Establishment of Engineering Geological Zoning in the Taipei Basin

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Outline

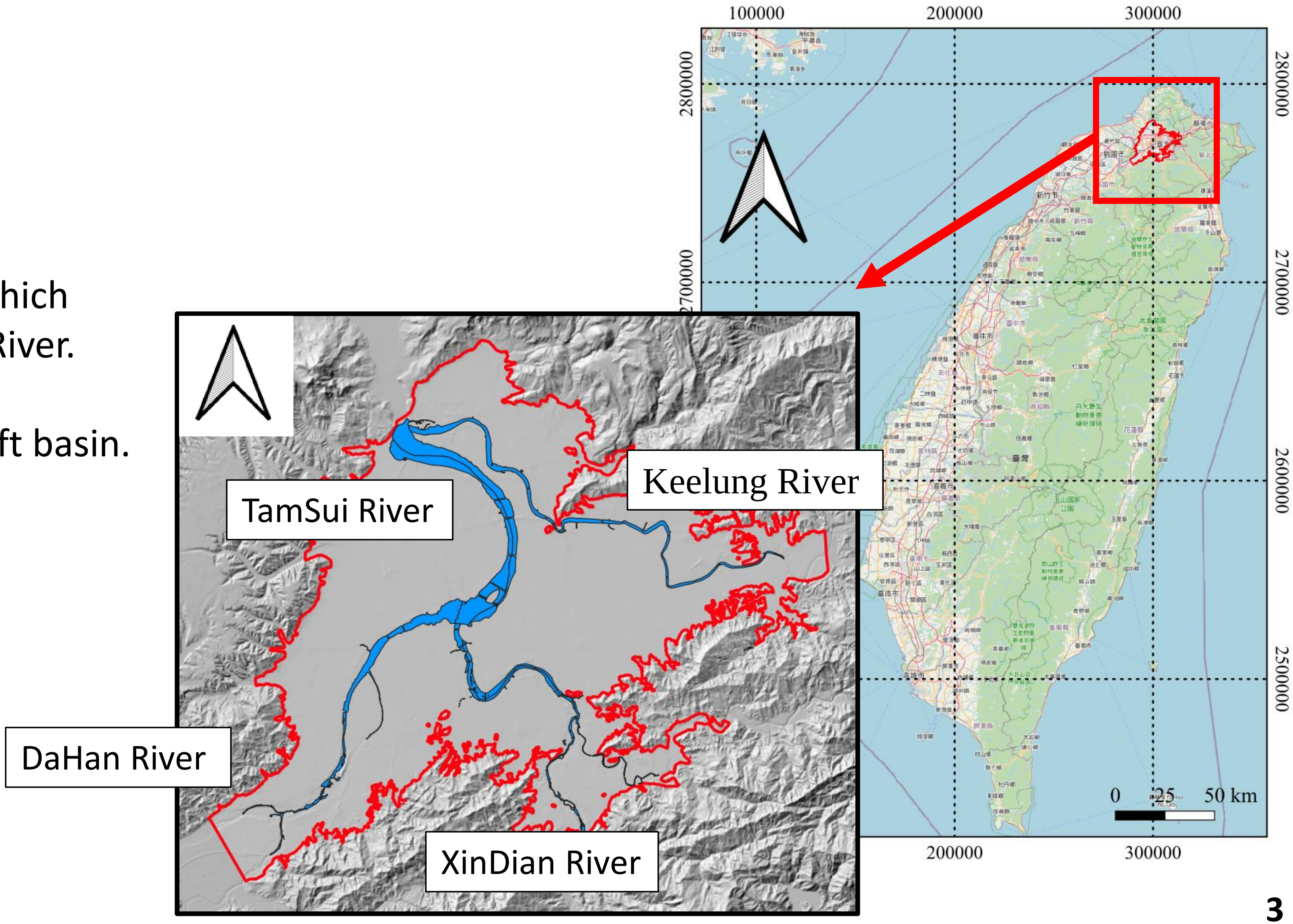
- Introduction
- Methodology
- Preliminary results
- Future works

Research area :

1. The Taipei Basin is located in northern Taiwan.

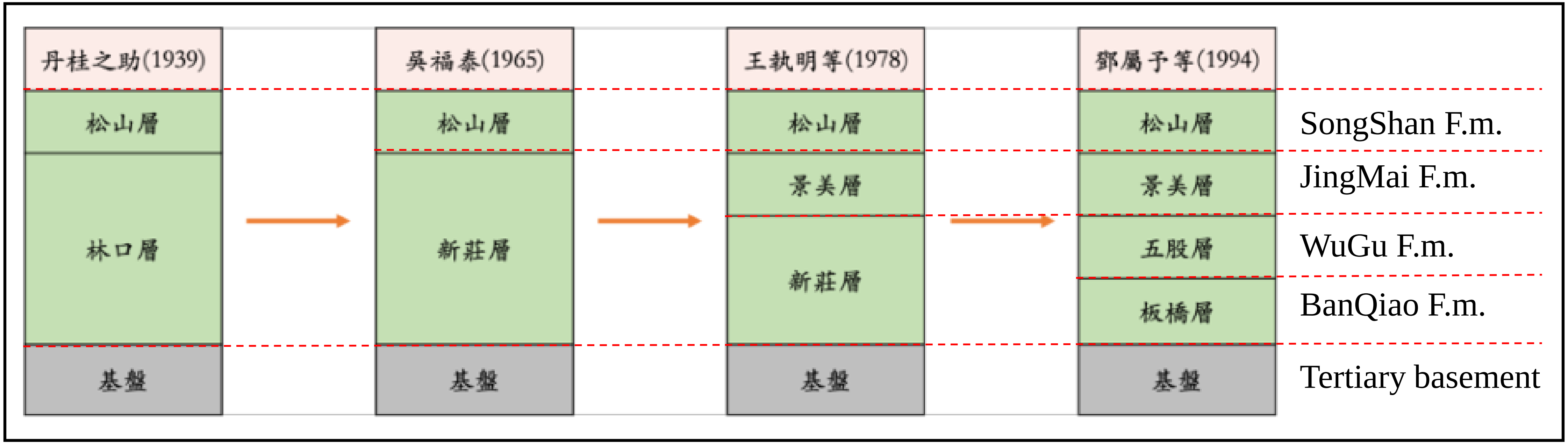
2. There are three main rivers, which converge to form the TamSui River.

3. Taipei Basin is classified as a rift basin.



Geological Background in Taipei basin:

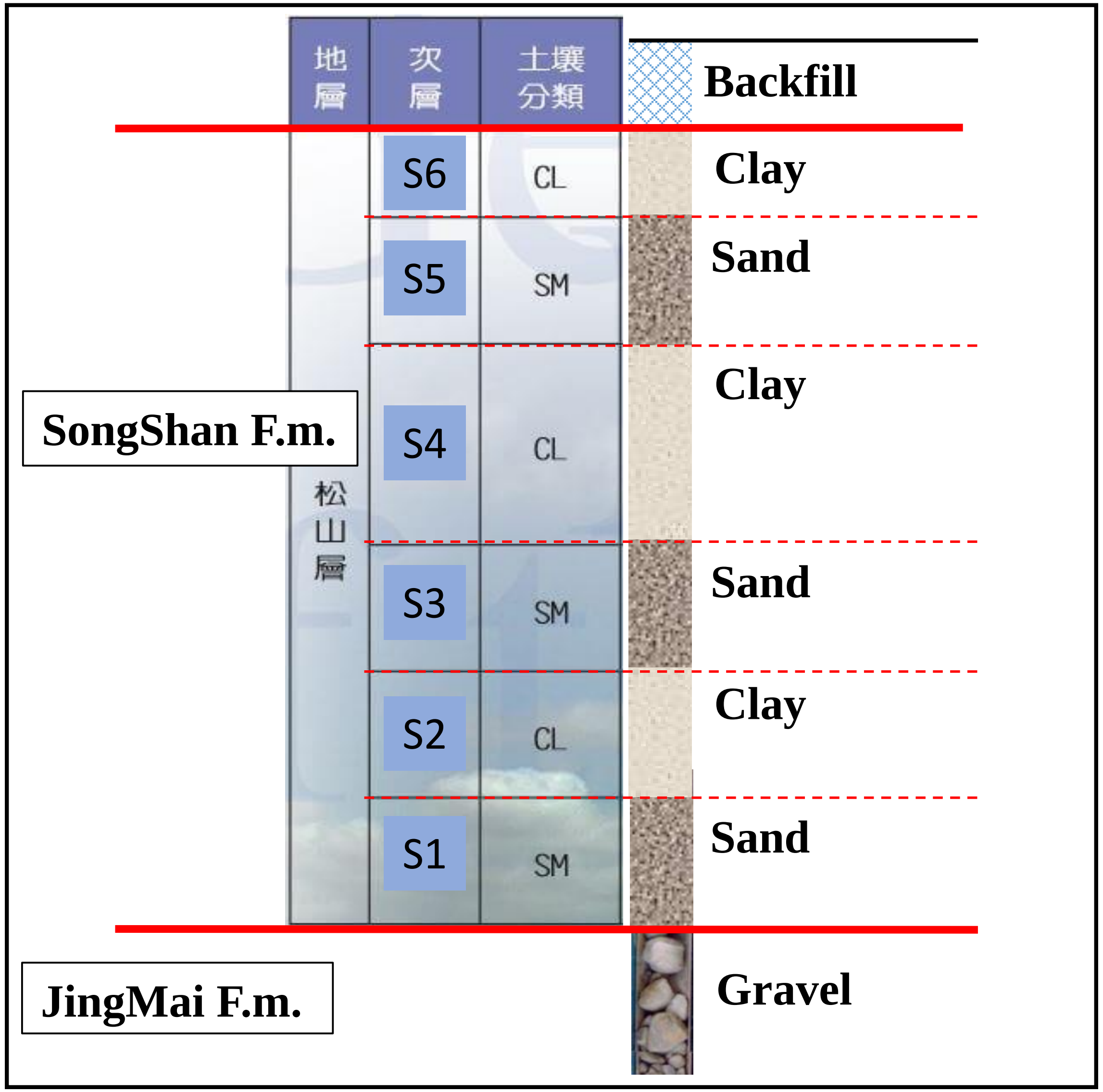
The stratigraphic composition of the Taipei Basin can be seen in the schematic diagram below.



