Improve the reliability of Vs30 distribution map by considering geological uncertainty —a case study of Taipei Basin

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- Outline -

1 **Introduction**

Motivation \ Purpose

2 **Methodology**

Workflow \ Database \ Data processing \ Ordinary kriging

3 **Result & Discussion**

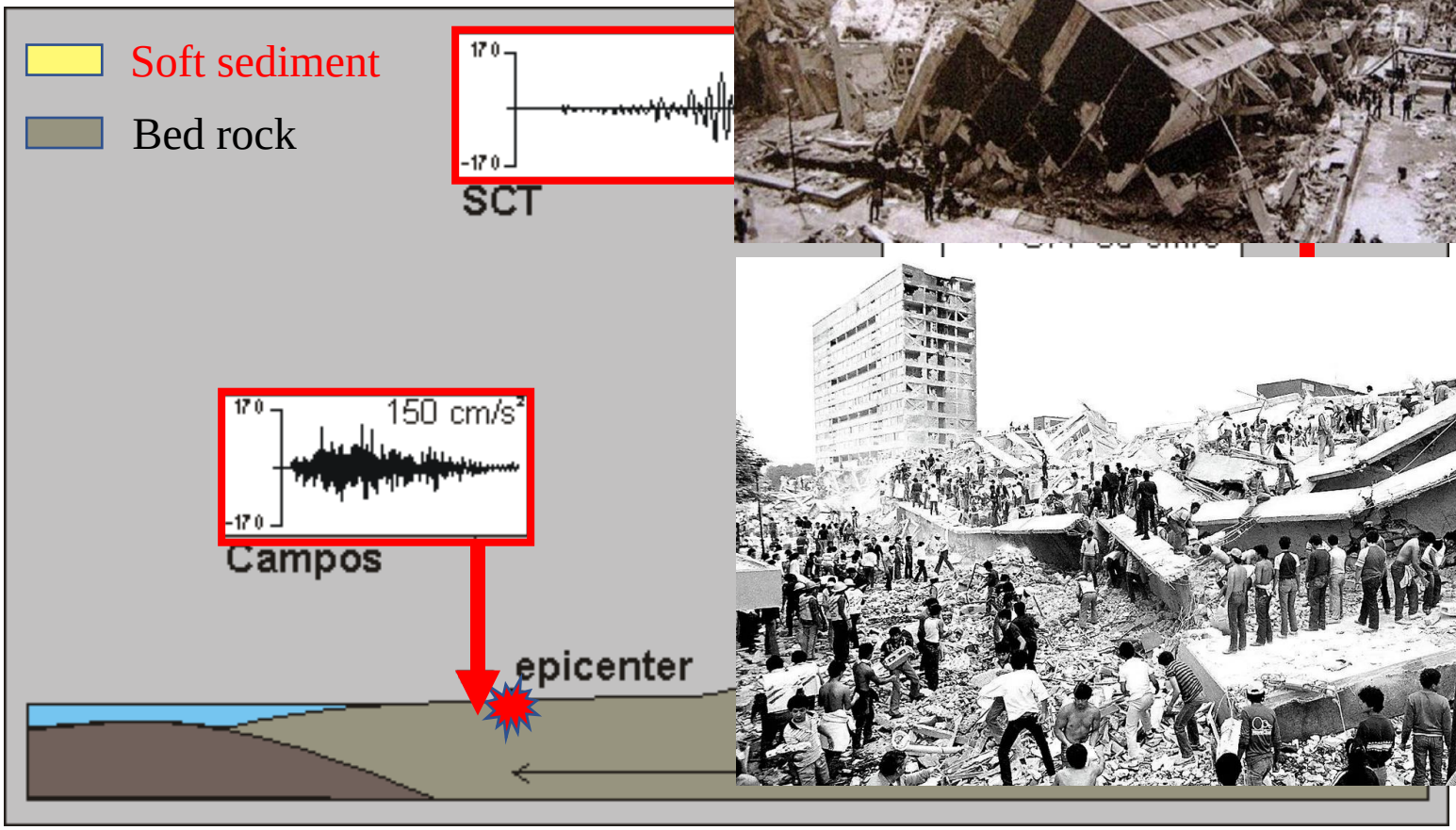
Gravel layer \ Basement

4 **Future Work**

Stochastic modeling \ Vs30 Distribution

Introduction - Motivation

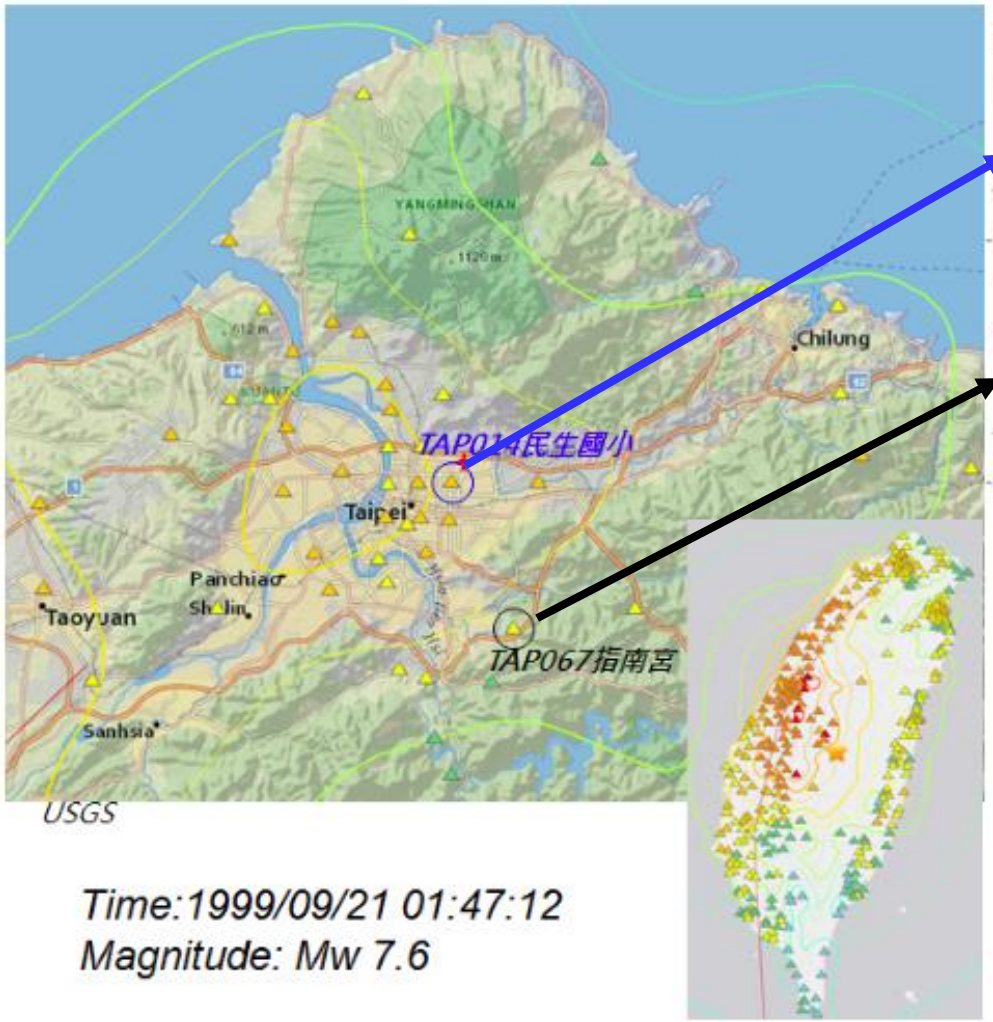
- Mw 8.0 earthquake caused serious disast
- The main reason for this is the geology c
  of soft sediment and hard bed rock.

