

**DEVELOPING A GROUNDWATER MODEL
FOR A COASTAL AREA
BY INTEGRATING GEMPY AND FLOPY**

110624011 王新博 Hsin-Po Wang

Advisor : Pf. 倪春發 Chuen-Fa Ni



OUTLINE

- Introduction
- Methodology
- Synthetic case
- Future works

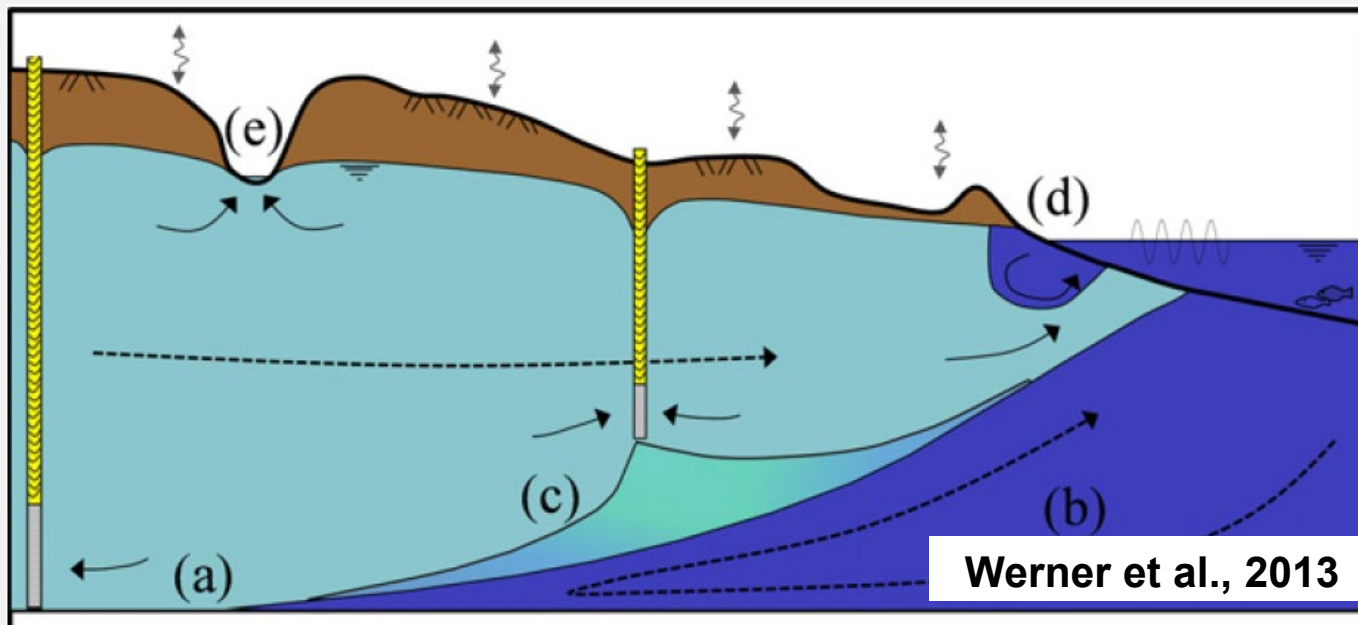


INTRODUCTION



BACKGROUND AND MOTIVATION

- Soil salinization in the coastal areas
- Proper groundwater management help reduce seawater intrusion
- An economical solution → Groundwater modeling
- Conceptual groundwater model is often oversimplified