This study will focus on the spatial distribution of the Sungshan Formation, Jingmei Formation, and the Tertiary basement, as they have a greater impact on engineering projects.

Geological Background in Taipei basin:

- Currently, the engineering field primarily subdivides the Songshan Formation into six sub-layers.
- The sedimentary facies of the SongShan Formation are characterized by transgressive and regressive processes, along with the influence of river systems, resulting in a more complex geological situation.
- Jingmei Formation is commonly regarded as a suitable deep foundation layer to engineering perspective (Lee and Chin, 1998)

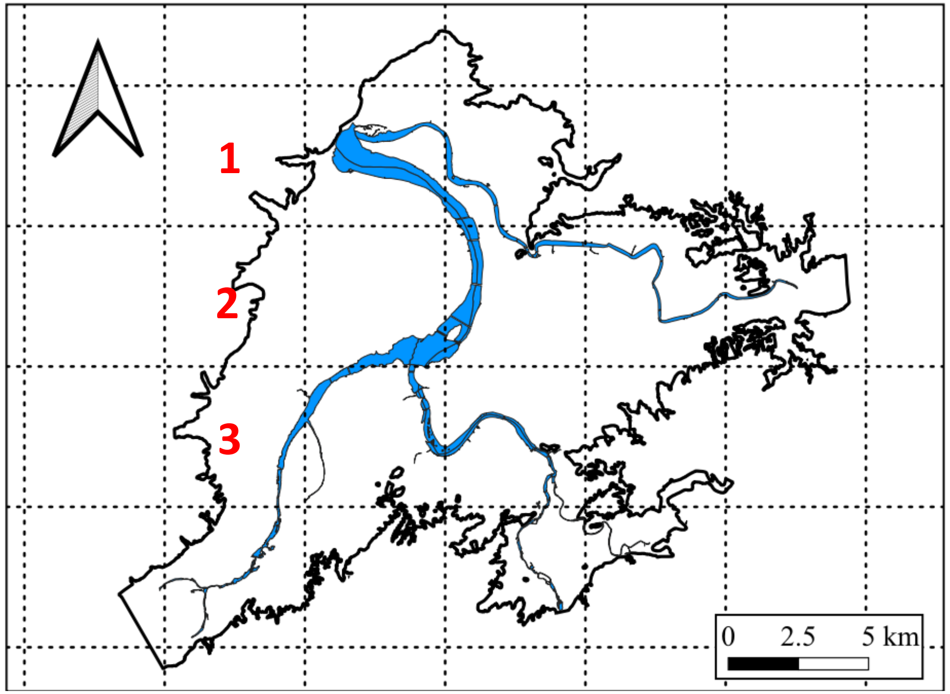


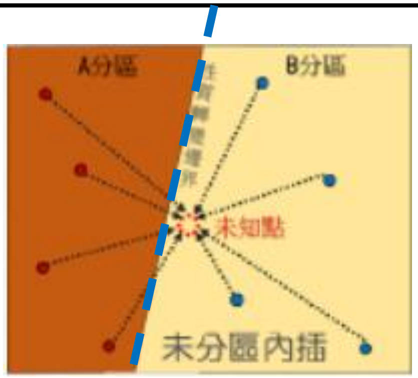
Songshan Sixth Layer will be designated as S1 to S6.

Research Objectives :

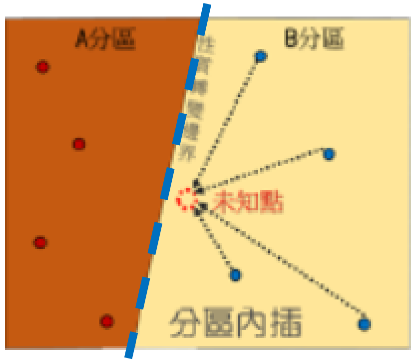
- For the zoning method, dividing boundaries in regular rectangles without considering geological structures may cause discrepancies with actual conditions, increasing uncertainty in the 3D engineering geological model.
- Engineering geological zoning based on geological background will help improve the accuracy of future simulations.

Regular Rectangles





The value at an unknown point in zone B is derived from data in both zones A and B, resulting in distortion.

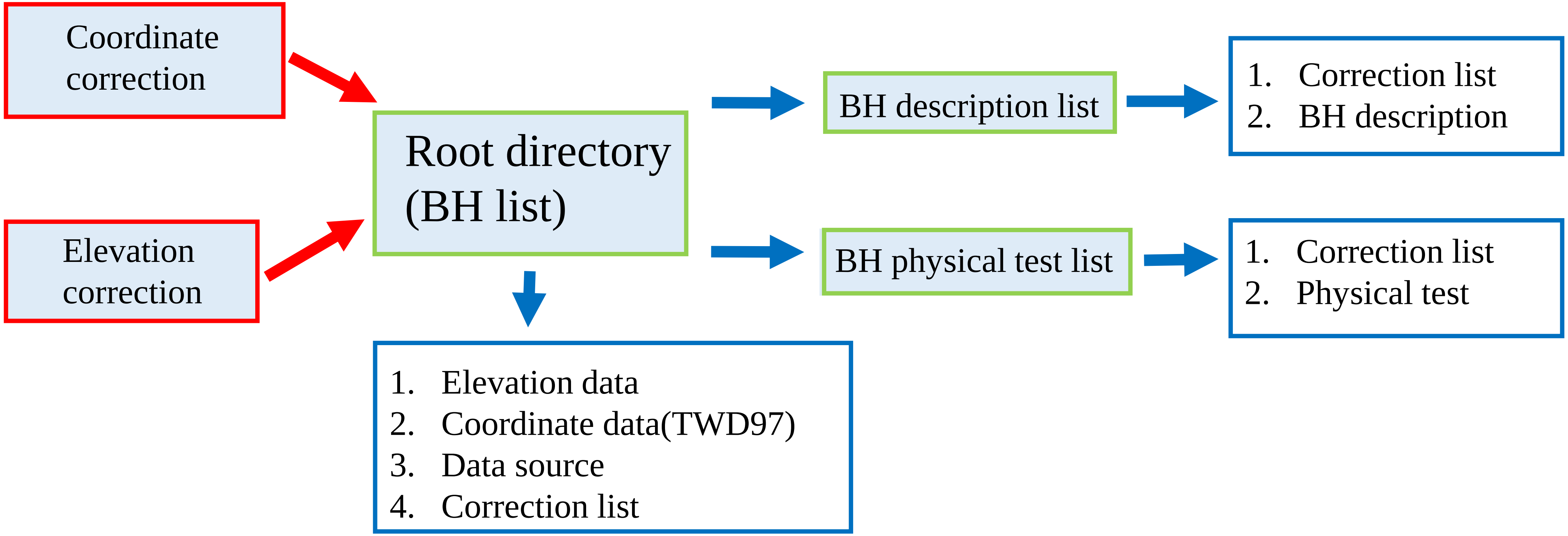


The value at an unknown point in zone B is derived solely from data within zone B, leading to a more reasonable result.

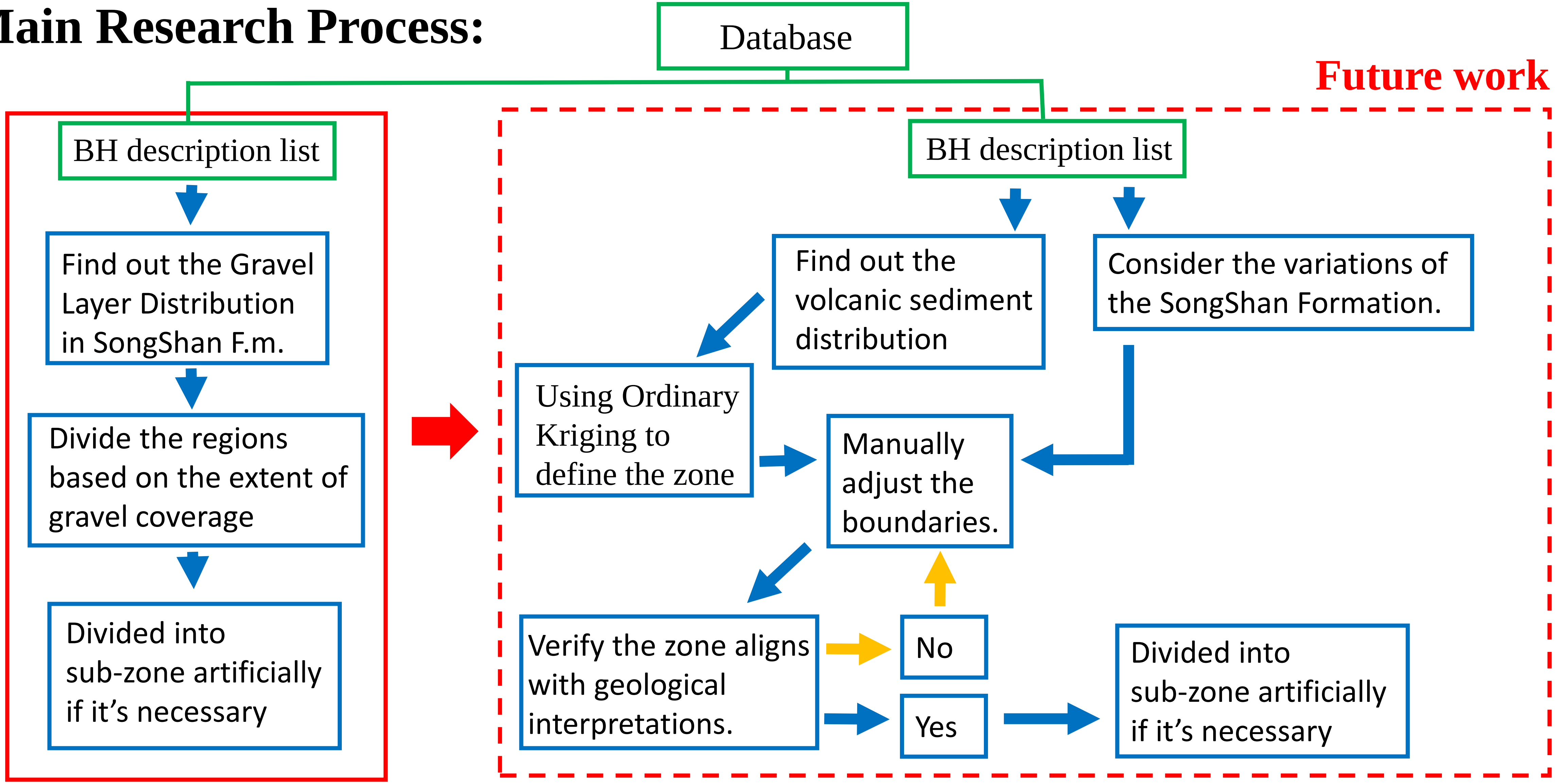
(台北市政府業化潛勢查詢系統)

Database Construction process in this research:

Before zoning, the borehole data from Central Geological Survey(CGS) is integrated in a root directory format to facilitate its use in the study.



