

IAHR 2009

Hydrologic Sensitivity Analysis – Contribution to the Assessment of Effectiveness of SUDS in Small Urban Catchments

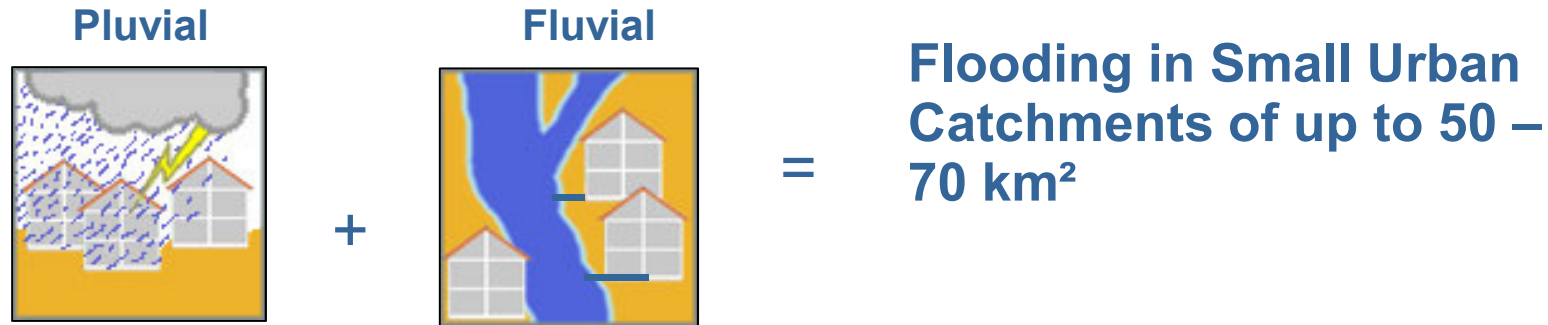
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Vancouver, August 2009

- Introduction
- Theoretical Approach of modelling SUDS
- Implementation in a rainfall runoff model
- Testing in a case study
- Conclusions and Outlook

Flood Risk Management in Small Urban Catchments:



Need to cope with uncertainties derived by:

- Future Urban Development
- Climate Change Aspects

Focus on adaptive responses:

- Non-structural measures
 - Flood Resilience Measures
 - Flood Probability Reduction measures
 - e.g. Sustainable Drainage Systems (SUDS)

1. Introduction

Sustainable Drainage Systems (SUDS's) :

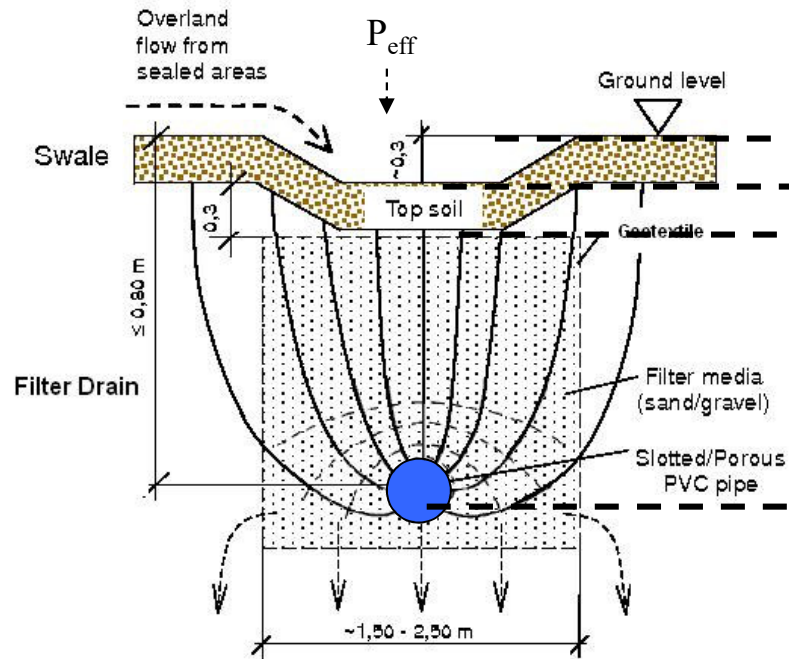
- Source Control Measures (e.g. green roofs)
- Detention structures (e.g. Ponds, Swales)
- Infiltration Techniques (e.g. Filter drains, Soakaways)
- Combined measures: (e.g. Swales with filter drains)

Objectives of the work:

- Quantifying the Hydrologic Effects of SUDS's in Small Urban Catchments at extreme storm events.
- Developing a new method to evaluate the effectiveness of SUDS on a catchment level
- Testing and verifying this new concept.