OBJECTIVES

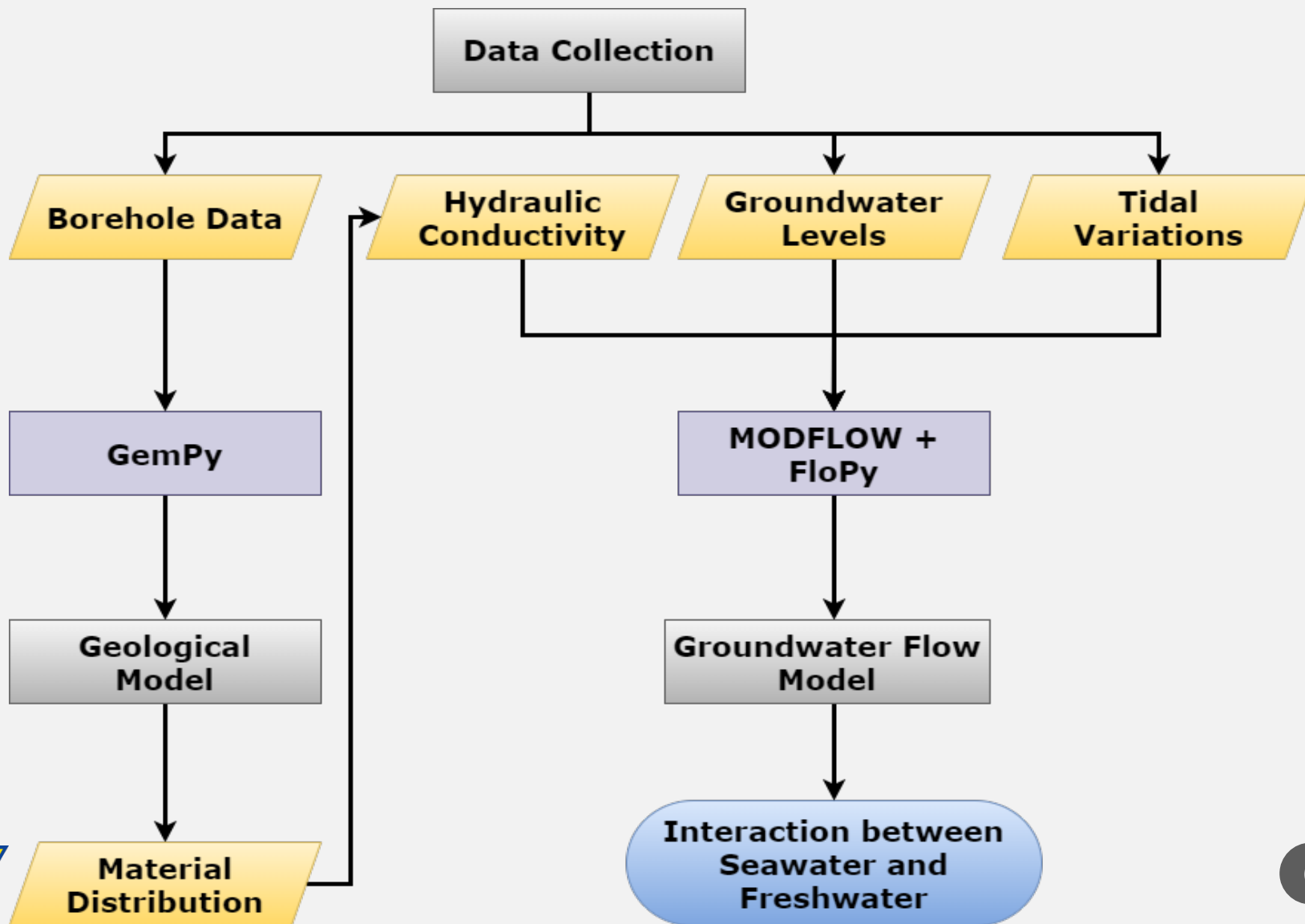
1. Build a geological model with more reasonable material distribution (from borehole data)
2. Develop a groundwater model based on above geological model
