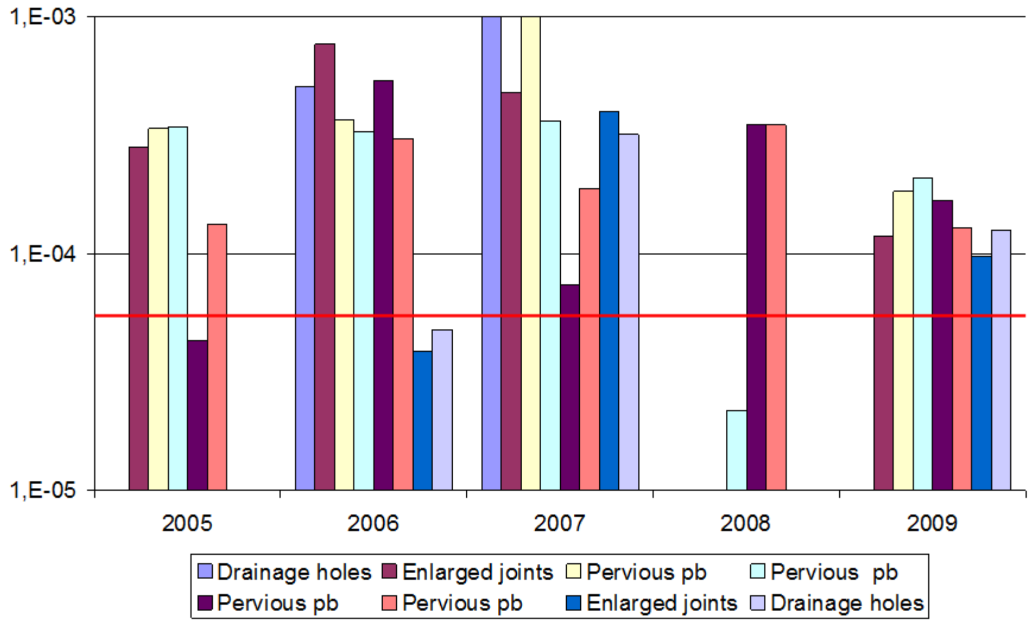
Surface permeability on parking lot



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Design volume for water storage in SUB BASE

- *Rain: average rain of 10 minutes with a return period of 30 years = 270 l/s/ha*

- *Successive rains:*

Outflow	Return period overflow			
	2 years	5 years	10 years	20 years
30 l/s/ha			180 m³/ha	240 m³/ha
25 l/s/ha		160 m³/ha	200 m³/ha	240 m³/ha
20 l/s/ha	120 m³/ha	170 m³/ha	210 m³/ha	260 m³/ha
15 l/s/ha	140 m³/ha	190 m³/ha	240 m³/ha	290 m³/ha
10 l/s/ha	160 m³/ha	220 m³/ha	270 m³/ha	330 m³/ha
5 l/s/ha	210 m³/ha	280 m³/ha	340 m³/ha	410 m³/ha

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D'Ieteren in Kortenberg
Sand bed 2/7; base layer 2/20; sub base layer 7/32 + 0/7

- *Road in jointed concrete plates*
- *Transition in pervious concrete pavement blocks*
- *Parking area in concrete pavement blocks with drainage holes (>30% porosity)*
- *70.000 m²*

CLASS workshop, ESPOO, April 8th, 2013

Projects on site: D'Ieteren

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Projects on site – surface permeability (measurements 2009)

Pavement blocks with enlarged joints

Paal, 2004 — $3{,}0*10^{-4}$ m/s

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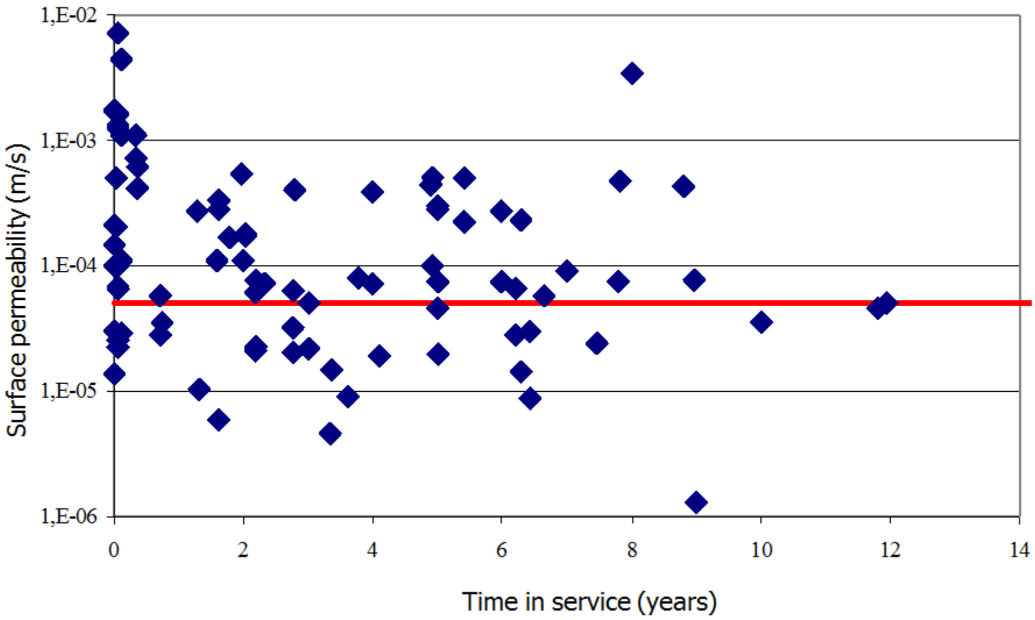
Projects on site – surface permeability over time



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BUT….