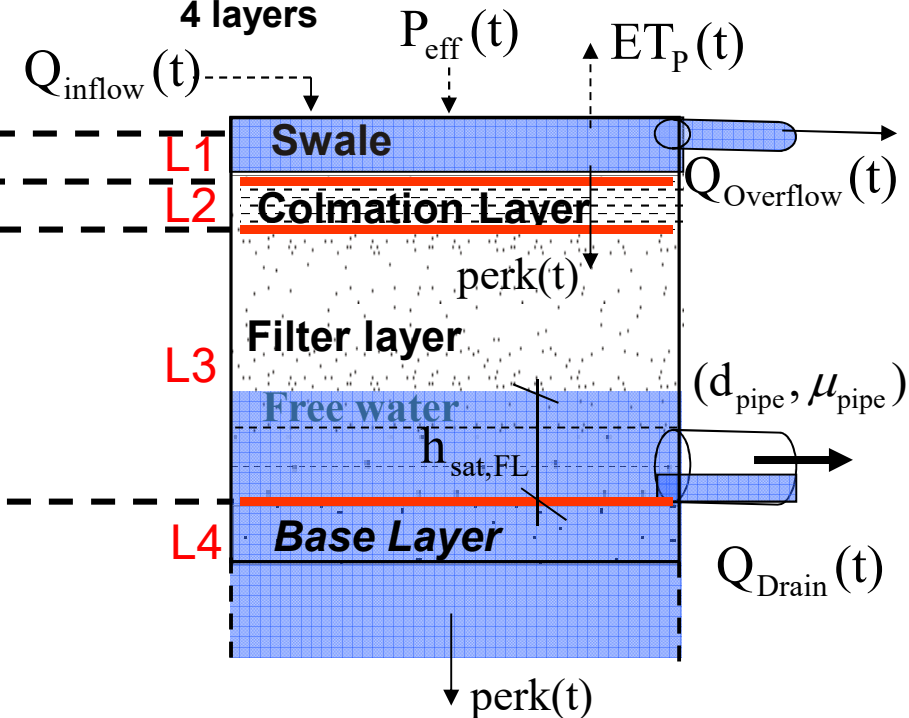
2. Theoretical Approach

Cross section of a Swale -Filter-Drain system



Theoretical approach:

Subdivision of the SUDS-unit into 4 layers



Water level (h) in the swale

$$\frac{\Delta h(t)}{\Delta t} = \frac{Q_{inflow}(t)}{A_{inflow}} + P_{eff}(t) - perk(t) - ET_p(t) - \frac{Q_{overflow}(t)}{A_{swale}}$$

Soil moisture (sw) :

$$\frac{\Delta sw(t)}{\Delta t} = inf(t) - perk(t) - ET_a(t) - \frac{Q_{drain}(t)}{A_{swale}}$$