3. Characterize interaction between seawater and freshwater as tide changes.

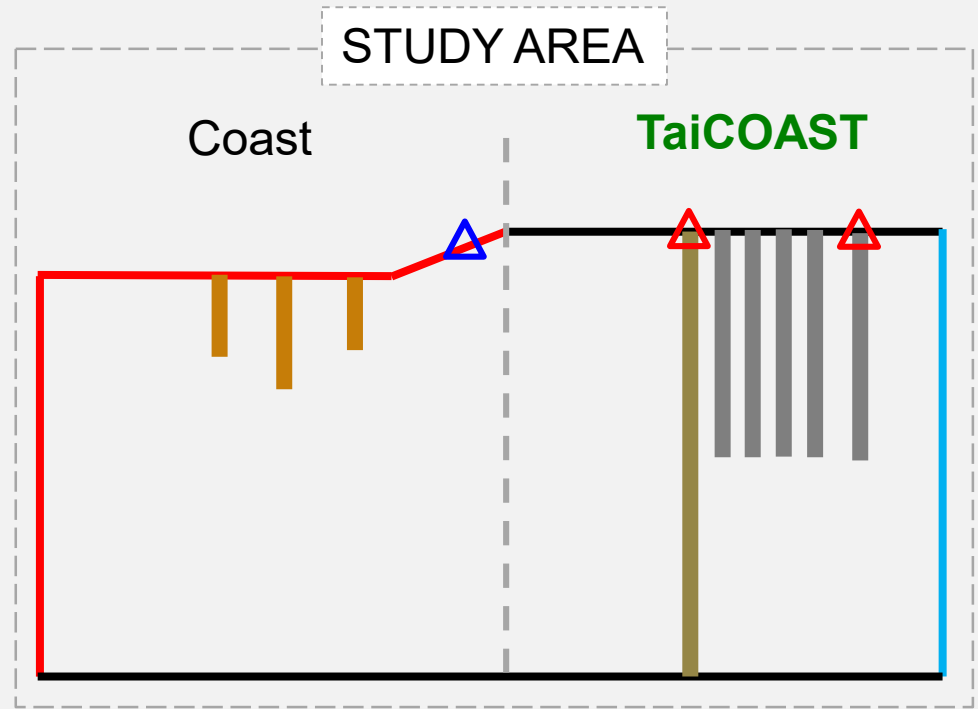
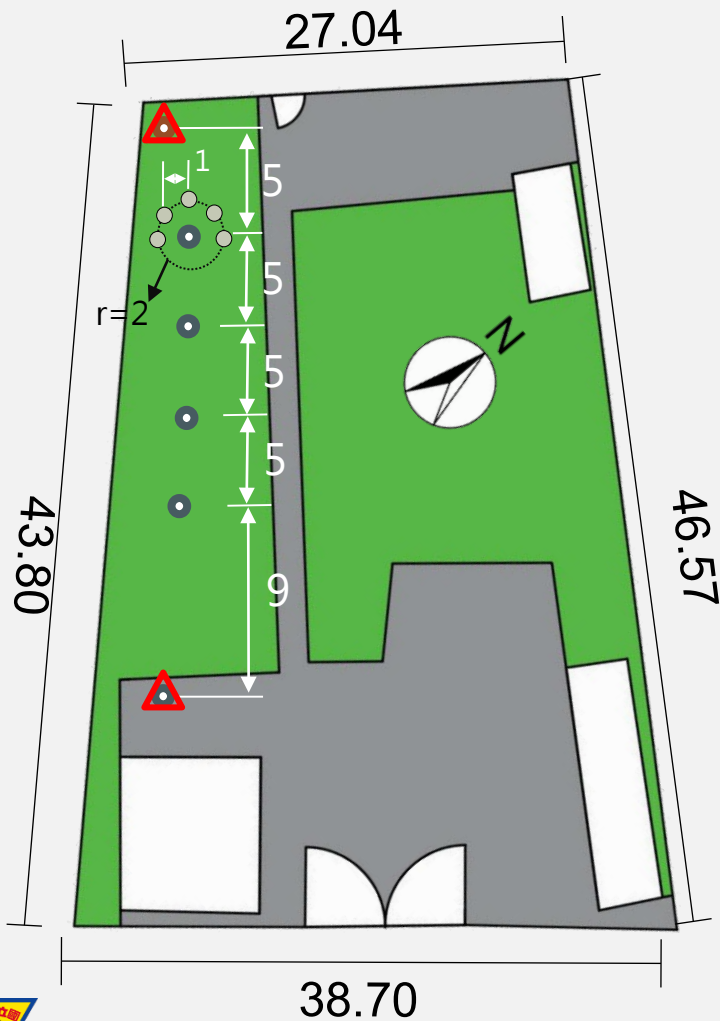






