Guidance for running GW_allocation_model with a different set of catchments

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6th of June 2025

Table of Contents

1. General guidelines 2
2. Description of the format of the input data used in the model 2
K_optim_NSE.csv 2
WB_**Catch_Geo** 2
Table_Catchments_**Catch_Geo**.csv 2
Table_WF_**Catch_Geo**.csv 2
Table_WW_**Catch_Geo**.csv 3
Table_WSA_**Catch_Geo**.csv 3
Table_WTP_**Catch_Geo**.csv 3
Table_Water_Transfer_**Catch_Geo**.csv 3
Anlaegid_hieraki.xlsx (only for scenario 2) 3
Matrix_WF_WW_**Catch_Geo**.csv 3
Matrix_WW_WSA_**Catch_Geo**.csv 3
3. Preprocessing steps: defining new catchments 4
4. Processing steps: formatting the data with the new catchments 4
Compute the area of your new catchments 4
Allocate wells to your new catchments 5
Allocate WSA to your new catchments 5
Add new water transfers if relevant 5
Process all data of the folder *Raw data* 5
5. Run the model with your new catchments! 5

1. General guidelines

This document describes the format of the data that should be used for running the model. It also details how to generate the data files in the correct format if you want to run the model with a different set of catchments, than the ones used in the study.

In all the document, **Catch** refers to the name of the catchments and **Geo** refers to the location of the catchments. In the study, **Catch** corresponds to Watersheds and **Geo** corresponds to Capital, which means that the catchments used are the ones called Watersheds, and the region of the study is the capital region of Denmark. For defining a new set of catchment, a new couple (**Catch**, **Geo**) should be chosen.

2. Description of the format of the input data used in the model

This section describes what information the input data should contain in order to run the model. Each file is a table containing multiple rows of data, and the names of the columns are described. For the matrices, data are also stored in table, but the IDs are both columns and rows IDs. If the model is provided with files containing this information, the model should run.

To ensure that the data are in the right format, I encourage you to check the format of the current files in the Input data model folder in the GitHub repository.

K_optim_NSE.csv

- "Catchment": Catchment ID
- "K": Residence time constant (week)

WB_Catch_Geo

- All processed WB data for all catchment, csv files called WB_SZ_**Catch**_*XX* containing each: (*XX* = ID number of the catchment)
    - "Start time of weekly time step": weekly datetime
    - "MIKE SHE GW recharge (mm)": groundwater weekly recharge in (mm)

Table_Catchments_Catch_Geo.csv

- "Catch_ID": Catchment ID
- "Area (m2)": Area of the catchment

Table_WF_Catch_Geo.csv

- "WFID": Wellfield ID
- "AnlgTillad": maximum pumping capacity (m3/year)

- "CatchID": Catchment ID where the Wellfield is located

Table_WW_Catch_Geo.csv

- "WWID": Waterworks ID
- "Storage Capacity (1000m3)": Storage capacity of the waterworks (1000m3)
- "Storage initial (1000m3)": Initial storage in the waterworks (1000m3)

Table_WSA_Catch_Geo.csv

- "WSAID": Water Supply Area ID
- "CatchID": Catchment ID where the WSA is located
- "Wateruse households (1000m3)": Water consumption of Households (1000m3/year)
- "Wateruse industries (1000m3)" : Water consumption of Industry (1000m3/year)
- "Wateruse services (1000m3)" : Water consumption of public services (1000m3/year)
- "Wateruse agriculture (1000m3)" : Water consumption of Agrictulture (1000m3/year)

Table_WTP_Catch_Geo.csv

- "Year": Yearly index
- "WTP Households (DKK/m3)": Willingness to pay of Households (DKK/m3)
- "WTP Industry (DKK/m3)": Willingness to pay of Industry (DKK/m3)
- "WTP Services (DKK/m3)": Willingness to pay of Public Services (DKK/m3)
- "WTP Agriculture (DKK/m3)": Willingness to pay of Agriculture (DKK/m3)

Table_Water_Transfer_Catch_Geo.csv

- 2-dimensions matrix containing the transfer capacity between WWID and WWID, only for the WW involved in water exchanges.
  (transfer capacity in 1000m3/day)

Anlaegid_hieraki.xlsx (only for scenario 2)

- "ANLAEGID": PlantID
- "OVERANLAEG": Upper PlantID
- "KOMMUNENR2007": Municipality ID of the municipality where the plant is located

Matrix_WF_WW_Catch_Geo.csv

- 2-dimensions matrix containing the connections between WFID and WWID
  (0 = not connected, 1= connected)

Matrix_WW_WSA_Catch_Geo.csv

- 2-dimensions matrix containing the connections between WWID and WSAID
  (0 = not connected, 1= connected)

3. Preprocessing steps: defining new catchments

For defining new catchments, the hydrological model needs to be run with MIKE SHE again, and the post processing of the results needs to be done with using the new catchments.

The catchments should be in a format that is compatible with MIKE SHE. For doing that, the shape of the catchment can be defined on a GIS software and extracted in an asc format. Then the GRD2MIKE tool can be used in MIKE SHE to convert the asc in the correct format.

Once the model is run, the data need to be extracted using the waterbalance caculation tool. Waterbalance calculations need to be run one by one, but a batch extraction is also possible. The extracted data should be saved in the folder Raw data/WB_Catch_Geo. Catch and Geo corresponding to your new catchments.

Then the python script *WB_data_processing.py* should be run to process the data in the proper format. The processed data will be saved in the folder Input data model/WB_Catch_Geo

4. Processing steps: formatting the data with the new catchments

After defining the new catchment and extracting the water balance calculation from MIKE SHE, more processing work is needed using a GIS software. This section describes the steps for processing data with QGIS.

Start by opening the following shapefiles with QGIS: (available in the folder *Shapefiles*)

- *Catchment_Catch_Capital*: Shapefile containing *your* new catchments, with their ID.
- *dk17_abstractions_Sjaelland:* shapefile containing all the wells of Zealand.
- *WSA:* shapefile containing the Water supply areas for the whole Denmark.

Follow the steps below and save all extracted data from QGIS in the folder *Raw Data.*

Compute the area of your new catchments

- In *Catchment_Catch_Capital* layer, in attribute table editing mode:
    - Make sure there is a columns with the **"Catch_ID"**
    - create a new feature with the formula ***$area,*** and name the column **"Area (m2)"**
    - check the unit in the coordinate system (it should be m2)
- Save data in a new layer called *Catchment area*
- Extract data as a xlsx file **'Catch_Geo_area.xlsx'**

Allocate wells to your new catchments

- Join Attributes by location
    - *dk17abstractions Sjaelland* **intersects** *Catchment_Catch_Capital*
- Extract data as csv **: 'Wells_Catch_Geo.csv'**

Allocate WSA to your new catchments

- Join Attributes by location on QGIS
    - (*WSA* **intersects** *Catchment_Catch_Capital*, take attributes of the feature with the largest overlap only)
- Extract data as csv : **'WSA_Catch_Geo.csv'**

Add new water transfers if relevant

In addition, you have the possibility to add water transfer connections by hand in the **Table_Water_Transfer.xslx** file. The data to be added is the water transfer capacity in 1000m3/day.

Process all data of the folder *Raw data*

After all these steps have been performed, run the python script *Data_final_processing.py*. It will process all the data in the correct format so it can be used by the main model.

5. Run the model with your new catchments!

Once your new catchments have been defined and you have run both the script *WB_data_processing.py* and *Data_final_processing.py,* all data are set-up. You can run the optimization model coded in the script *GW_allocation_model.py* with your new catchments.