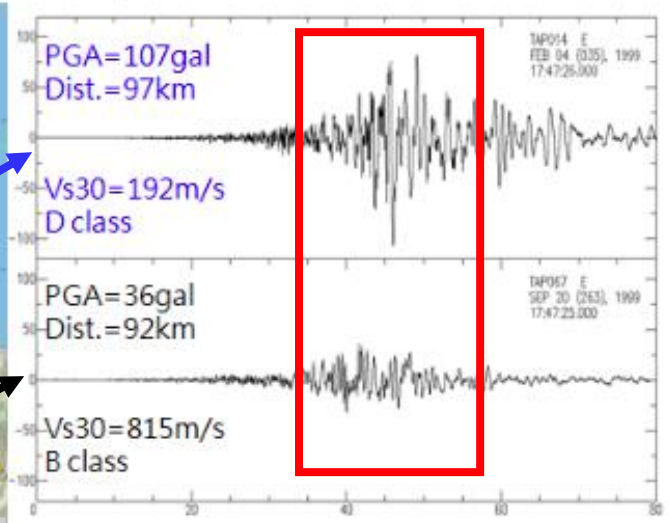


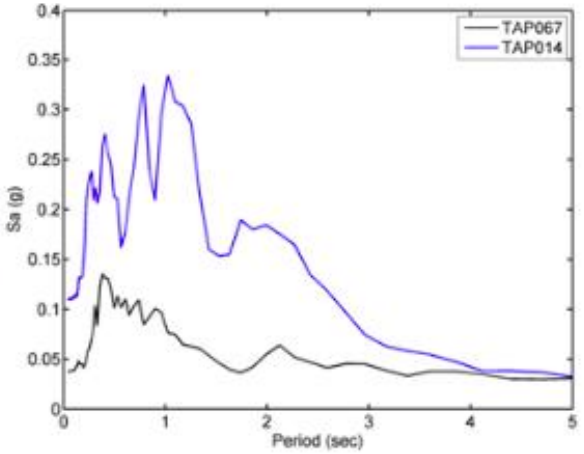
Jean-François Semblat, 2014

Introduction - Motivation

1999 Chi-Chi Earthquake



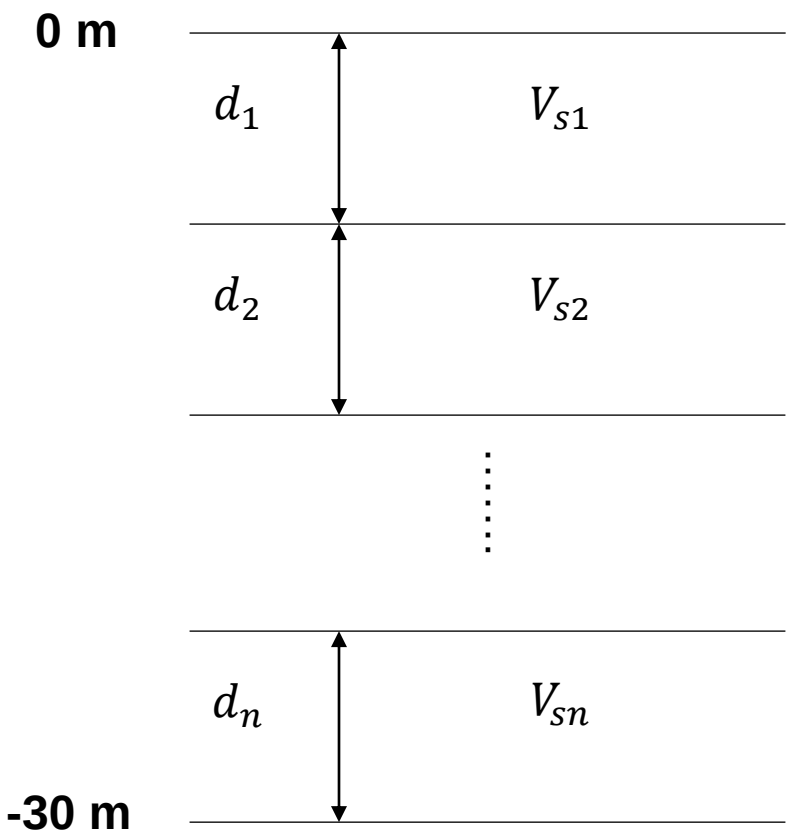


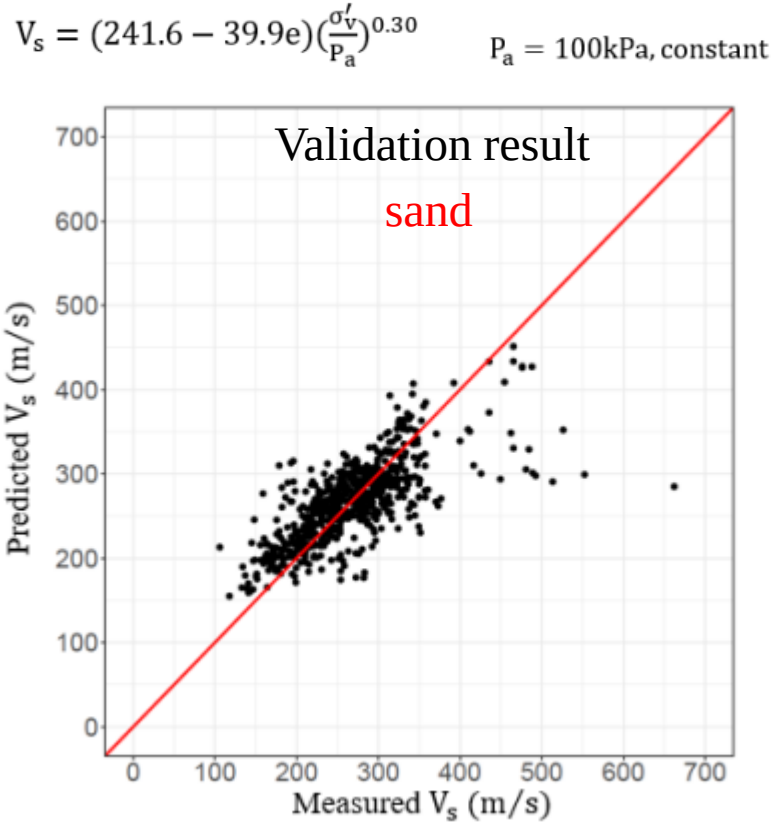


Kuo et al., 2017

Introduction - Purpose

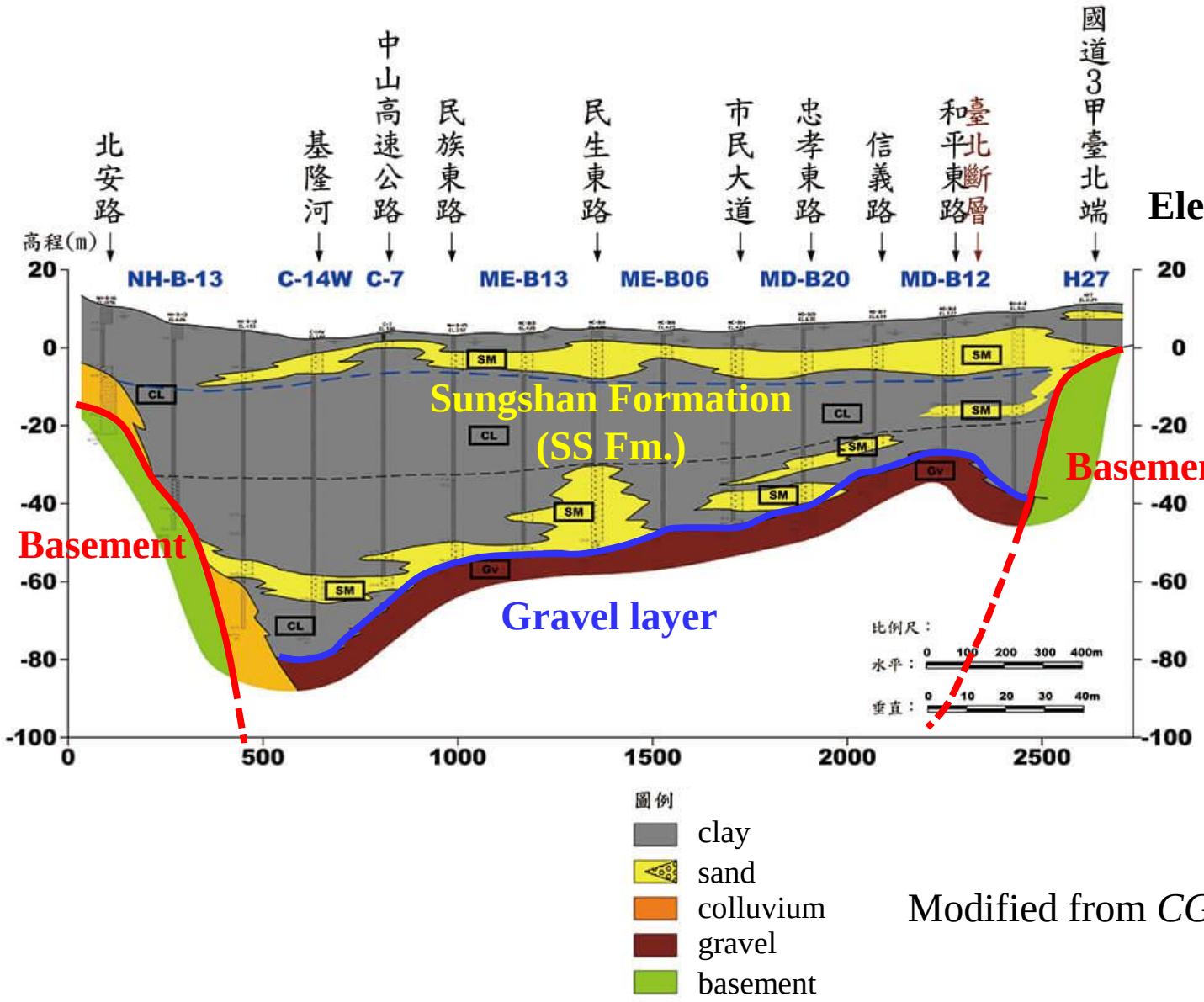
- Evaluate the Influence of Site Effect - Vs30
- There is a high correlation between shear wave velocity(Vs), soil void ratio(e) and effective stress(σ_v'). *Roesler (1979), Robertson et al. (1995)*