METHODOLOGY



RESEARCH PROCESS



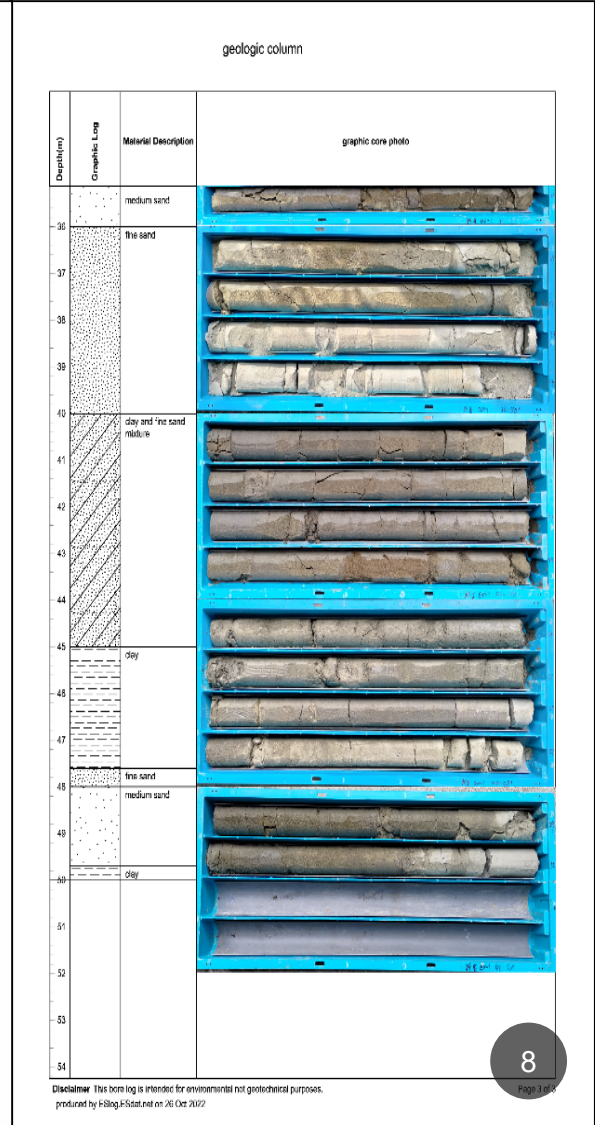
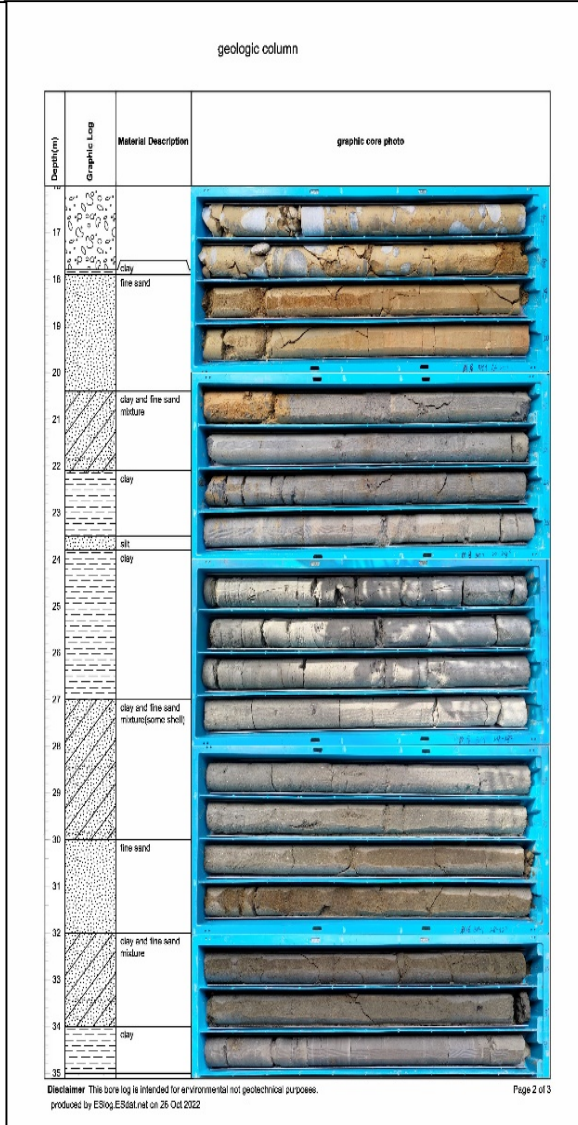
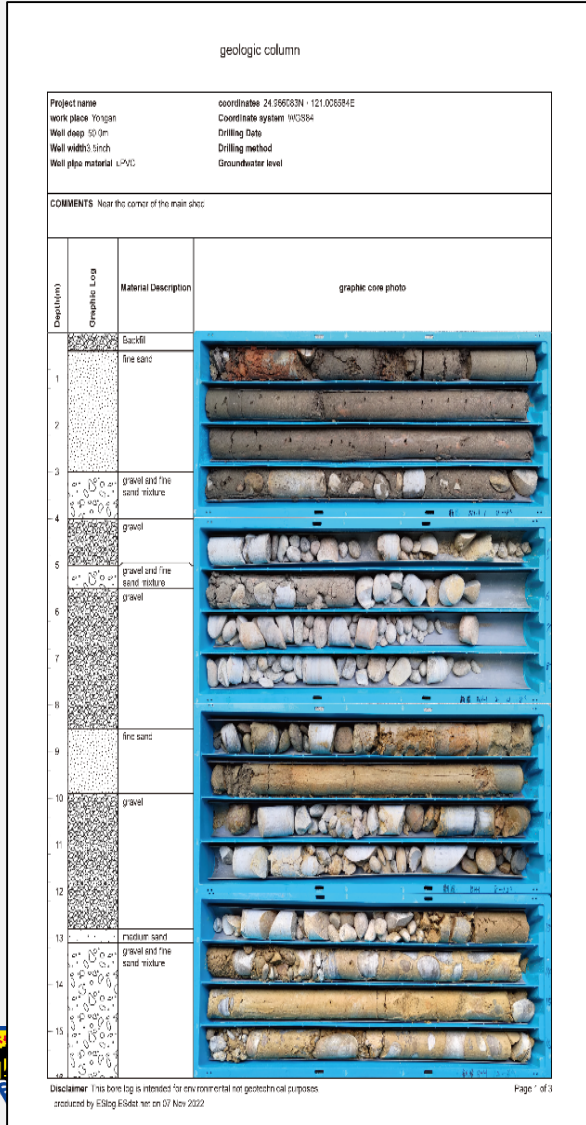


	4-inch well, 100 m, full screen
	4-inch well, 50 m, full screen
	2-inch well, 25 m, full screen
	Wells having borehole data

