# Urban hydrological modelling

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# Applications with SWMM

**WAT-E2030 Hydrological Modelling**

**13.2.2022**

Aalto-yliopisto
Aalto-universitetet
Aalto University

Finnish pioneer project, Kartanonkoski, Ciy of Vantaa. Designers Ismo Häkkinen, Petra Tammisto and Ulla Loukkaanhuhta, constructor VRJ Etelä-Suomi Oy/City of Vantaa. Photo: Mikko Sillanpää

# Schedule and contents

**Monday 13 Feb, 9:00-12:00**

- Introduction to the topic
- Individual modelling work begins

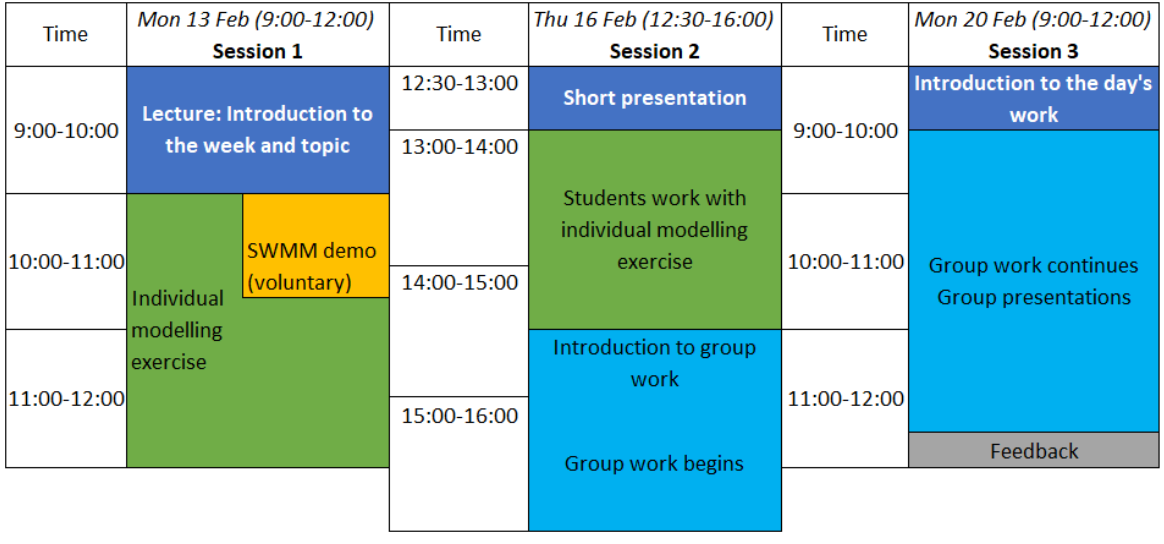
**Thursday 16 Feb, 12:30-16:00**

- Short presentations
- Individual modelling work (cont.)
- Group work begins

**Monday 20 Feb, 9:00-12:00**

- Group work (cont.)
- Group presentations
- Feedback and farewell

- Instructions and materials for the individual modelling assignment is given in MyCourses.
- Group work is based on the individual modelling work.



# Learning outcomes

After this week, the students…

… have hands-on experience in using SWMM for rainfall-runoff modelling

… understand the changes that occur in catchment hydrology during urbanisation

… are able to identify and quantify the basic techniques/mechanisms that can be utilised to solve urban runoff problems

Grading: 10 pts total (6/10 individual modelling exercise, 4/10 group work)

- Grading is given based on a written report.
- Due date: Friday 24.2.2022
- Instructions for the report: MyCourses

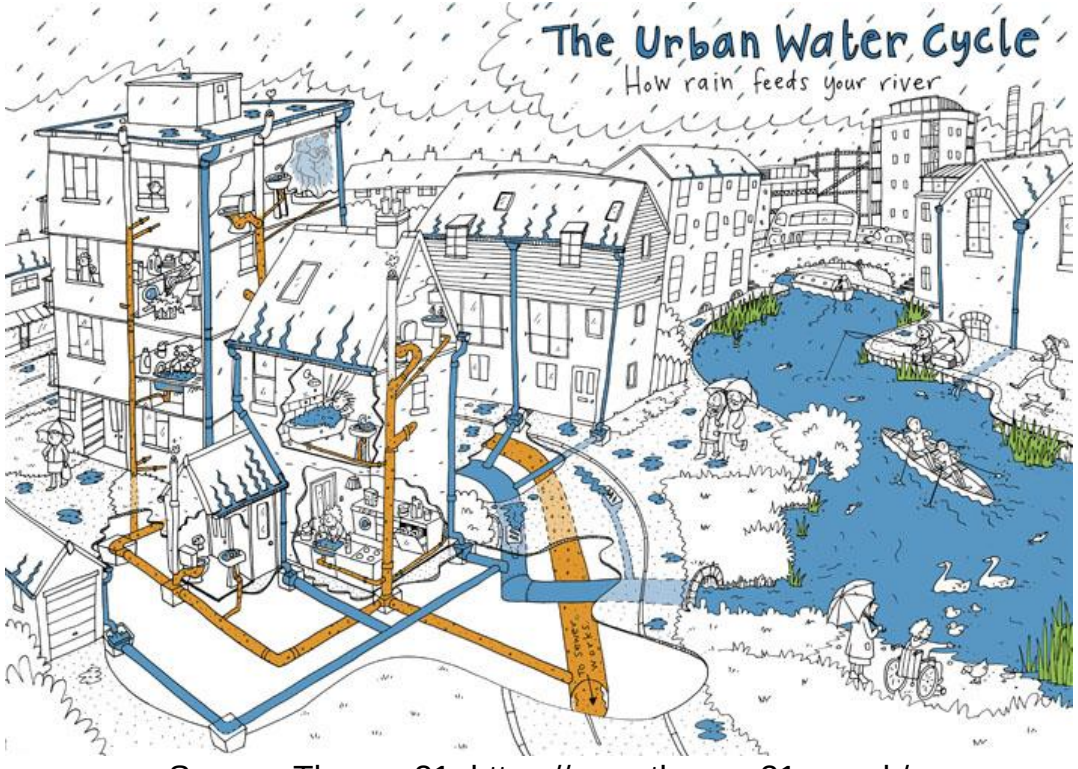
*The written report is a concise summary of your tasks and outcomes during the week. You should be able to finish your report during the teaching sessions.*

