國立中央大學
National Central University

NATIONAL CENTRAL UNIVERSITY
Graduate Insitute of Applied Geology

The approaches to quantify surface water-groundwater interactions through coupled models

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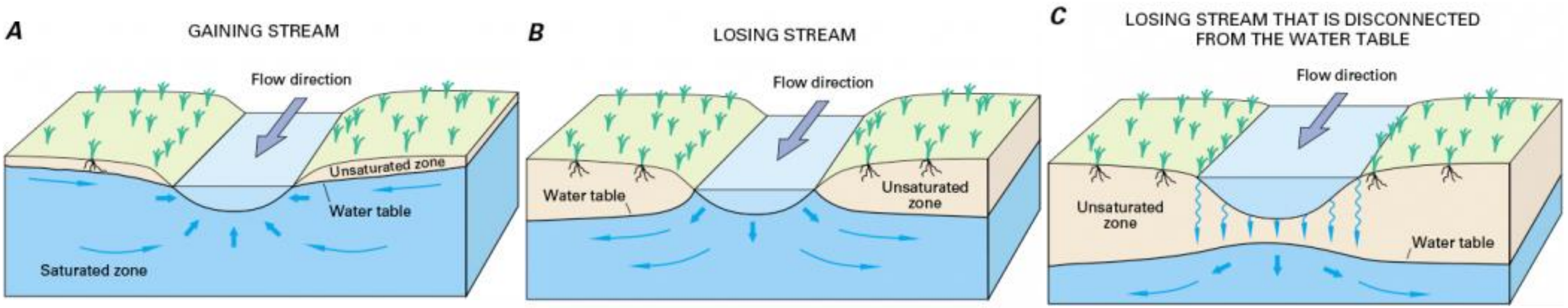
Introduction

- The **interactions** between groundwater (GW) and surface water (SW) have been a **major concern** of researchers and managers in recent times.
- Numerical models are increasingly used to explore hypotheses and to develop *new conceptual models of GW-SW interactions*.



Groundwater (GW) – Surface water (SW) **interaction**

Introduction

- The intricate interplay between SW and GW systems *necessitates a thorough investigation* to inform sustainable water resources planning.
- The critical needs to address this issue is underscored by the imperative to *develop comprehensive strategies for managing both surface and groundwater resources.*
- Recognizing the pivotal role of subsurface models in maintaining the longevity and effective management of water resources, *this study focuses on the Choshui basin*, *aiming to develop a system model to quantify the GW-SW interactions*

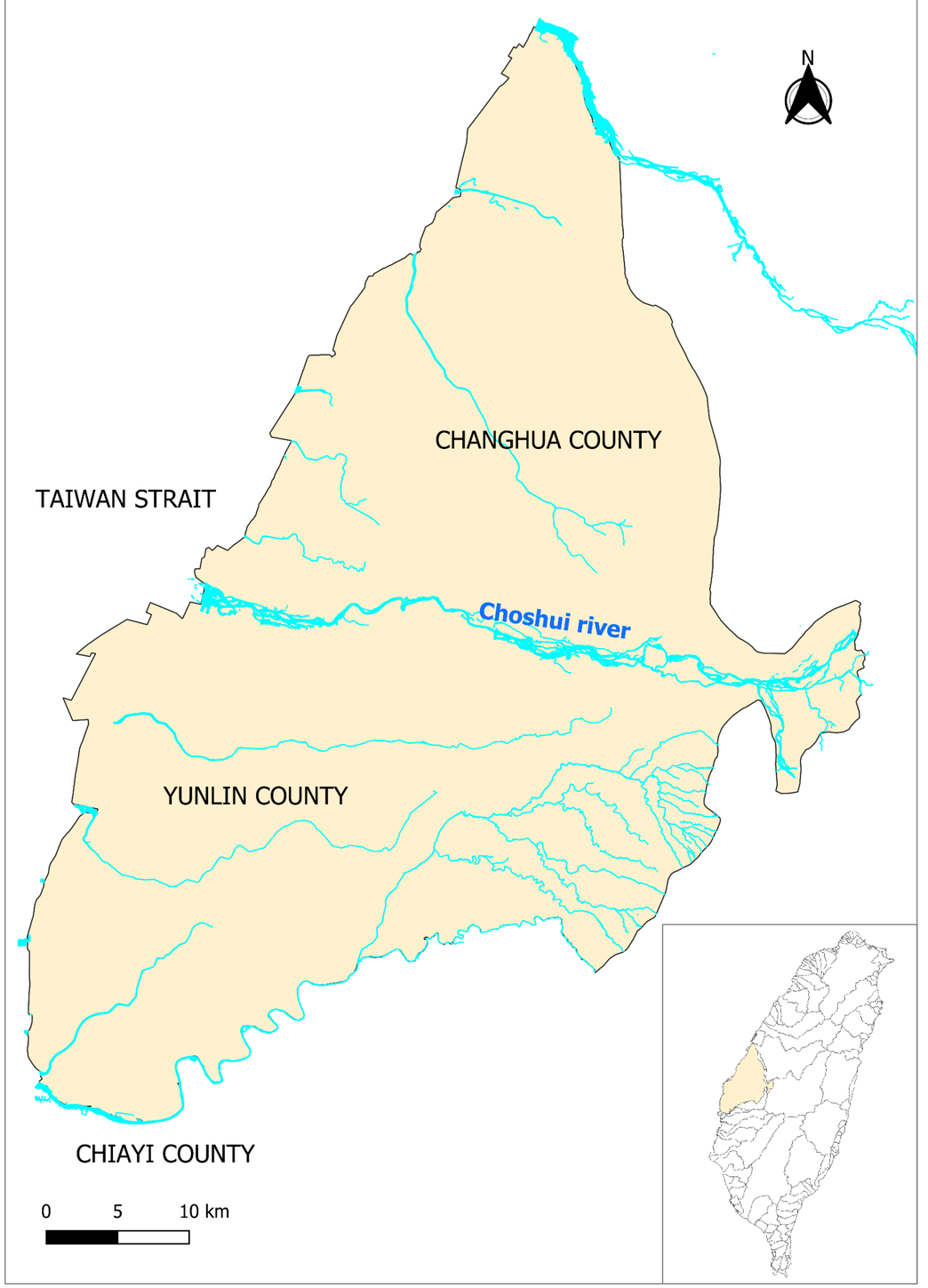
Introduction

- This study presents the *beginning development of a groundwater flow model* for the Choshui River Basin utilizing the Groundwater Modeling System (GMS).
- The modeling process involved *data collection*, *geological and hydrogeological characterization*, *conceptual model development*, and *numerical simulation* using GMS software MODFLOW 2000 package.
- This is a *useful initial results* for further studies on the GW-SW interactions

Introduction

Study area

- The Choshui River originates from the Hehuan Mountain in the Central Mountain Range of Taiwan and flows westward to the Taiwan Strait.
  - ➢ It is **the longest river in Taiwan**
  - ➢ Total length: **187 km**
  - ➢ Drainage area: **3157km^2**
  - ➢ It is **the second largest basin** in Taiwan.
- The elevation in the Choshui River basin decreases from east to west.



Methodology

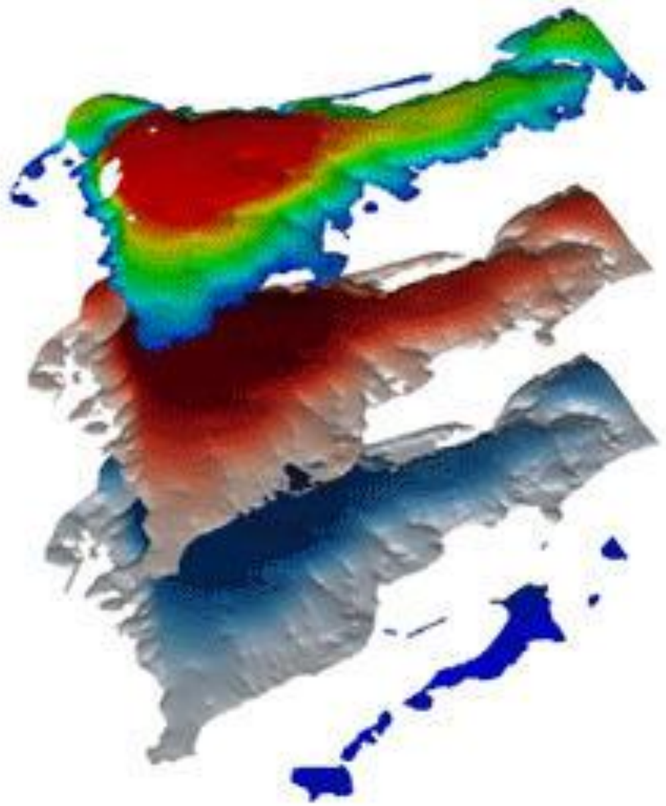
❑ Data collection

- In the present study, data are collected from the Taiwan Climate Change Projection Information and Adaptation Knowledge Platform (TCCIP; https://tccip.ncdr.nat.gov.tw/) and the Hydrological Yearbook (https://gweb.wra.gov.tw/wrhygis/) provided by Water Resources Agency of the Ministry of Economic Affairs.
- The data include hydrological, hydrogeological, rainfall and well data.