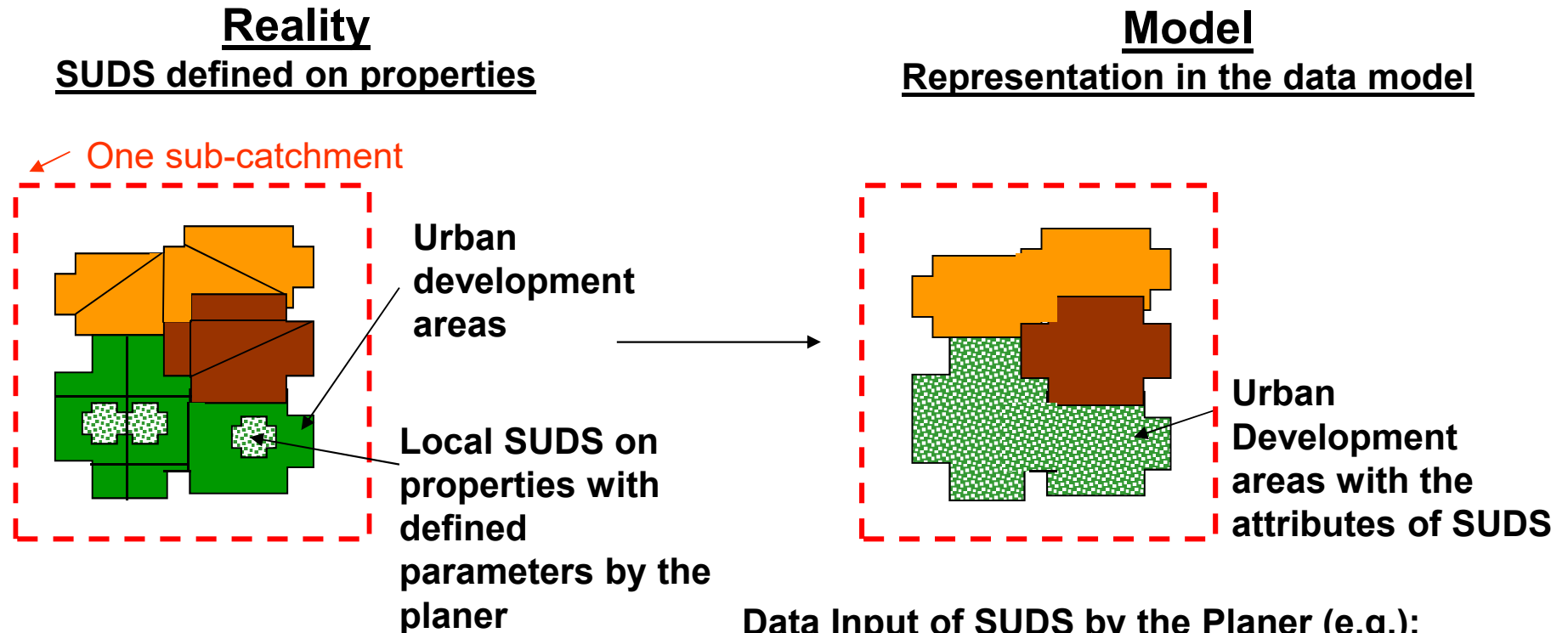
Groundwater recharge

Funktion of Q_{drain} :