# Today


**Monday 13 Feb, 9:00-12:00**

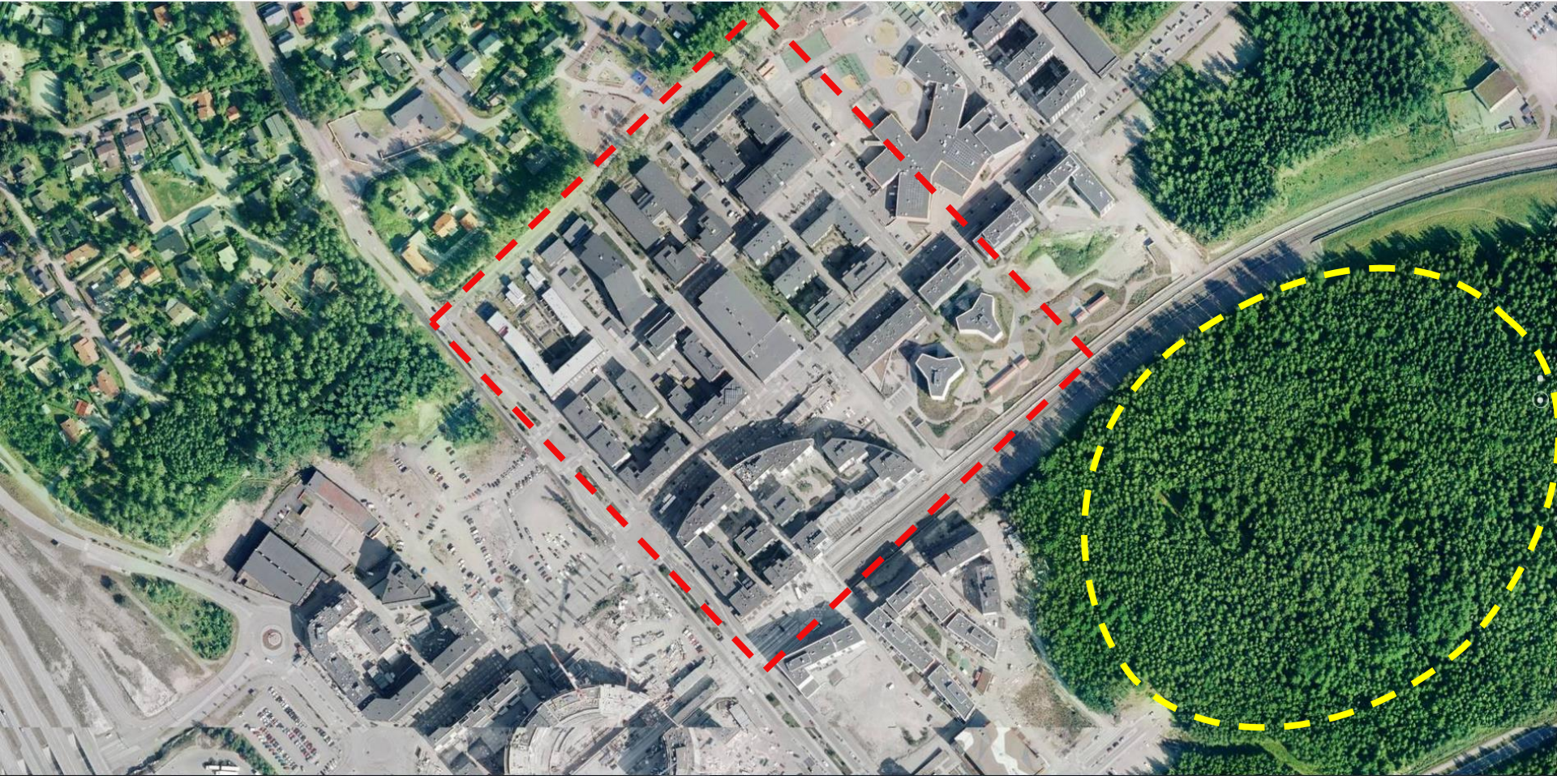
- Introduction to the topic
- Individual modelling work begins
- Voluntary SWMM demonstration