Methodology

MODFLOW MODEL

- MODFLOW is the U.S. Geological Survey modular **finite-difference flow model**, was developed by the U.S. Geological Survey (USGS).
- MODFLOW used for **simulating groundwater flow**.
- It's an object-oriented program that **supports multiple models** and **types** within the same simulation, allowing for interaction and coupling at the matrix level

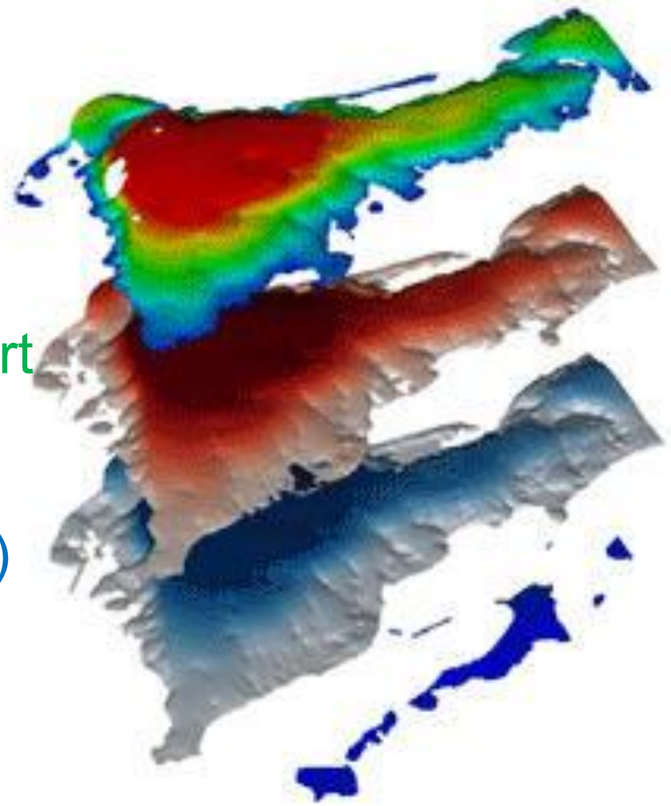


Methodology

MODFLOW MODEL

Model Components:

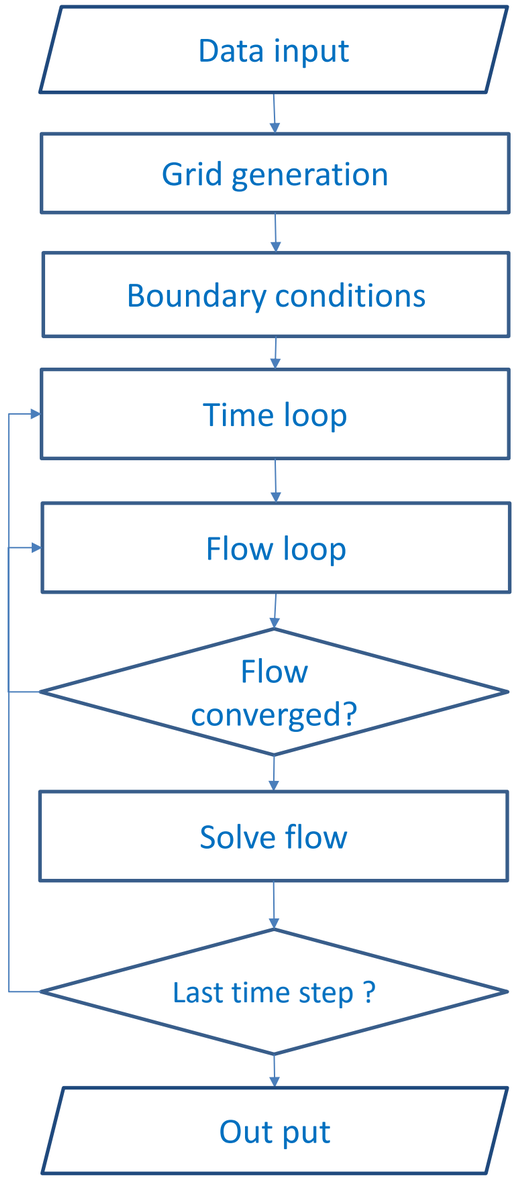
- The model contains two types of hydrologic models: the Groundwater Flow (GWF) Model and the Groundwater Transport (GWT) Model.
- The GWF Model uses a **control-volume finite-difference** (CVFD) approach, allowing cells to be hydraulically connected to any number of surrounding cells.