Kuo, 2021

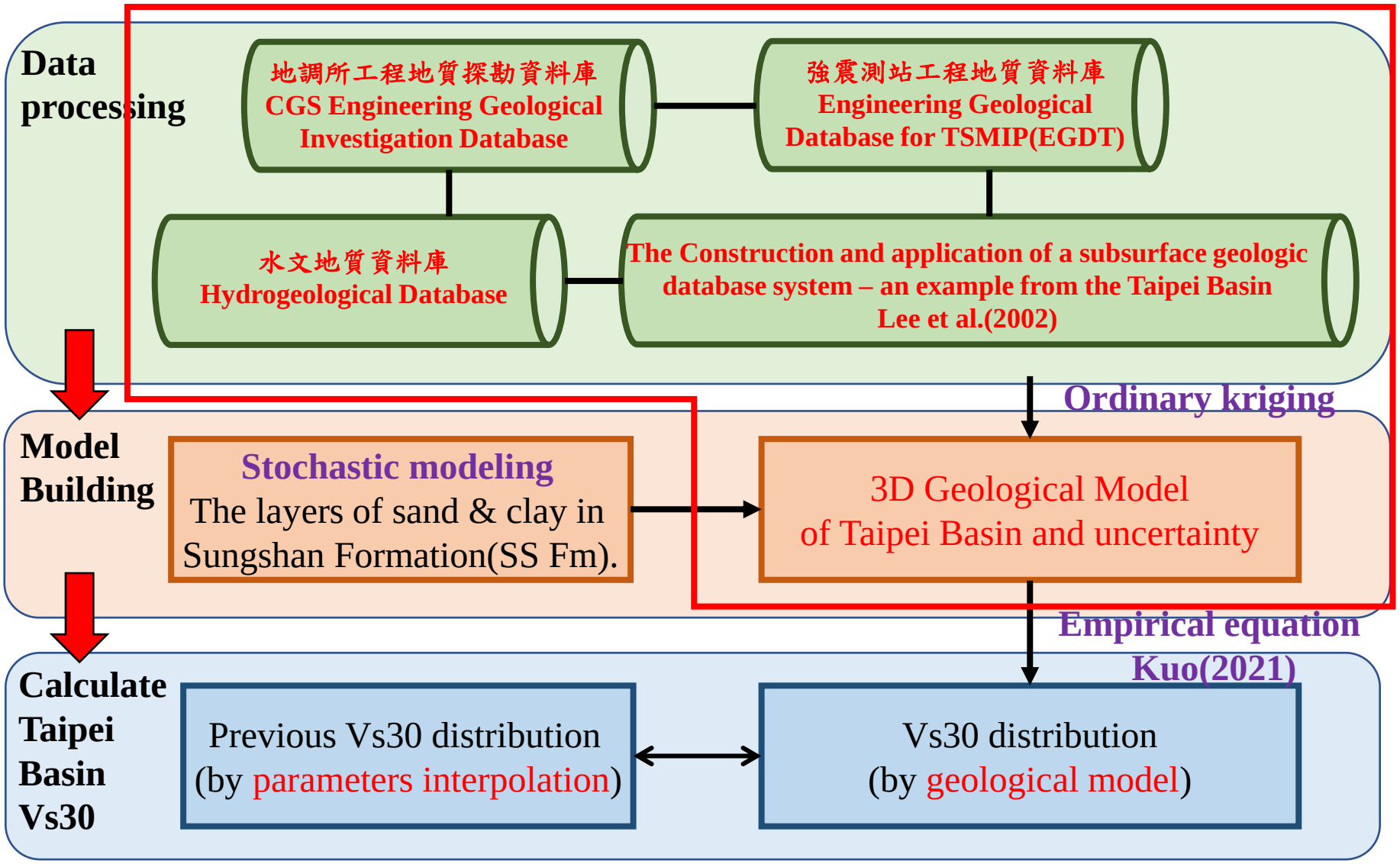
Introduction - Purpose



Modified from *CGS, 2014*

Methodology - Workflow

Today's talk

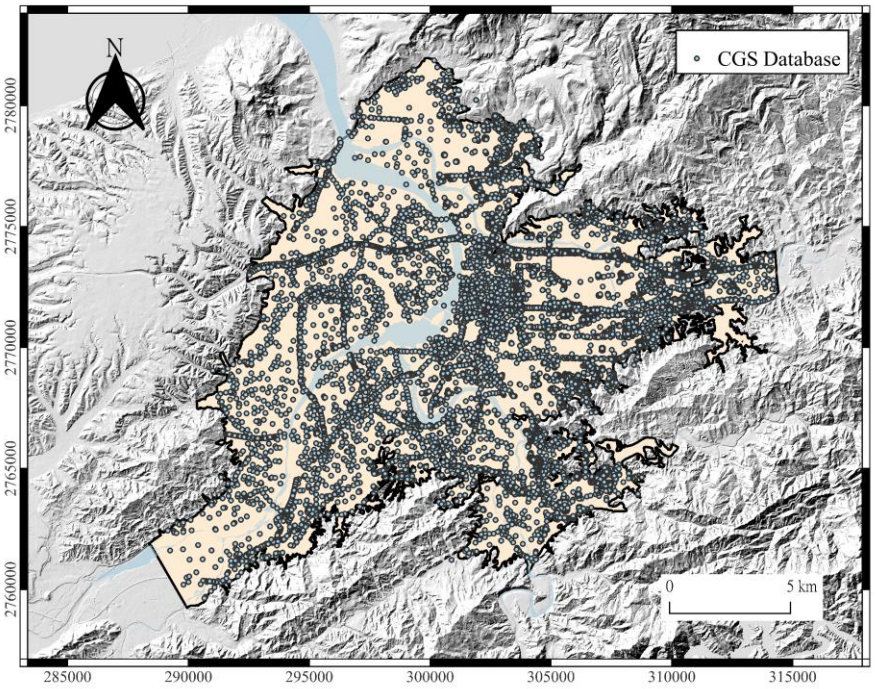


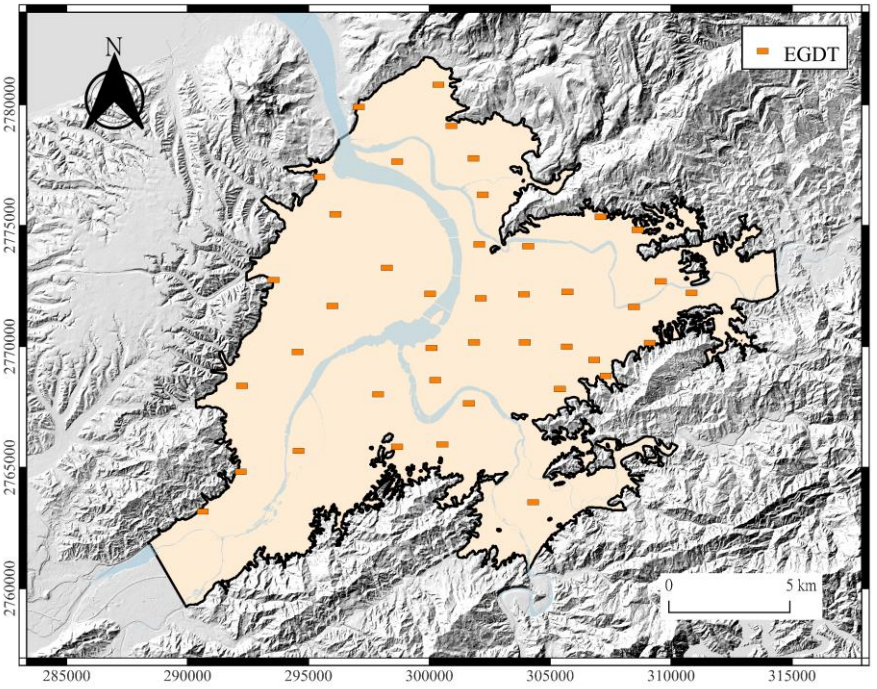
Methodology - Database

工程地質探勘資料庫

NCREE

全國強震測站場址工程地質資料庫
Engineering Geological Database for TSMIP (EGDT)