# Urban runoff challenge



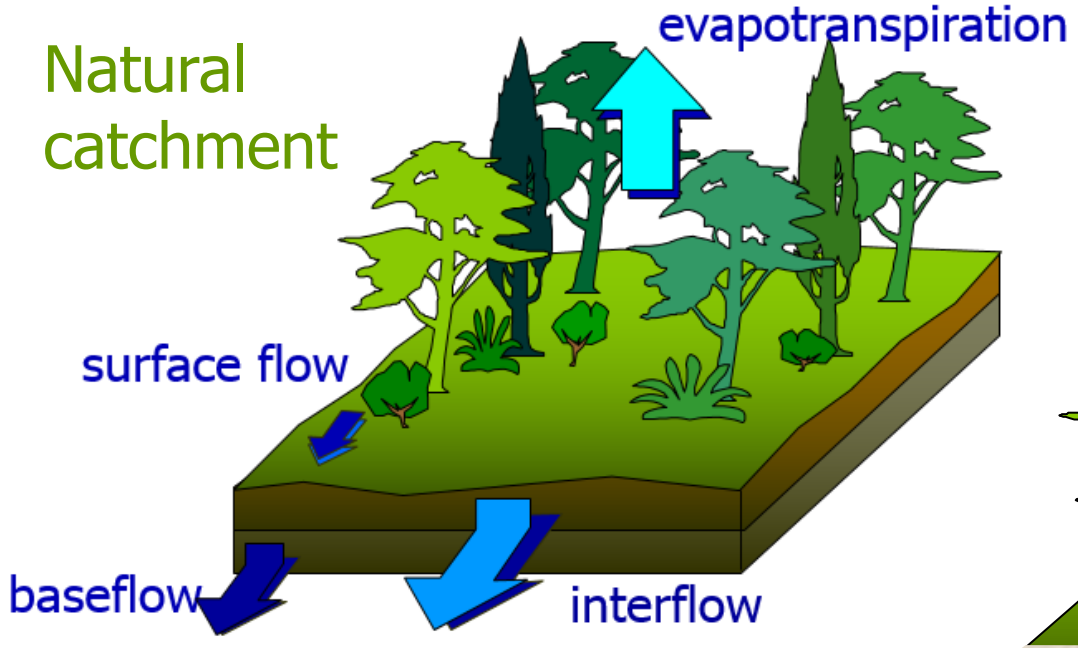

Source: Thames21, https://www.thames21.org.uk/

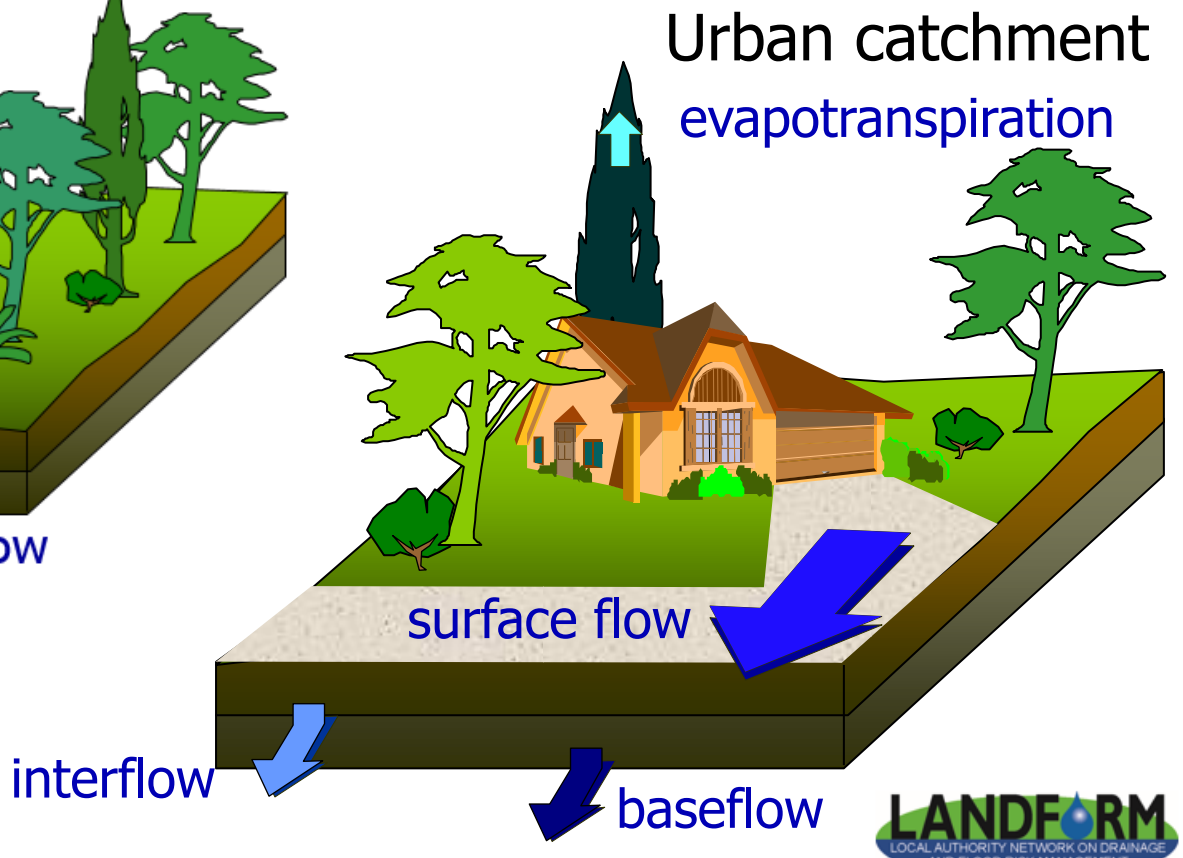
Helsingin Sanomat, 1.3.2020: Muutos ilmasta, an article about the land use changes in the Helsinki Metropolitan area