Methodology

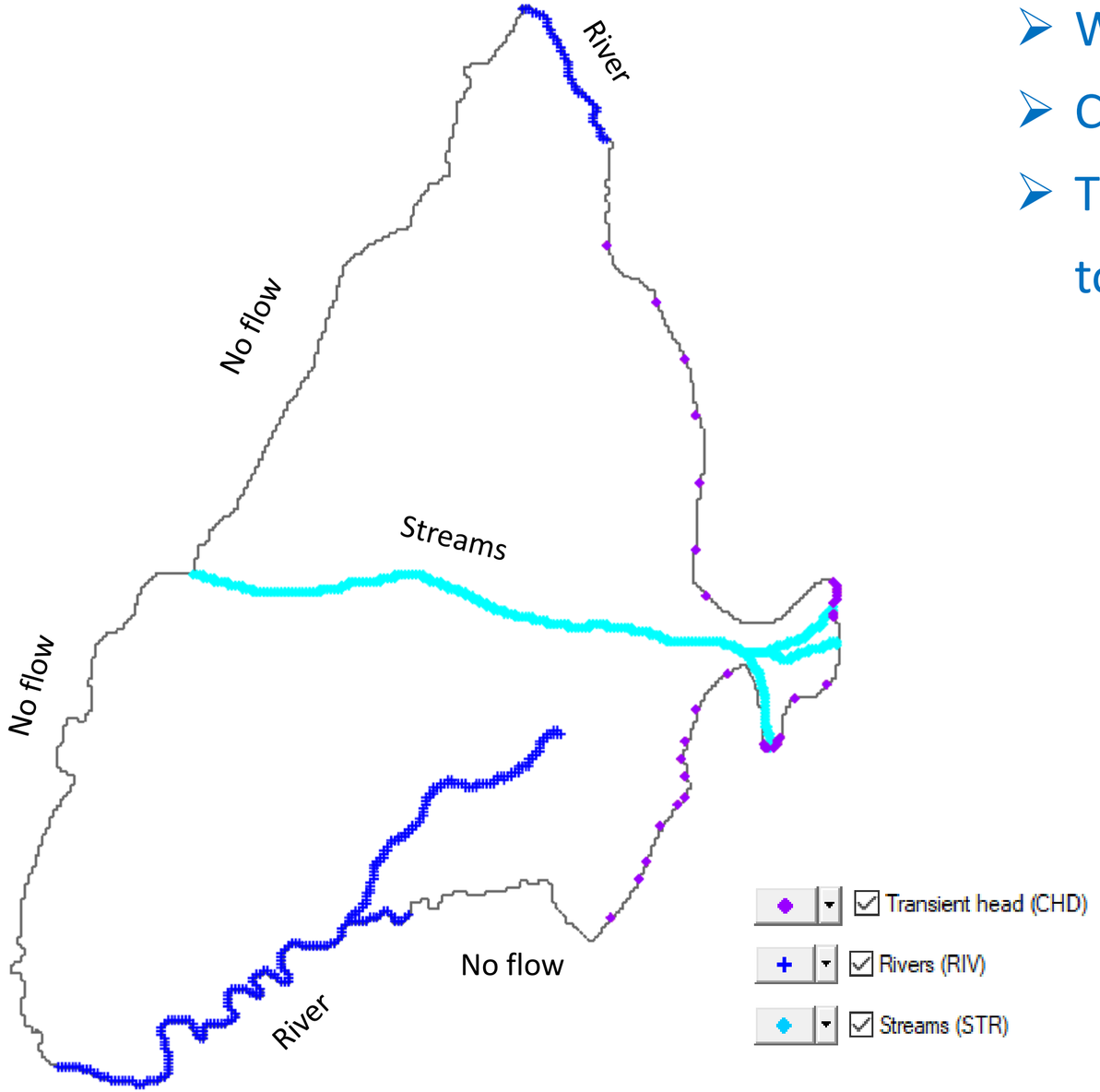
MODFLOW MODEL

- A multi-aquifers condition can be constructed by MODFLOW, and hydro-geologic parameters are assigned to cells based on actual field situations to practically simulate groundwater flow.
- Boundary conditions, such as Dirichlet, Neumann, Cauchy, or time-variant specified-head boundary, can be specified



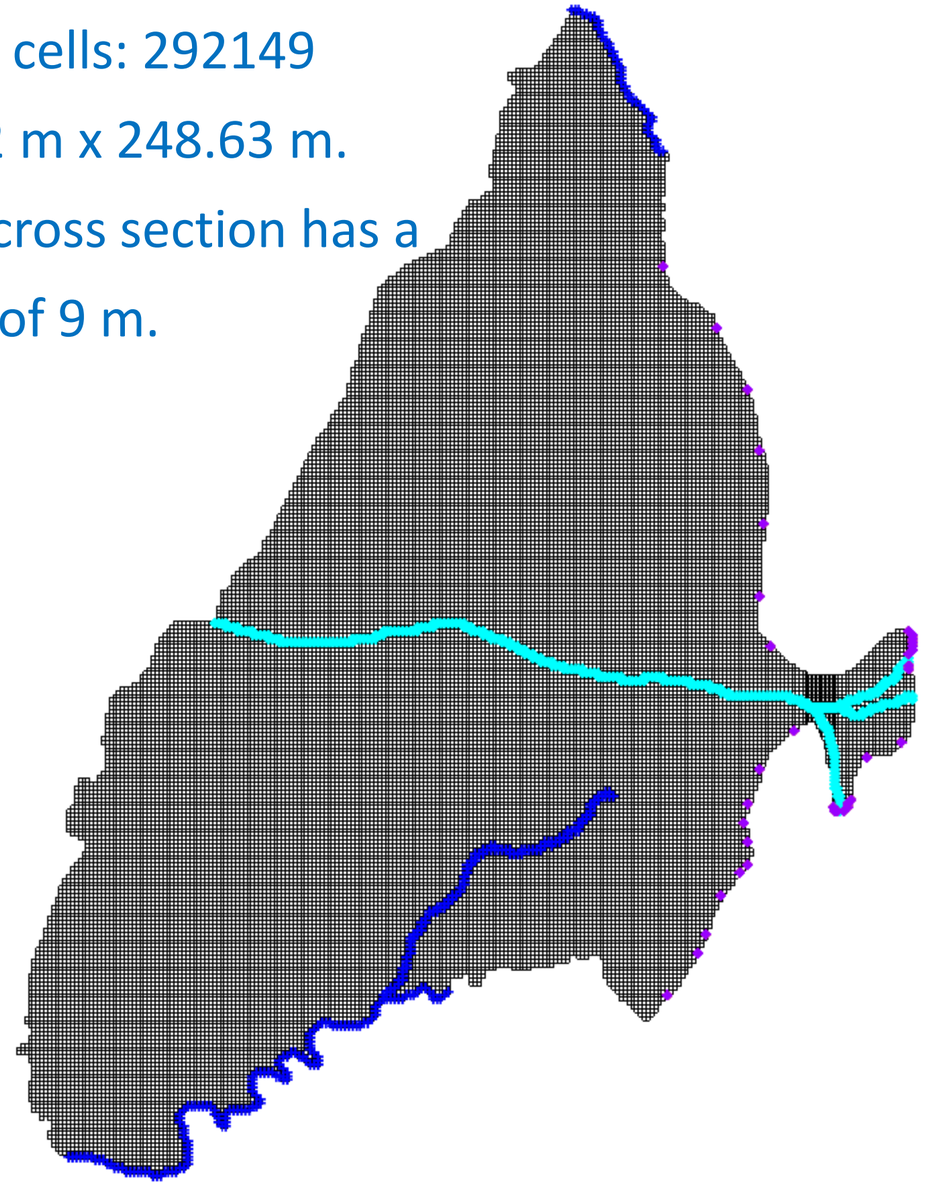
Flow chart for the flow model using MODFLOW

Current Results



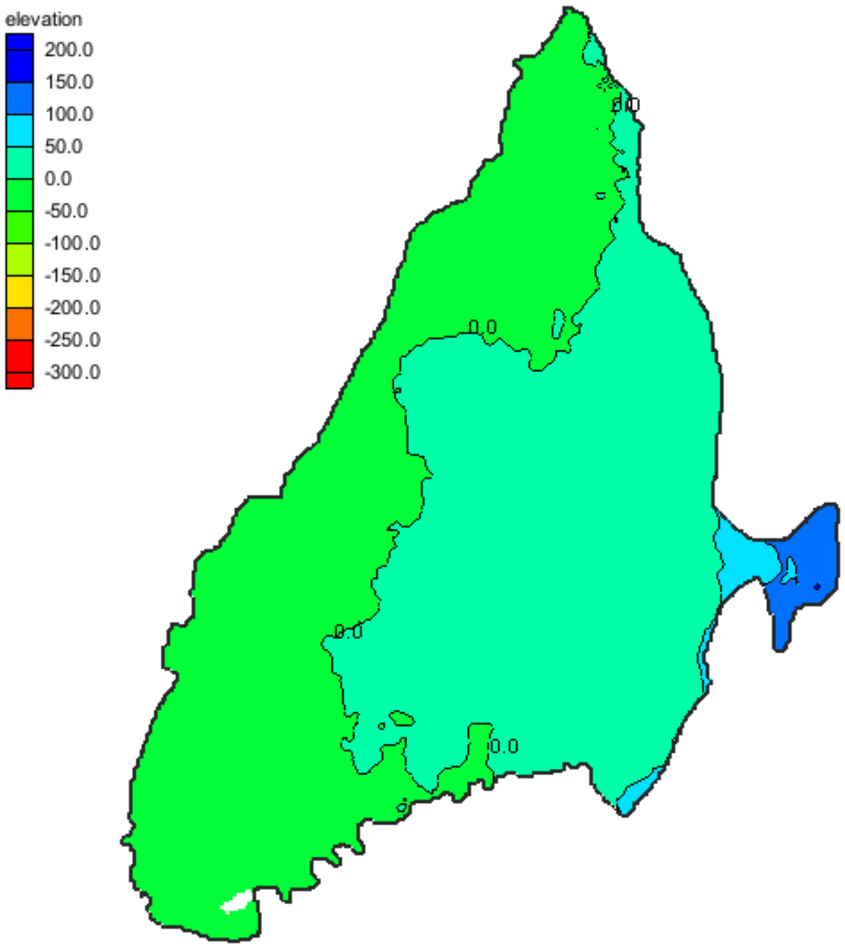
The boundary conditions used in the study

- With No.Active cells: 292149
- Cell size:242.72 m x 248.63 m.
- The simulated cross section has a total thickness of 9 m.