Unit : meter



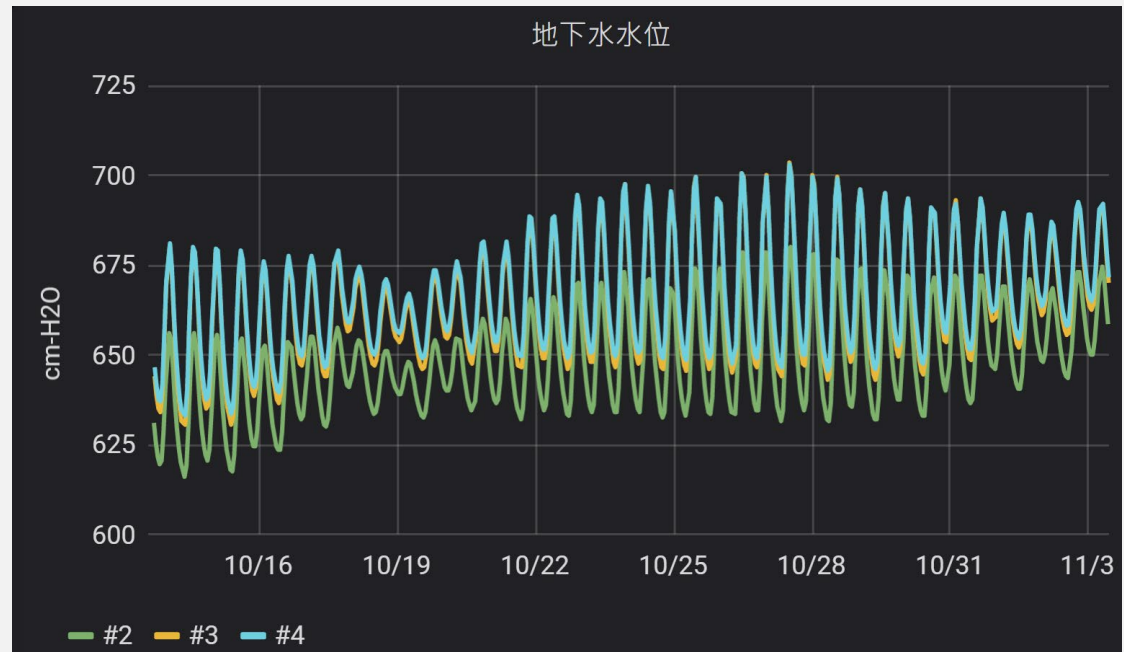
BOREHOLE DATA



GROUNDWATER LEVEL DATA



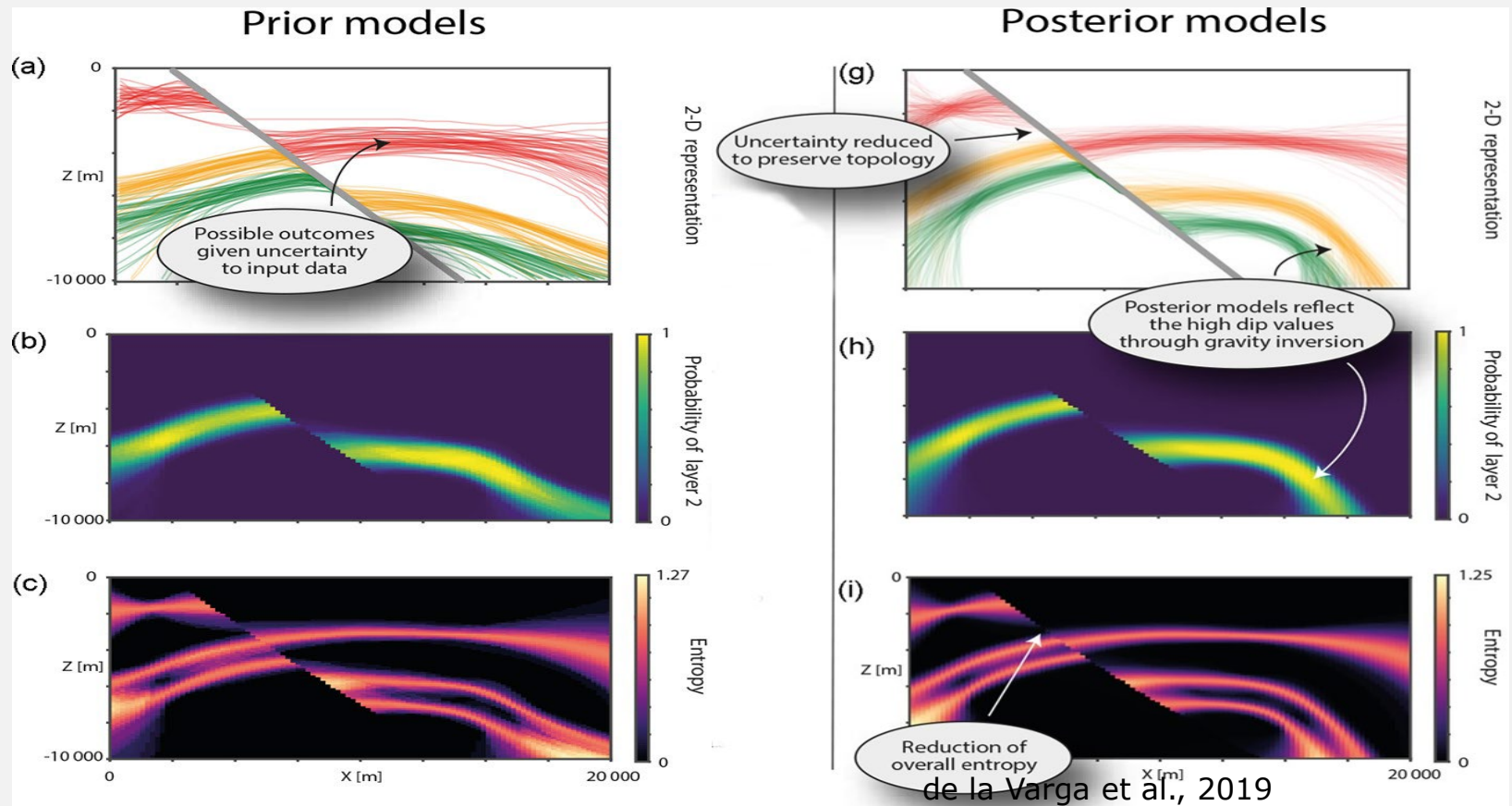
EXPERIMENT AT TAICOAST



MONITORING DATA

GEMPY – BRIEF INTRODUCTION

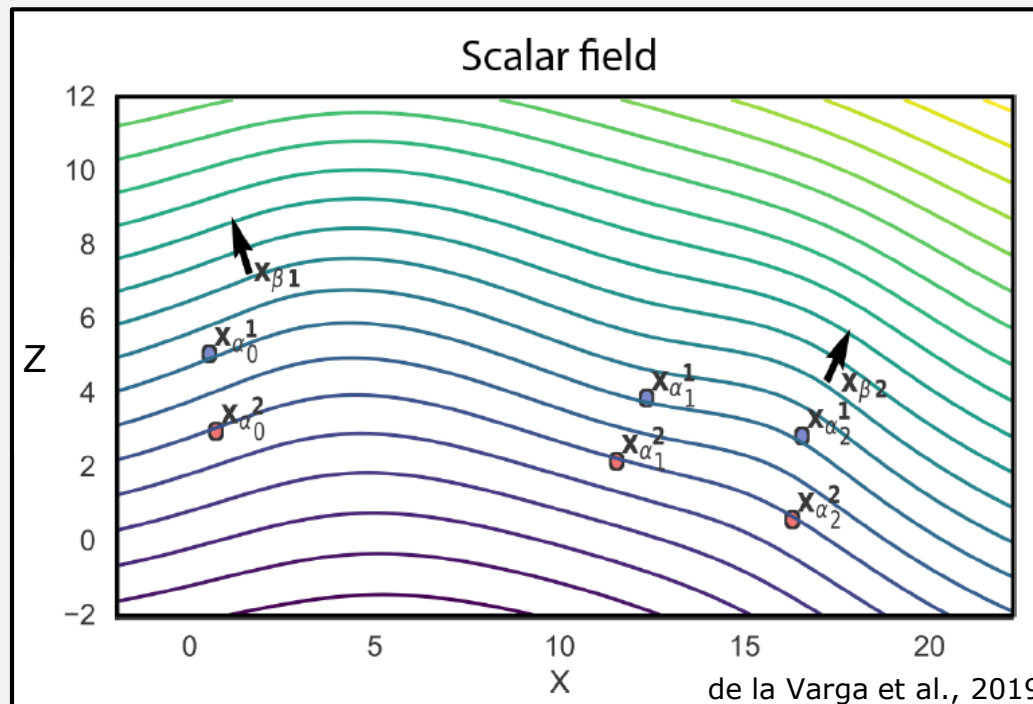
- A tool to generate 3D structural geological models
- Based on Universal Cokriging



GEMPY – BRIEF INTRODUCTION

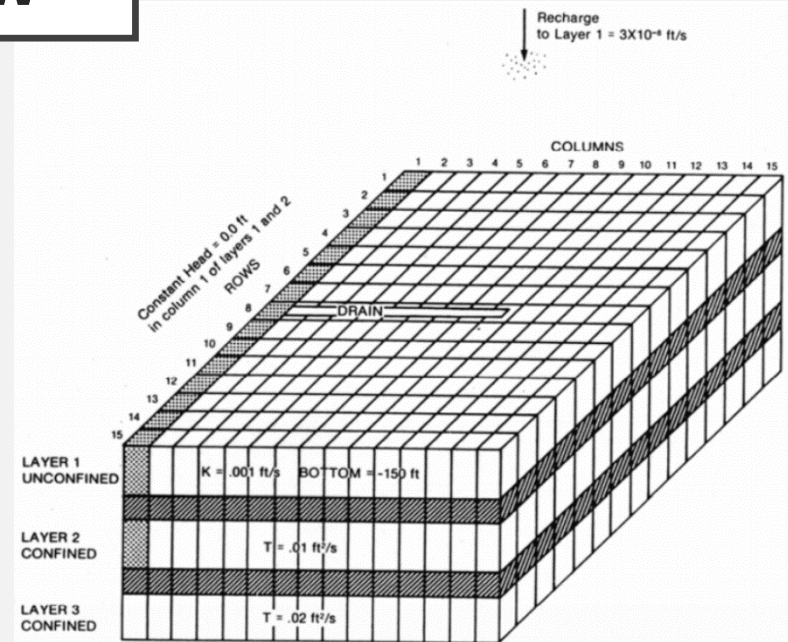
$$\frac{\partial \mathbf{Z}}{\partial u}(x) = \lim_{\rho \rightarrow 0} \frac{\mathbf{Z}(x + u) - \mathbf{Z}(x)}{\rho}$$

Parameter	
Z	Interpolation function
u	Any unit vector
ρ	The number of distinct parameters involved in the interpolation



MODFLOW

- A 3D groundwater-flow modeling computer program
- Based on the finite-difference method
- Including main program & packages handling different aspects (river, pumping, recharge,...)