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Problems with design

Ertvelde,
Market Place
2004

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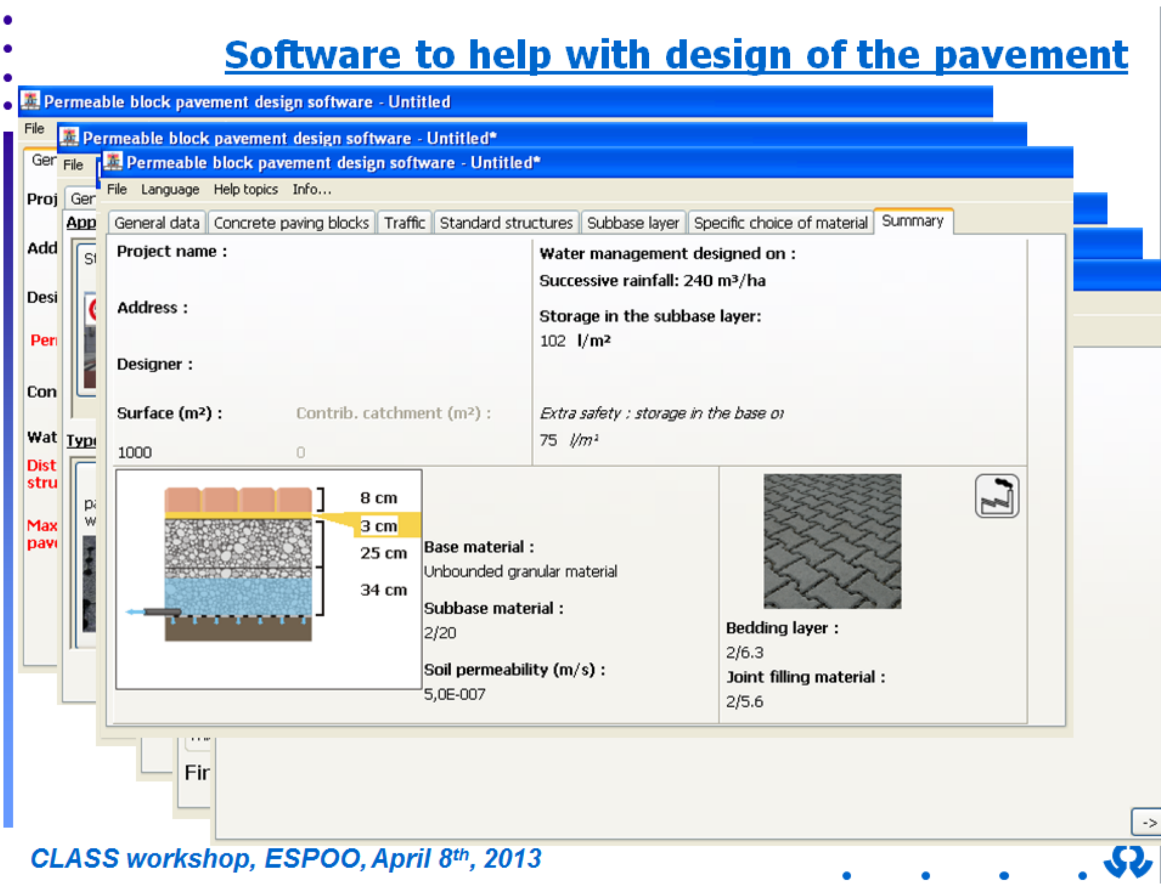

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New technical prescription PTV 827: Water permeable pavement system

- *Evaluation and certification of the whole system: drainage, sub-base layer, base layer, pavement blocks*
- *Specific structure is certified, taking into account the material characteristics as well as the placing of the structure on site*

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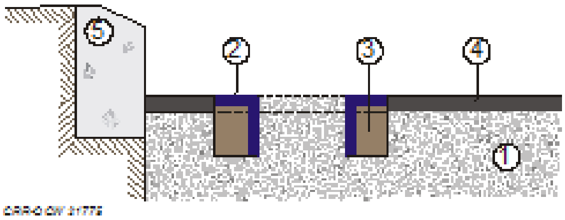
Special applications: water permeable structures in allotments

- *Risk of silting of structure during construction of houses*

Anne Beeldens, BBRC

Possible solutions to minimize risk of silting

- *Working in 2 phases: sub base and asphalt layer during phase 1, removal of asphalt layer and final base layer, bedding layer and pavement blocks in phase 2 after construction: water evacuation!*