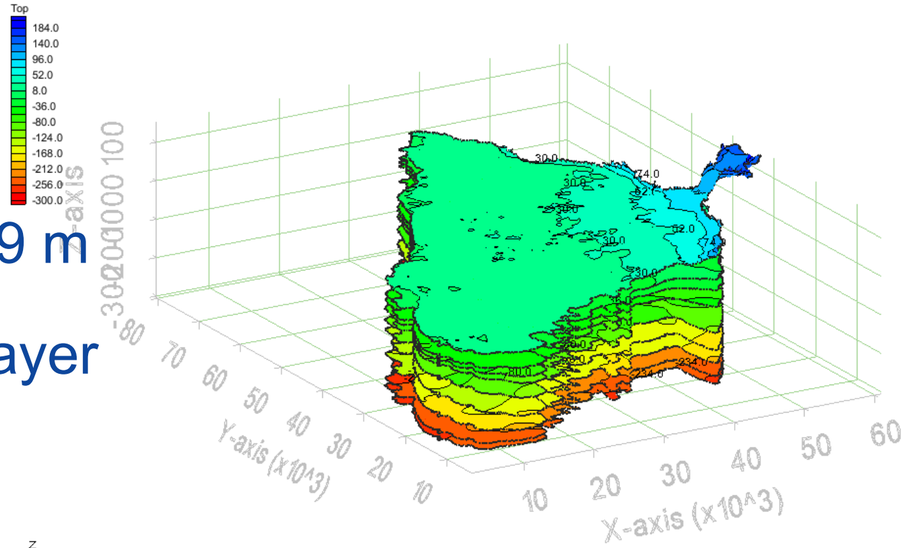


Current Results

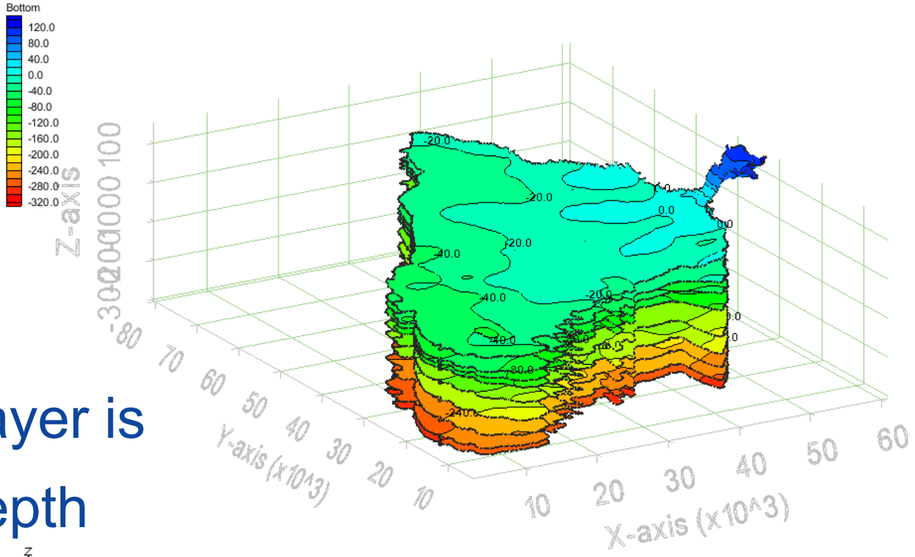
The terrain gradually decreases from west to east.



- Top Elevation:
- Max:201.2 m; Min: 0.10589 m
- The Top value of the first layer is determined based on surface topography data

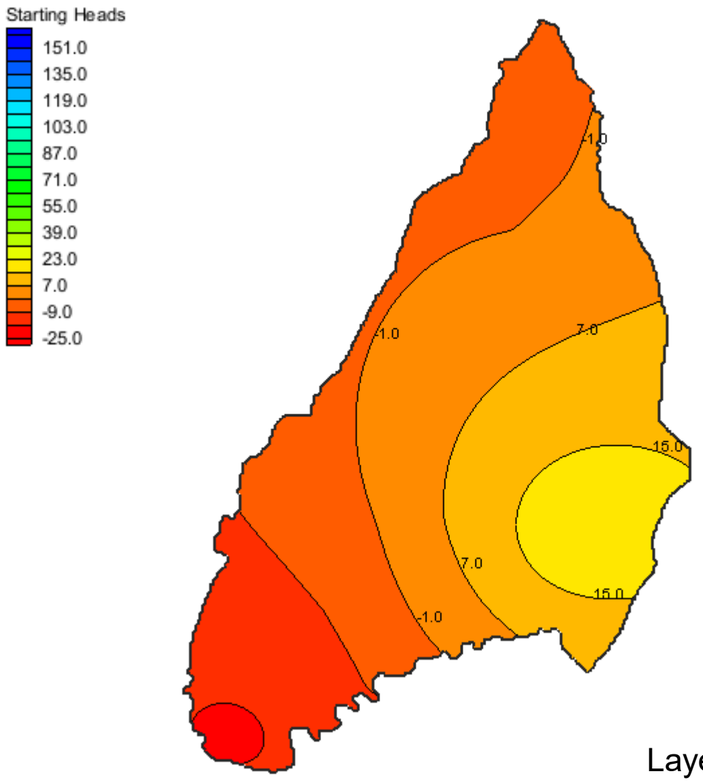


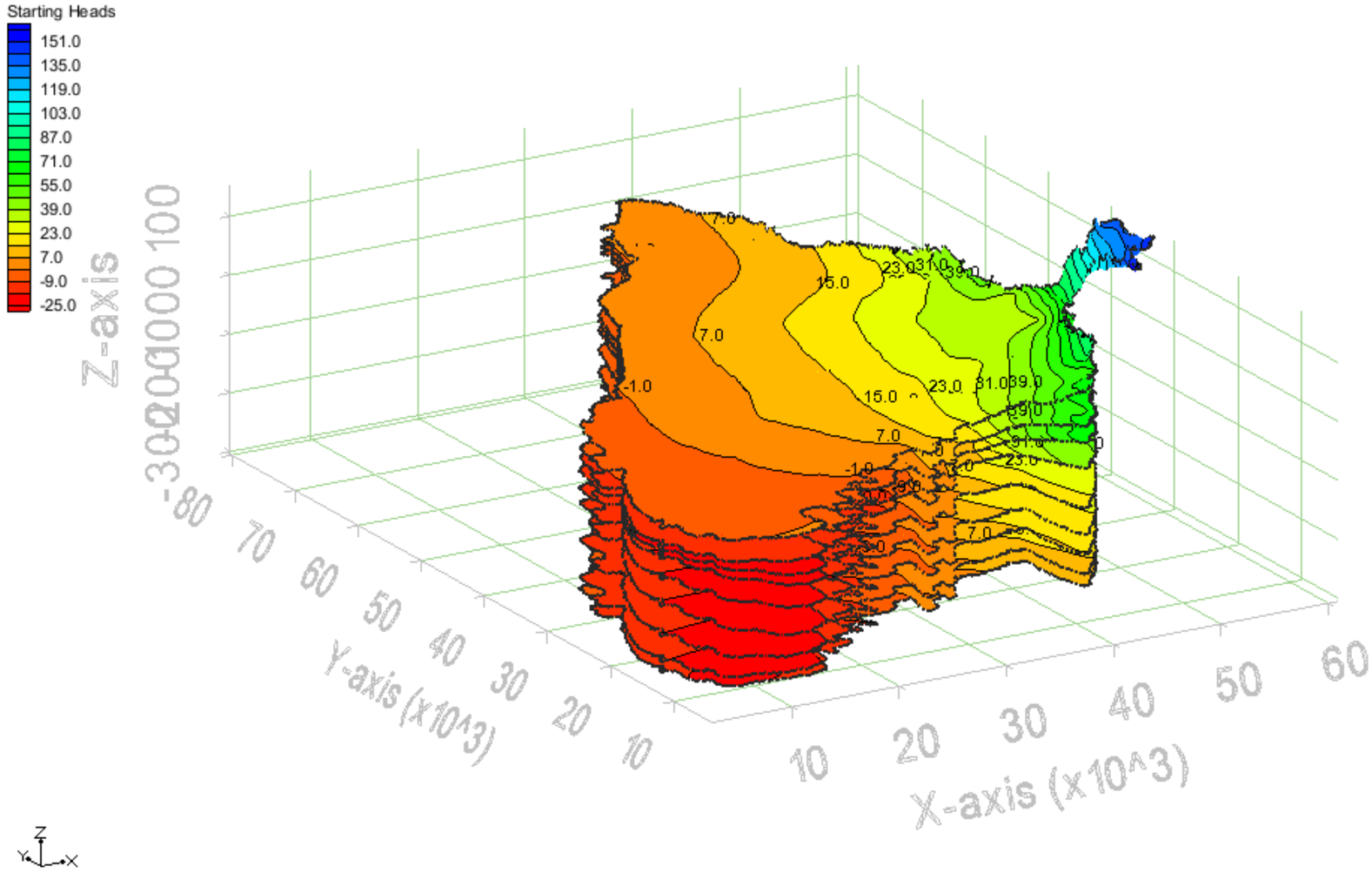
- Bottom Elevation: Max: 128.85; Min: -69.567
- The Bottom value of each layer is determined based on the depth of that layer



