

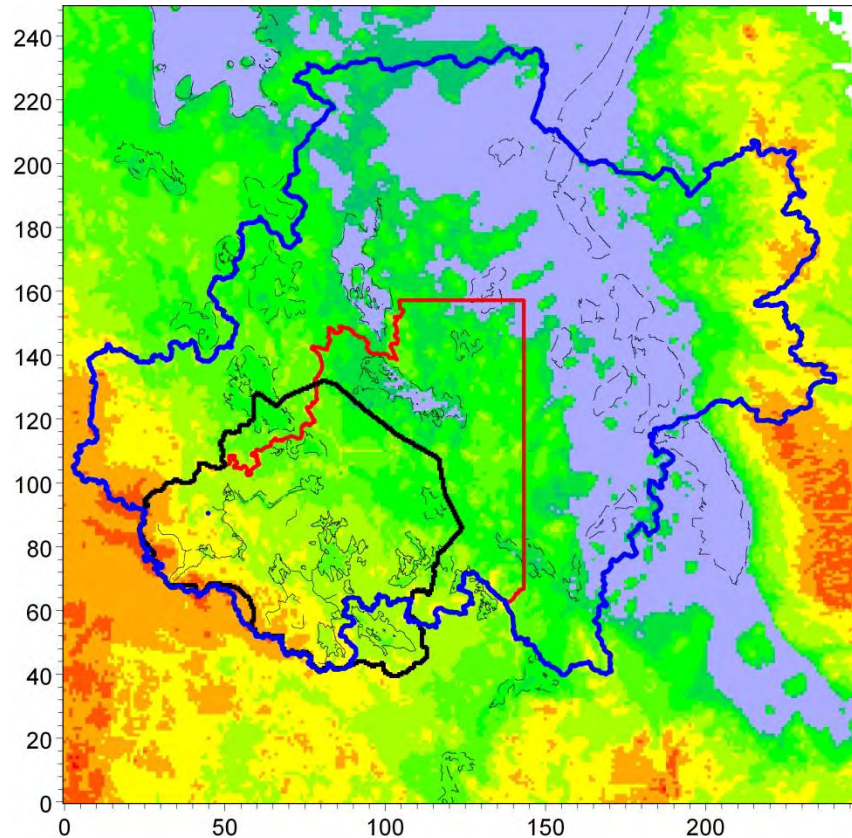
**Surface hydrology in SR-Site and its translation into the TR-10-06
radionuclide transport model**

**Questions concerning the application of
MIKE SHE**

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Questions 1:

Are there substantive differences between the MIKE-SHE results for the SDM-Site area, the pre-modelling area and the SR-Site regional model area? (R-10-02 Chapter 8, Fig 8-1 and associated material).

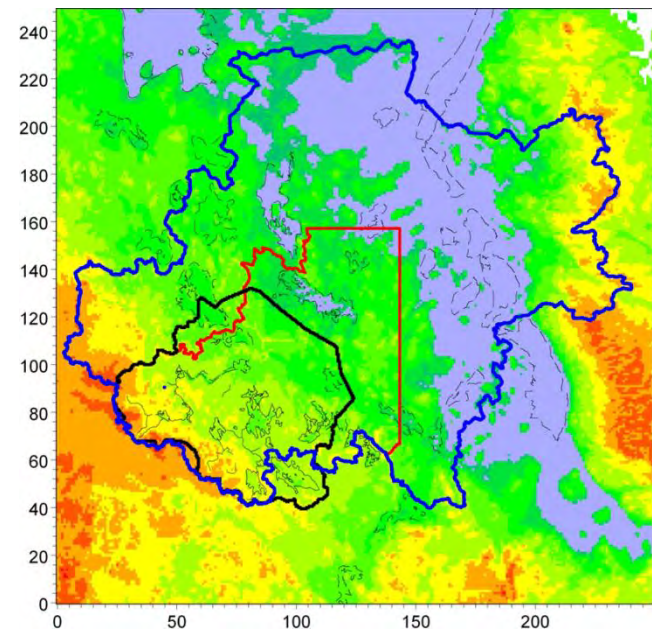


R-10-02; Figure 8-1

Answer 1:

No, the results of the models representing today's (2000AD) conditions should be comparable.