Governing equation:

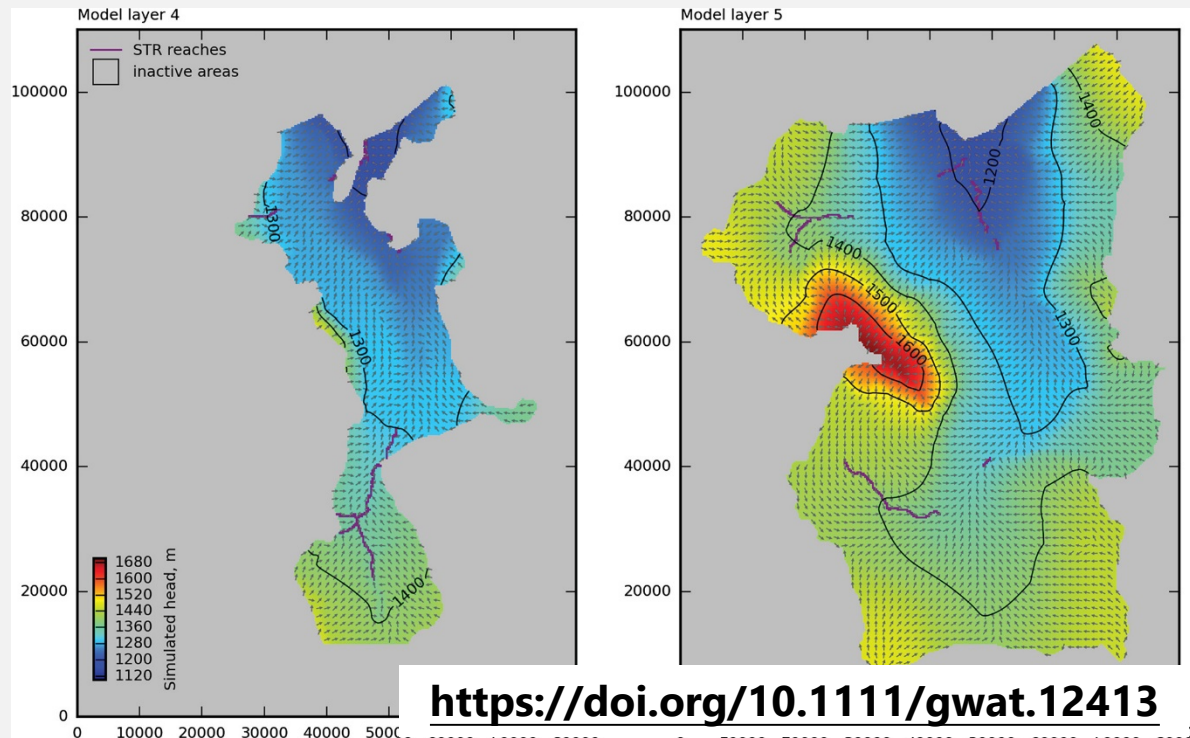
$$\frac{\partial}{\partial x} \left(K_{xx} \frac{\partial h}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_{yy} \frac{\partial h}{\partial y} \right) + \frac{\partial}{\partial z} \left(K_{zz} \frac{\partial h}{\partial z} \right) + W = S_s \frac{\partial h}{\partial t}$$

Parameter Properties

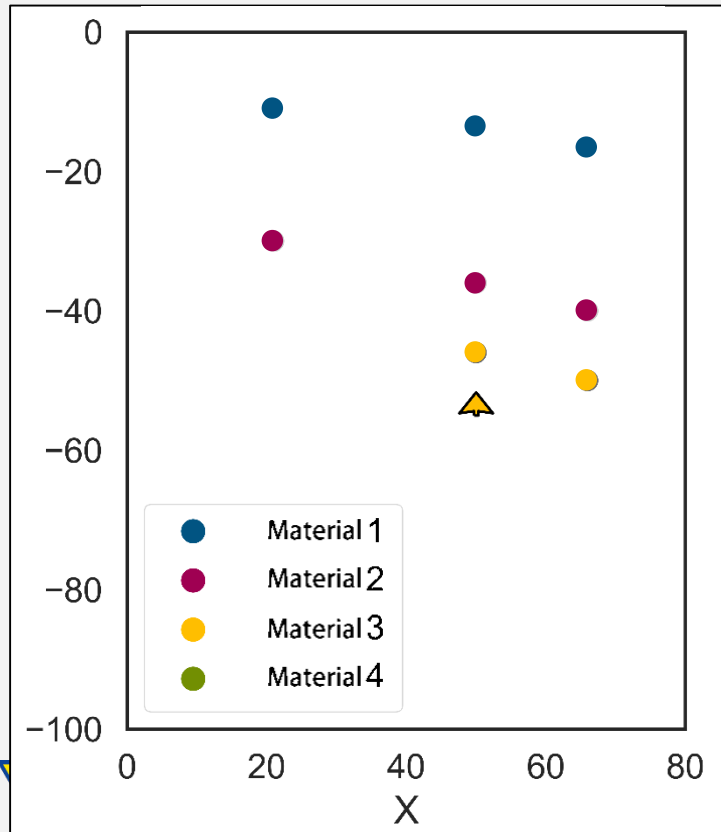
K_{xx} K_{yy} K_{zz}	Hydraulic conductivity	L/T
h	Potentiometric head	L
W	Sources and/or sinks of water	T^{-1}
S_s	Specific storage of the porous material	L^{-1}
t	Time	T