Main Research Process:



Spatial distribution of gravel layers within the Songshan Formation.

Step 1

Find out the gravels within borehole

Step 2

Find out the gravels in SongShan F.m. by previous studies

Step 3

Calculate the thickness of the gravel layers within SongShan F.m.

Ordinary Kriging with thickness

Values equal to “0” will be show in contour form as the representative of converge boundary

Assume the gravel layer will pinch out in the nearby boreholes which have no gravels within.

Connect the nearby borehole to get the boundary

Step 4

Consider the results from the two methods and the borehole data, adjust the converge boundary manually

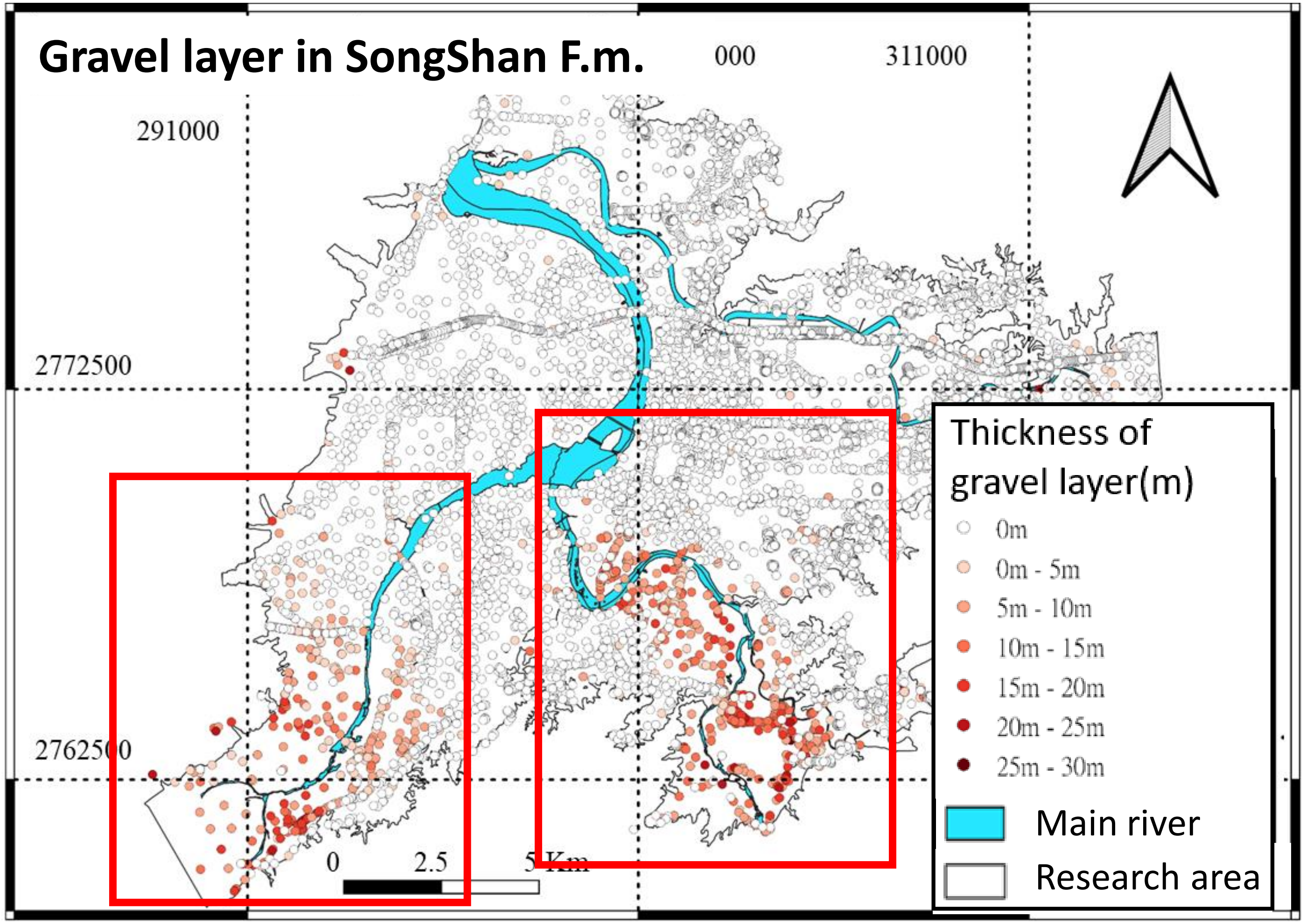
Converge boundary of gravel layer in SongShan formation will be constraint in a individual zone

legend

process

Data provided

Spatial distribution of gravel layers within the Songshan Formation.



Step1:
Excluding keywords that indicate layers is not belong to gravel layer.

Compare the borehole data one by one. If the proportion of gravel is the highest in a particular layer, it will be classified as a gravel layer.

Step2:
Using the results from previous studies, gravel layers that belong to the Jingmei Formation will be excluded.

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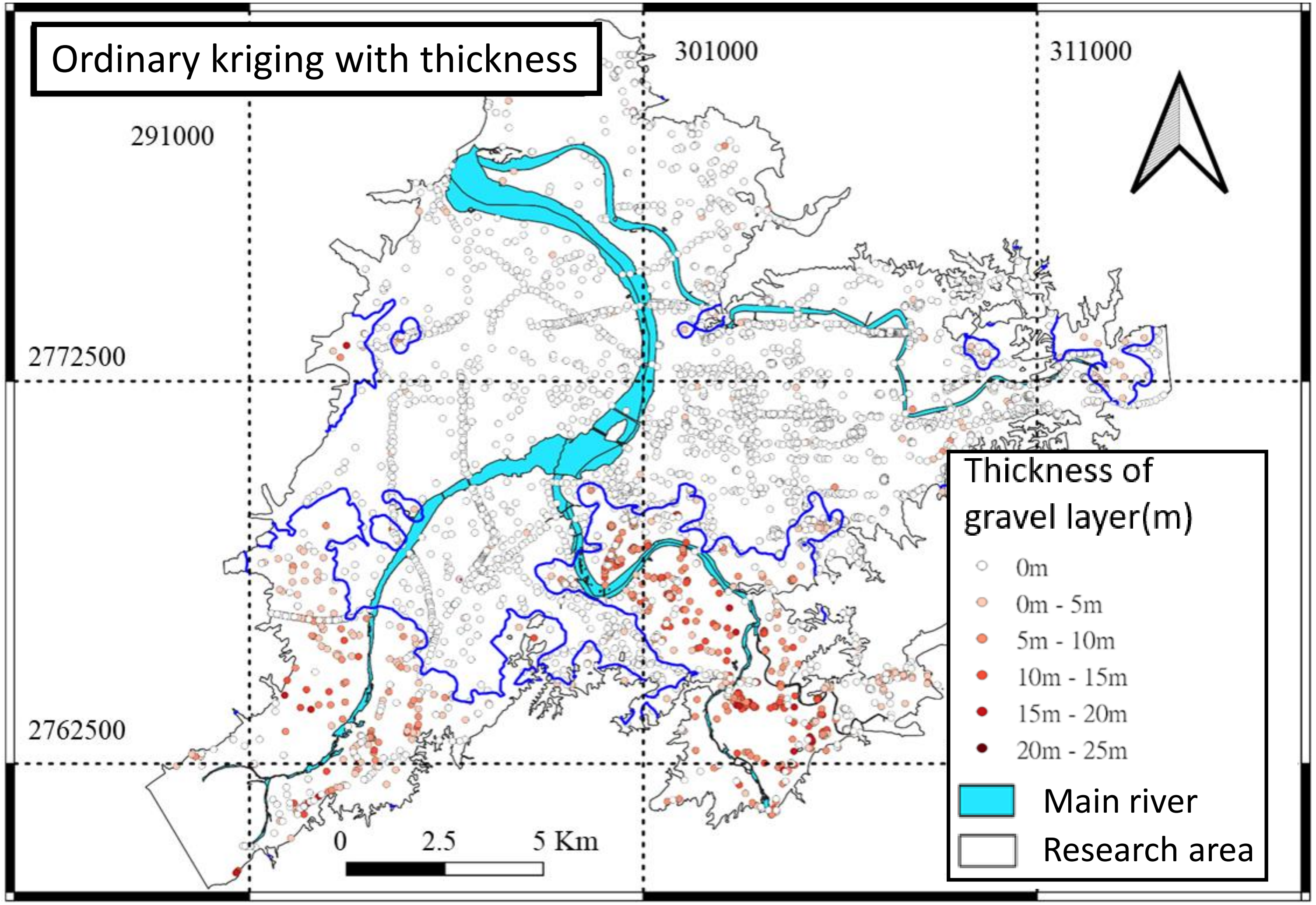

Step3:
Using Ordinary kriging with thickness, trying to find out the converge boundary of gravel layer in SongShan F.m.

