



Summary of UMLs and Work-flows for Use Case 2

Use case 2 is described as: “Find the economically optimal investment plan for a user defined service level in the catchment”.

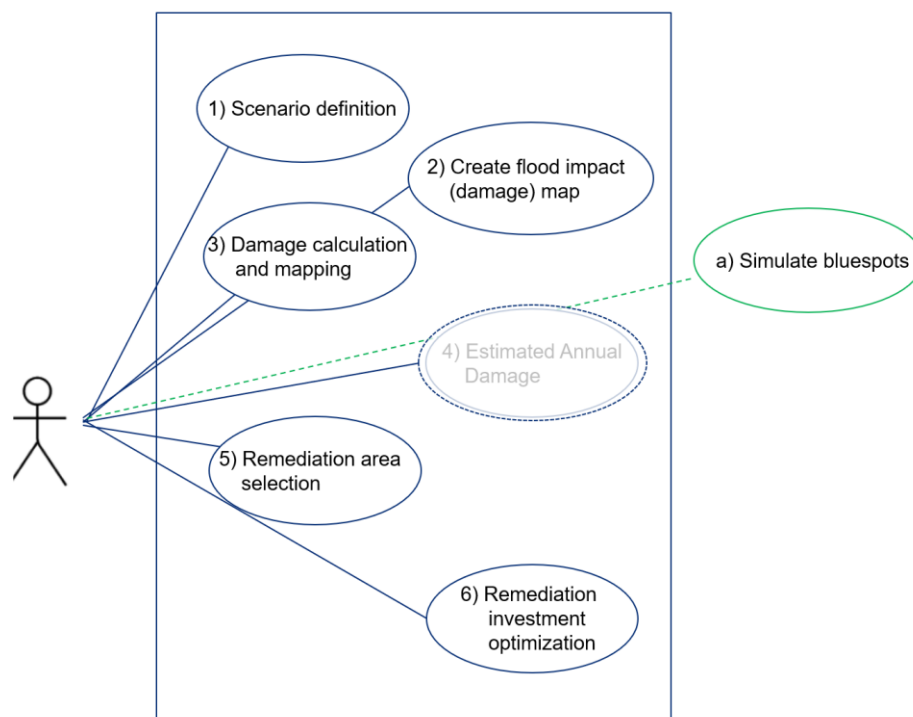
Service level is defined in accordance with “Skript 31” from IDA Spildevandskomiteen. This implies that service levels can be defined in one of three ways:

- 1) Uniform for the community – eg. 10 cm water depth on the ground to be exceeded on average once per 100 years.
- 2) Depending on use – eg. for housing districts, 10 cm water depth on the ground to be exceeded on average once per 100 years – for parks, 20 cm water depth on the ground to be exceeded on average once per 30 years.
- 3) On a sub-area basis with different criteria (each eg. as type 1) for each sub-area.

Like Use Case 1, this use case should be able to handle large as well as small catchments.

A reminder: The tool is intended for fast screening of options. Detailed modelling for verification of the resulting combination of options may well be relevant.

UML – Use Case 2:



The diagram is similar to Use Case 1, but with the calculation of Estimated Annual Damage deferred to after steps 5 and 6. EAD is not used in the optimization, but still useful as output.

Work-flow with illustrations – Use Case 2

The section numbers refer to the UML above.

- 1) Scenario definition
 - Select area, cell size (spatial resolution, default = DEM resolution)
 - Select precipitation map/table (map only if needed, default is no spatial variation) for 10, 20, 50, 100 yr return periods



- Select drainage capacity of existing system - map/value (only if needed, default is fixed mm precipitation)

In addition, for this use case:

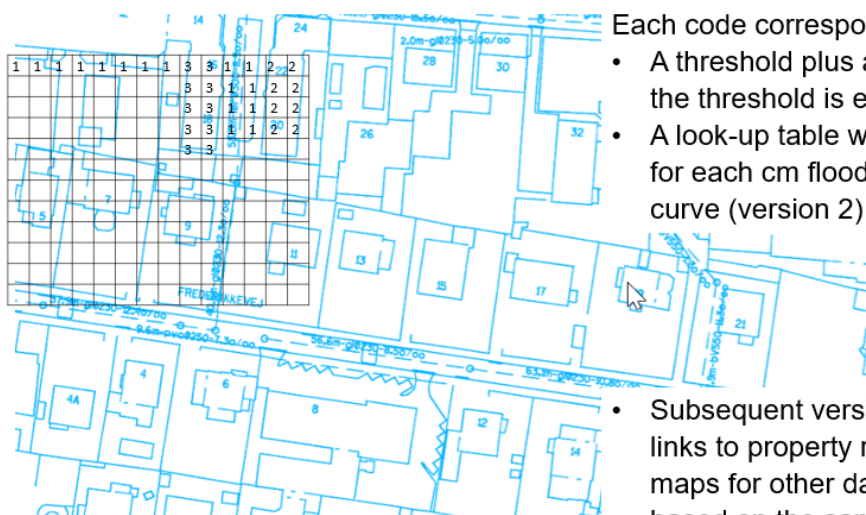
- Define service level property classes (eg villa, villa with basement, industry, hospital, road). Must match damage curve classes used in damage map.
- For each property class, define service level in terms of maximum water depth for specified return period (one set per property class).

2) Create Flood Impact (damage) Map

- (Default is spatially uniform, same threshold, same damage per m² if exceeded)
- Consists of a) threshold flood depth and b) damage per m² if exceeded – mapped through graphical cell value editor with a background map of physical properties

This step is identical to the same step in Use Case 1.

The damage data is still needed in order to calculate the economic optimum (this time with an additional constraint in terms of service level).



Each code corresponds to:

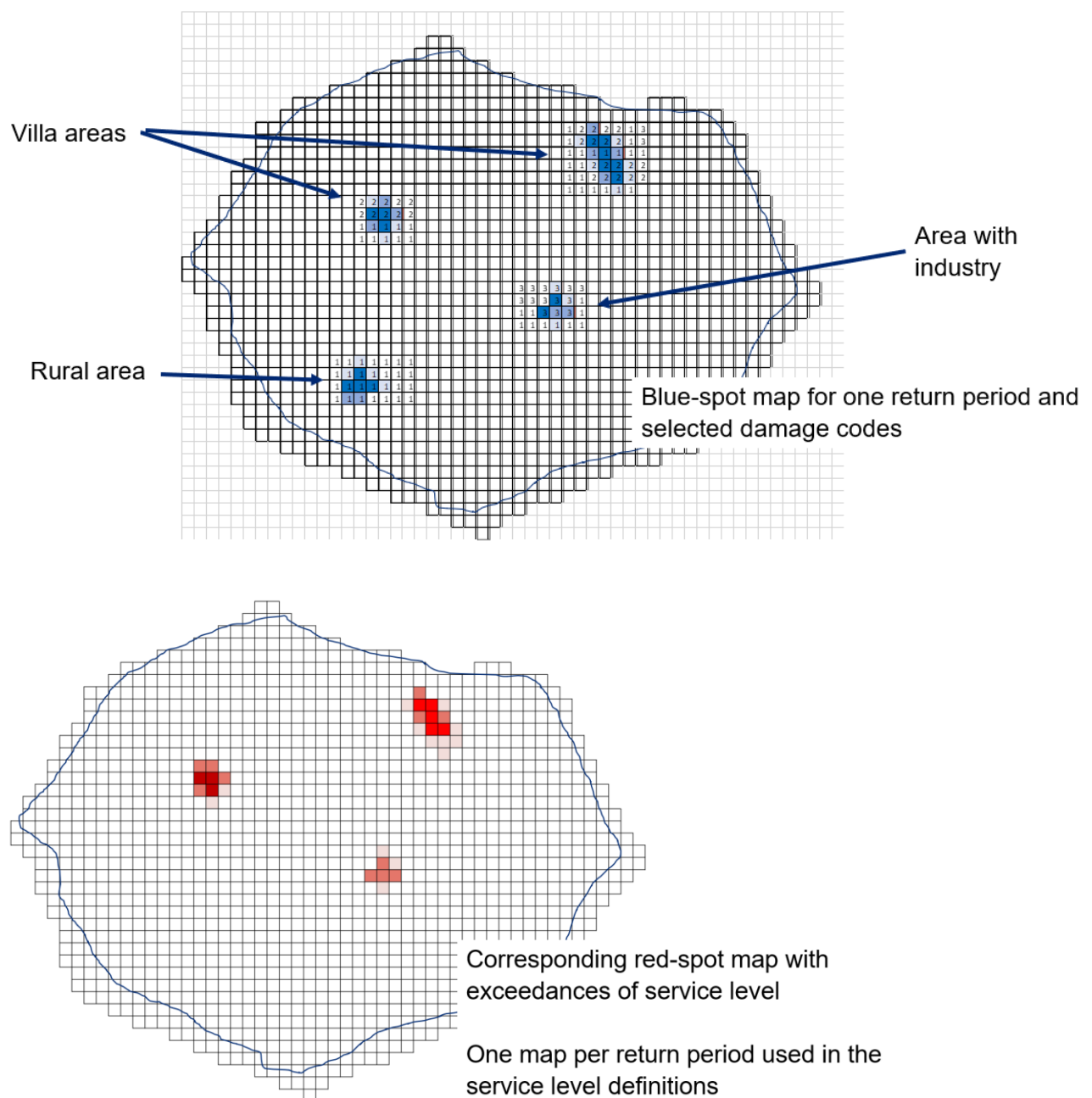
- A threshold plus a damage per m², if the threshold is exceeded (version 1)
- A look-up table with damage per m² for each cm flood depth = damage curve (version 2)