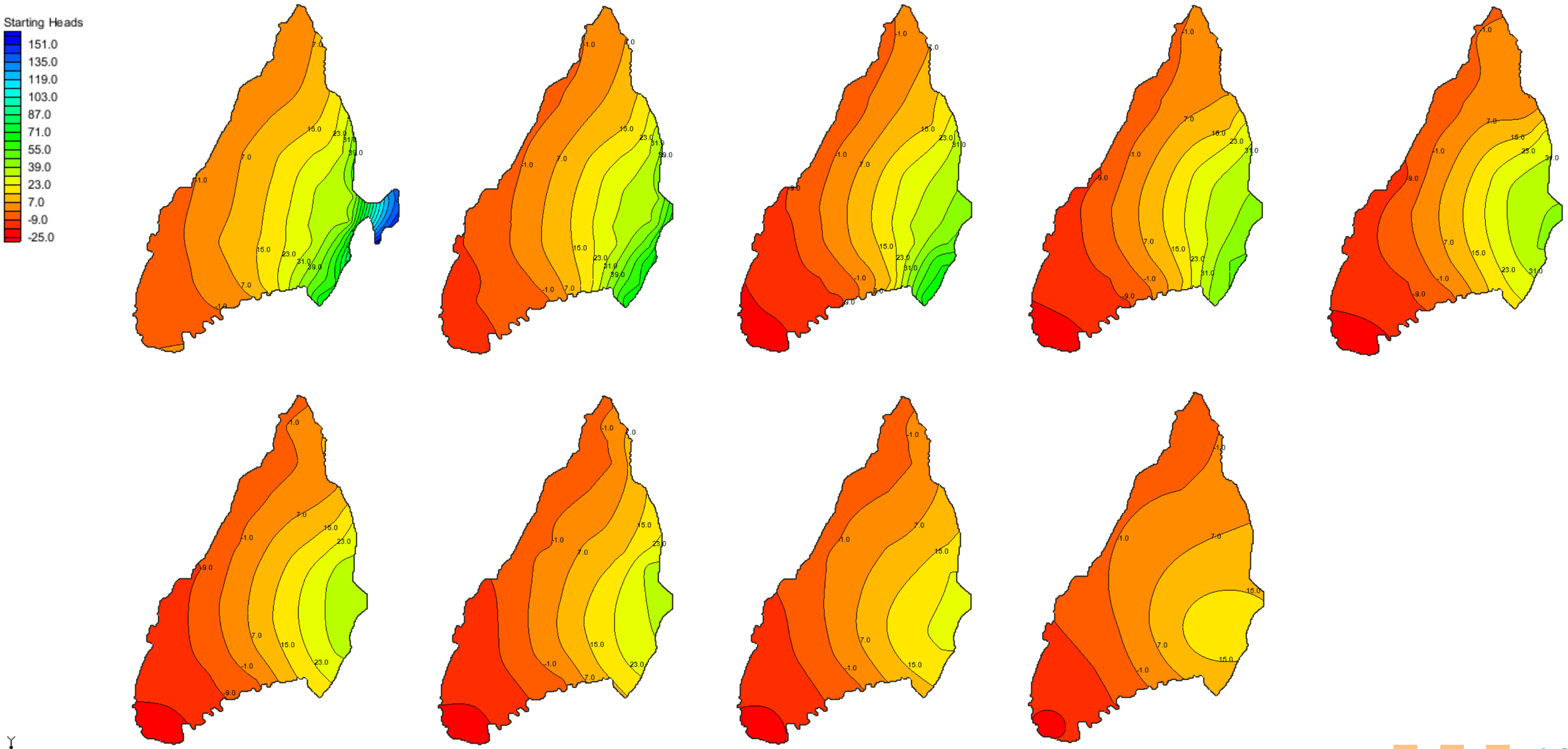
Current Results

- 9 layers
- Stating heads: Based on the cell peak height data, enter different starting heads values.