Source of areal photos included in the article: open data of Helsinki, Espoo, Vantaa, and HSY

# Urbanisation and water balance




ciria

www.ciria.org/suds

LANDFORM
LOCAL AUTHORITY NETWORK ON DRAINAGE AND FLOOD RISK MANAGEMENT

# Urban flood (2011) in Brisbane, Australia

Consequences: $2.4 billion in damage, 35 confirmed deaths

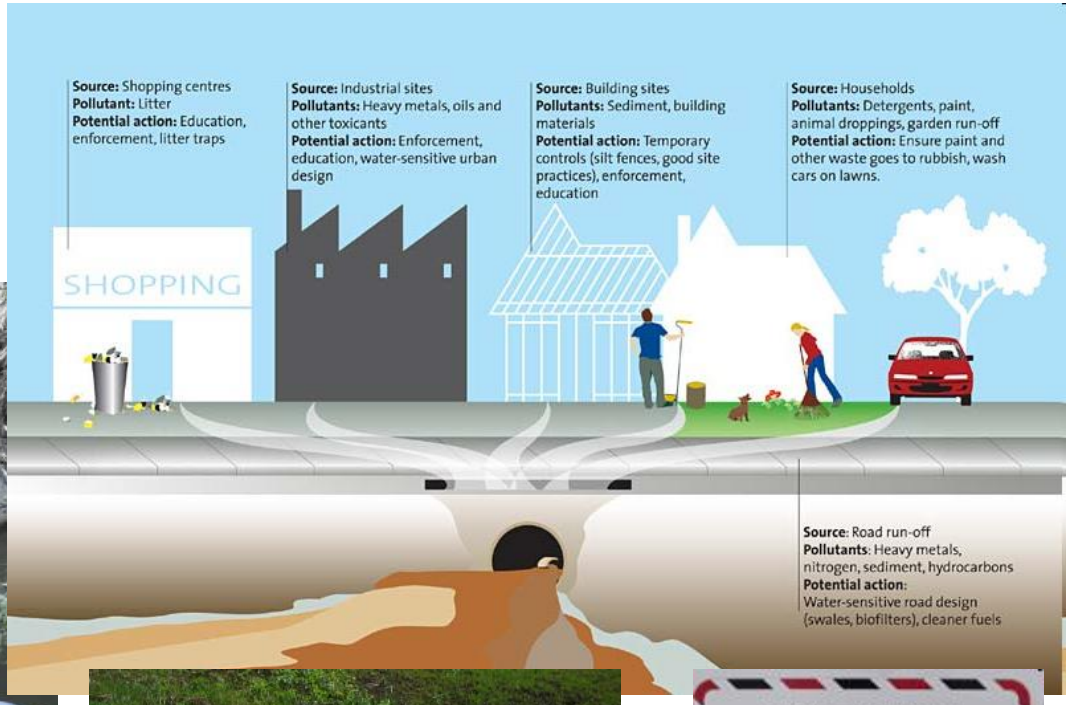
Photo: *Torsten Blackwood/AFP/Getty. Short Sharp Science*