$$Q_{Drain}(t) = f(h_{sat,FL}, d_{pipe}, \mu_{pipe})$$

3. Implementation

Integrative approach to model SUDS on the catchment level

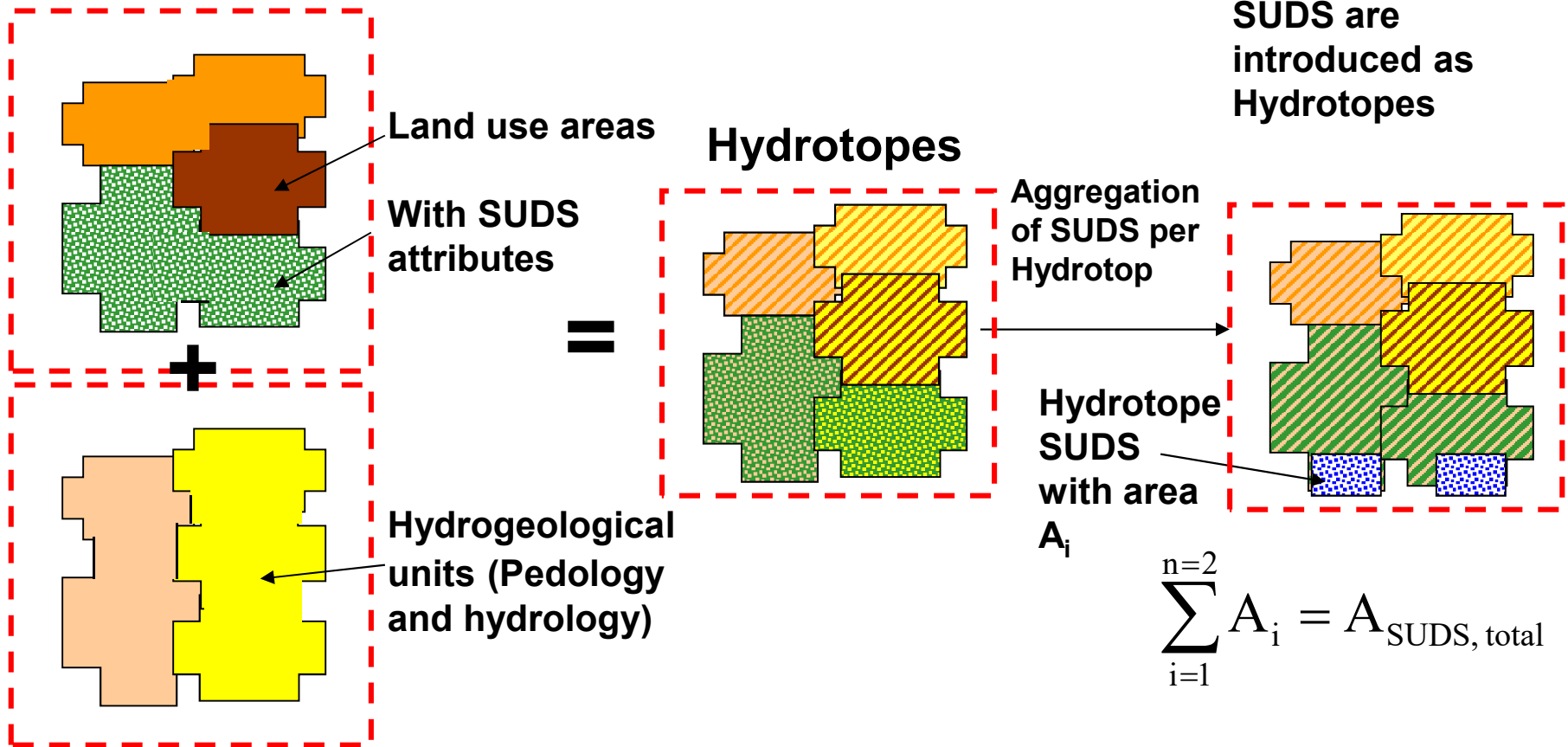


Data Input of SUDS by the Planer (e.g.):

- total area of SUDS = $A_{SUDS, total}$
- Percentage of area connected to the SUDS
- Average depth of swale and filter drain
- Average permability of the soil layers
- Size and elevation of the drain pipe