- *The SDM-Site MIKE SHE model was calibrated thoroughly against measurements (see R-08-09).*
- *The MIKE SHE pre-modeling was based on the SDM-Site model but with an extended model area and with model set ups representing future conditions. Results from the pre-modeling representing today's conditions were compared with results from the SDM-Site model to ensure a good agreement.*
- *In the same way as for the pre-modeling, the MIKE SHE SR-Site model was set up based on the SDM-Site model. The model area was increased once again in order to cover the area where possible future exit points may occur. The model area was substantially larger for the SR-Site model and in order to make model calculations practically feasible, the grid cell size was increased from 40x40 m to 80x80m and the sub-catchment for Lake Fiskarfjärden was removed.*

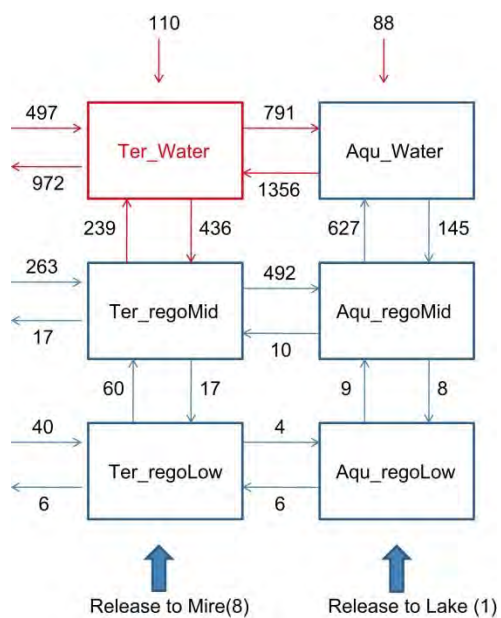


R-10-02; Figure 8-1

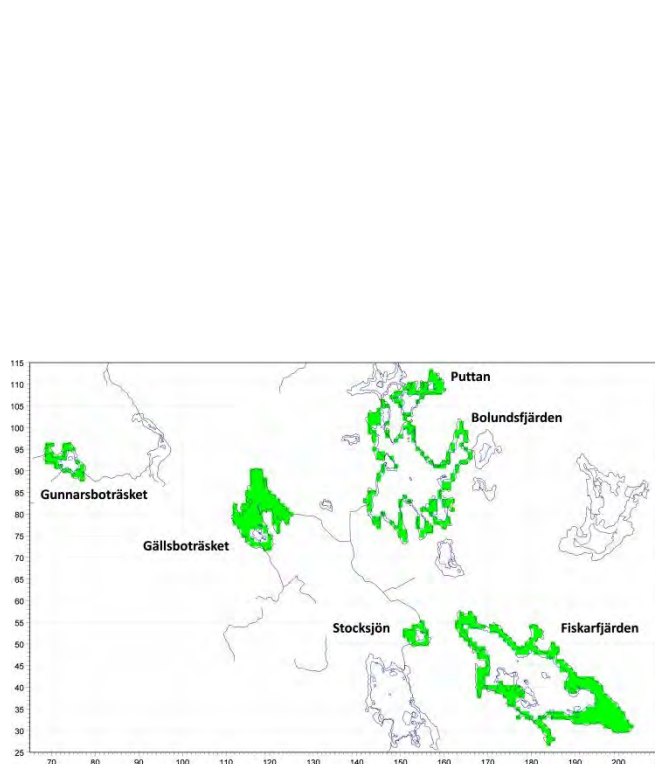
Question 2a:

The “average object” has a mass balance presented as Figure 8-5 in R-10-02. We understand that this is based on the mass balance for six objects (Figures 8-2 and 8-3 of R-10-02). MIKE-SHE outputs mass balance for the objects under consideration:

- Can we obtain the mass balance results corresponding to the six objects at the times 2000, 3000 and 5000 CE? (How are these related to Fig 8-4 and Fig 5-22?).