# Urban flood (2007) in Pori, Finland

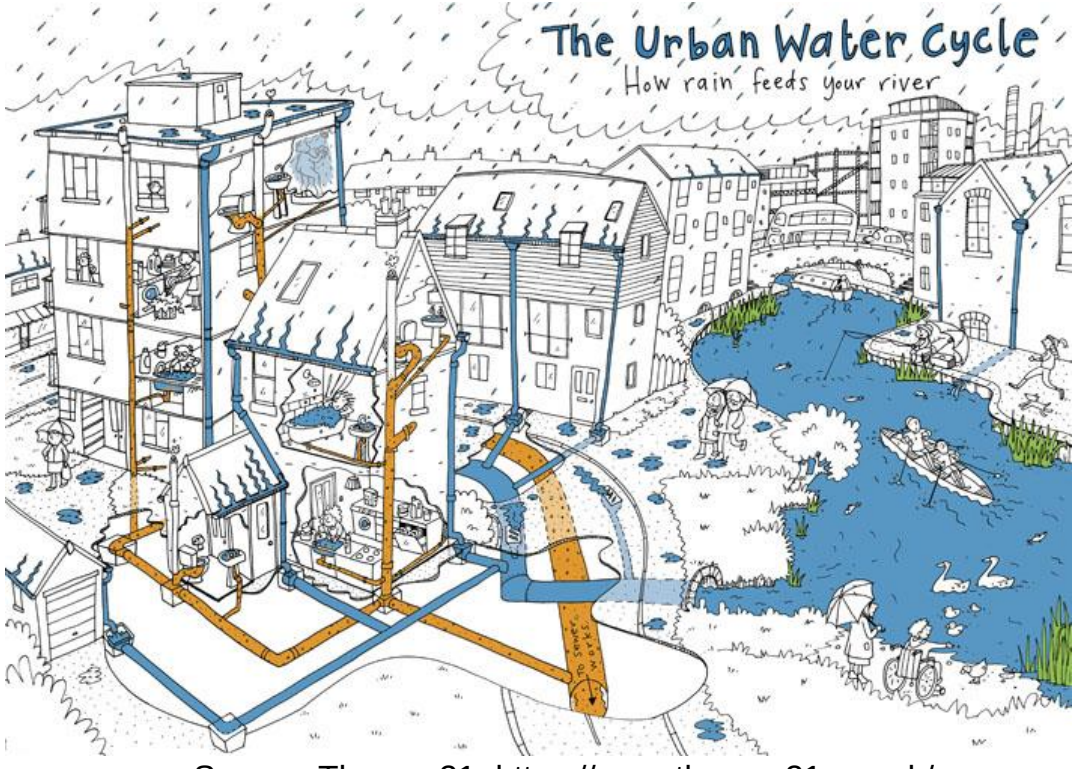
Source: Porin kaupunkitulva, loppuraportti 22.10.2009, photos Janne Lumme