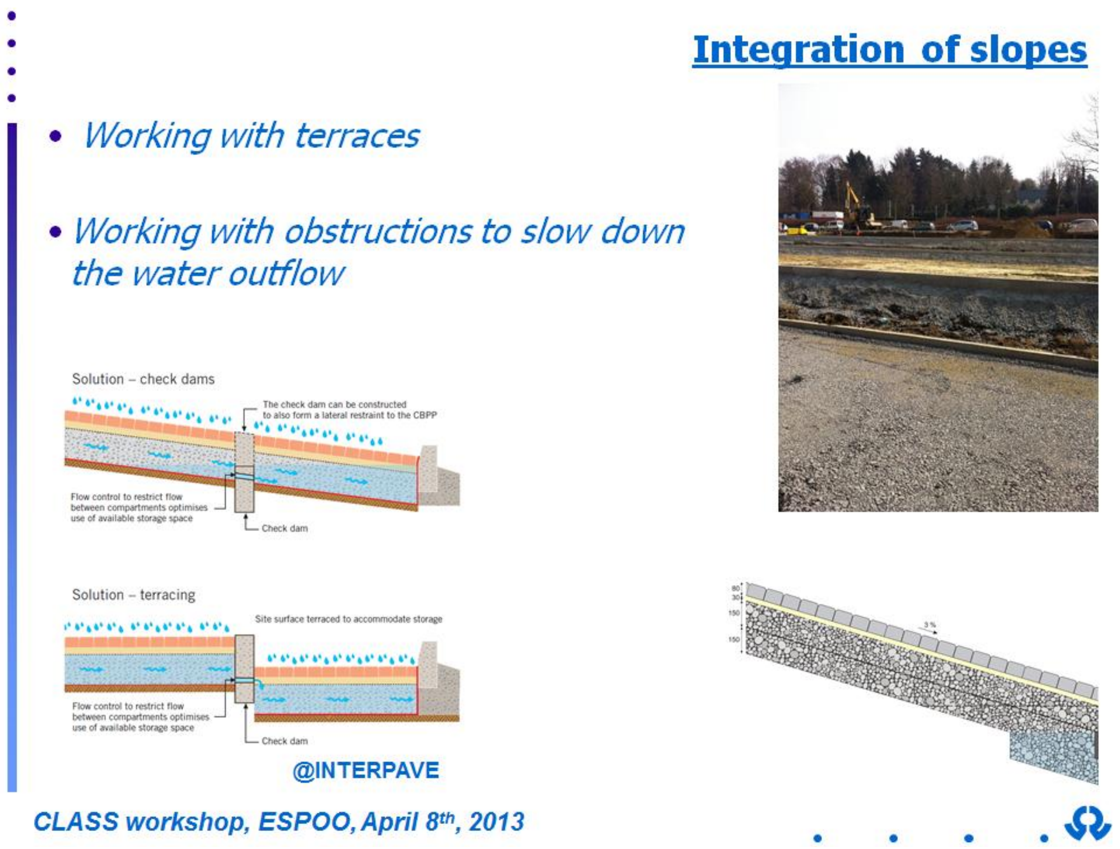
- *Final road with a very precise cleaning scheme and filling of joints*

CLASS workshop, ESPOO, April 8th, 2013

Water permeable pavements – sustainable choise, also economical!

Cost	Asphalt structure	Permeable structure
Structure	93,5 k€/m²	128,3 k€/m²
Sewer pipes	+ 7,5 k€	
Extra length, inspection holes, gullies,…	+25,5 k€	
Extra storage capacity	+26 k€	
Extra rain water drainage	+59 k€	
Extra cost for project	**+24,3 k**	

Anne Beeldens, BBRC



Anne Beeldens, BBRC

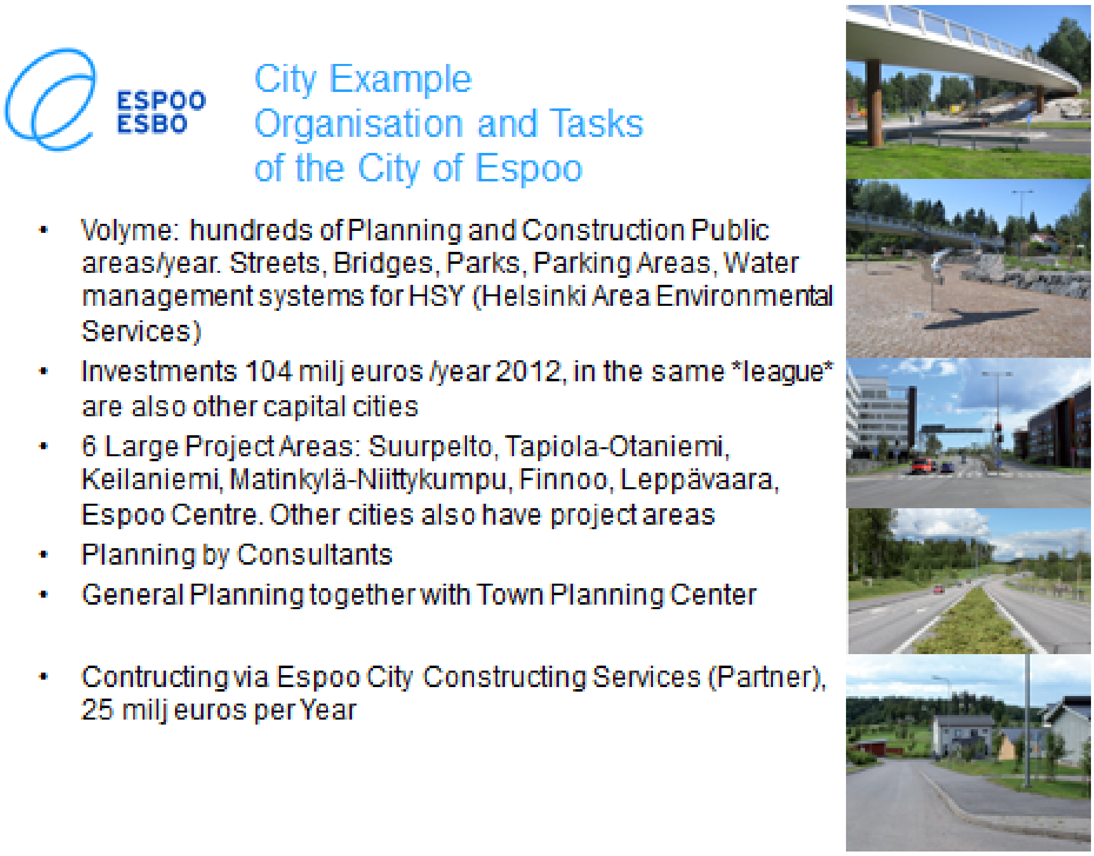
Anne Beeldens, BBRC

Conclusions

- *Large increase in application of water permeable pavement blocks in Belgium, due to good knowledge distribution and to new legislation*
- *Application of standard structure, provision of software in order to design correctly water permeable structures*
- *Combination of bearing capacity and water storage is improved by splitting up these tasks over the different layers in the structure*
- *Choice of material and control towards bearing capacity as well as permeability during execution is important*
- *Durability of the permeability demonstrated in research project as well as on site*
- *Maintenance is limited, mainly filling up joints*