R-10-02; Figure 8-5



R-10-02; Figure 8-3

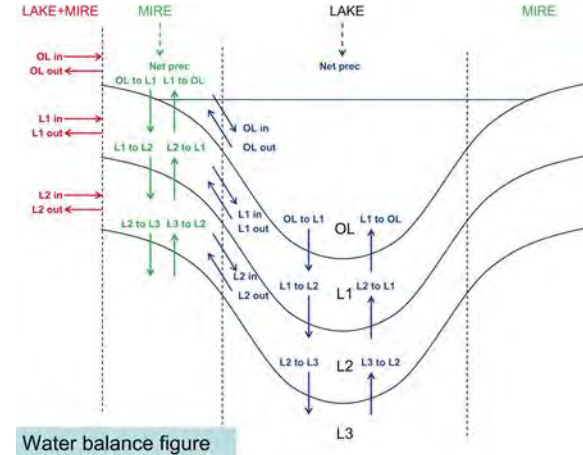


R-10-02; Figure 8-2

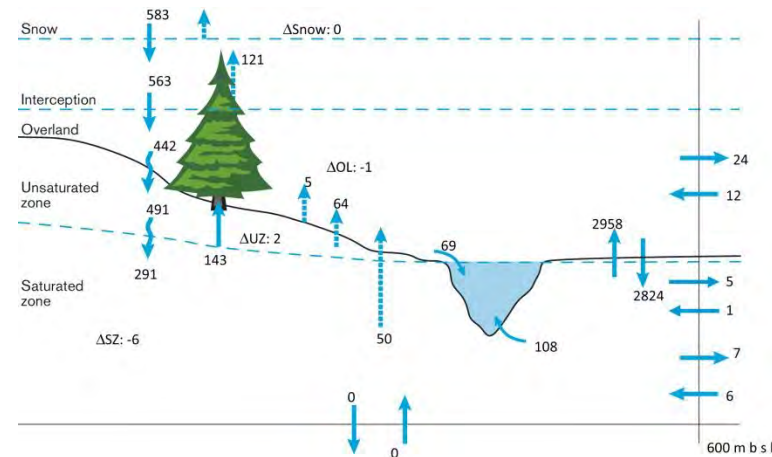
Answer 2a:

Results from 5000AD may be obtained

- *Water balances for the lake objects were only extracted from the pre-modeling 5000AD!*
- *Results from the extracted water balances may of course be obtained. Original data are in MIKE SHE dfs0-format but the necessary parameters are copied to excel files for post-processing.*
- *The MIKE SHE water balance tool is very flexible and data can be generated at a variety of spatial and temporal scales and can include area normalized flows, storage changes, and model errors resulting from convergence problems. Figure 8-4 shows the water balance items that were used for the lake-mire water balances in Figure 8-5. Figure 5-22 is water balance describing the overall balance of a catchment area, not focusing on fluxes between different soil layers.*



