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HYPE model parameter identification for urban watersheds based on infiltration characteristics and geographic information: a preliminary study

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Introduction

In recent years, a variety of urban hydrological phenomena are recognized. Increased impermeable land surface due to urbanization causes surface runoff to increase, infiltration to decrease and evapotranspiration to decrease. Consequently, risks of flooding, lowered groundwater levels and heat island effects increase in urban watersheds. Therefore in order to analyze hydrology in urban watersheds, hydrological model calculation have to take urbanization effects into account.

HYPE in urban watersheds

HYPE applications have not yet focused on urban areas, and therefore very limited efforts have been spent identifying suitable parameter sets. It has also been difficult to obtain correct land surface data for urban watersheds. At present, in S-HYPE the main urban land use class, “Urbant”, has default parameters set to the same values as those of class “Tunn jord och kalt berg”.

Study contents

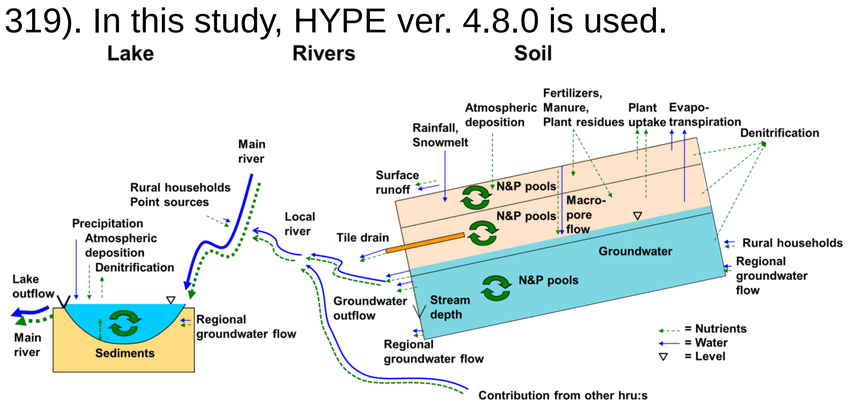
HYPE model parameter identification for urban watersheds is performed based on *geographic information* and *infiltration characteristics*.

GIS process: Soil-Land Classification (SLC) in “urbant” area → Calculating each land use fraction of “urbant” area

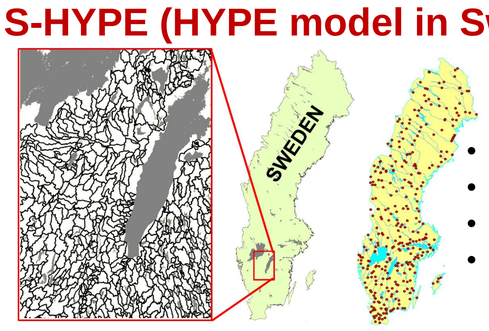
Parameter process: Setting model parameters of each land use & soil type → HYPE model calculation

HYPE

The Hydrological Predictions for the Environment (HYPE) model is a dynamic, semi-distributed, process-based, integrated catchment model developed by SMHI (e.g. Lindström et al., 2010, Hydrol. Res 41.3-4:295-319). In this study, HYPE ver. 4.8.0 is used.



S-HYPE (HYPE model in Sweden)



- 450 000 km²
- 38 000 sub-basins
- Mean sub-basin size: 11 km²
- ~300 stations for discharge observation

SLCs provided as S-HYPE default

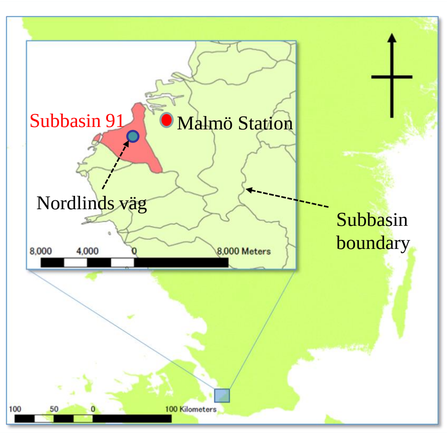
- 13 Landuses; lake, bog, fen, glacier, craggy, urban, conifer forest, deciduous forest, grass, other, agricaltural area, logging area and semi urban
- 9 soil types ; peat, clay, coarse, moraine, bare rock, water, silt, urban, and glaciofluvial sediments

HYPE data is available at: **hypeweb.smhi.se**

Target Basin

Subbasin no.91, which is a part of Malmö and described as 100% urban land use in S-HYPE, is used as a target basin.

Subbasin 91
- 13.44 km²
- 100% ”Urbant” SLC
- Inundation area (e.g. 31/8 2014)
- No discharge observation station



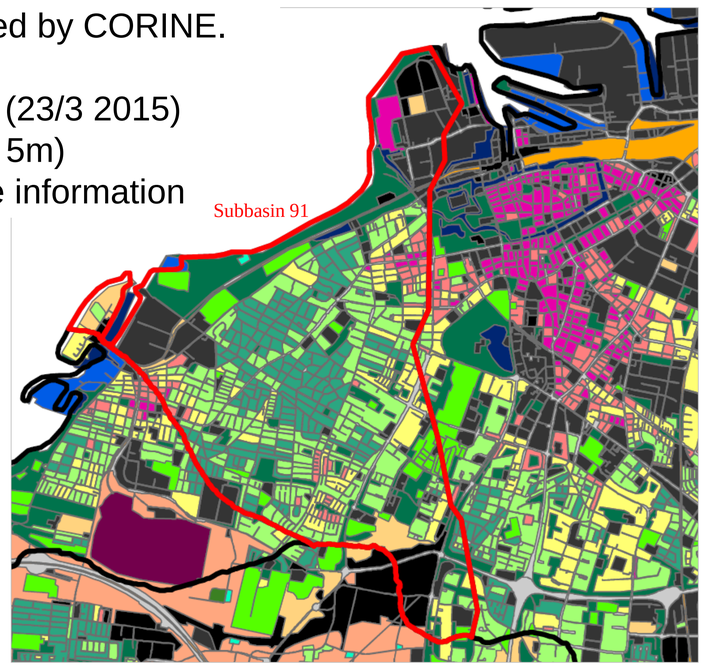
Storm event 31/8 2014

GIS process

Subbasin 91 is divided into 7 land use & 3 soil types by using ”Urban atlas”

What is Urban Atlas?