Data Processing in a Rainfall Runoff Model

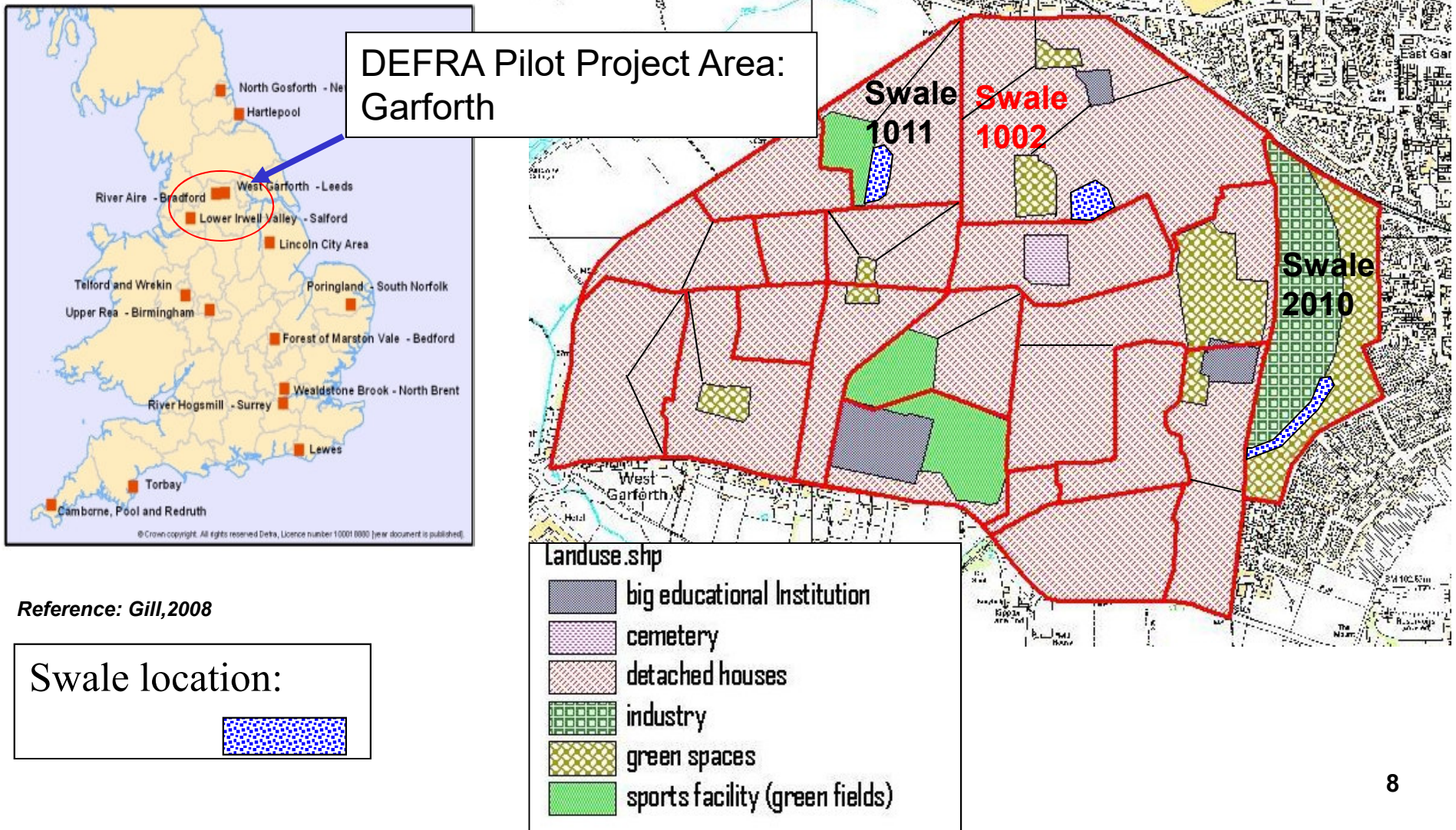
Intersection



Hydrotopes: hydrological similar response units with the specific pedology, hydrology and runoff characteristic

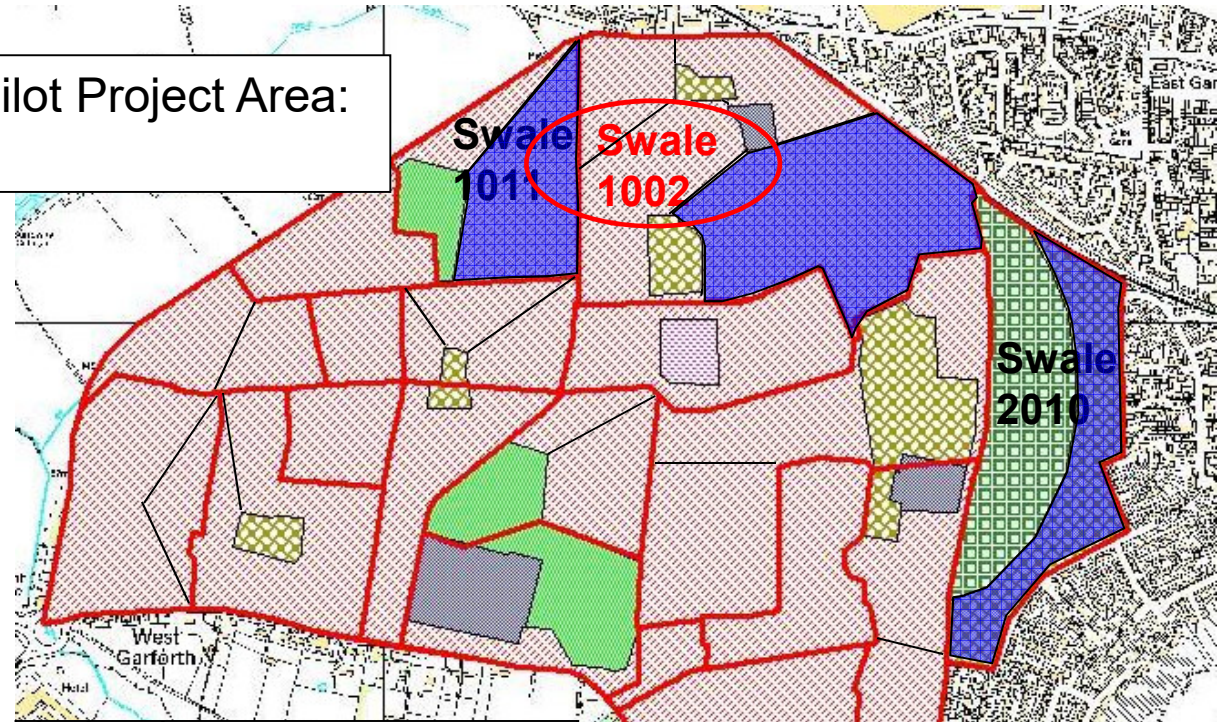
4. Testing : Planning Scenario Swale

- Implementation in the rainfall runoff model Kalypso Hydrology
- Case Study area: Garforth, West Yorkshire in England