R-10-02; Figure 8-4

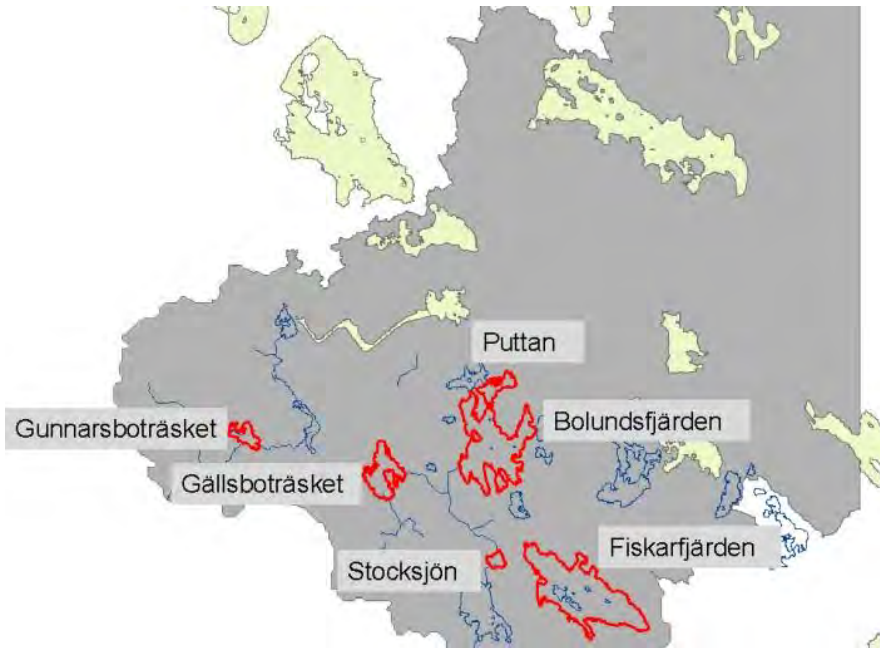


R-10-02; Figure 5-22

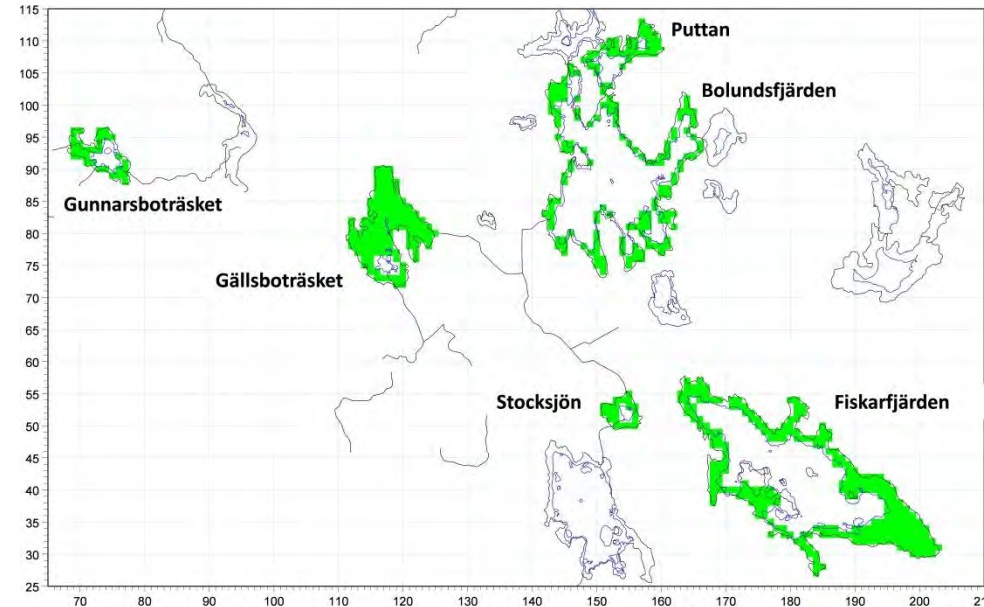
Question 2b:

The “average object” has a mass balance presented as Figure 8-5 in R-10-02. We understand that this is based on the mass balance for six objects (Figures 8-2 and 8-3 of R-10-02). MIKE-SHE outputs mass balance for the objects under consideration:

- Can SKB illustrate how these objects are combined to generate the “average object”?