CLASS workshop, ESPOO, April 8th, 2013

Pirjo Siren, City of Espoo



Pirjo Siren, City of Espoo

ESPOO
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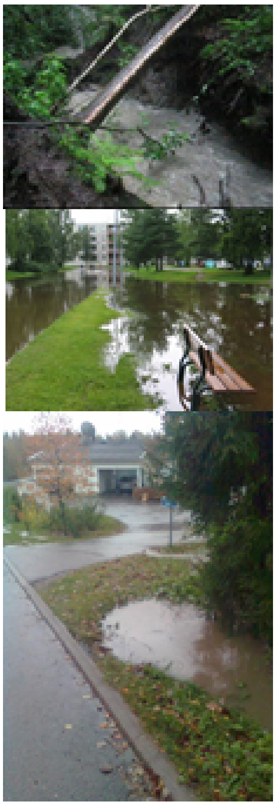
Urban Needs Perspective for Class Shortly about Rain Water Programs of The Cities in the Capital Area



- All the big Cities in the Capital Area have made their Rain Water Programs, and the Programs are accepted by the politicians
- Now the cities are executing those programs
- The General Needs are the same everywhere, where the Cities are expanding and you have to plan your Landuse on that basis
- Rain amount grows in general 10-15% by period 2071-2100
- The average summer season hard day rains grow 10-30%, six hours rain about 15-40%
- Rain once in ten years happens once in five years…
- The Quality and the Flow of the Streams are worsening, Flows become more common, there is Erosion, Pipeline measurements aren't big enough anymore and it is not economically-technically reasonable to oversize the piping system. There are also EU Directives and we have quite new national laws (about Flows and Water Law)

ESPOO
ESBO

Urban Needs Perspective for Class Shortly about Rain Water Programs Vision, Priorities and Measures

- There has been a need for new kind of measures concerning Rain Water management
- The Order of Priorities by Rain Water Programs:
- I Preventing Forming of Rain Waters and the Weakening of the Quality
- II The Rain Water is utilized in the place it's been forming
- This second Priority is the most complicated and the most important. For example Espoo has over 3000 new inhabitants per Year. We (and also Vantaa and Helsinki) have made a lot of Land Use plans in last years, in which –by the detail plan regulations- our contract partners have to utilize water in the private plot. Who causes, pays…
- III-IV The Rain Water is delayed and filtered in the General Areas
- Some challenges right now in the general areas: no Street Pilots in larger scale (usually not enough space in the green lanes, no usage in the structural layers ((freezing and filling of the structure)), no Parking Area Pilots in larger scale, some Park pilots

4

Pirjo Siren, City of Espoo

ESPOO
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Urban Needs Perspective for Class

- The Order of Priorities by Rain Water Programs:
- V The Traditional System...

- The Cities also have responsibility of the Maintenance of the Streets, Parking Areas and Parks: this means Mechanical Maintenance (no manual work or manual labour)
- The Cities can not improve rain water usage arears every five or ten years (for example structural layers or planting)

5

ESPOO
ESBO

Urban Needs Perspective for Class
Draft of the Needs of the Cities

- **KICK OFF Meeting 29th of November, Year 2012**
- What outputs does your company expect from the project?
- Permeable materials' life cycle durability, maintenance, winter conditions
- Focus on public areas with large hard surfaces: parking areas, streets, fields, parks
- Impacts of vehicle use, loads to permeable surfaces
- Information for dimensioning of storm water systems: climate change impacts on precipitation, amounts of water
- How to prevent clogging, sanding materials, impurities
- Combined solutions: permeable surface materials & underground structures
- Costs
- International experience

6

Pirjo Siren, City of Espoo

ESPOO
ESBO

Urban Needs Perspective for Class Draft of the Needs of the Cities

- **KICK OFF Meeting 29th of November, Year 2012**
- What information/experience can your company provide to the project?
- Cities have know-how on maintenance, durability of structures, practical solutions, life cycle costs
- Information and experiences about present solutions Possible piloting areas
- What inputs are needed to this WP from other WPs and/or companies?
- Climate change impacts on precipitation (WP4)
- Hydrological modeling: precipitation, amounts of water, dimensioning of storm water systems
- Modeling for public areas
- Permeable materials' life cycle durability, maintenance, winter conditions (WP2)
- Is permeable concrete possible in Finnish conditions Utilization of the Swedish project (WP0)
- Cooperation Finland-Sweden

7

ESPOO
ESBO

Urban Needs Perspective for Class Draft of the Needs of the Cities

- **KICK OFF Meeting 29th of November, Year 2012**
- Are the specific problems that should be addressed during this project? (What topics are most critical or should be the focus areas)
- Investment costs of present and developed solutions Cities can promote know-how about costs
- WP1 needs cost information from other wp's, too
- Is it possible to cut surface runoff and thereby costs? Focusing is important
- Need for views of other cities: Vantaa, Oulu...
- What outputs can this WP provide to the other WPs? How cities are developing, building
- What kind of expectations there are for this kind of solutions? Life cycle costs and durability of present surfaces

8

Pirjo Siren, City of Espoo

ESPOO
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Some Measures after Rain Water Program in the City of Espoo (Process)

- Rain Water Controlling Planning is made as part of the Communal technic general plans with the Land use plans
- Some projects also have made seperate Rain water plans
- In the Land use plans we direct the goal (delaying and improving the water quality), but is not combined to certain tecnics
- In recent Land use plans there is Rain water treatment in the private plots, not only in the public Parks