The simulation results overestimated the extent of the gravel layer.

Therefore, the drilling data was manually compared to obtain a more reasonable distribution map.

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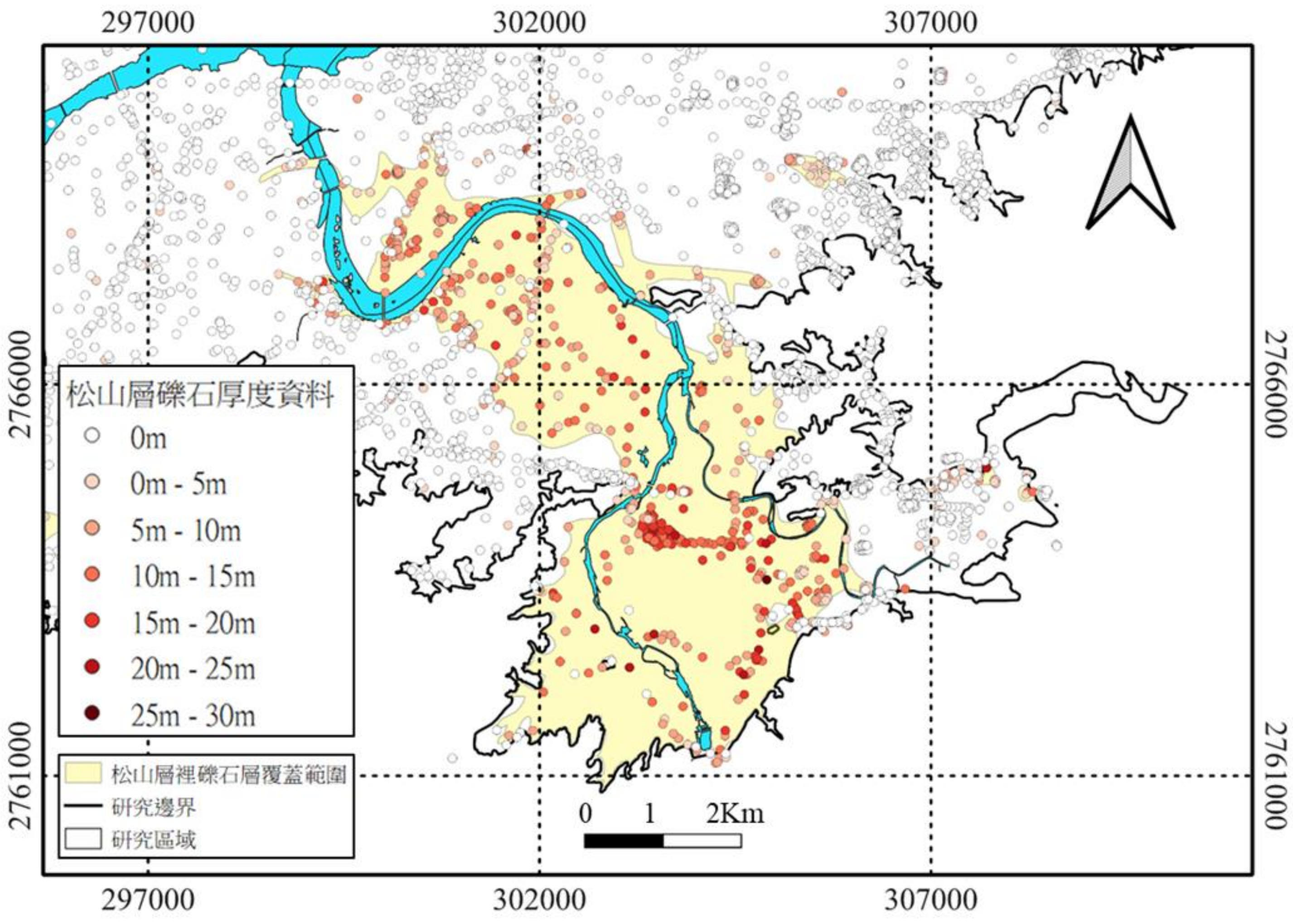
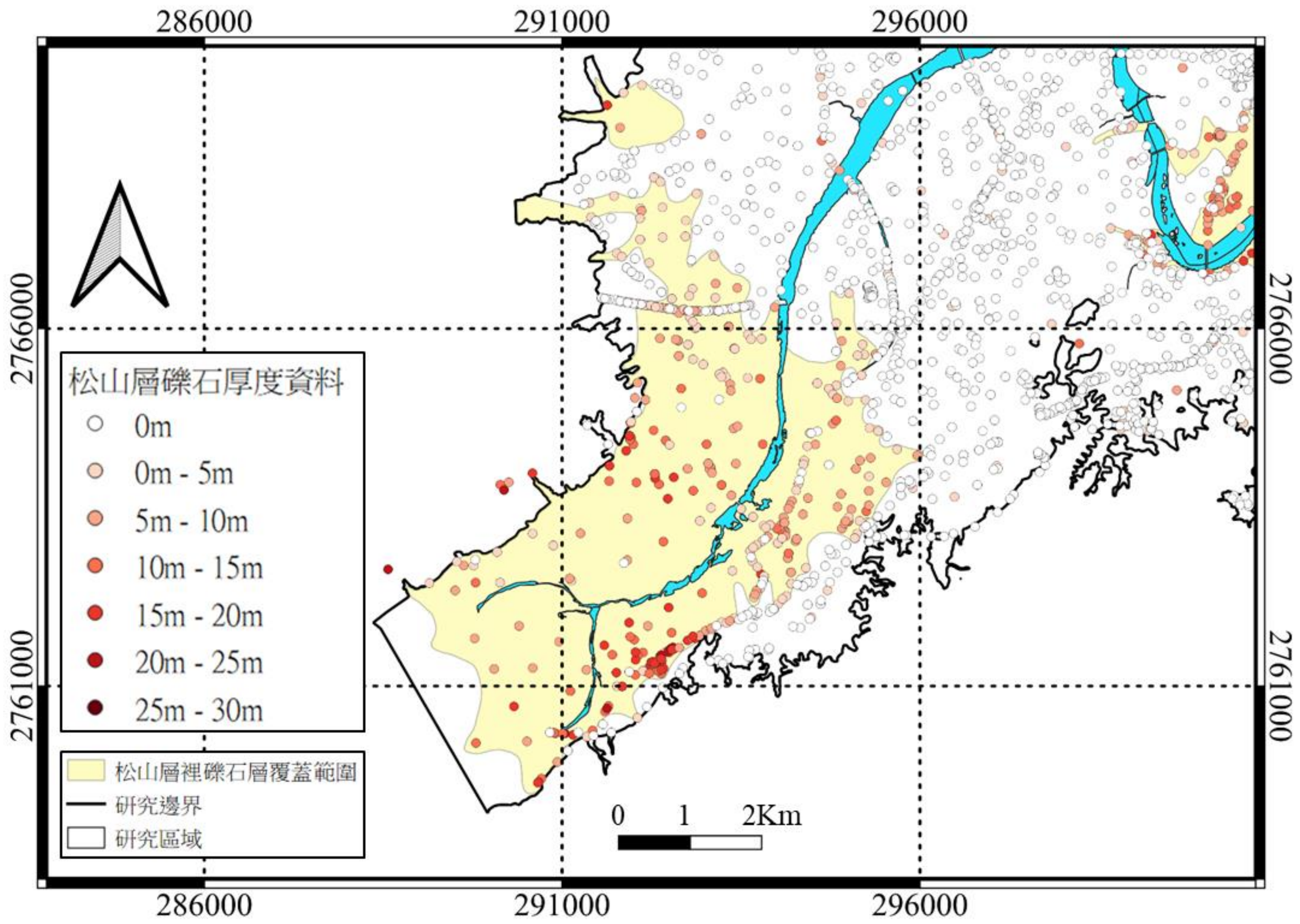


Step 4

Manually zone the gravel layer distribution in SongShan formation in the XinDian River, the area should not exceeds the kriging boundary.

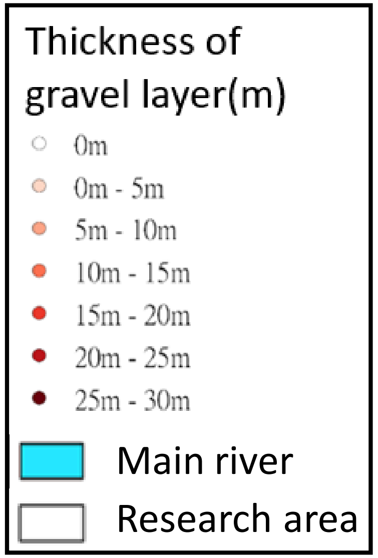
Thickness of gravel layer(m)
- 0m
- 0m - 5m
- 5m - 10m
- 10m - 15m
- 15m - 20m
- 20m - 25m
- 25m - 30m
- Main river
- Research area

Spatial distribution of gravel layers within the Songshan Formation.