R-10-02; Figure 8-2

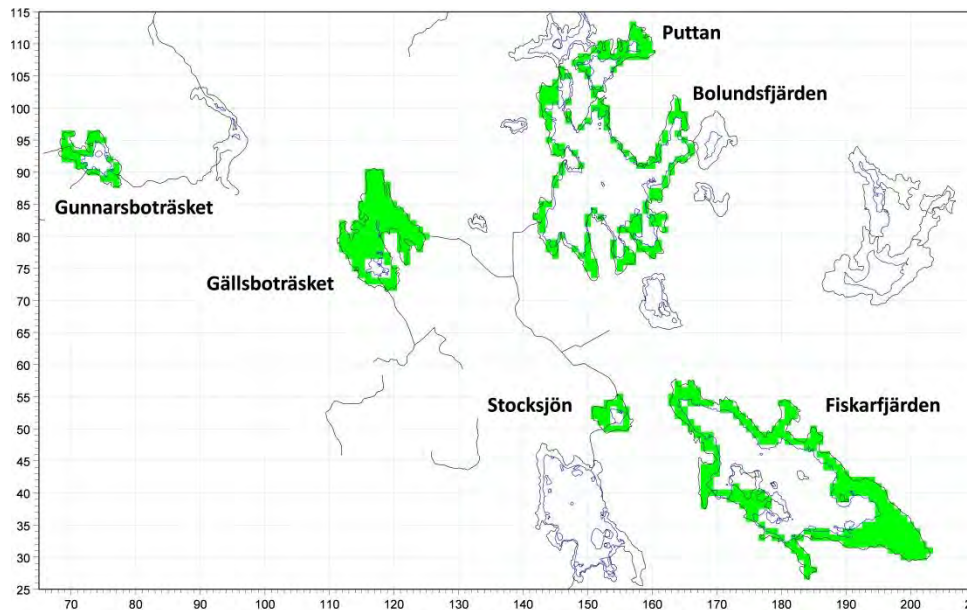


R-10-02; Figure 8-3

Answer 2b:

The water balance tool automatically calculates average values for the area defined; the total areas are illustrated in Figure 8-3 in R-10-02

- *Averaging was made in two different ways for the “average object”*
 1. *Water balances for all six objects were extracted and mean values were calculated.*
 2. *Water balances for all six lakes together were extracted, which automatically gives mean values for the area.*



Green areas = mire areas

White areas within green = lake areas

R-10-02; Figure 8-3

Questions 3a and 3b:

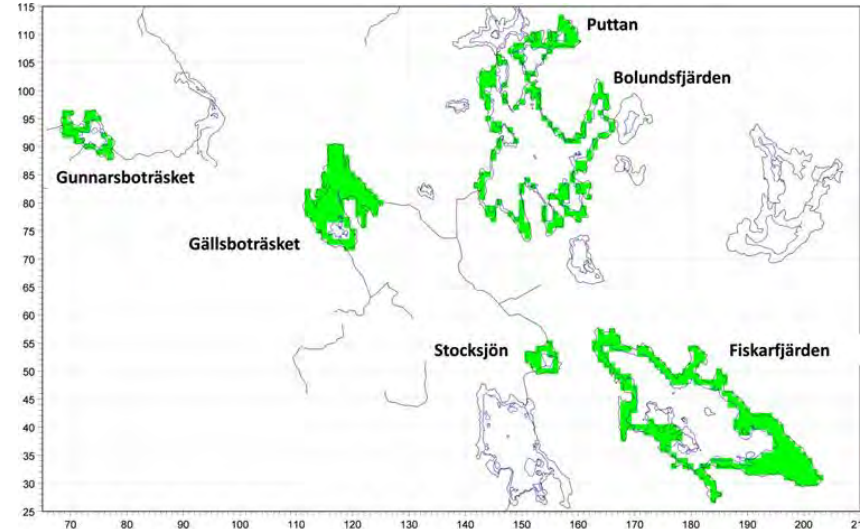
Noting that MIKE-SHE has a water balance utility that can output water balance as “area normalised flows” (R-10-02 p304); it seems that these “advective fluxes” were used in the derivation of the “average object”:

- a. For each of the objects used to define the “average object” what is the normalizing area?
- b. Does this area change in time? If so what are the relevant values at 2000, 3000 and 5000 CE? What is the normalizing area of the “average object”?