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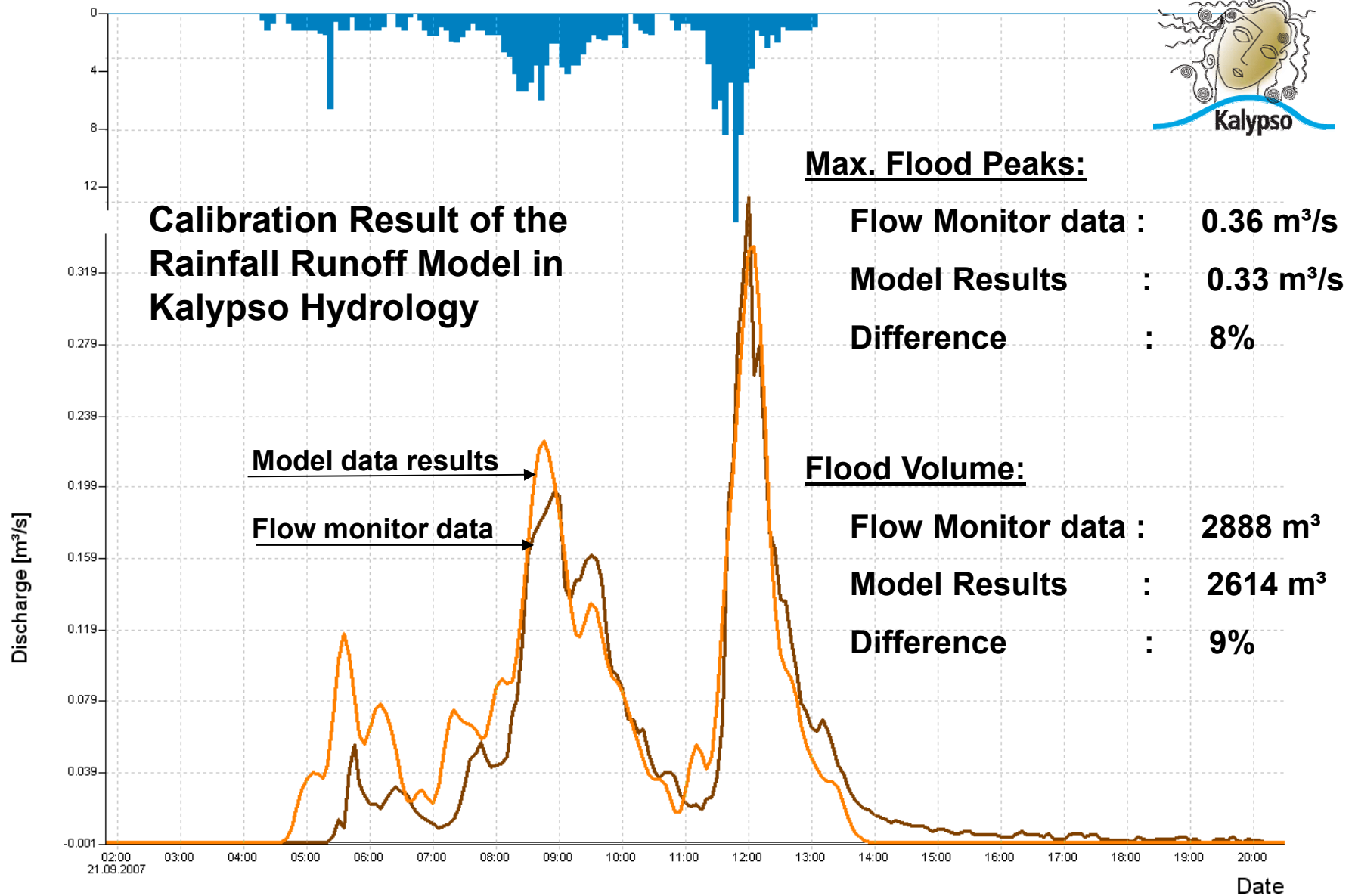
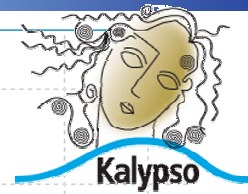
Landuse.shp

	big educational Institution
	cemetery
	detached houses
	industry
	green spaces
	sports facility (green fields)