- In Espoo there is a Instruction of General plans, Street and Park plans and Consruction plans
- they include Model plans of the Water treatment (for example flow routes, basins, channels, etc)
- In year 2011 there was about 15 new Land use plans, in which about 20 new basins (and channels and ditches)

9

ESPOO
ESBO

Some Measures, Rain Water Program in the City of Espoo (Pilots)

- Very few Street Pilots (Kuitinmäentie, Kauklahdenväylä,Lasimäentie)
- About 20 Park Pilots, which mainly are basins and Ditches, either for Flows of for Delaying (Suurpelto, Lukupuro, Leppävaara Monikonpuro, Punavarpusenallas, other basins, Niipperi's golf Area, Espoonjoki Kauklahdenkoski and Espoonjokivarsi Park)
- In Espoo about 15 larger communal tecnical General Plans
- (Henttaa, Finnoo, Holmanpuisto, Nupurinkallio, Perkkaa, Lommila, etc)

Pia Rämö, Rudus

Pia Rämö, Rudus

Rudus

Rudus

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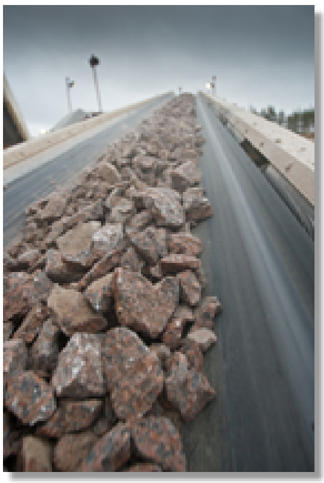
CRH

CRH
- operates in 36 countries, employs 76,000 people at more than 3,600 locations
- Sales 2011 18.1 billion EUR
- listed on the Dublin, London and New York (NYSE) stock exchanges

Rudus

Material Development perspective for CLASS

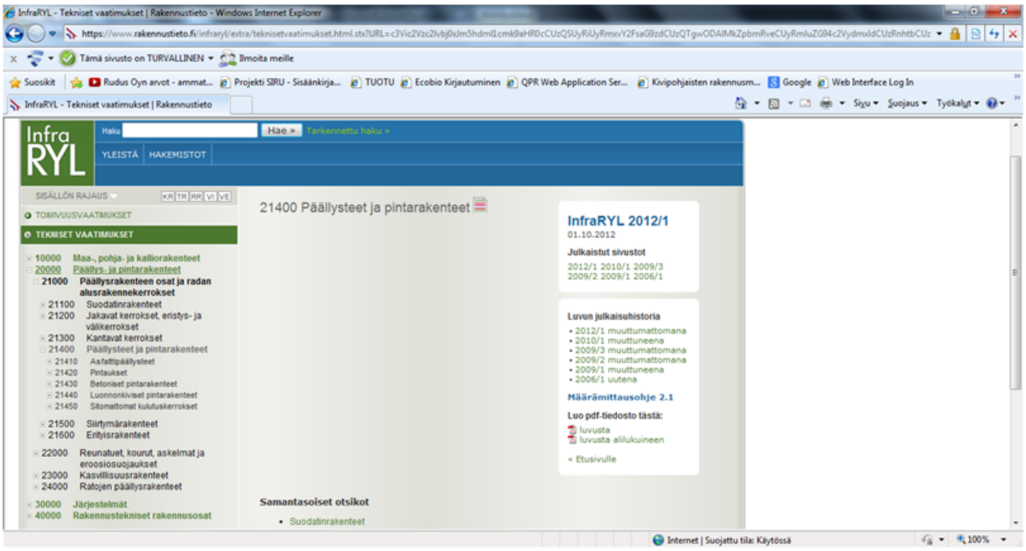
- Materials used in infra constructions nowadays
- New circumstances:
  - Climate changes
  - Changes in city planning
  - Changes in legislation and environmental awereness
- Materials for climate adaptive surfaces
- Demands for new structures
  - Functional requirements
  - Technical requirements
  - Environmental and material efficiency requirements
  - Safety requirements



Pia Rämö, Rudus

Rudus

Materials used in infra construction surfaces nowadays



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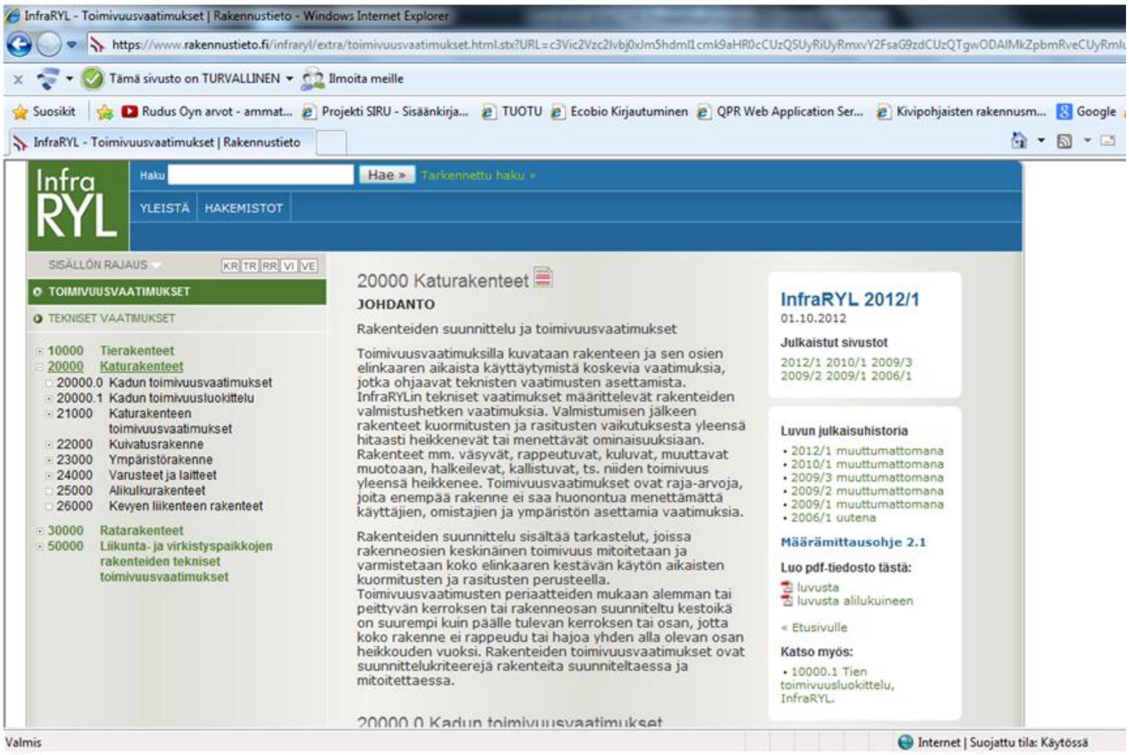