# Urban erosion

# Urban water quality problems

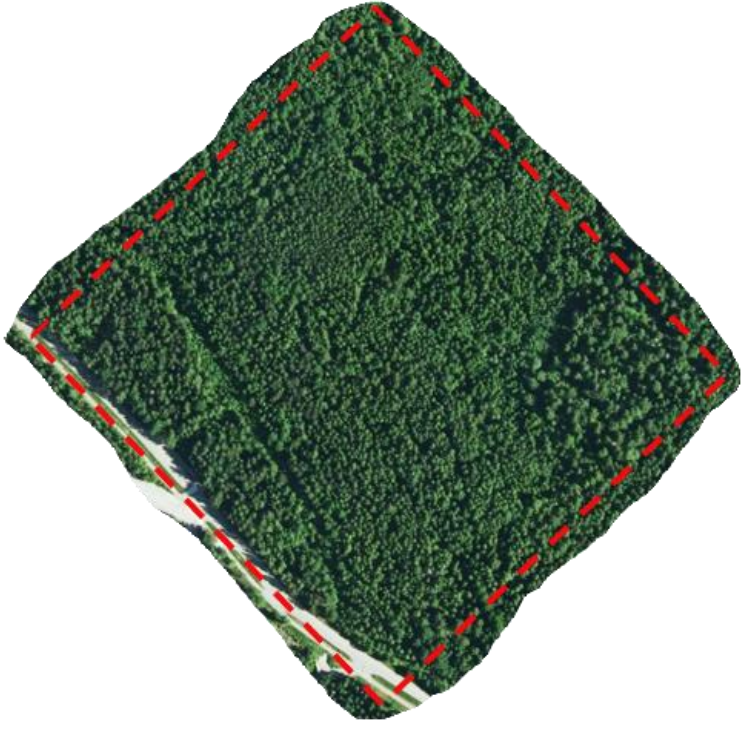



# Urban runoff solution?



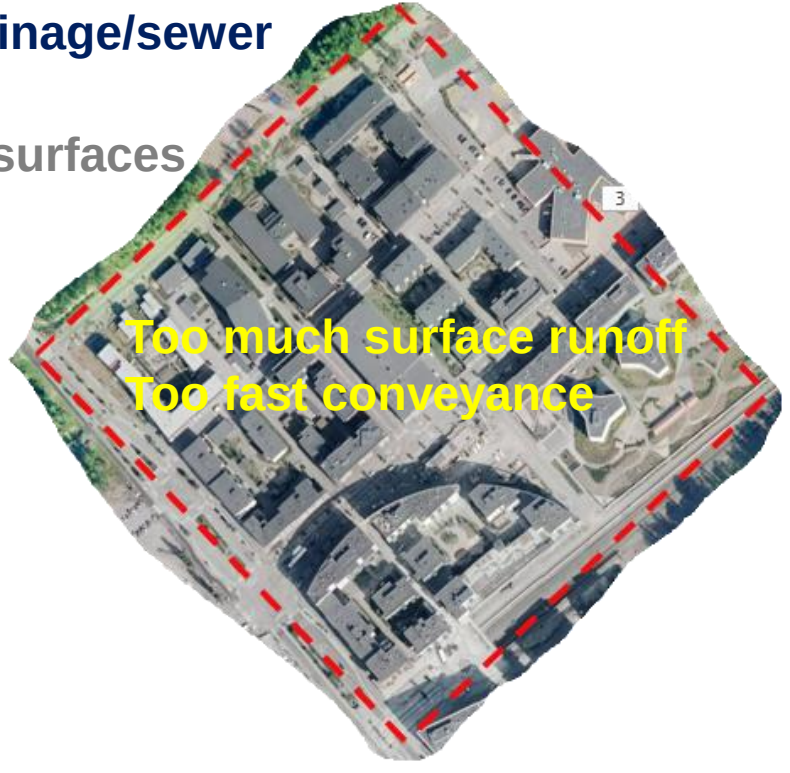

Source: Thames21, https://www.thames21.org.uk/

# Solution = ?



**Efficient drainage/sewer systems**

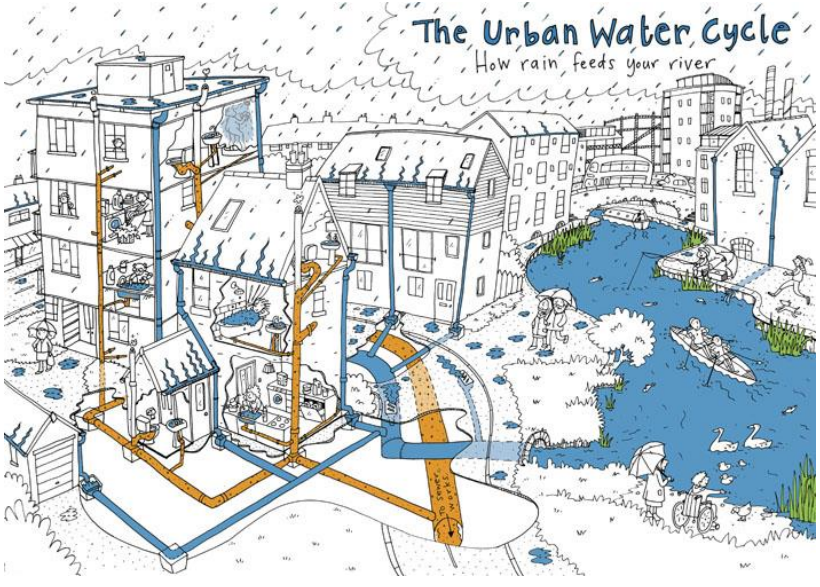
Impervious surfaces




We need to restore or mimick natural mechanisms…

# Solution = Sustainable Urban Drainage Systems

**SUDS = Sustainable Urban Drainage Systems**
**LID = Low Impact Development**
**WSUD = Water Sensitive Urban Design**
**NBS = Natured Based Solutions**
**GI = Green Infrastructure**

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**Task:**
***How many LID techniques where mentioned in the video?***

Ever wondered where the rain goes? Sustainable drainage animation

CIRIA's susdrain project has launched an exciting new animation on Sustainable Drainage Systems (SuDS) that provides an engaging and digestible overview of SuDS.

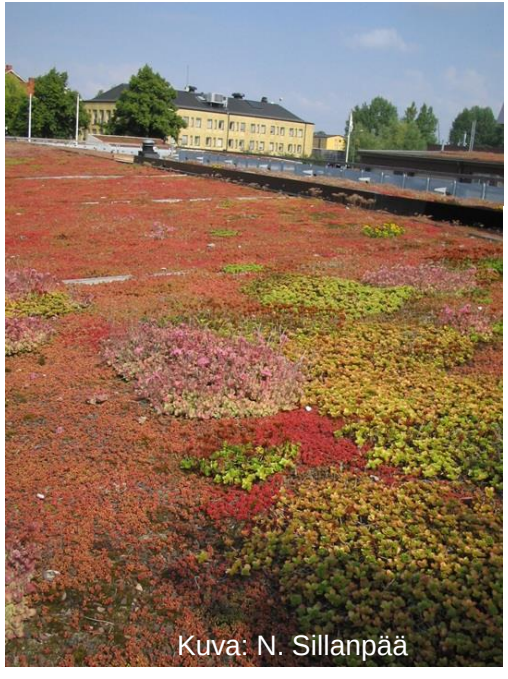
The short animation called "Ever wondered where the rain goes?" demonstrates how changes to the natural water cycle caused by development can be positively managed, and, how SuDS turns this challenge into an exciting opportunity contributing to better places.

For more information about sustainable drainage visit www.susdrain.org or contact enquiries@susdrain.org.