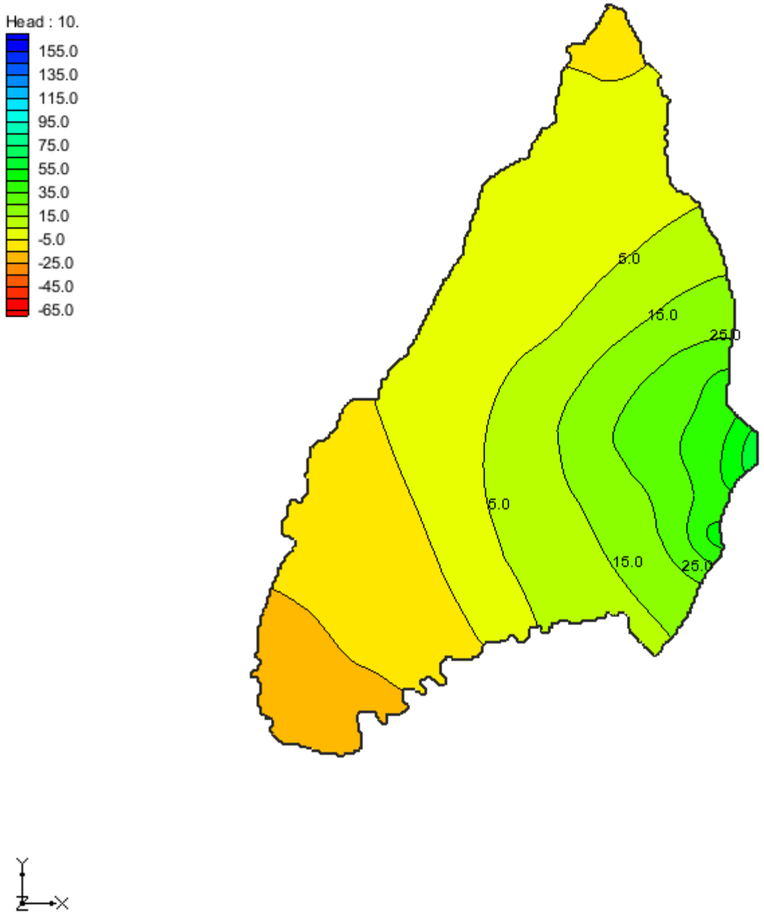


Current Results

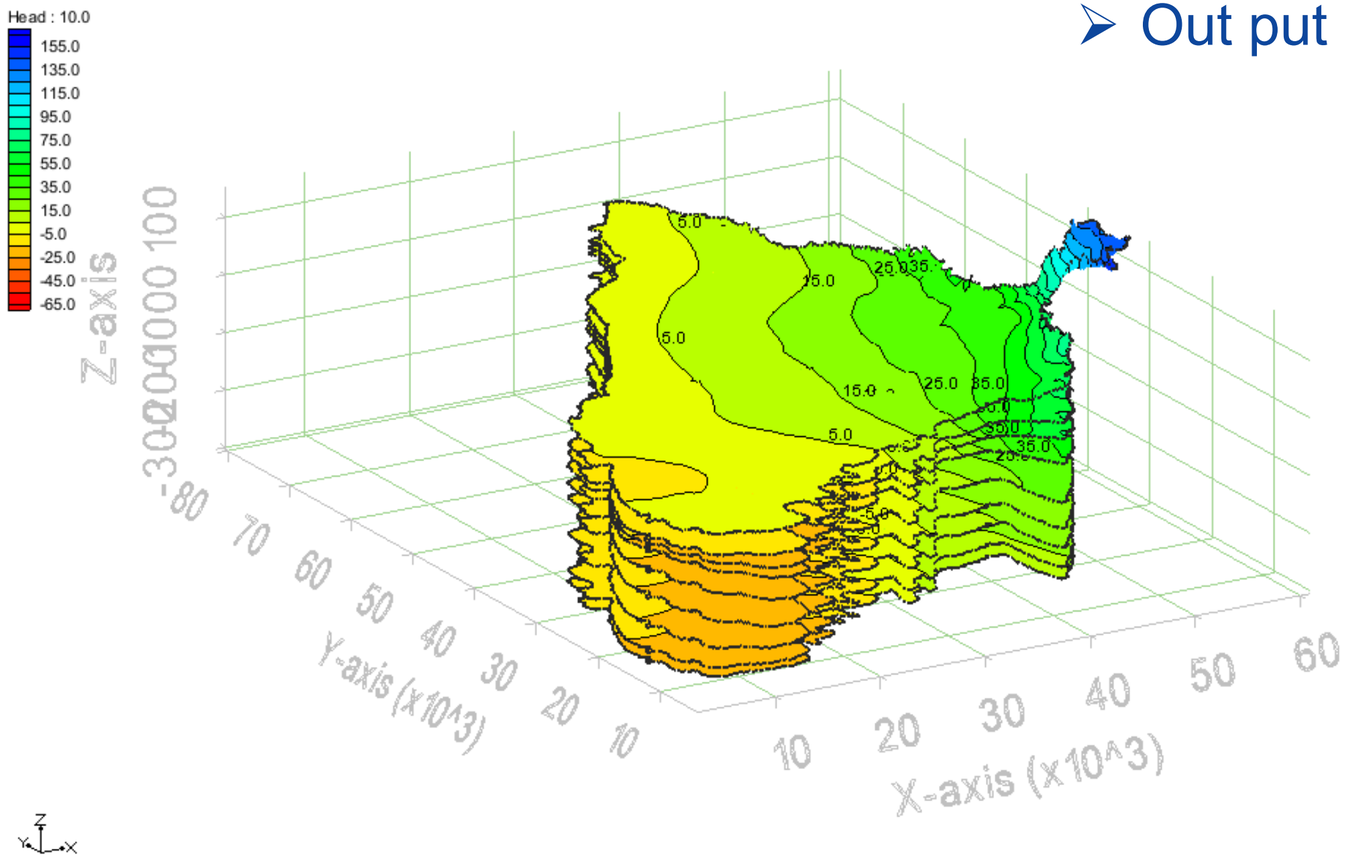


Current Results

- Groundwater Heads



- Out put

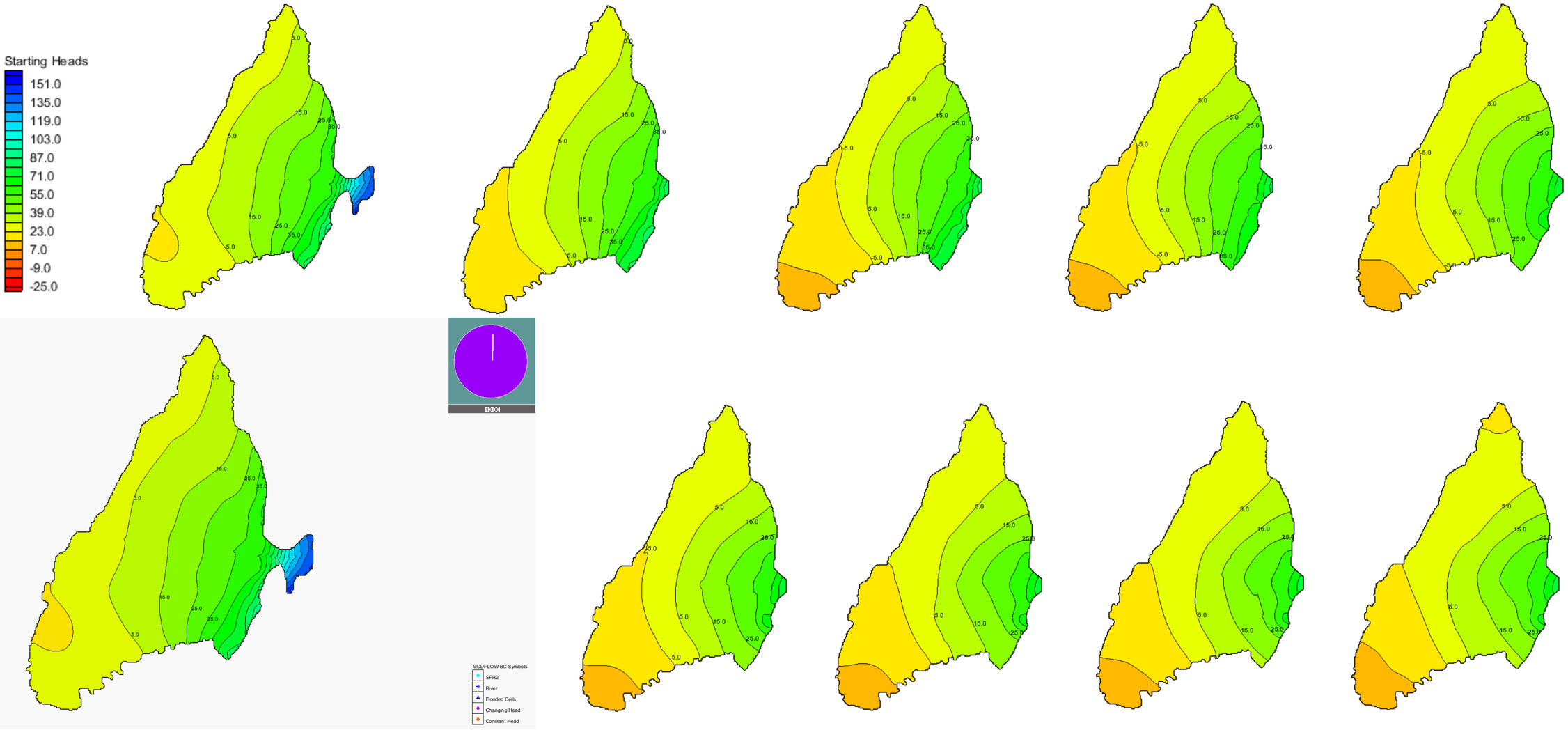


Groundwater Heads in the aquifers revealed two prominent flow directions: northwest from a mountainous area in the east (Changhua) and southwest (Yunlin)