Urban Atlas is a dataset provided by CORINE.
- Polygonal land use map
- 307 cities in Europe covered (23/3 2015)
- High positional accuracy (+/- 5m)
- Based on Permeable surface information

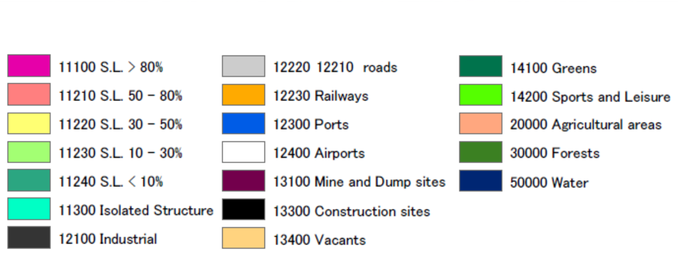


How to obtain SLC info.?

U.A. type	Code	SLC
Residential	11***	Permeable/ Impermeable
Trafic & Indestrial	12***	Impermeable
Mine & Dump	13100	Permeable
Construction	13300	Permeable
Vacant	13400	Grass
Green	14100	Forest
Sports	14200	Permeable
Agricultural	20000	Agricultural
Forests	30000	Forest
Water	50000	Lake

Impermeable ratio ; S.L. ＊ ; any number

- Permeable/Impermeable area (residential area); calculated based on S.L. value.



Urban atlas: **http://www.eea.europa.eu**

Area, area ratio, Soil & Land parameters of SLCs

SLC	Impermeable	Permeable	Forest	Grass	Agricultural	Lake
Area [ha]	45101.8	62907.0	19232.9	3654.1	82.2	722.0
Area Ratio[%]	34.2	47.8	14.6	2.8	0.1	0.5
Soil parameters	Impermeable	Urban	Urban	Urban	Urban	Water
Land use parameters	Impermeable	Semi urban	Conifer forest	Grassland	Agricultural	Lake

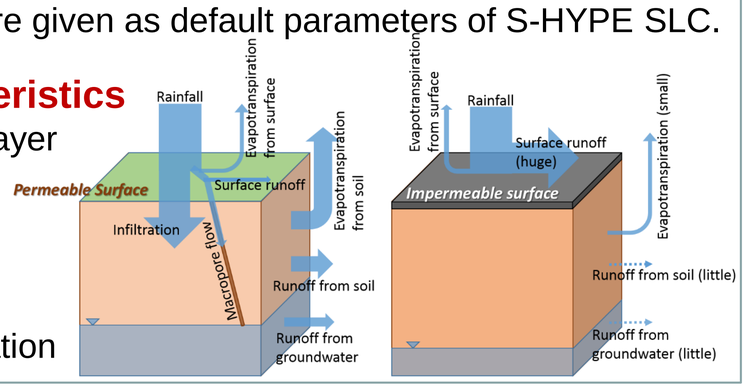
Parameter process

SLCs´ parameter setting

All SLCs except *Impermeable* are given as default parameters of S-HYPE SLC.

Impermeable SLC characteristics

- Top soil layer; Impermeable layer
- No infilteration
- Immediate surface runoff
- Little evapotranspiration
- Little macropore flow
- Smaller porosity by consolidation



Calculation & Result

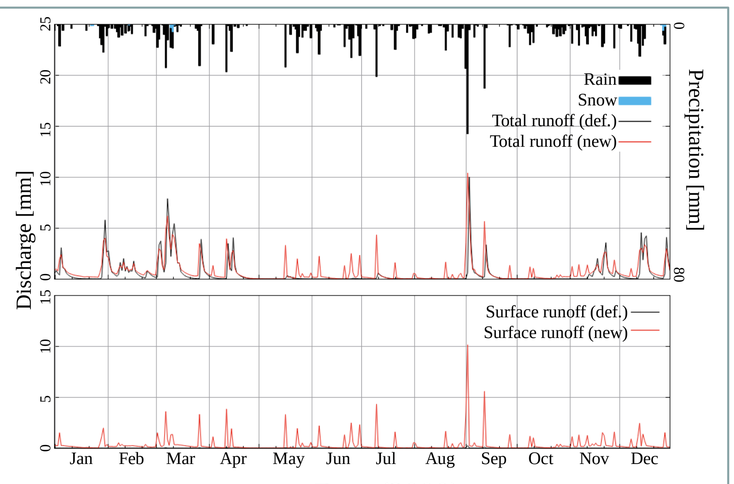
Condition

- machine learning; 01/Jan./1996 - 31/Dec./1999
- Simulated period 01/Jan./2000 - 31/Dec./2000

Result

- Immediate runoff caused by surface runoff in new model

+ Immediate runoff ; typical phenomenon in urban areas



Conclusion

Calculation of urban runoff by using HYPE with tailored parameter set based on geographic characteristics is qualitatively more realistic than HYPE default.

Next Step

1. Application of HYPE with high temporal resolution (1 hour)
2. Model verification by using observation, alternative models, etc.

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