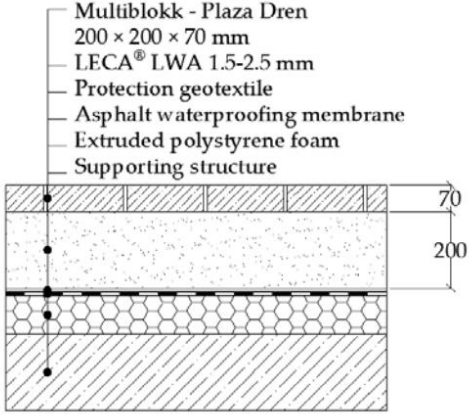
- https://www.youtube.com/watch?v=LMq6FYiF1mo

# Stormwater toolbox

”Green” roofs




”Grey” roofs


”Blue” roofs

Photo: radmat.com

Rainwater harvesting

# Stormwater toolbox

*Filtration*
*Biofiltration*
*Infiltration*


Photo: Matthias Borris

Photo: Nigel Dunnett, Sheffield 'Grey to Green'-project, retrofit solutions in existing city


Photo: Alan Hoban

# Stormwater toolbox

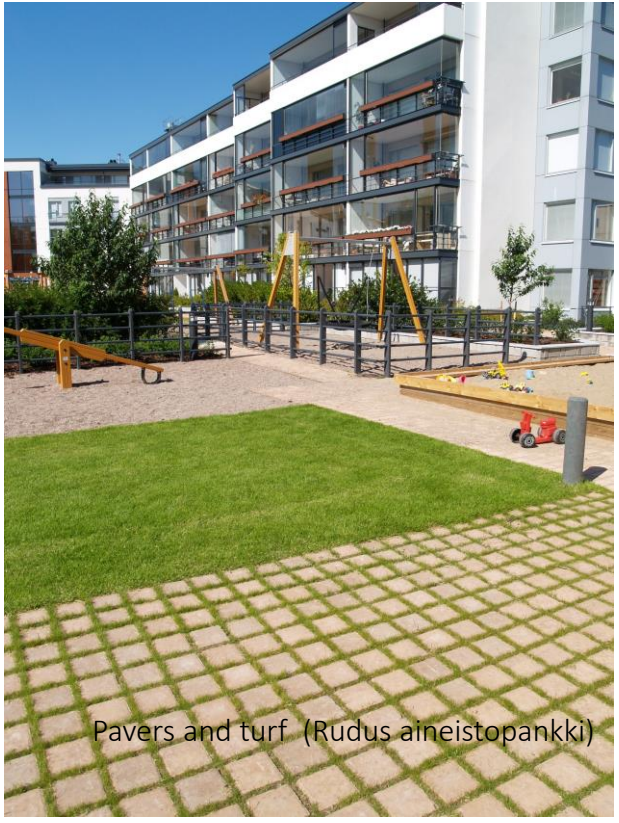
*Permeable pavements include a porous storage layer under the pavement layer*

*Usually underdrains are needed in cold climate locations*

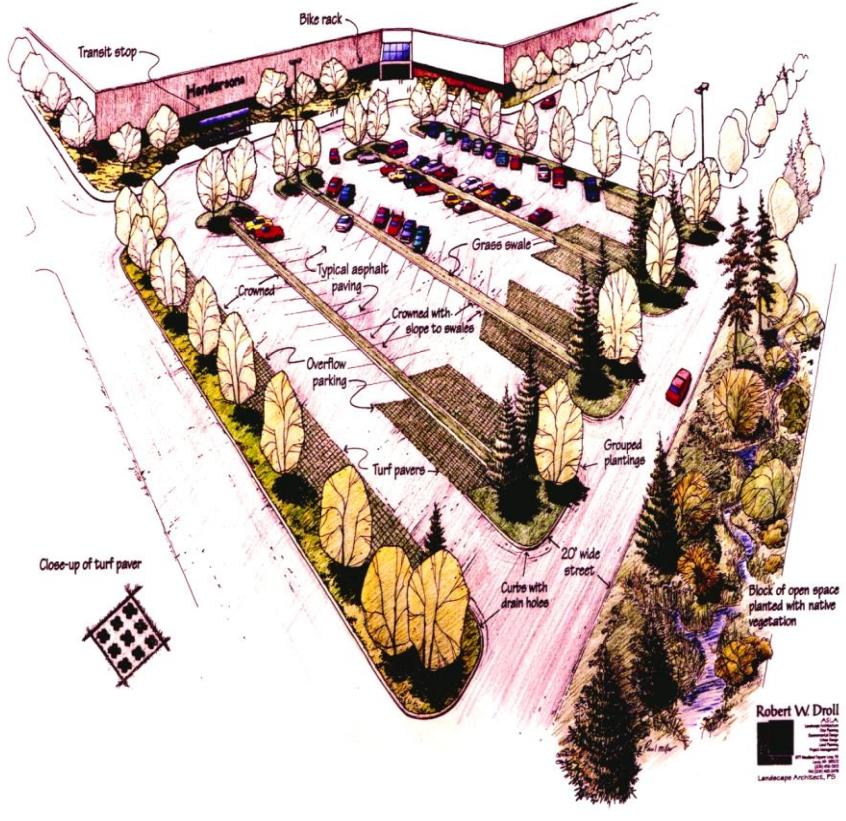

Recycled rubber (lockwoodlandscapes.co.uk)


Open asphalt (ncc.fi)


Permeable concrete (Rudus aineistopankki)


Pavers and turf (Rudus aineistopankki)

# Complete (decentralized) SUDS system



# Aalto research example: LID modelling with SWMM

*Example: Saunalahti residential area, City of Espoo, Finland (monitoring/ modelling studies)*


- Traditional residential area, separate pipe sewer system
- **Modelling study - Comparison of different managemement options:**
  - *detention pond at the catchment outlet*
  - *rain barrels for roof runoff*
  - *permeable pavements at private plots*