Current Results

- Groundwater Heads

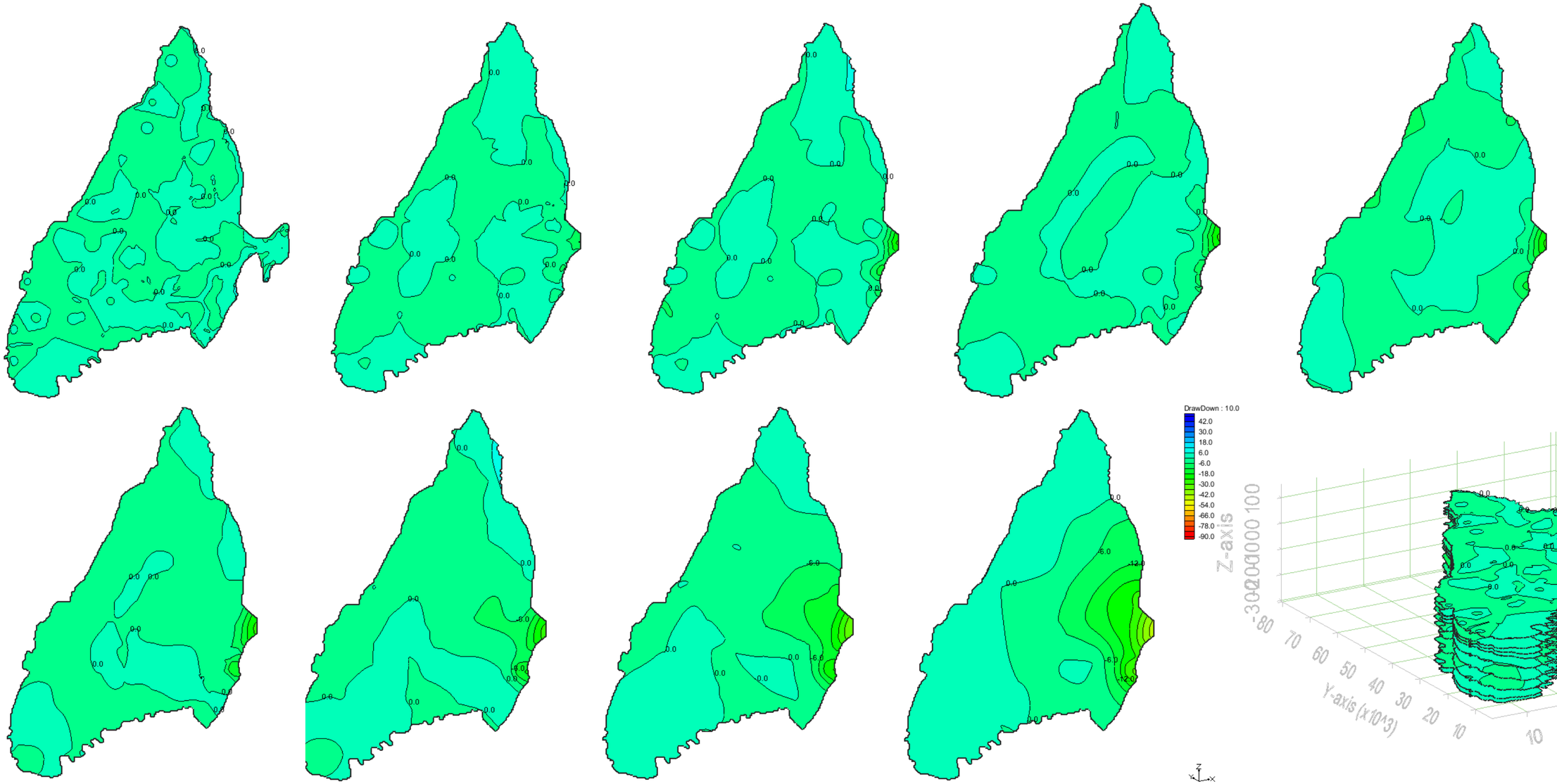
- Out put



Current Results

- Drawdown

- Out put



Conclusion

- In conclusion, the groundwater flow modeling for the Choshui river basin groundwater basin represent a ***significant first step*** in ***understanding the hydrological dynamics*** of the region.
- This study stands out as *an initial investigation of the groundwater basin* of the **Choshui River basin** that has gained valuable insights into the complex interactions of factors influencing groundwater flow and availability in the region.

Future Work

- *Further development of groundwater flow modeling for the Choshui river basin (for the recharges,…)*
- *Developing of surface water model or the Choshui river basin with HYPE*
- *Developing of couple model for testing and calibration of model*

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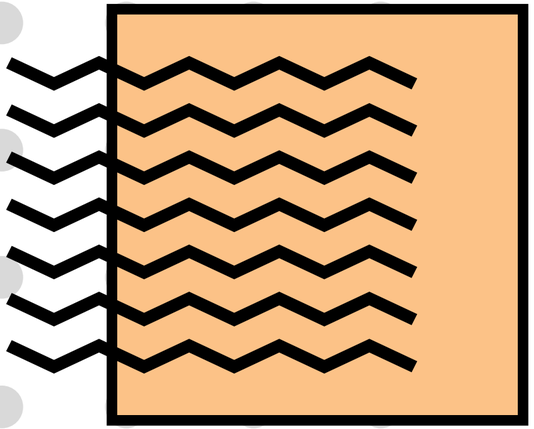

THANKS FOR YOUR ATTENTION

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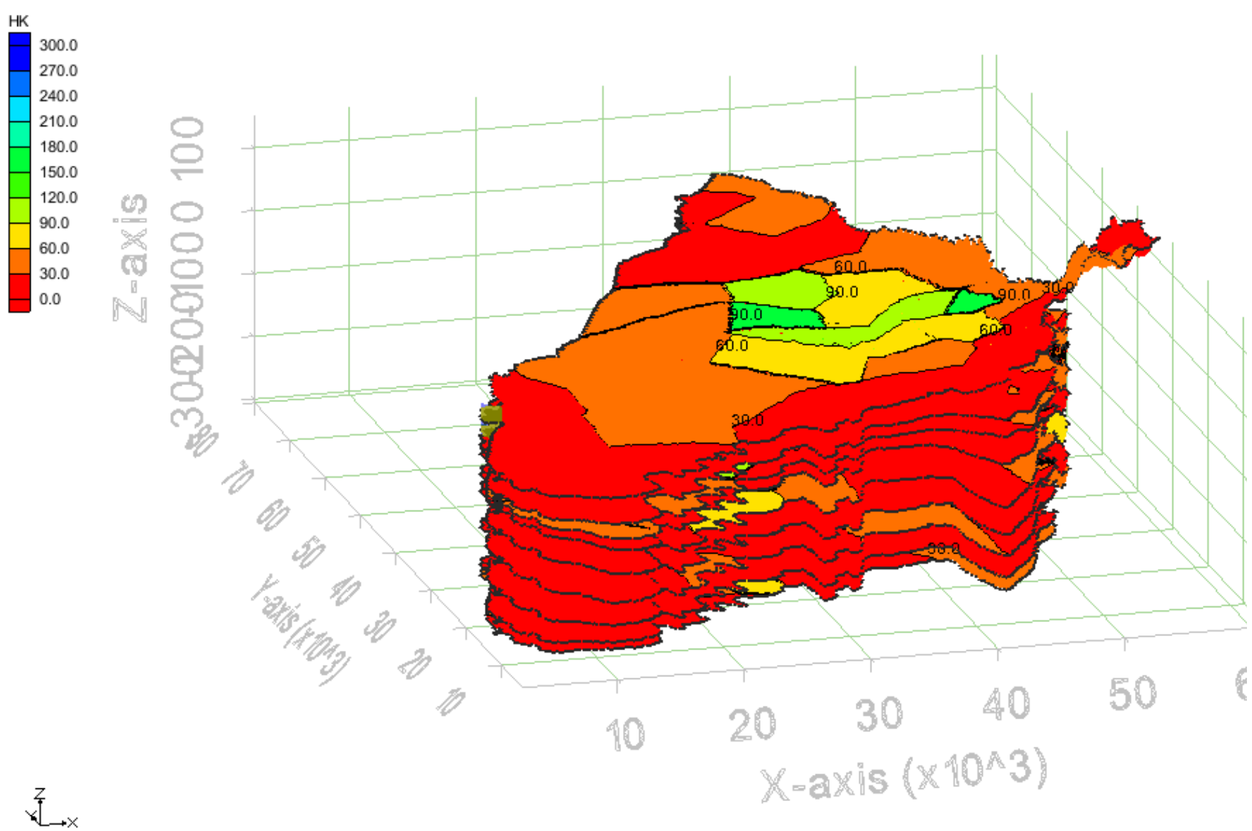
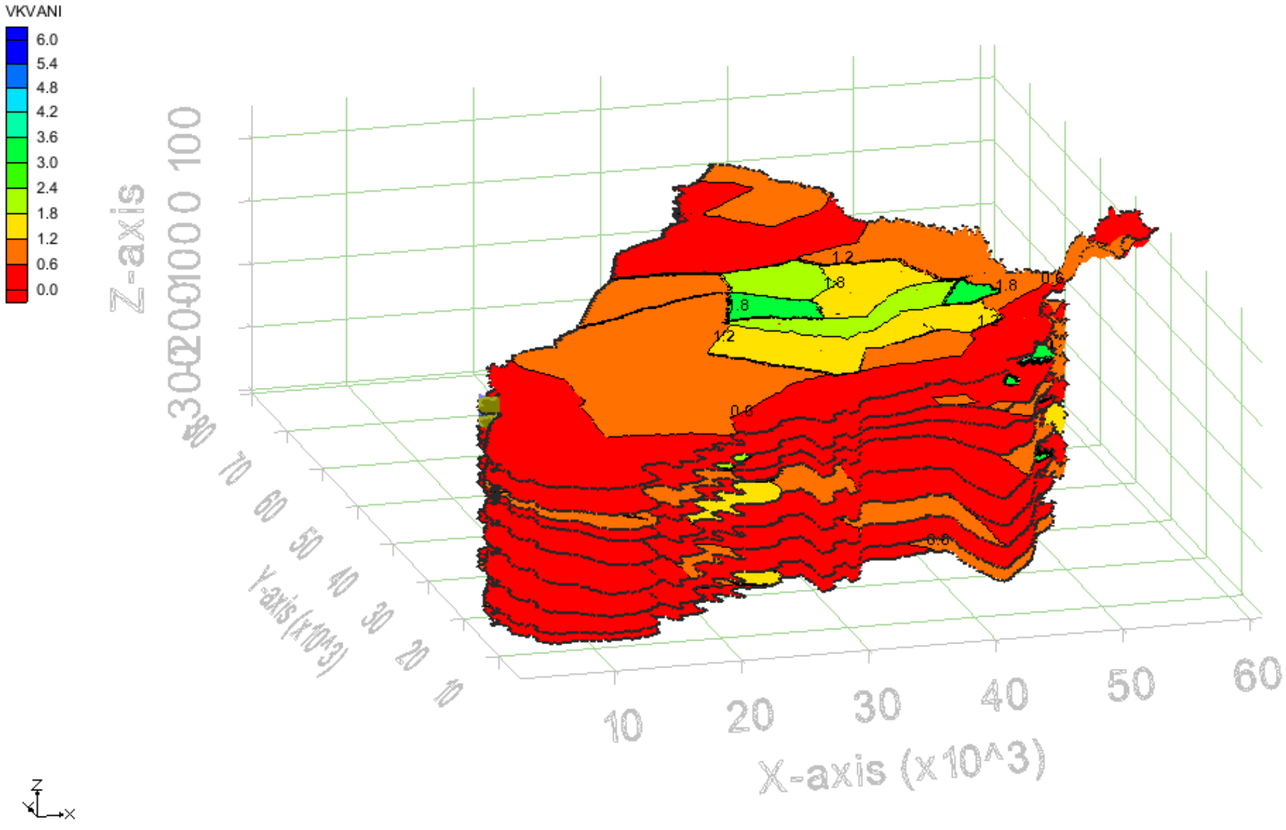
Introduction