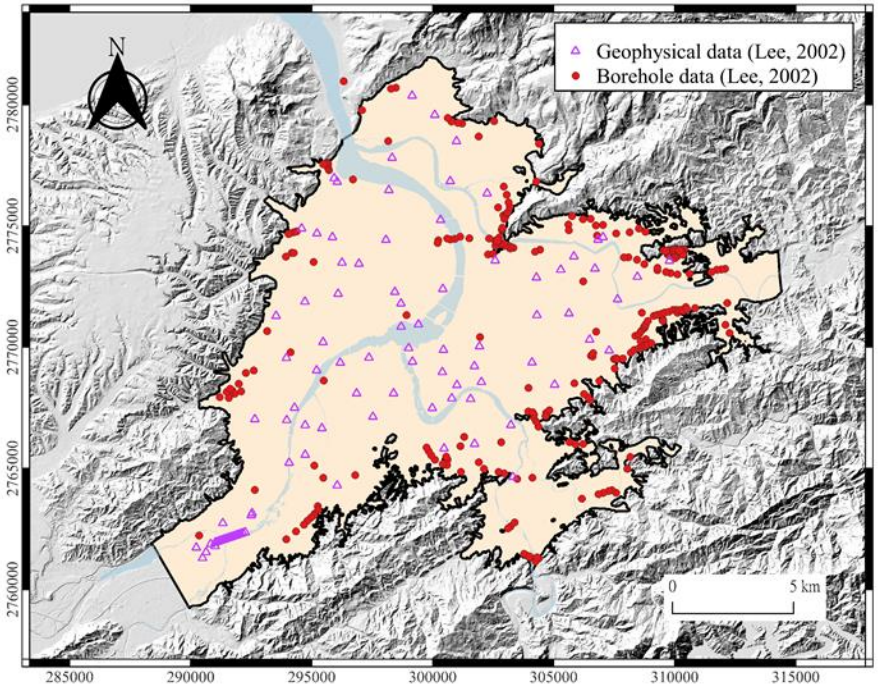


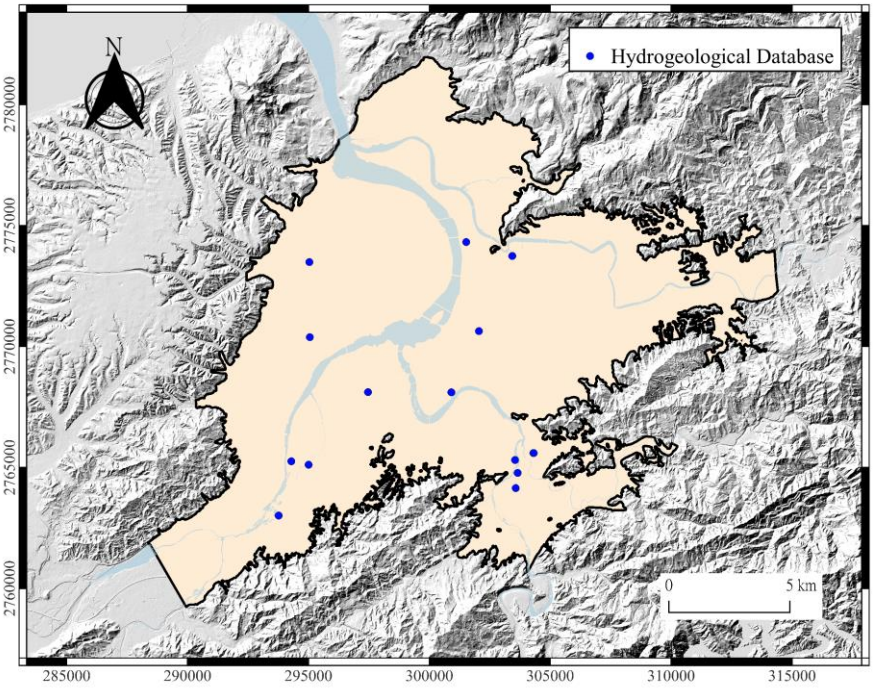
Methodology - Database

THE CONSTRUCTION AND APPLICATION OF A SUBSURFACE GEOLOGIC DATABASE SYSTEM – AN EXAMPLE FROM THE TAIPEI BASIN

LEE C. T. HUANG TZE-MING
INSTITUTE OF APPLIED GEOLOGY, NATIONAL CENTRAL UNIVERSITY

水文地質資料庫整合查詢平台





Methodology - Data processing

1. Rock and Gravel(step 1):

In the raw data, the description includes “Rock (岩)”and “Gravel (礫)”.

Borehole_id	Description
009481512_BH-1	回填層(混凝土鋪面、岩塊、粉土質砂、粘土、雜物等)
009481512_BH-1	黃棕色至灰色，砂岩至砂岩頁岩互層
00956671(10802)_C-1	灰色砂岩，16.20m~16.50m，17.35m17.60m，19.20m~19.60m破碎，膠結不佳
00956671(10802)_C-1	灰色砂岩、膠結尚可
010166070908_A-15	崩積物;岩屑堆積;碎屑
01016607A9801-01C_A3	棕黃色粉土質細砂夾岩塊、卵礫石

Keyword	Boreholes
Rock(岩)	**3209**
Gravel(礫)	**7138**

Methodology - Data processing

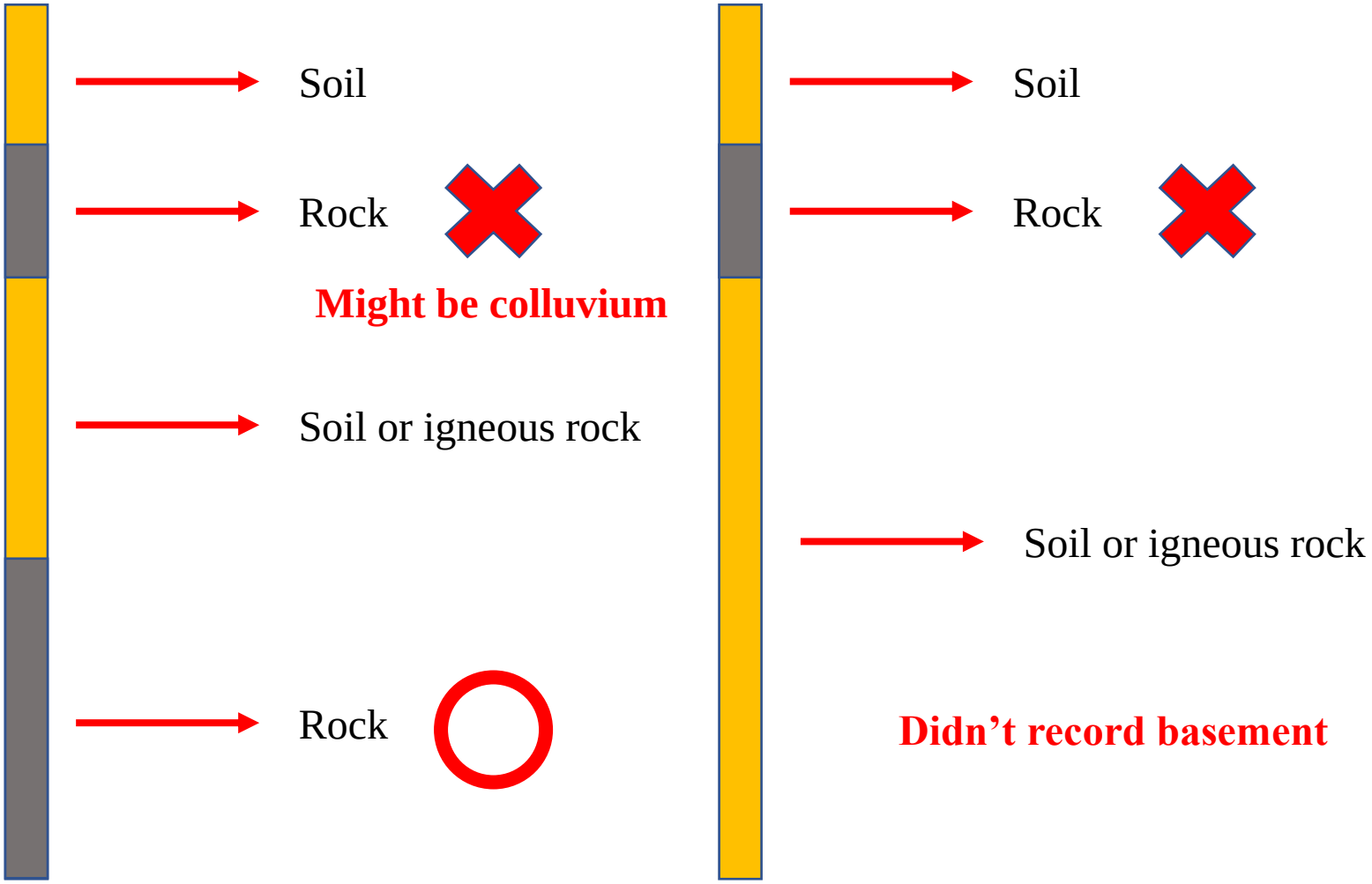
2. Data Screening of basement(step 2):