Pia Rämö, Rudus

Rudus

New circumstances

- Climate changes
- Changes in city planning
- Changes in legislation and environmental awereness

Rudus

Materials for climate adaptive surfaces

- Permeable concrete
- Porous asphalt
- Concrete stone pavings
- Natural stone pavings
- Unbound surfaces

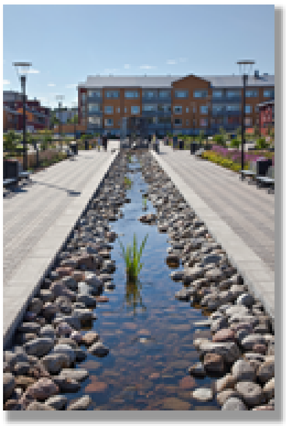
- Aggregates (natural, recycled and manufactured)
  - bearing layers
  - supporting layers
  - Filtration layers
- Pipes, wells and other water collection systems
- Geotextiles

Pia Rämö, Rudus

Rudus

Demands for new structures

- Functional requirements
- Technical requirements
  - Bearing capacity
  - Filtration capacity
  - Freezing-thawing (salt)
- Environmental and material efficiency requirements
  - Water quality
  - Demands for recycling
- Safety requirements



Perttu Hyöty, FCG

FCG
SUUNNITTELU JA TEKNIIKKA

Perttu Hyöty

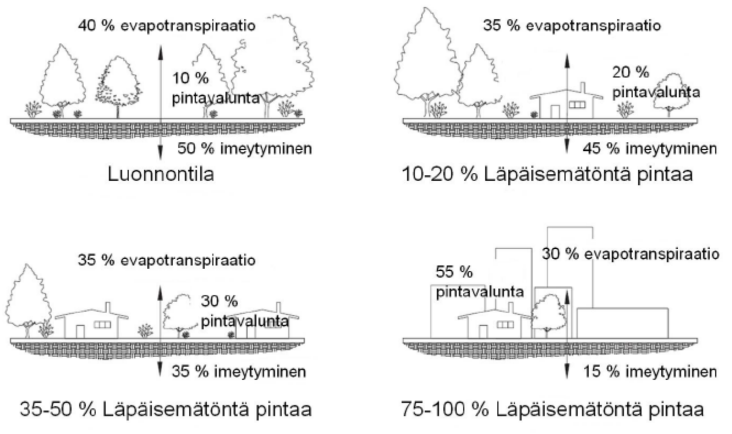
Urban & Stormwater Design perspective for CLASS

Project workshop 8.4.2013

DI Perttu Hyöty, FCG

8.4.2013 Page 1

Hydrologic impacts of land use



- Building of natural areas disturbs the water cycle
- With less infiltration and evapotranspiration surface runoff gets bigger, faster and more extreme
- Bigger flows and flow velocities cause flooding and erosion
- Enhanced runoff flushes different impurities from surfaces, such as sediment, metals, nutrients and bacteria
- Less infiltration means lower ground water table and smaller base flow

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Kuva perustuen: Livingston & McCarron 1992

8.4.2013 Page 2

Perttu Hyöty, FCG

Different land use, different impacts

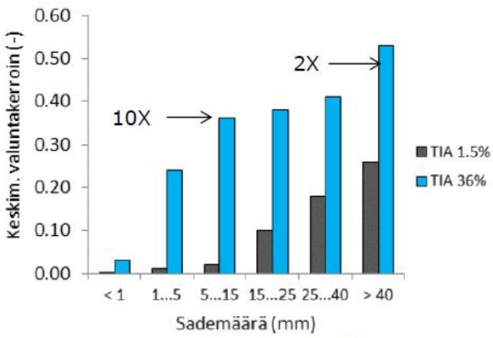
FCG

Kuvat: Paikkatietoikkuna.fi / Eniro.fi

8.4.2013 Page 3

Runoff changes are not constant

- Surface runoff forms when the intensity and / or amount of rain is greater than the capacity of the surface to detain water
- On impervious surfaces these initial losses are small, on semi-pervious or pervious surfaces they are large
- With larger rains the runoff from pervious areas becomes significant
- Urbanization affects most with small or medium rain events
- With larger rains even the watershed area can change



Sillanpää, N., 2012

FCG

8.4.2013 Page 4

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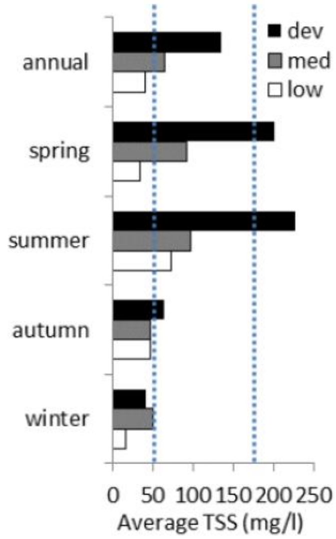
Quality issues