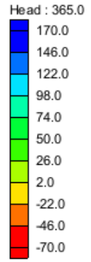
Objectives

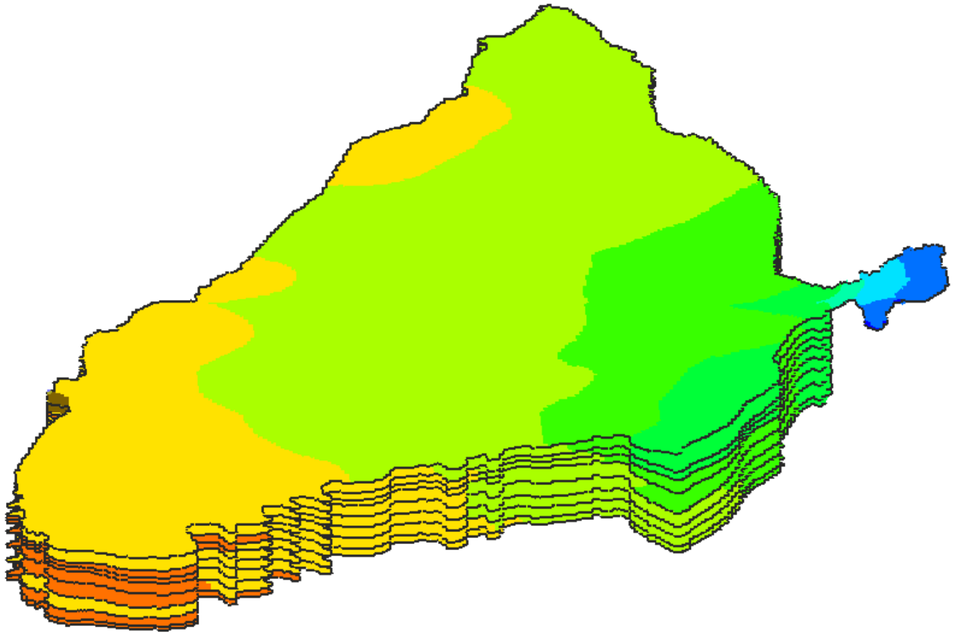
Current Results

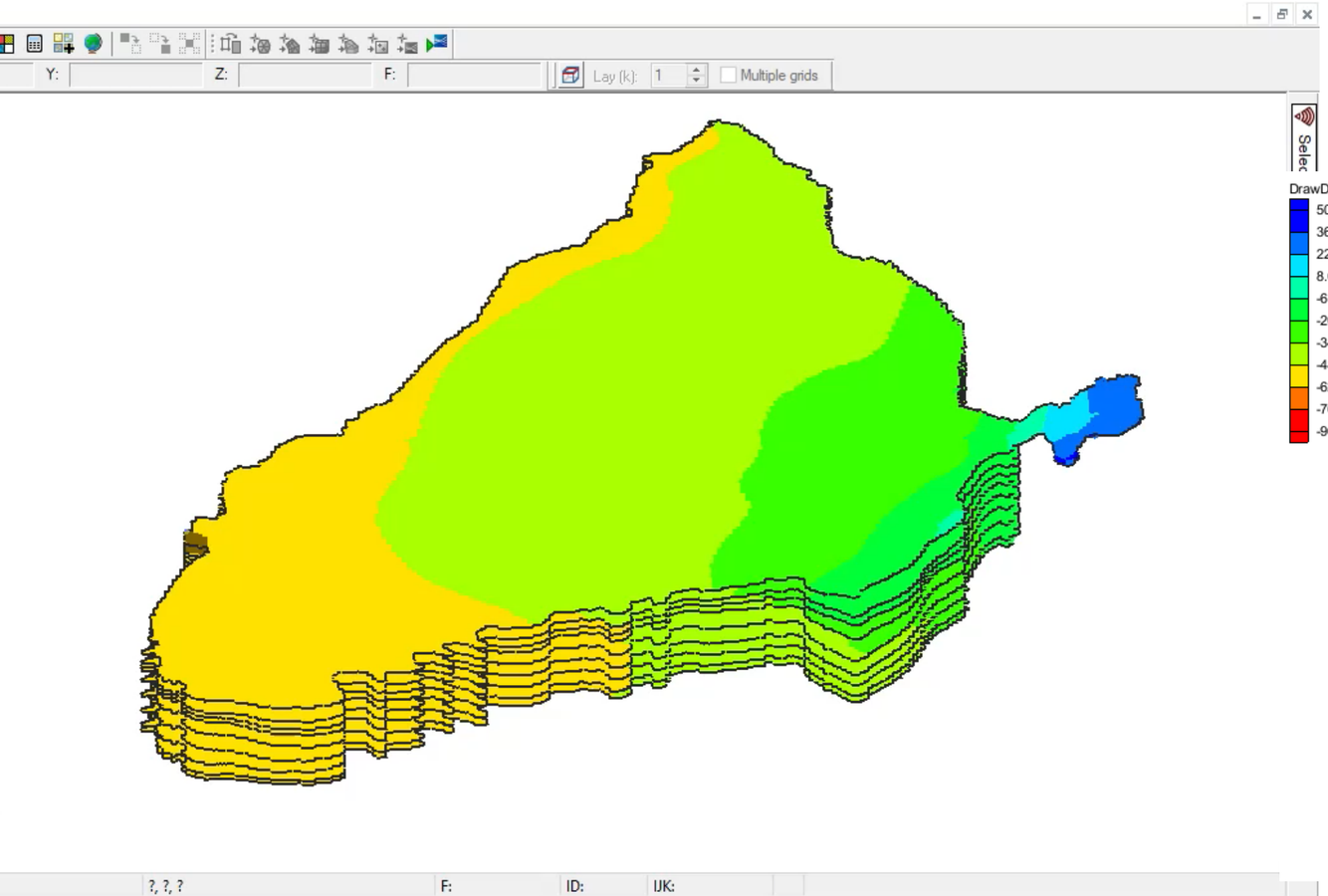
- 9 layers
- *HK, VK*






Head : 365.0
170.0
146.0
122.0
98.0
74.0
50.0
26.0
2.0
-22.0
-46.0
-70.0

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1
Multiple grids
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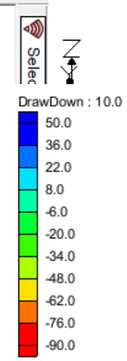
DrawDown : 10.0
50.0
36.0
22.0
8.0
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-34.0
-48.0
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