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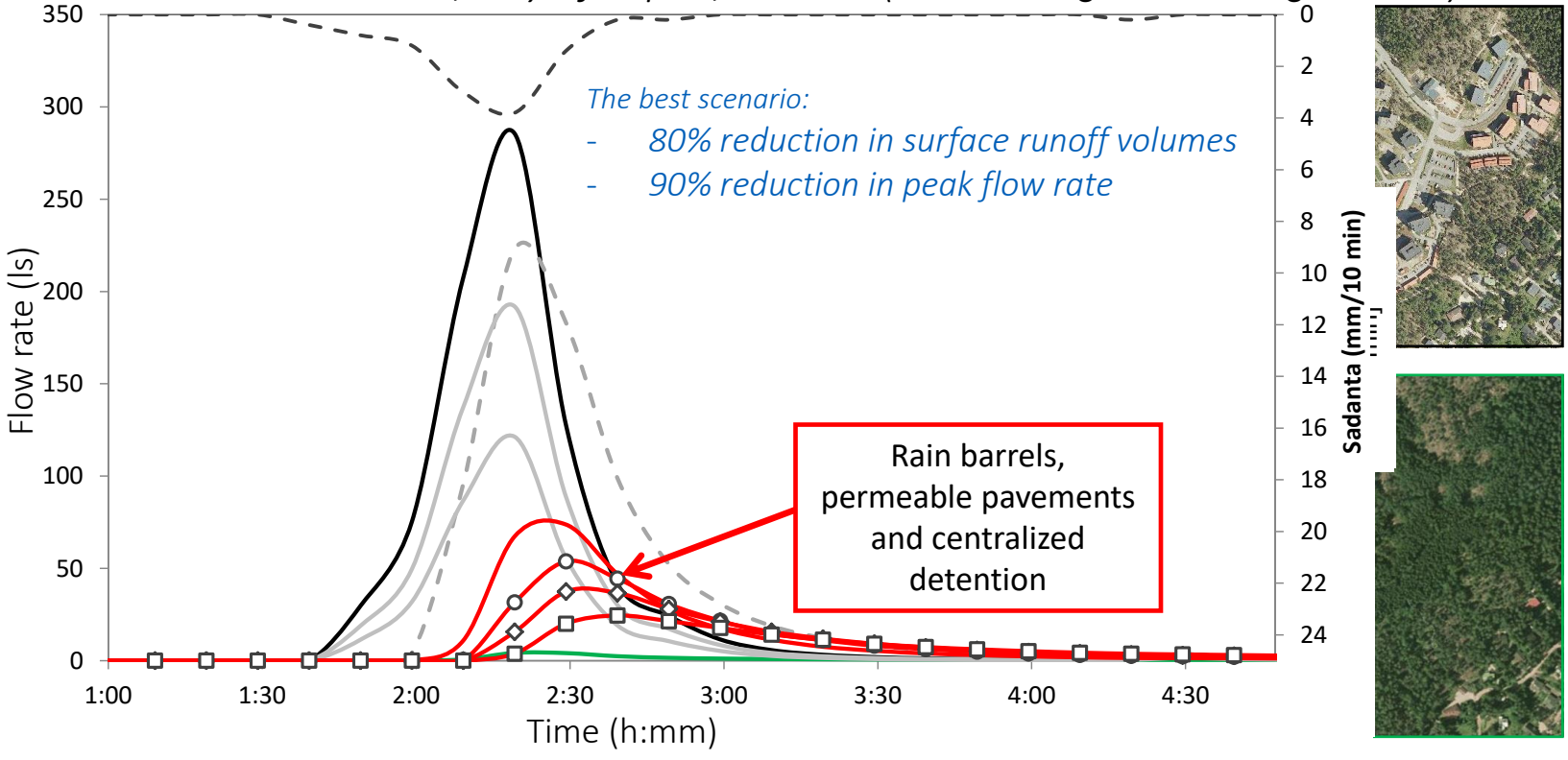
References: Guan, M., Sillanpää, N., Koivusalo, H. 2015. *Modeling and assessment of hydrological changes in a developing urban catchment*. Hydrological Processes, 29(13): 2880-2894. Guan, M., Sillanpää, N., Koivusalo, H. 2015. *Assessment of LID practices for restoring pre-development flow regime in an urbanized catchment in southern Finland*. Water Science & Technology, 71(10):1485-1491.

# Aalto research example: Management potential of SUDS

*Example: Saunalahti residential area, City of Espoo, Finland (monitoring/ modelling studies)*

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# Individual modelling assignment

*Read the assignment instructions from MyCourses* ***(Weeks's assingment and instructions)***

*Download materials from MyCourses (two locations:* ***Materials to be downloaded*** *and* ***Catchment files for the individual modelling exercise)***

**In short:**

- ✓ Create an alternative LID system for your study catchment
- ✓ Simulate its performance using a 5-year design storm
- ✓ Compile your results: catchment hydrology (infiltration, evaporation, surface runoff) and flow rates at the catchment outlet
- ✓ Compare the simulation results with the catchment without LID units