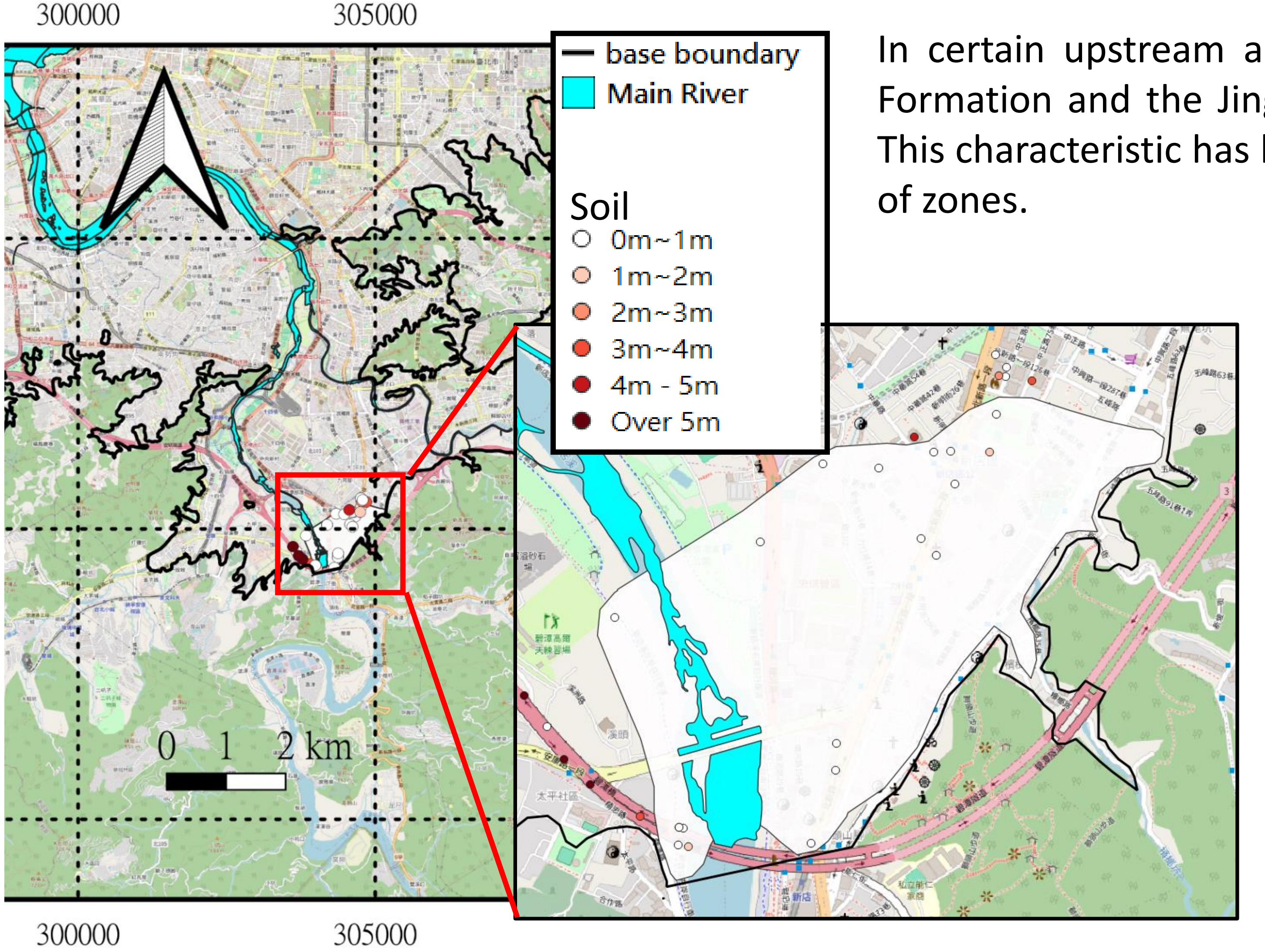


Step 4

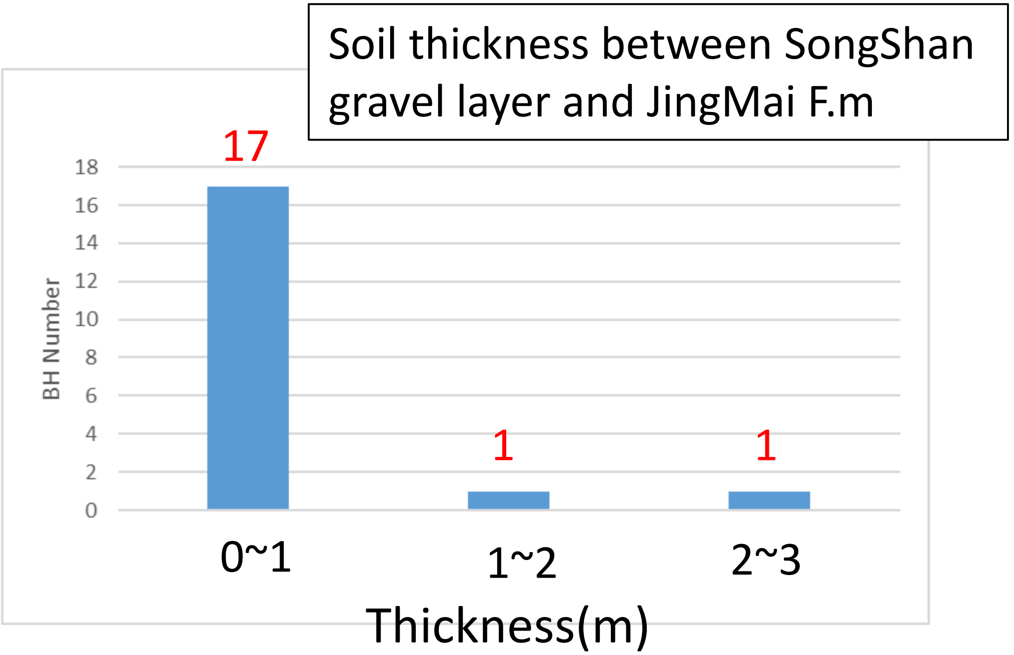
Manually zone the gravel layer distribution in SongShan formation in the DaHan River, the area should not exceeds the kriging boundary.



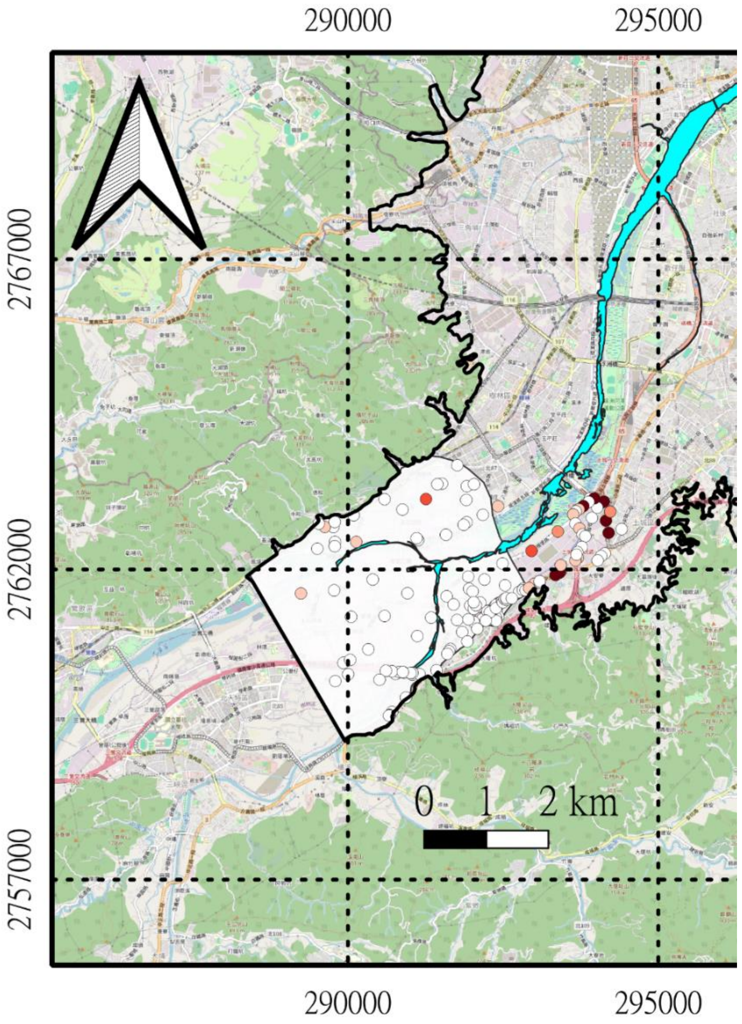
The sub-zones in main gravel divisions



In certain upstream areas, the gravel layers within the SongShan Formation and the JingMei Formation are difficult to differentiate. This characteristic has been considered as a basis for the subdivision of zones.