- Subsequent versions may include links to property registers and/or maps for other damage types – based on the same general principles.

3) Damage Calculation and Mapping

- User selects return period and this tool calculates damage values for each cell based on blue-spot simulation for this return period and based on Flood Impact Map. Blue-spot results are brought in from 3rd party software.
- Results of damage calculations are shown in map (red-spot map).
- Includes a quick integrator (pick area, and total damages for the area are shown)

For Use Case 2, the red-spot map shows violations of the service levels in terms of exceedance of permitted water depth for each cell.



In Use Case 2, the EAD calculation is deferred until after the calculation of the optimum remediation options.

This optimum is calculated so that it matches all specified service levels at the minimum costs.

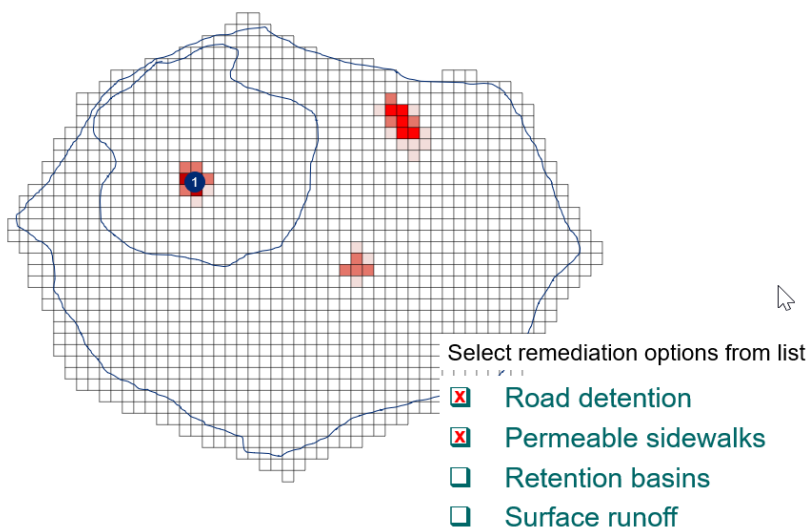
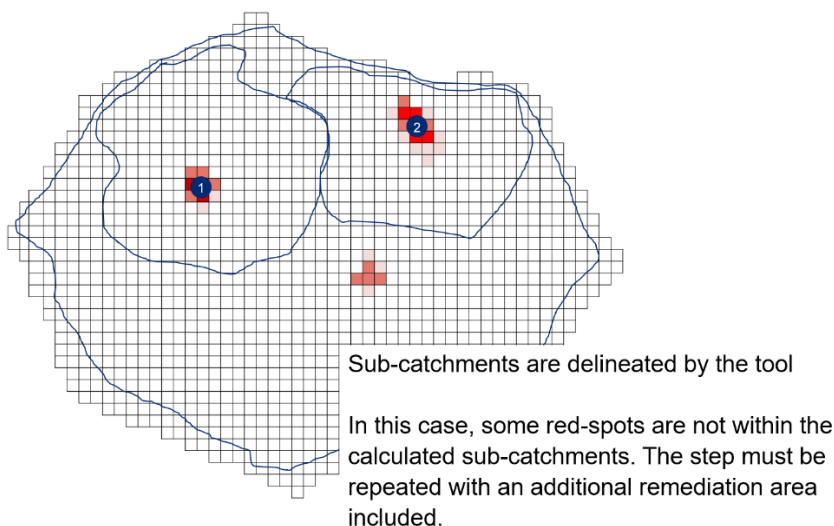
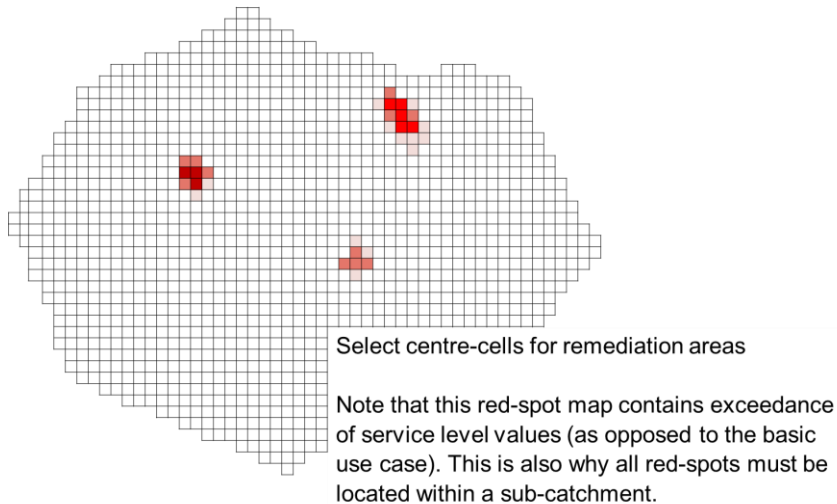
4) Remediation Option Selection (same as for Use Case 1)