Keyword	Remaining boreholes
Last step	3209
Backfill (回填)	3114
Brick (磚)	3107
Topsoil (表土、崩積、填方)	3093
Igneous rock (安山、凝灰、火山、火成)	2760
Others (草、雜、地表、混凝、夾岩塊、水泥、腐)	2700

3. Data Screening of basement (step 3):

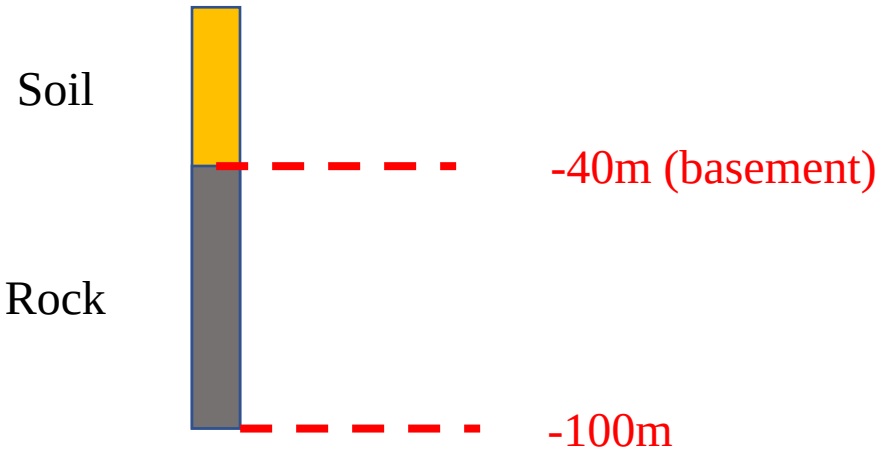
Criterion	Remaining boreholes
• Rock that is not part of the basement.	2494
• Multiple data in the same borehole location.	2435