The sub-zones in main gravel divisions



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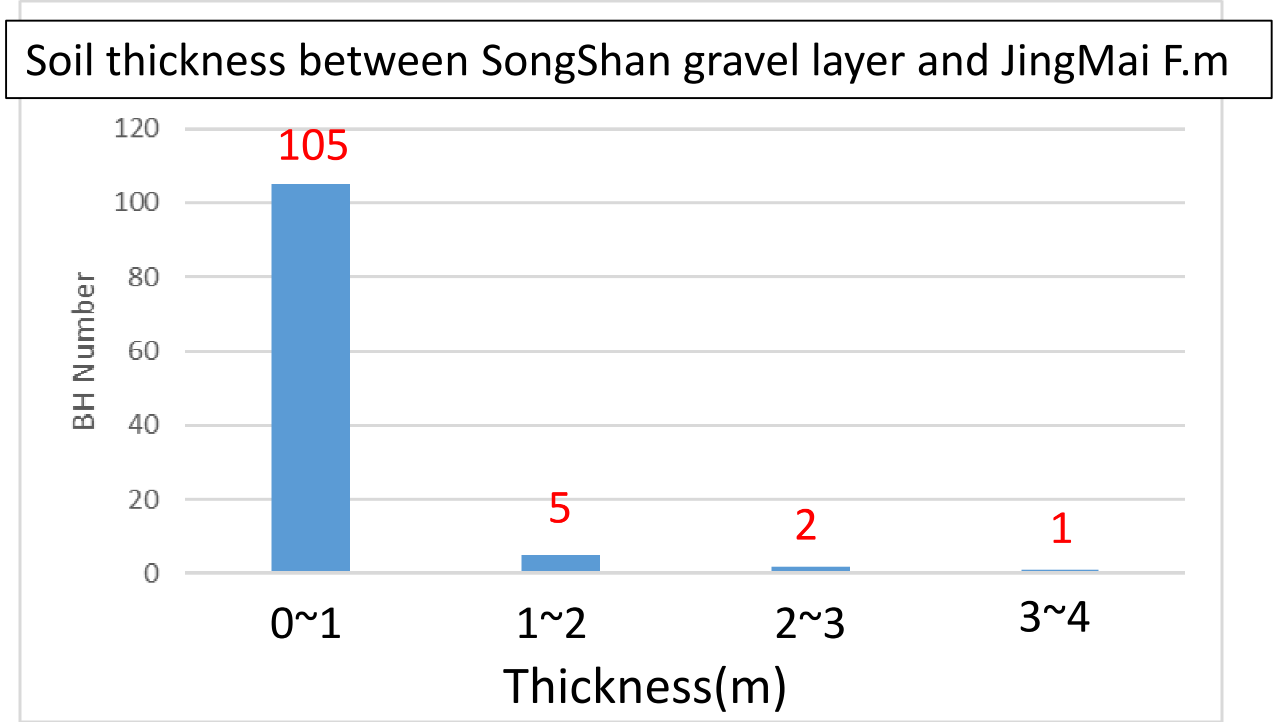
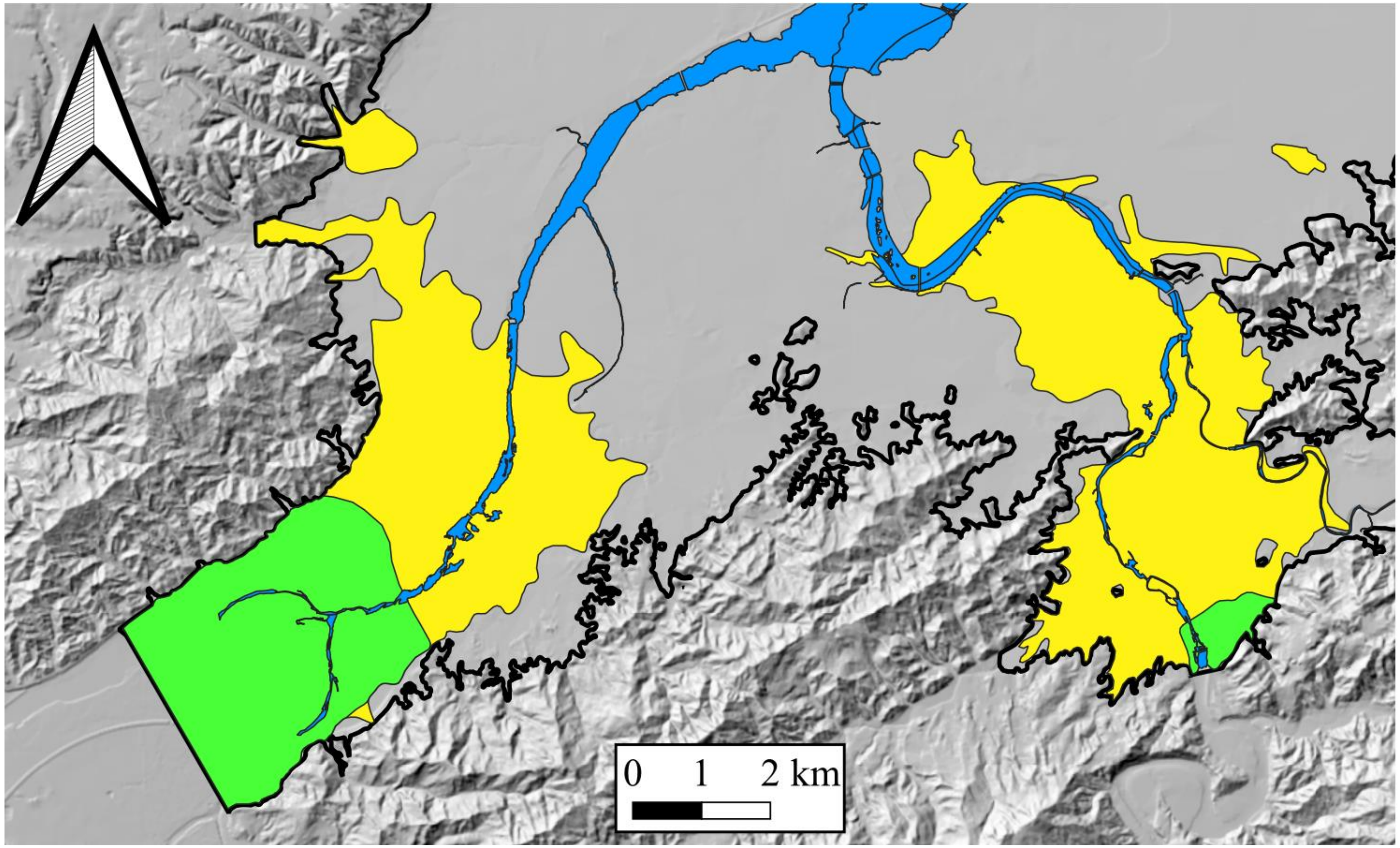


The zone consider with the gravel layer

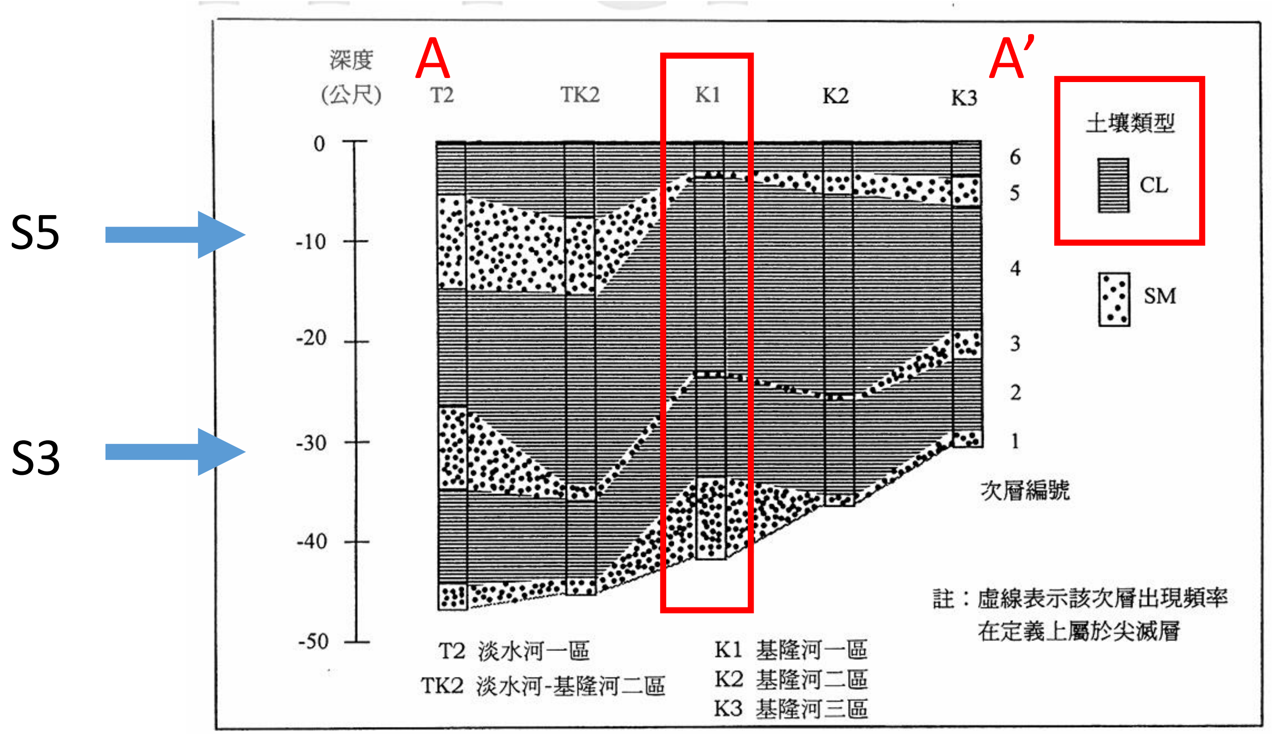


- Yellow part are the region we can see gravel layer in SongShan Formation, and these gravel layer isn't connect with JingMai Formation's gravel layer.

- Green part are the region no easy to distinguish the gravel layer belong to which SongShan or JingMai F.m..