FLOPY

- A set of Python scripts that help user interact with MODFLOW (and other related programs)
- An open-source program
- It's all Python → easy to integrate with other Python packages



- A test data generated by myself
- Data points corresponding to the interface between two materials
- Orientation data to define geological settings



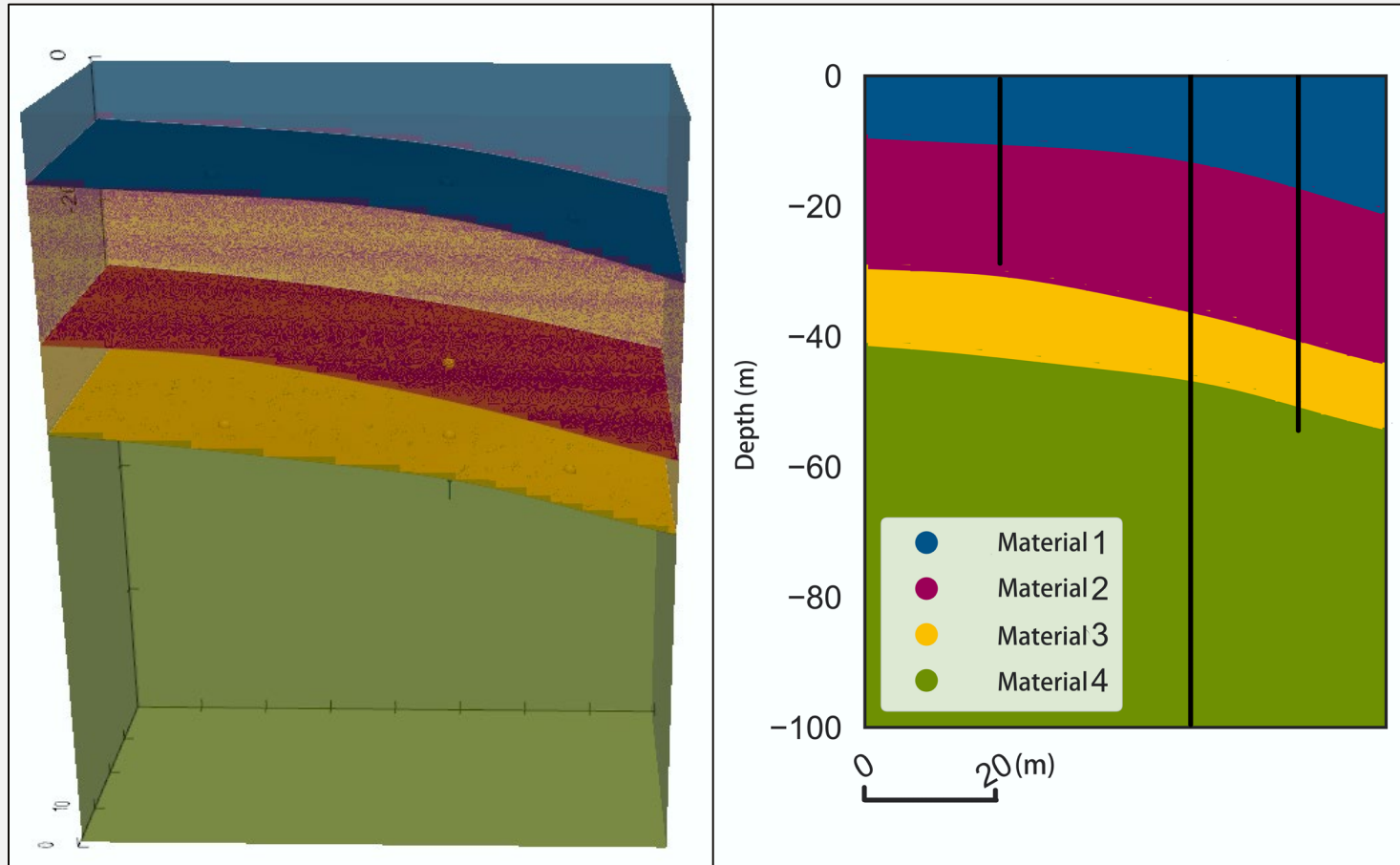
Points

NO.	X(m)	Y(m)	Z(m)	Material
1	21.0	10.0	-10.0	Material 1
2	21.0	10.0	-30.0	Material 2
3	50.0	15.0	-12.0	Material 1
4	50.0	15.0	-36.0	Material 2
5	50.0	15.0	-46.0	Material 3
6	66.0	13.0	-16.0	Material 1
7	66.0	13.0	-40.0	Material 2
8	66.0	13.0	-50.0	Material 3

Orientations

NO.	X(m)	Y(m)	Z(m)	Material	vector
1	50.0	15.0	-55.0	Material 3	(0,0,1)

OUTPUT



FUTURE WORK



FUTURE WORKS

1. Interpret borehole data.
2. Build a geological model utilizing GemPy.
3. Based on geological model to develop a groundwater flow model, using FloPy
4. Calibrate groundwater model by using the monitoring data.



THANK YOU FOR YOUR
ATTENTION