Answers 3a and 3b:

- Each of the object has areas according to Table 8-1 in R-10-02. The total area for calculating the average object is the sum of all the individual lake- and mire areas
- Water balances are only extracted from the 5000AD model. Any changes of areas, or lake-mire fractions, in time are not handled by the delivered MIKE SHE water balances

Name of lake	Subarea	No of cells	Area (km ²)
Fiskarfjärden	Lake	252	0.4032
	Mire	247	0.3952
	Lake + Mire	499	0.7984
Bolundsfjärden	Lake	246	0.3936
	Mire	139	0.2224
	Lake + Mire	385	0.616
Puttan	Lake	16	0.0256
	Mire	41	0.0656
	Lake + Mire	57	0.0912
Gällsboträsket	Lake	10	0.016
	Mire	120	0.192
	Lake + Mire	130	0.208
Gunnarsboträsket	Lake	13	0.0208
	Mire	31	0.0496
	Lake + Mire	44	0.0704
Stocksjön	Lake	5	0.008
	Mire	20	0.032
	Lake + Mire	25	0.04



R-10-02; Table 8-1

Question 3c:

Noting that MIKE-SHE has a water balance utility that can output water balance as “area normalized flows” (R-10-02 p304); it seems that these “advective fluxes” were used in the derivation of the “average object”:

- c. Would mass balance in the “average object” be different if water flow rates (m^3 year⁻¹) had been used instead of velocities (m year⁻¹)?

Answer 3c:

- c. The balance would not change
- *The MIKE SHE water balance tool automatically gives all results in mm/yr, based on the given area used for the water balance*
 - *If the flows are desired as m^3/y , they have to be transformed manually by multiplying with the area they were calculated for. This does not change the balance though since all numbers are re-calculated using the same area.*

Question 4:

Is it possible to access (from SICADA?) results from the flow fields calculated by MIKE-SHE?

Answer 4:

Results are available if requested, but not from SICADA.

- *Modeling results may be delivered if they are requested, however the flow field data are only available in the MIKE SHE dfs3-format.*
- *In order to read dfs3-files MIKE SHE has to be installed. In order to work with the data it is also necessary to have a MIKE SHE license.*
- *All models and model result files are located on servers at SKB; in the model data base documents it is shown where all modeling results are located and may be found.*

Question 5:

Is it possible to use MIKE-SHE to characterize fluxes in agricultural systems imposed on the natural ecosystems, i.e. including modified drainage?

Answer 5:

Yes, absolutely

- *You can specify drainage in a number of different ways in MIKE SHE.*
- *Saturated zone drainage is a special boundary condition in MIKE SHE used to define natural and artificial drainage systems*
- *You may also define drainage by coupling the MIKE SHE model to the surface stream model MIKE11 or the pipe-flow model MIKE URBAN*
- *Besides defining drainage, the agricultural system may be described in MIKE SHE by changing the vegetation. Properties for several crops are available.*

Question 6:

In MIKE-SHE, does the volumetric flow of water from the bedrock change on the transition from aquatic to terrestrial conditions at the surface?

Answer 6:

No detailed water balances were made to investigate this, but the change in water flow from the bedrock is probably small when going from limnic to terrestrial conditions

- *As long as the climate is the same, the changes in the overall water balances are small and no shifts in hydraulic gradients are noted as the landscape evolves*
- *Model simulations with a warm and wet climate show that the water flows on the surface increase but the changes are small for lower depths. No shifts in hydraulic gradients compared to the temperate climate.*
- *Model simulations with a peri-glacial climate show a significant change in the overall water balance and hydraulic gradients differ from those seen for a temperate climate*