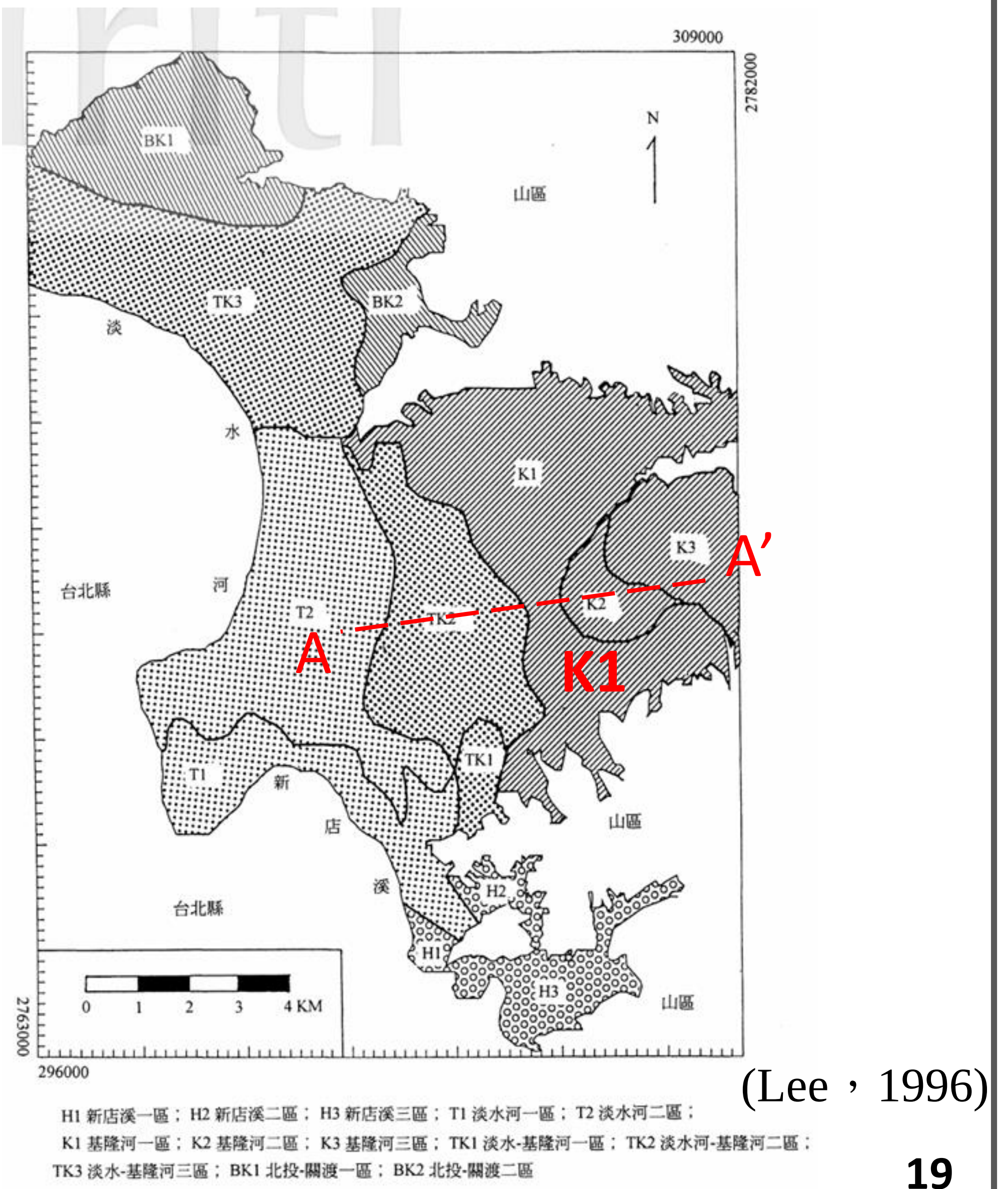
Example zone in Keelung River

From the stratigraphic profile AA', it can be observed that the sand layer of S5 and S3 have disappeared in the K1 area of previous research.



(Lee，1996)

圖三 台北市東西向剖面示意圖

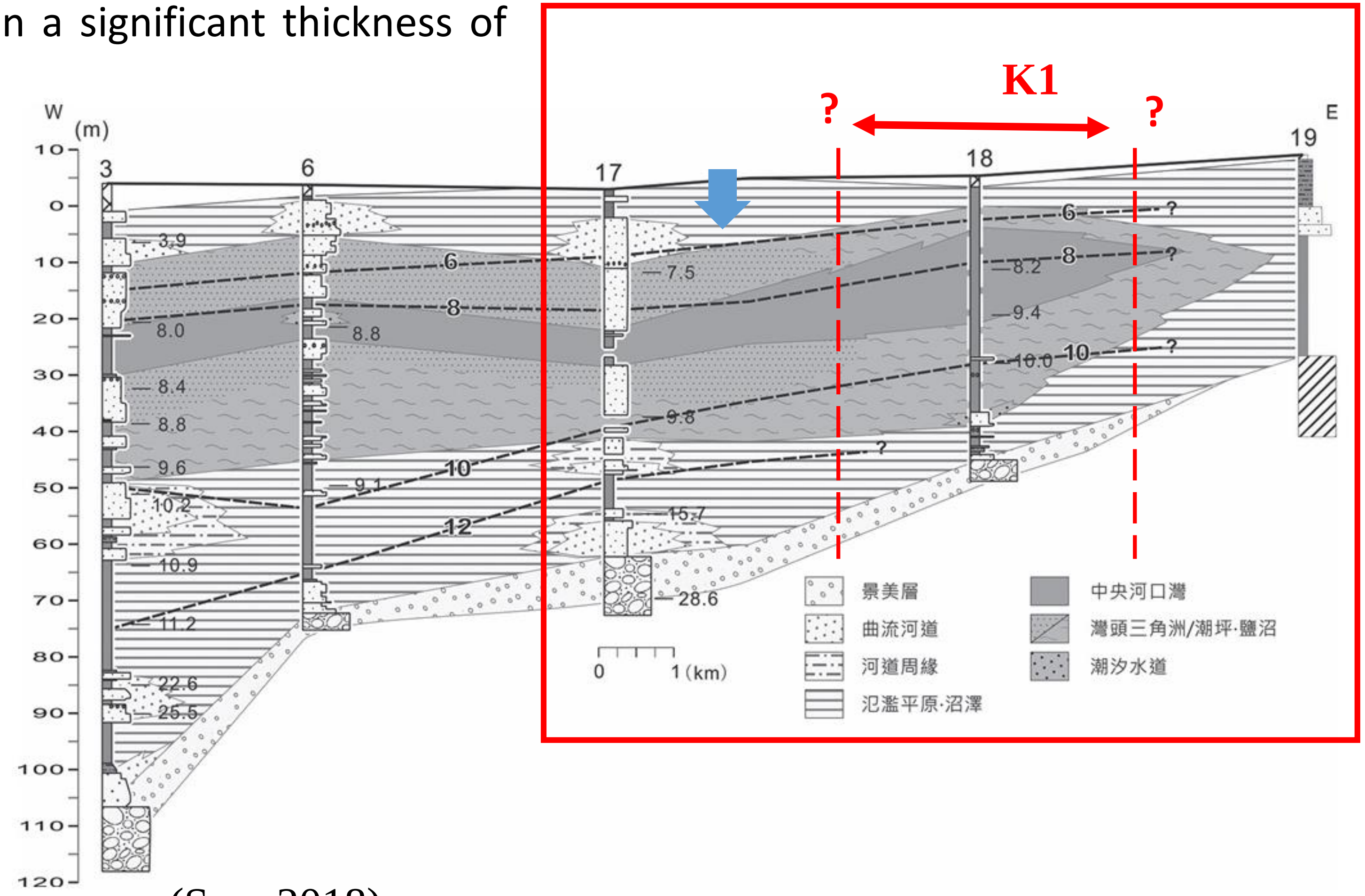


(Lee，1996)

Songshan Sixth Layer will be designated as S1 to S6.

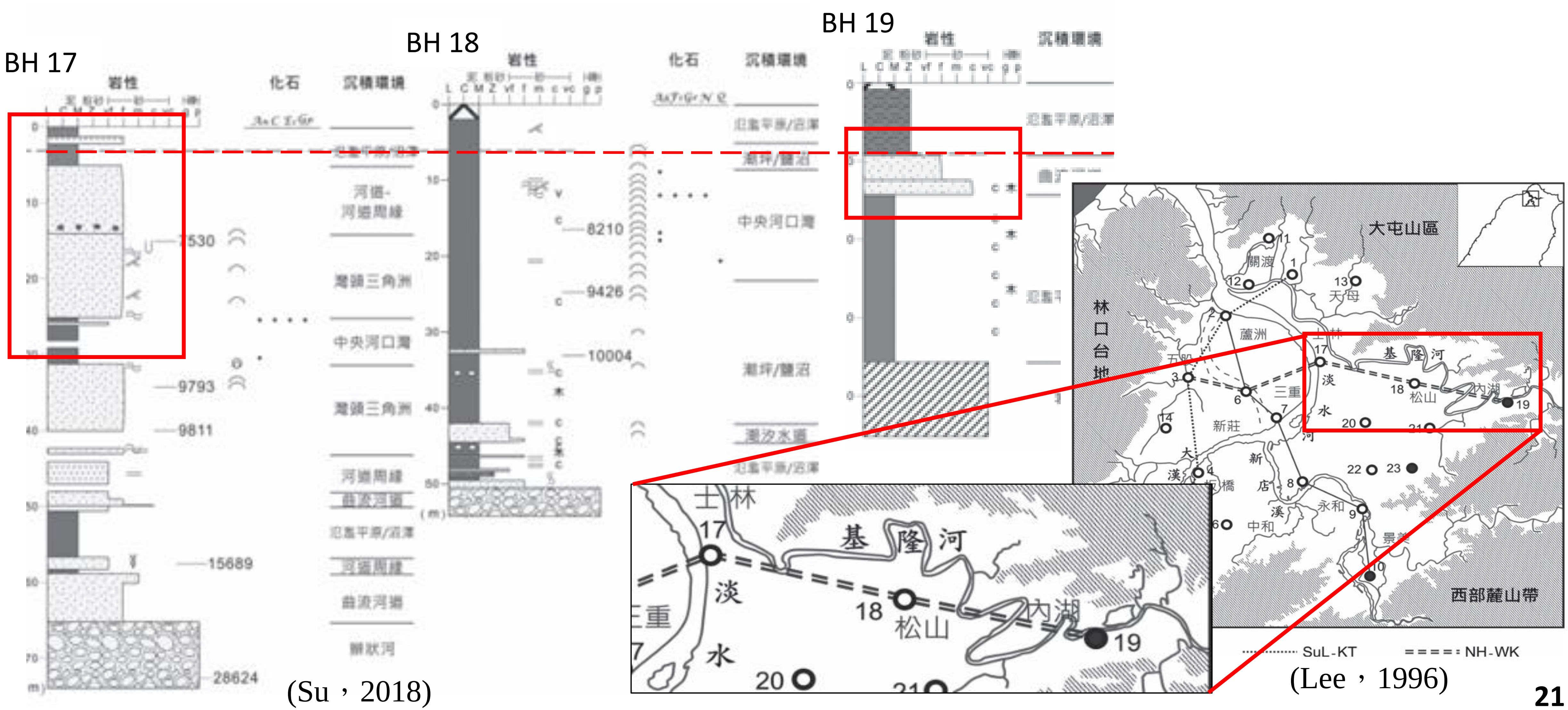
Example zone in Keelung River

It can be anticipated that the Keelung River will have at least one subzone, characterized by the abrupt termination of the sand layers within the Songshan Formation, resulting in a significant thickness of mud layers in that area.