Methodology - Data processing



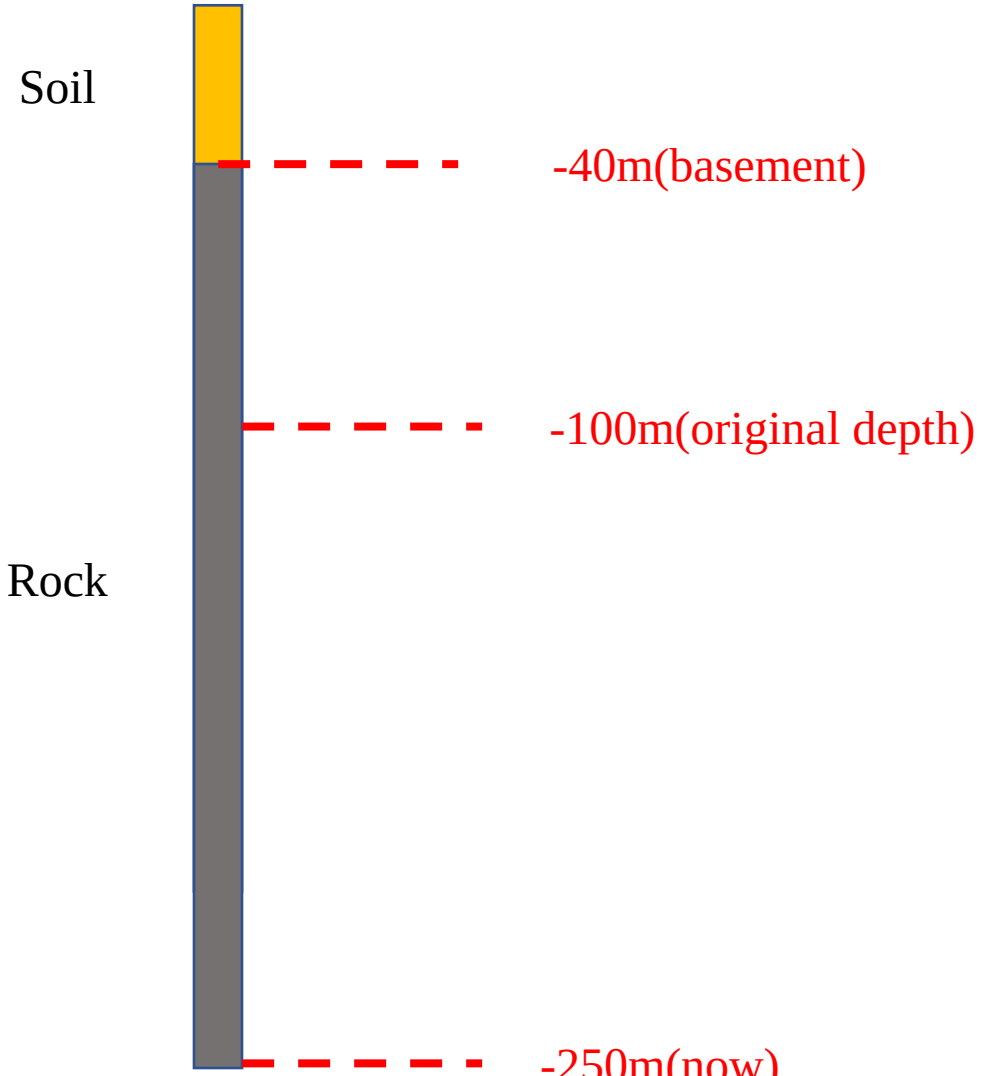
Methodology - Data processing

Bh_1, in 2000, 121E, 25N



Methodology - Data processing

Bh_1e, in 2010, 121E, 25N

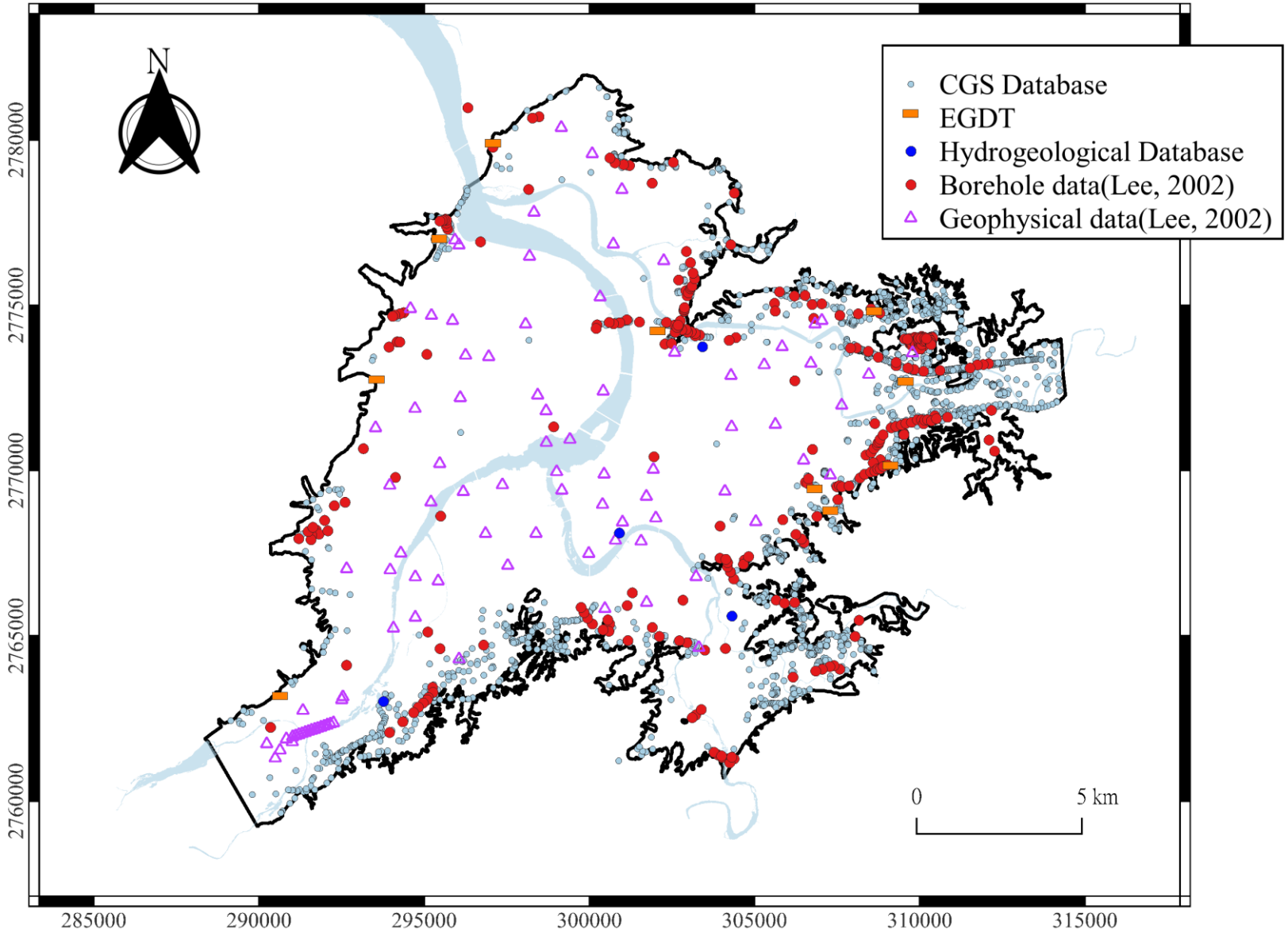


Methodology - Data processing

4. Data used for basement analysis

Source	Numbers
CGS Engineering Geological Investigation Database	2435
EGDT	10
Hydrogeological Database	4
Boreholes used in Lee(2002)	303
Geophysical data used in Lee(2002)	93
Total	**2845**

Methodology - Data processing



Methodology - Data processing

2. Data Screening of the gravel layer under SS Fm.(step 2):

Keyword	Remaining boreholes
Last step	7138
Backfill (回填、填方)	5343
Brick (磚), Topsoil (表土、草、崩積)	5176
Igneous rock (安山、凝灰、火山、火成)	4593
Others (雜、地表、混凝、水泥、腐)	4846

3. Data Screening of the gravel layer under SS Fm.(step 3):

Criterion	Remaining boreholes
• Screen out the intercalated gravel	4309
• Main properties are sand, clay or silt	3710

Methodology - Data processing

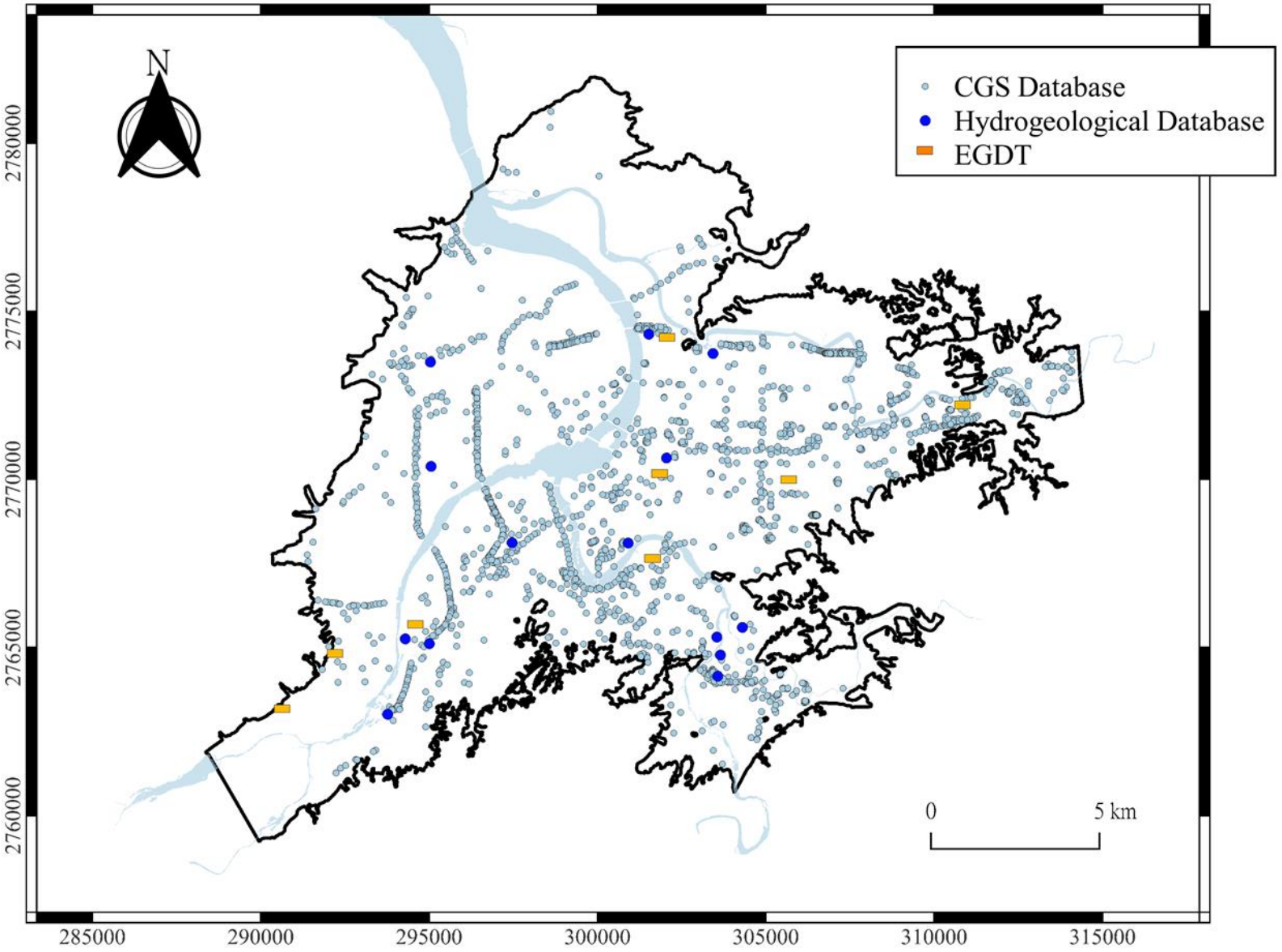
4. Data Screening of the gravel layer under SS Fm.(step 4):

Criterion	Boreholes
Gravel **above** the bottom of SS Fm. --by comparing with the bottom of Sungshan formation (Lee, 2002)	1777
Gravel **under** the bottom of SS Fm. --by comparing with the bottom of Sungshan formation (Lee, 2002)	**1933**

5. Data used for the gravel layer under SS Fm. analysis

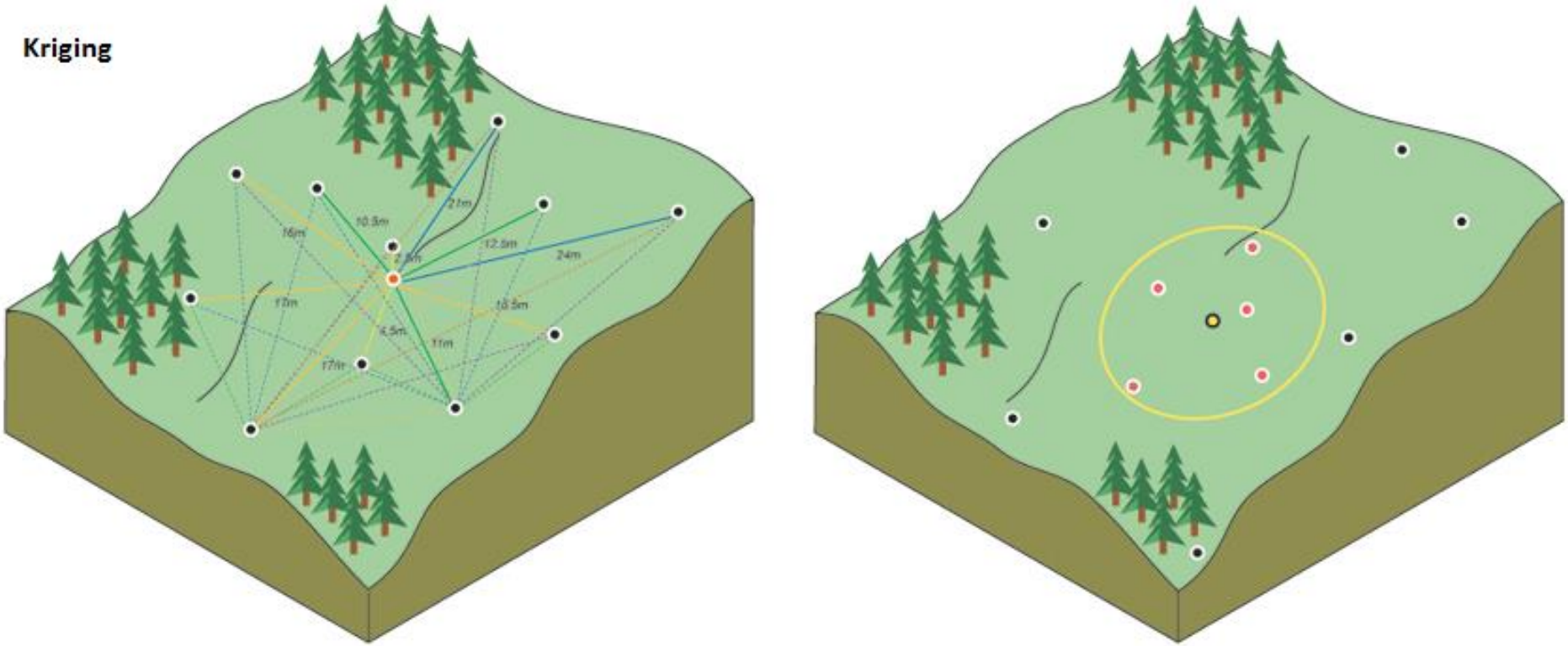
Source	Numbers
CGS Engineering Geological Investigation Database	1933
EGDT	8
Hydrogeological Database	14
Total	**1955**