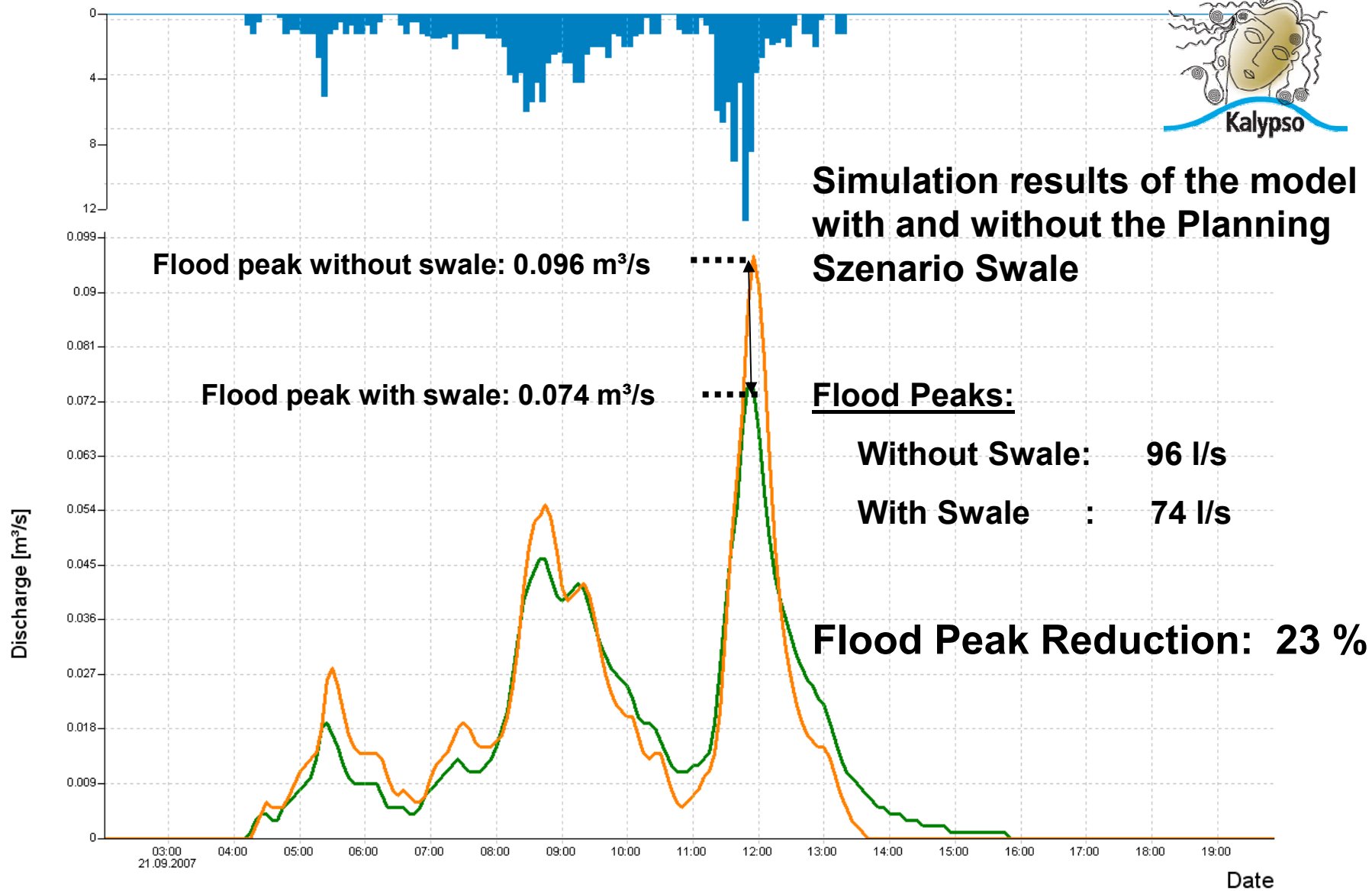
Reference: Gill, 2008

Land use area with SUDS attributes:

