Integration of GemPy and FloPy packages for modeling seawater and

freshwater interactions in coastal aquifers



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BW11

Gravel-Sand mixture

Gravelly Sands

Sand-Silt mixtures

Gravelly Sands

Sand-Clay mixtures Sand-Silt mixture

Abstract

Coastal groundwater resource is a potential alternative water resource to bridge the gap of increasing water demands. An accurate hydrogeological model could reduce the uncertainty of the flow and transport estimations in coastal aquifers. The study aims to develop a framework that integrates the open-source GemPy and FloPy for modeling seawater and freshwater interactions in the coastal aquifer in Taoyuan, Taiwan. In the study, a series of field works were conducted to acquire site-specific information, including core drilling and identification of geological materials, groundwater level observation, and hydraulic tests. The geological model uses data obtained from the core samples to map the stratigraphic distribution of the coastal aquifer. The results show that the strata in this area are mainly stacked horizontally within 100m underground, the upper part is dominated by gravel layers, and the middle and lower parts are stacked by sand and mud layers. Next, the data obtained from the test and the material distribution in the geological model will be used to establish a flow field model in this area.

Study Area

The TaiCOAST workstation is located in the coastal area of Taoyuan in northern Taiwan. The surface is covered with alluvial layers, with an average upper layer thickness of about 20 meters composed of gravel. The lower layer is mainly composed of interbedded sand and silt.



Methodology & Results

A geological model was established based on the borehole data from the site, and the GemPy and FloPy were combined using Python code, allowing for the efficient

input of the geological simulation model into the groundwater flow conceptual model.



Figure 1. The UAV figure of the study area in the red rectangle, the map in the upper right corner is a topographic map of the Taoyuan area (Wang Yu, 2003).





Figure 4. The left figure shows Using GemPy to generation the 2D geological model. All the cells in the geological model are assigned an ID, which represents the material, so that the location of the material can be defined in the groundwater flow model using the cells location and ID. The right figure shows the conceptual model of groundwater flow model with 400*110 grids (Grid size: Δx : 1m; Δz : 1m). The hydraulic conductivity are set according to different materials.





Reference

1. Wang Yu, Taiwan. (2003). Morphotectonics in Taoyuan – Hsinchu Area, Northwestern Taiwan.

simulate head of groundwater field in high tide and low tide.

Figure 5-2. Using FloPy to simulate salanity of groundwater field in high tide and low tide.

Conclusion

wells position.

1. This study use the Python code in conjunction with open-source software GemPy

and FloPy, that enhancing the efficiency of model development.

- 2. The GemPy model results reveal the distribution of geological materials within the site, with a horizontal layering.
- 3. Above an elevation of -30m, the distribution of groundwater salinity is more noticeably influenced by tidal periodicity.