Methodology - Data processing



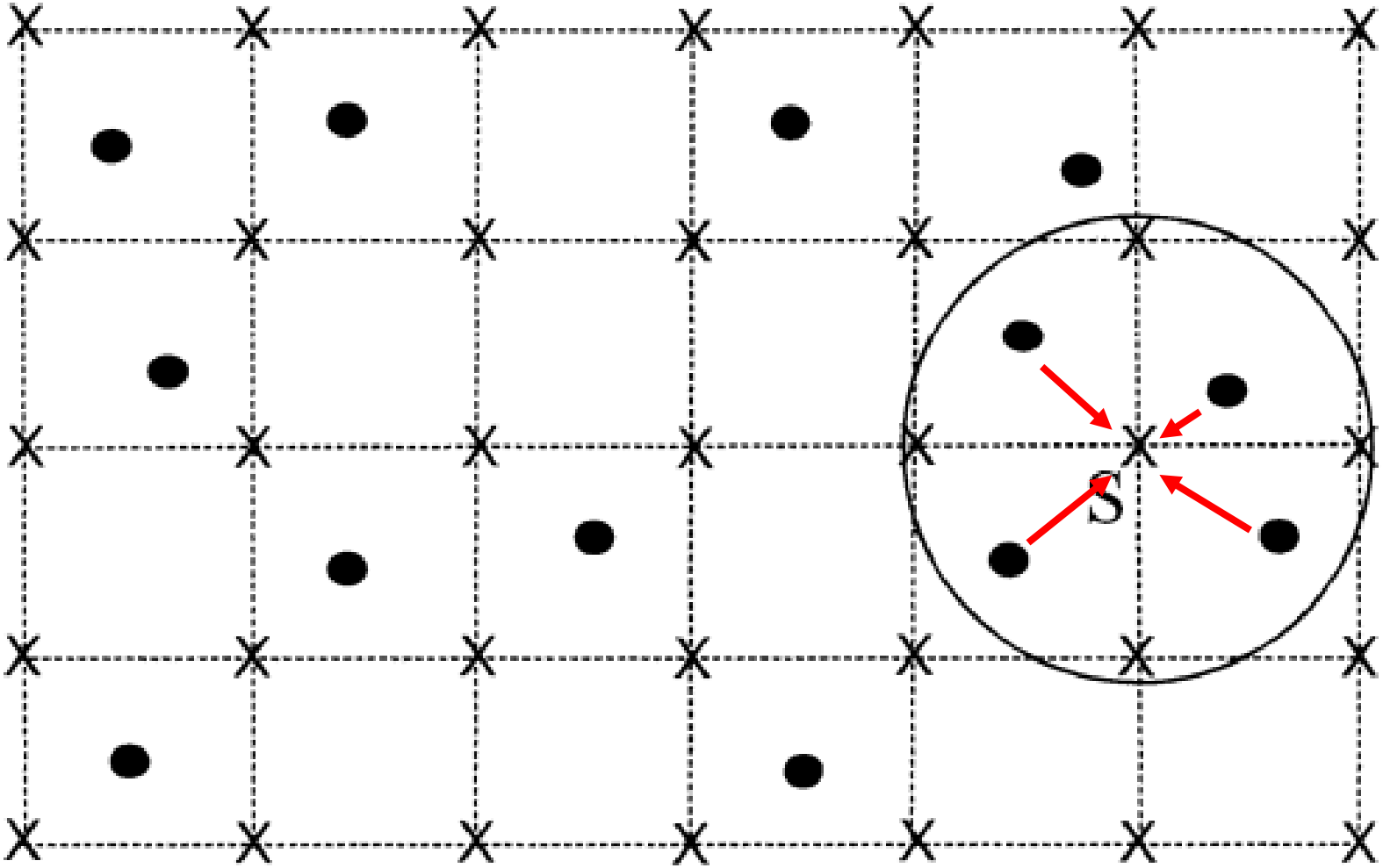
Methodology - Ordinary kriging

- Tobler's First Law of Geography: everything is related to everything else, but near things are more related than distant things.
- If geography is worth studying at all, it must be because phenomena do not vary randomly across space. *O'Sullivan and Unwin(2003)*



ESRI, [*Kriging: An Introduction to Concepts and Applications (esri.com)*]