- Stormwater quality generally gets worse with urbanization
- Sediment load from areas under construction is much greater than from finished areas
- The effects of bad quality are dependant on the characteristics of the receiving waters
- Quality is also quantity issue; stormwater floods can cause mixing with wastewater and other contaminant sources
- Older cities and towns have still some combined sewers, overflows are regular event during bigger rains



Sillanpää, N., 2012

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8.4.2013 Page 5

The principals of stormwater management

Integrated approach

- Try to make urban areas function hydrologically in similar way than they did prior to construction
- The goal is to minimize the negative impacts in the environment
  - Stormwater management should begin at the source
- Compensation also possible, not everything has to be done within the area in question

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8.4.2013

6

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Designing stormwater management system

Phases:
1) Goals, principles and ideas
2) Watershed analysis
3) Land use assessment
4) Building a model
5) Sizing criteria
6) Model analysis
7) Detailed design

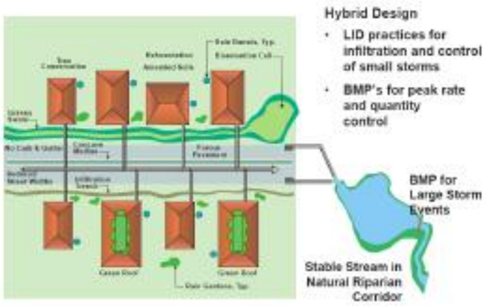
CLASS project

FCG

8.4.2013 Page 7

Data requirements, design and modelling issues

- Large part of urban runoff is created within the lots
- In already built up areas there's usually no space for centralized measures -> on the lot retrofit is key issue
- In central areas on the lot measures are basically the only way to detain stormwater
- In order to figure out what kind of effect decentralized measures would have in the big picture, we need modelling
- For modelling we need information on performance of these measures (detention capacity, infiltration speed etc.) to figure out water balance on the lot
- With stormwater model we can scale up to the level required



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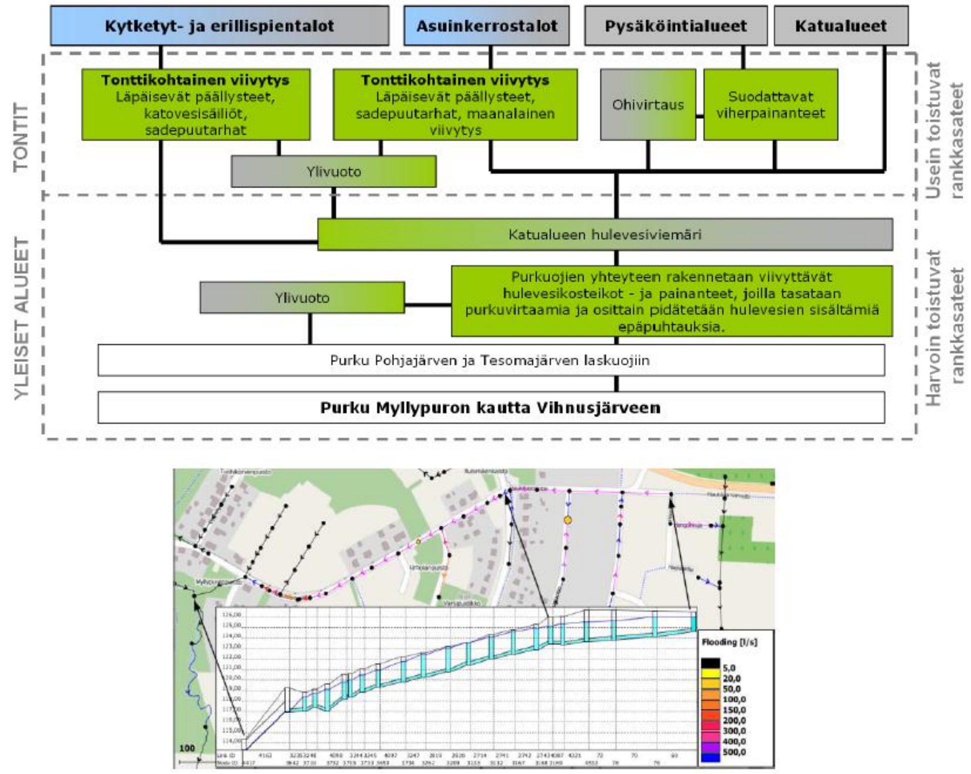
Modelling example



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Jukka Jormola, SYKE

Choices of Permeable Materials in Landscape Architecture

Jukka Jormola
Finnish Environment Institute SYKE

CLASS Climate Adaptive Surfaces 8.4.2013

SYKE

Approaches

- Legislation and environmental policy in progress
- Goals for urban environment
- Measures of stormwater management
- Materials

SYKE

2

Jukka Jormola, SYKE

Legislation of stormwater management

- Increasing rain events and winter rains require new duties for urban drainage – also detention/retention
- National level planning goals in Finland 2009 to prevent urban floods
- Stormwater guide (Hulevesiopas) published 2012
- Several cities already have their stormwater program or strategy
- New legislation 2013 - 2014: responsibility of stormwater for cities instead of water supply and sewerage
- Stormwater plans will be required
- Leading stormwater into sewage pipes will be illegal (with exceptions)