- Pick from the red-spot map 1-n cells located in areas with flood damages. (These cells are then each the centre of a sub-catchment). This tool then creates catchment areas for the selected cells based on the underlying DEM.
- This tool is also where you pick and define your remedial options. The option definition includes the following input values for each sub-catchment and each option



type: max capacity (defined as volume or as length (eg of roads) plus volume per length unit), price estimate per unit.

- Note that prices may be different from one sub-catchment to another (eg if the costs of constructing a retention basin is higher in a city than in a suburb).





5) Remediation Option Selection

Sub-catchment delineations are used for assessing the available remedial measures.

For instance: How many m of roads can be modified for local retention?

Table for each sub-catchment, example:

	Minimum	Maximum	CAPEX	OPEX/year
<input checked="" type="checkbox"/> Road detention	<input type="text" value="50"/>	<input type="text" value="450"/>	<input type="text" value="10.000"/>	<input type="text" value="25"/>
<input checked="" type="checkbox"/> Permeable sidewalks	<input type="text" value="200"/>	<input type="text" value="1200"/>	<input type="text" value="12.000"/>	<input type="text" value="30"/>
<input type="checkbox"/> Retention basins	<input type="text"/>	<input type="text"/>	<input type="text" value="2.000"/>	<input type="text" value="4.000"/>
<input type="checkbox"/> Surface runoff	<input type="text"/>	<input type="text"/>	<input type="text" value="700"/>	<input type="text" value="35"/>

6) Remediation Option Optimization

For each of the sub-catchments, this tool finds the optimal investment plan by selecting remediation options from the list and removing the corresponding amounts of water from blue-spots until there are no more red-spots in the exceedance maps.

6) Result presentation (Use Case 2)

The results are shown as:

- Tables with the optimal investments listed for each sub-catchment (see below)
- A map with reduced blue-spots and summary of optimal investments shown as table inserts
- EAD curves and NNV curves corresponding to Figs. 11 and 12 in “Skript 31”.
- A map with reduced red spots (EAD values) corresponding to the investments

	Optimum	CAPEX	OPEX/year
<input checked="" type="checkbox"/> Road detention	<input type="text" value="300"/>	<input type="text" value="3.000.000"/>	<input type="text" value="7.500"/>
<input checked="" type="checkbox"/> Permeable sidewalks	<input type="text" value="850"/>	<input type="text" value="1.700.000"/>	<input type="text" value="25.500"/>
<input type="checkbox"/> Retention basins	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="checkbox"/> Surface runoff	<input type="text"/>	<input type="text"/>	<input type="text"/>
Total	<input type="text" value="1.150"/>	<input type="text" value="4.700.000"/>	<input type="text" value="33.000"/>

(all numbers in graphs and tables are purely artificial and for illustration purposes only)