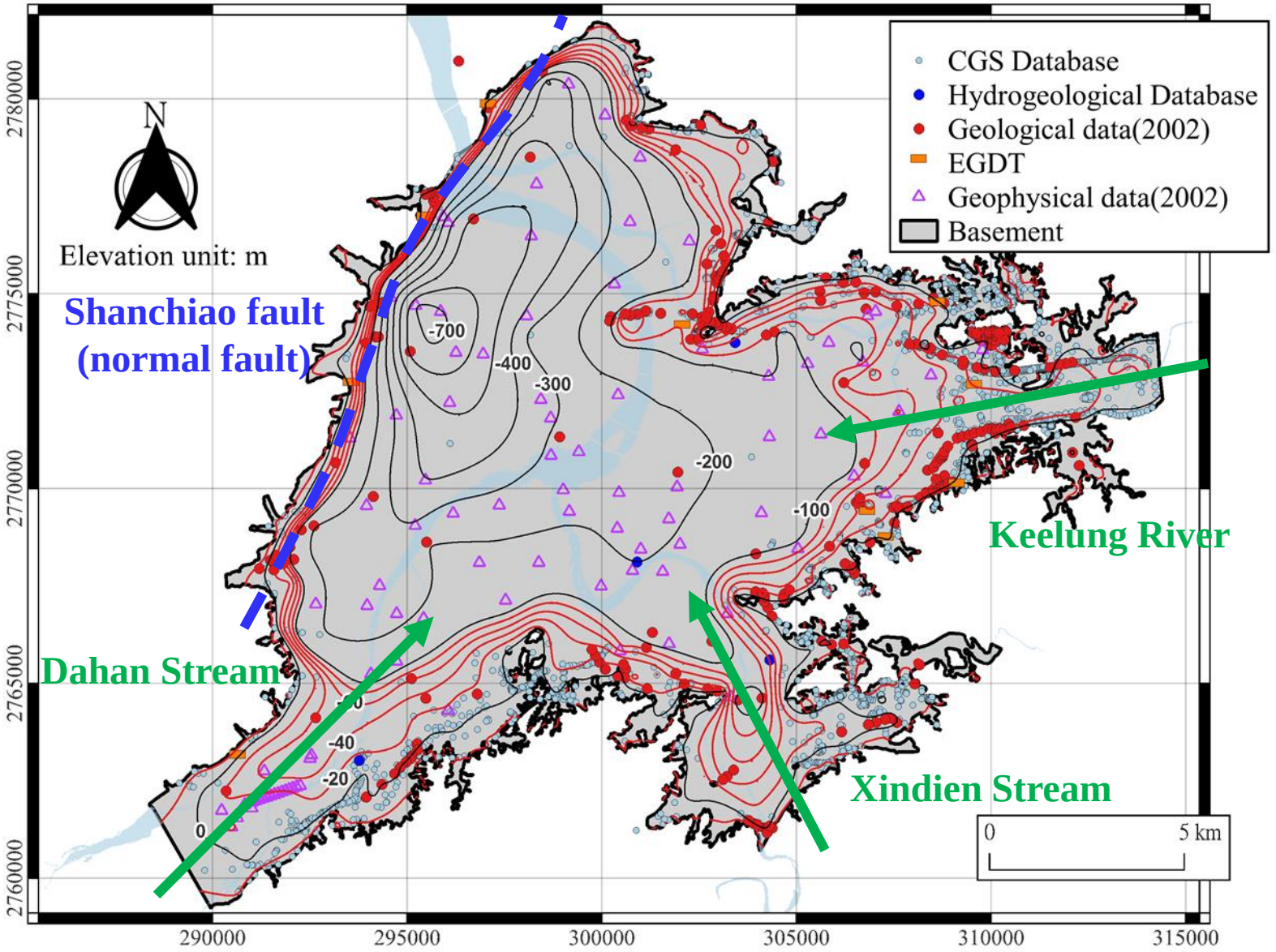
Methodology - Ordinary kriging



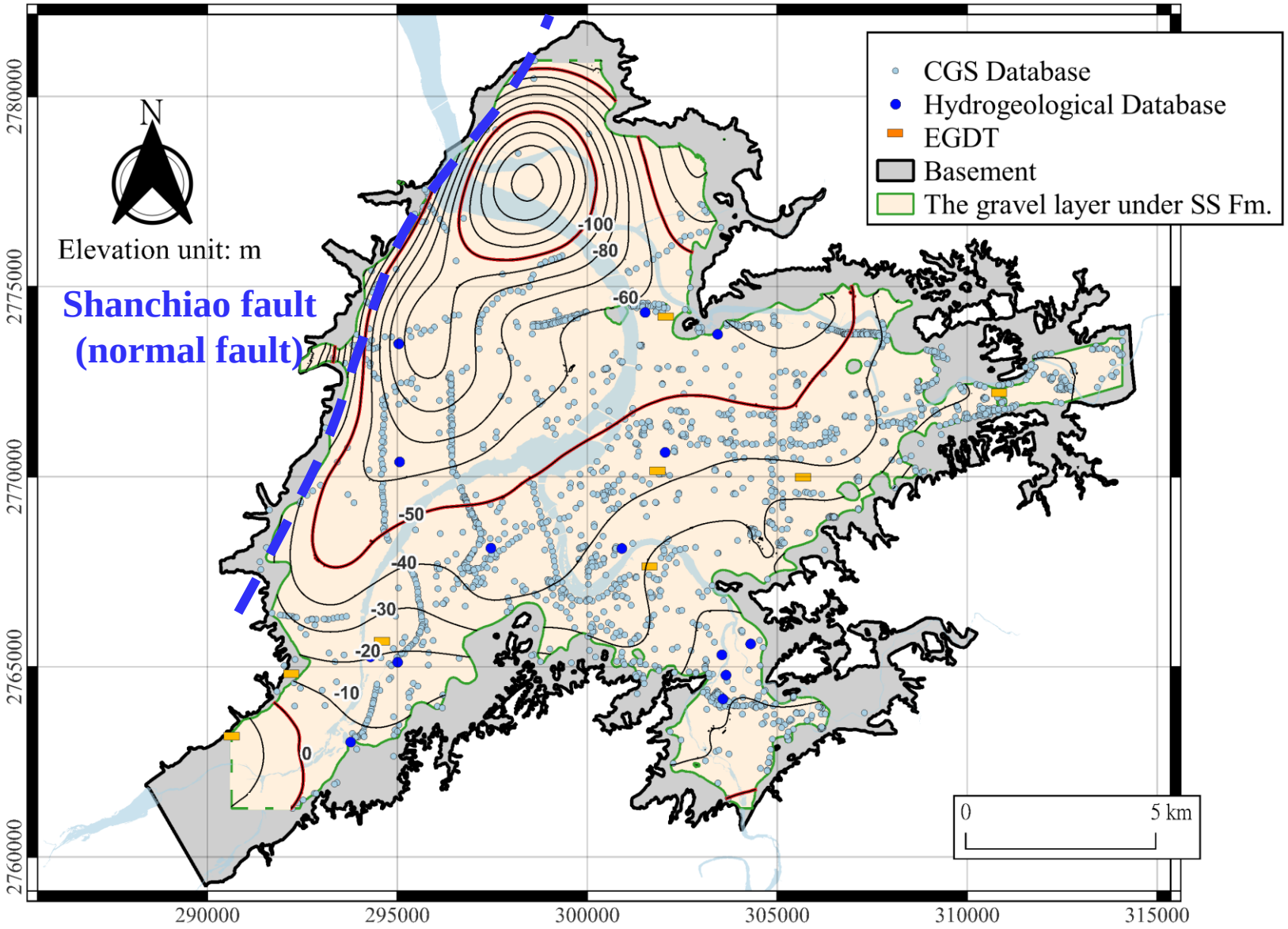
X estimation gridpoint ● investigation site with known values

O. Marinoni, 2002

Result & Discussion - Basement

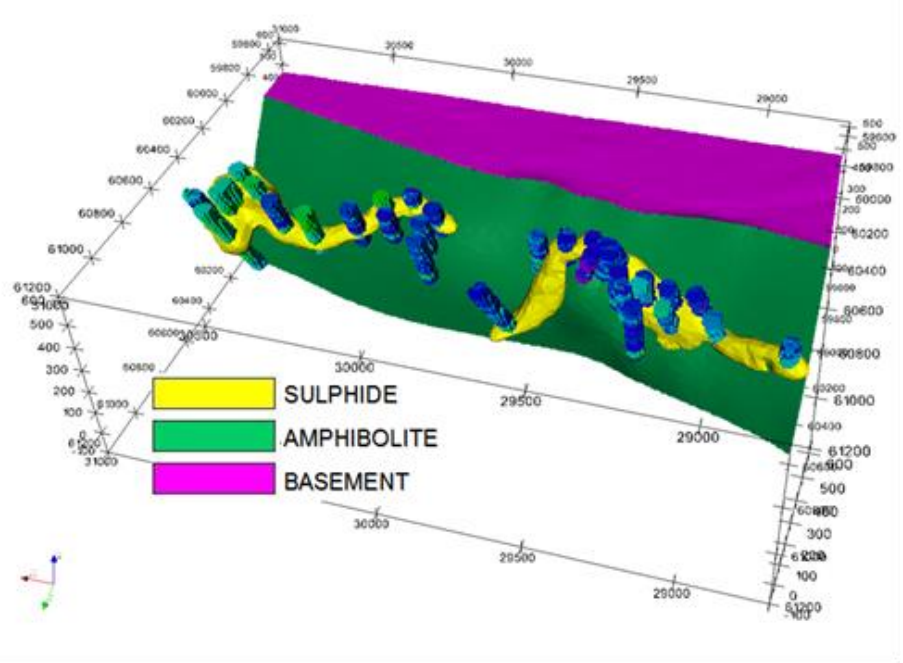


Result & Discussion - The gravel layer under SS Fm.

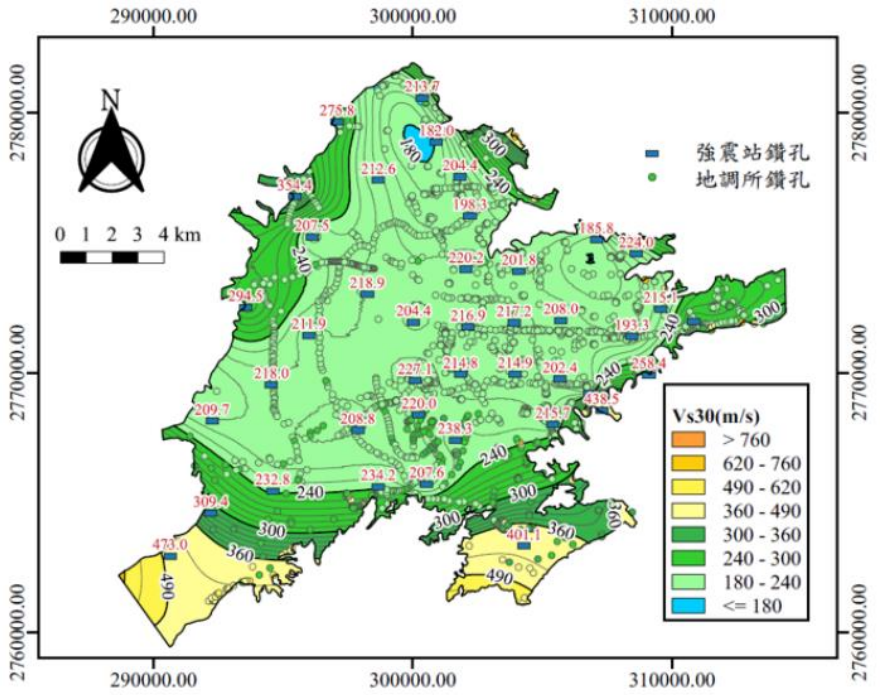


Future work - Stochastic modeling and Vs30 map

- Finish the stochastic modeling to construct the layers of sand & clay in Sungshan Fm.
- Use the geological model to evaluate the value and the uncertainty of Vs30.



3D Forward Modelling and Stochastic Inversion - Intrepid Geophysics (intrepid-geophysics.com)



Kuo, 2021


Thanks for your attention