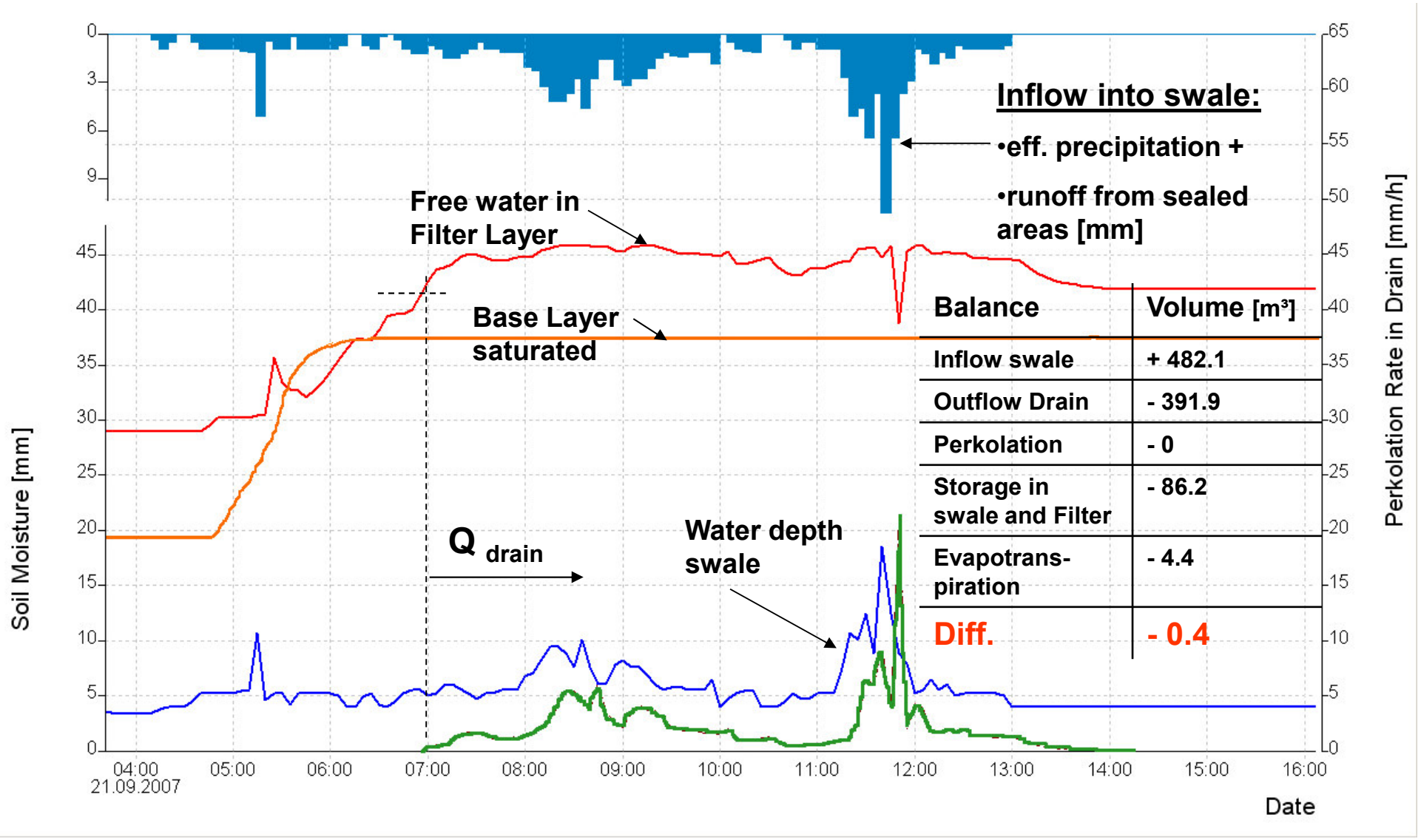
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4. Testing - Water Balance in the Swale - Unit



Conclusion:

- **A physically sound concept with a high level of detail in describing the hydrological processes in SUDS has been implemented in a rainfall runoff model.**
- **The new method enables the planner to define the Input data in an easy way via attributes of land use.**
- **First testing confirms the method of the new approach and demonstrate the effect of SUDS on the flood hydrograph on the catchment level.**

Outlook:

- **Extensions to further types of SUDS Systems: e.g. green roofs draining into swales.**

Acknowledgment:

The Pennine Water Group (University of Sheffield) provided the hydrological and pedological data for the Rainfall Runoff Model in the case study.

Thank you for your Attention!

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- Gill (2008): Gill E., Halcrow Group Ltd: Making Space for Water - Urban Flood Risk and Integrated Drainage (HA2); IUD pilot summary report, London.
<http://www.defra.gov.uk/enviro/fcd/policy/strategy/ha2finalreport.pdf>