Photos: Helsingin sanomat

SYKE

3

Environmental policy under development: Compensation of habitats and hydrology

- Compensation of environmental values which cannot be maintained
- Wetland mitigation by creating new wetlands (USA)
- Habitat compensation by equal or other type of constructed habitats (Germany)
- Compensating hydrology by retention measures (Germany)
- Green Factor in urban areas: Constructing green roofs and stormwater facilities to compensate loss of nature (USA, Germany, Sweden)

SYKE

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Jukka Jormola, SYKE

Principles of stormwater management with preference order – new urban hydrology

- Decreasing the amount of stormwater
  - - permeable surfaces with infiltration and detention capacity – pavements , green roofs
  - - collecting and re-use, mainly from roofs
- Leading stormwater in open channels
- Retention in ponds and wetlands
- Leading into watercouces preferably as clean and constant drainage water
  - Fishery interests - Being Salmon friendly

Photo Aki Janatuinen

SYKE

International interest for stormwater management for fish

Seattle

Photo Juha Järvelä

SYKE

Jukka Jormola, SYKE

Ecosystem services produced by green areas and stormwater facilities
- Green infrastructure as a new EU-strategy

Regulatory services
balancing urban hydrology

Provisioning services
Clean water for fish production

Question in Landscape Architecture:
Are we able to promote all of these?

Supporting services
Increasing the diversity of urban ecosystems

Cultural services
Attractive urban landscape for recreation

SYKE

7

Combination of different measures in one project

- Permeable paving for remote parking
- Retention pond for waters from intensively used parking lots
- Kaakkuri, Oulu

SYKE

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Jukka Jormola, SYKE

Jukka Jormola, SYKE

Streets: Green stripes for biofiltration

- Solution for urban centres with combined sewers
- Portland
-

- Main streets – purification of first flush
- Koivukylänväylä, Vantaa
- Trout brook nearby

SYKE

Cold climate problems

- Frost - how to treat melting snow and winter rains
- Good drainage needed – filtration instead of infiltration

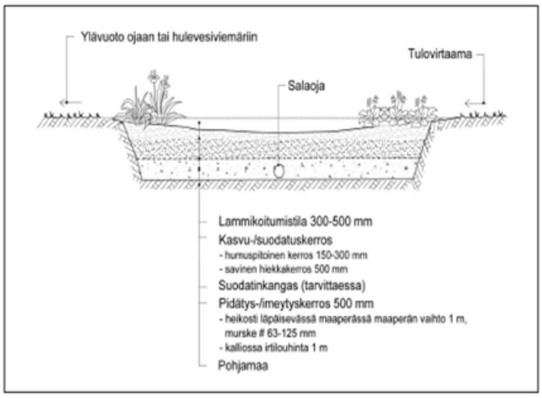
SYKE

Jukka Jormola, SYKE

Biofiltration has proved to work in cold climate

- Organic layer- biofiltration
- Sand - filtration
- Drainage layer and pipe

14300 Kuivatusrakenteet



Kuva 14352:K1. Imeytyspainanteen rakenne-esimerkki.

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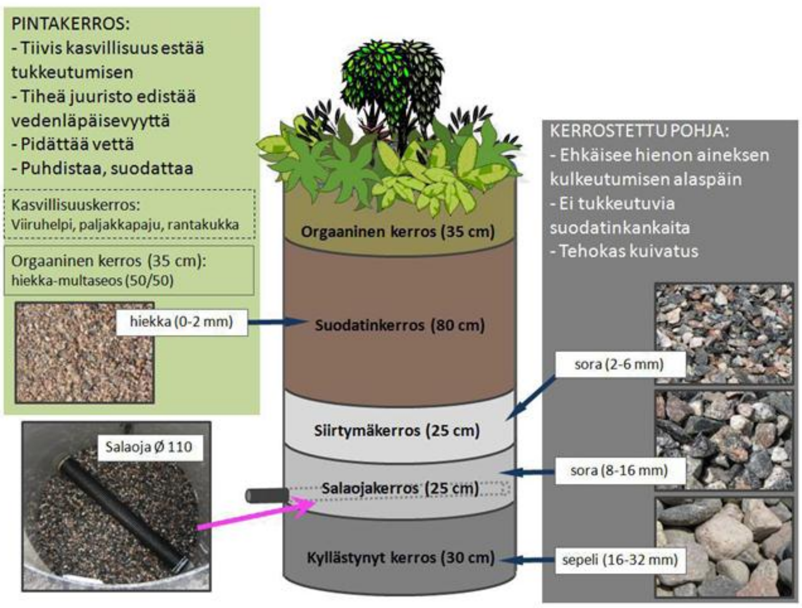
Stormwater- project (Marjo Valtanen 2011)

87-97% retention of PO4, Zn and Cu – Salmon friendly



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Rain gardens – design with temporary water

Minneapolis

SYKE

15

Rain gardens as development products

- Minnesota, "Inspiration"
- Gaining cultural services

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Infiltration near to houses

Portland

Infilration further from houses

- Portland

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Open stormwater systems in green areas

- Open dry swale
- Oulu Housing fair 2005

- Chain of small wetlands
- Ecological corridors, supporting urban ecology
Kuopio, Housing fair 2010

SYKE

Swales with retention

- Portland

SYKE

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Jukka Jormola, SYKE

Large ponds for retention in parks
- water surface as visual and recreation element
- base flow from drainage pipes

Illenpuisto park,
Kartanonkoski, Vantaa

Vuores central park, Tampere

SYKE

Conclusions

- Different measures and materials according to quality and amount of stormwater:
  Infiltration – filtration – detention –retention
- Drainage of permeable facilities is important in cold climate - constant drainage water flow is valuable for urban watercouses
- Trends of environmental policy and advantages for urban environment can be combined

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30

PANEL DISCUSSION

- What outputs could your company use from the project?
- Are the specific problems that should be addressed during this project? (What topics are most critical or should be the focus areas)