

# Chapter 2

## Modelling Strategy

### 2.1 Work Flow

The numerical model should represent the best characterization of the groundwater flow and solute transport process for the aquifer system of the study area in Ashi catchment. In order to simulate the processes, a large number of input data sets from different sources are required. By employing the *OpenGeoSys Data Explorer* we are able to integrate hydrological, geological and geographic input data from different sources to set-up the model. The framework of the *OGS Data Explorer* also supports the creation of finite element meshes and boundary and initial conditions to complex, unstructured geometries (Rink 2013). Beside *OpenGeoSys* and *OpenGeoSys Data Explorer*, *Paraview*, *QGIS* and *Notepad++* are applied for visualization and further preprocessing/postprocessing steps.

For this case study, a step by step description of the complete model setup will be provided in the following, including remarks on the simulation and post processing of the three-dimensional flow-model. The model set-up covers several steps and three different models of the same study area will be created within the tutorial.

1. Stationary Groundwater flow model
  - a. Model geometry (*OGS Data Explorer*)
  - b. Surface and subsurface meshes (*OGS Data Explorer*)
  - c. Boundary conditions (*OGS Data Explorer*, *Notepad++*)
  - d. Process specification, material and numerical parameters, time steps (*Notepad++*)
  - e. Simulation (*OGS*)
  - f. Results and post processing (*ParaView*)
2. Reactive Nitrate transport model within a stationary flow field
  - a. Kinetic biodegradation reaction definition (*Notepad++*)
  - b. Boundary conditions (*QGIS*, *Notepad++*)
  - c. Extension of existing files (*Notepad++*)

- d. Simulation (*OGS*)
  - e. Results and post processing (*ParaView*)
3. Reactive point pollutants model within a transient flow field
- a. First-order decay reaction (*Notepad++*)
  - b. Boundary conditions (*QGIS*, *Notepad++*)
  - c. Results and post processing (*ParaView*)

## 2.2 Overview of Available Data-Sets

All available topographical, geological and hydrological data of the Ashi River study area catchment were organised and digitalised in the geographic information system *QGIS*. The input data for the model setup contain:

Raster files:

- Digital elevation model of the Ashi catchment (*ashi\_dem.asc*)
- Raster data of hydrogeological subsurface layers: unconfined loess layer (*unc.asc*), Aquitard (*aqd.asc*) and confined aquifer (*conf.asc*)
- Groundwater recharge (*gwr.asc*)

Shape files:

- Boundary of the study area (*boundary\_line.shp*)
- Course of Ashi River (*ashi\_river.shp*)
- Location of drinking water wells and the water work (*wellfield\_bottom.shp*; *wellfield\_top.shp*)
- Location of Suspicious sites (*suspicious\_sites\_3d.shp*)

The digital elevation model with a resolution of three arcseconds, which is about 93 m at this latitude, was obtained from the freely available data set of the Shuttle Radar Topography Mission (Farr et al. 2007). The different raster files of the hydrogeological layers were derived by layer-wise spatial interpolation of existing bore hole data (Heilongjiang Research Institute for Environmental Sciences (HRIES) 1983). This approach was feasible due to the horizontal layering within the study area and the absence of faults. The groundwater recharge is based on the average annual precipitation in the area of 515 mm.

The boundaries of the study area and the river course of Ashi River have been calculated using watershed analysis. The interested reader is directed to the *OGS-Tutorial: Computational Hydrology I* (Sachse et al. 2015) for further information about watershed delineation using GIS software.

The location of the groundwater wells and the abstraction rates are provided by local authorities. Land cover data was obtained by satellite data from China's GlobeLand30 data set.

## 2.3 Software Requirements

The first step in order to start our numerical modelling will be to download all the necessary softwares and the needed input files. For this tutorial, we use only open access software which is easily available for any user from different web sources. Please download the softwares individually from the following sources considering your operating system (32-Bit or 64-Bit).

1. *OGS* version 5.7.0 : <https://docs.opengeosys.org/download5>
2. *OGS Data Explorer* version 6: <https://docs.opengeosys.org/download>
3. *GMSH*: <http://gmsh.info/#Download>
4. *QGIS*: <http://www.qgis.org/en/site/forusers/download.html>
5. *ParaView*: <http://www.paraview.org/download/>
6. *Notepad++*: <https://notepad-plus-plus.org/download/>
7. Input Files: <https://docs.opengeosys.org/books/computational-hydrology-ii>

OpenGeoSys Tutorial

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Modeling

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