(Su，2018)

Example zone in Keelung River

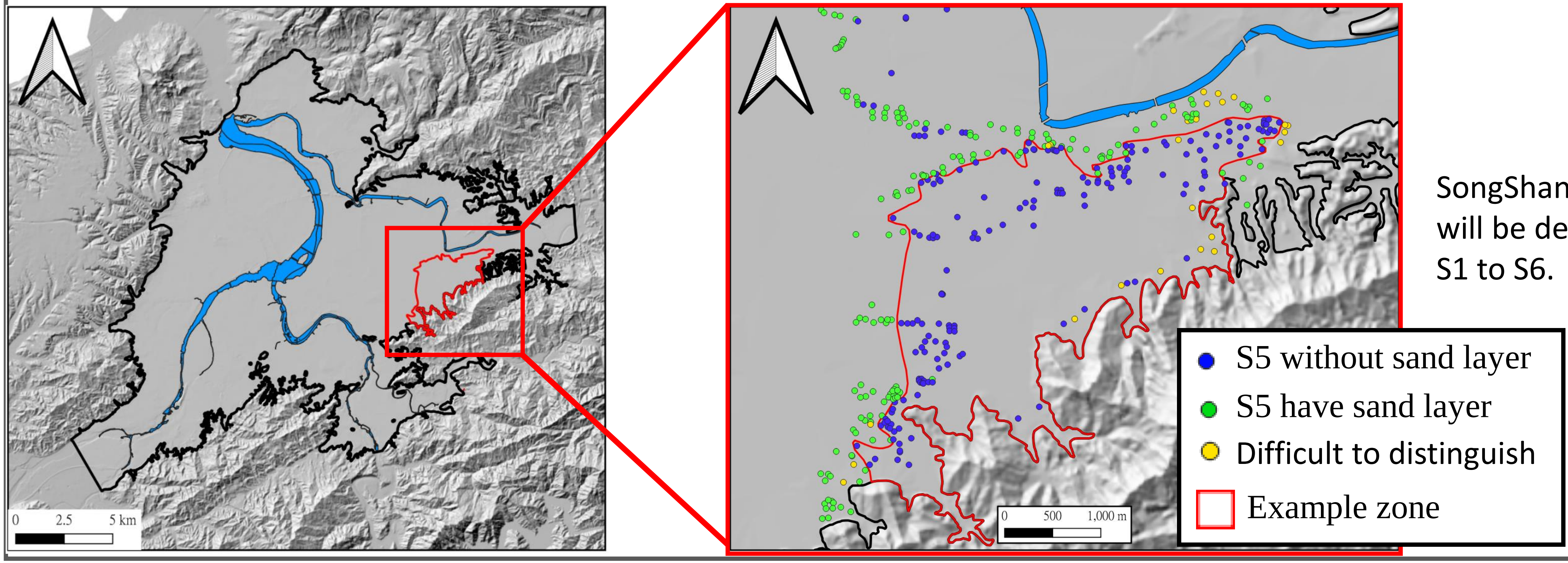


(Su，2018)

(Lee，1996)

Example zone in Keelung River

1. Classification will be performed using borehole core descriptions.
2. In example zone, S5's sand layer and S3's sand layer disappear, the sedimentary facies consists with thick mud layer cause S6 and S4 are belong to mud layer.
3. This situation will serve as the basis for delineating engineering geological zones.



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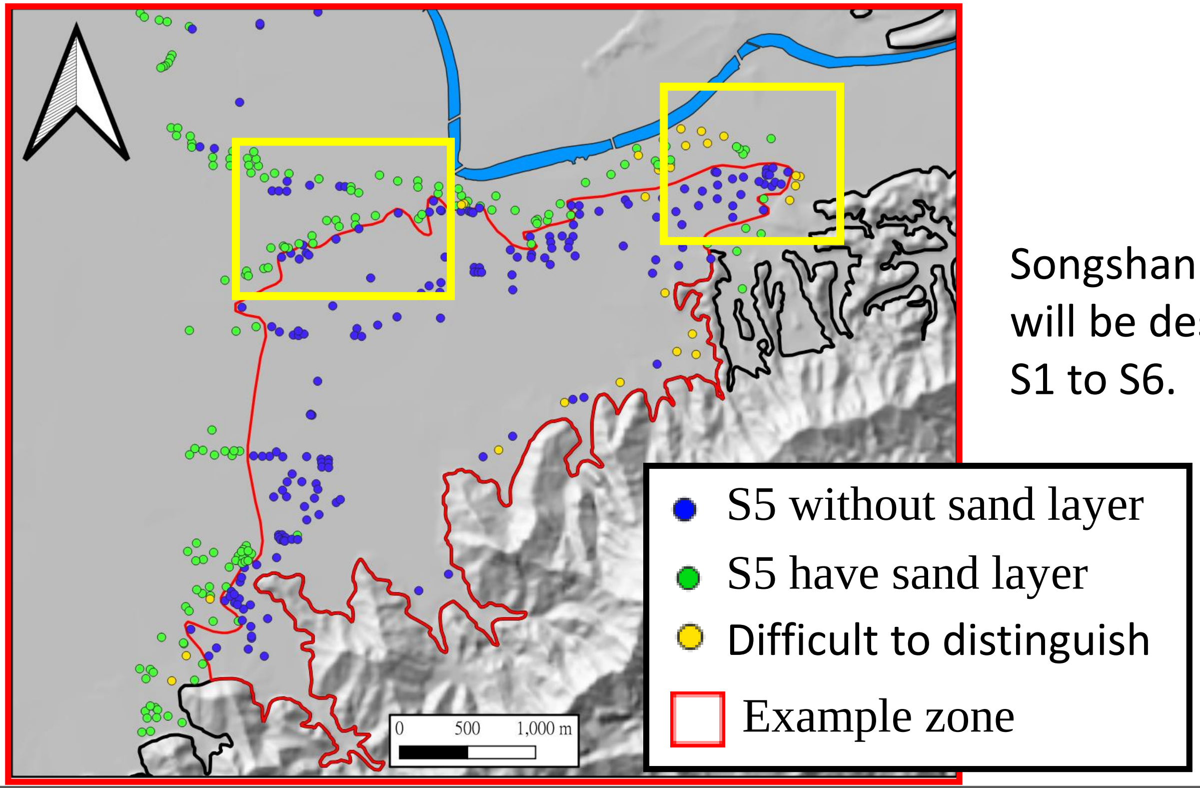
Example zone in Keelung River

Due to the difficulty in delineating boundaries based on the results shown in the drilling data from the yellow area. It will be considered to use the USCS data from the physical property tests for secondary validation of the yellow area.



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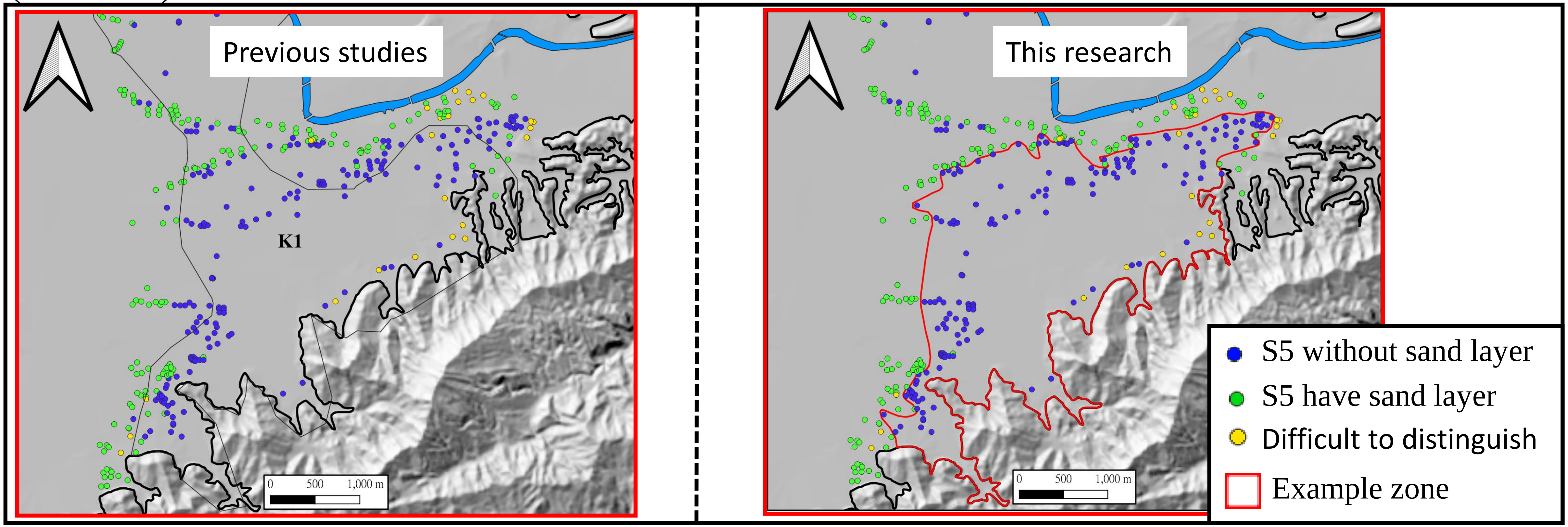
Unified Soil Classification System, USCS
統一土壤分類法

Example zone in Keelung River

1. Under the same conditions, this study is generally consistent with previous research findings. However, due to the availability of more data points in this study, it can yield more refined results.
2. Some areas show differences compared to previous research; therefore, reference will be made to several cross-sectional diagrams to determine if better results can be achieved.

(Lee，1996)



Conclusion

Considering geological characteristics for engineering geological zoning greatly aids in restoring the 3D model of the Taipei Basin. In terms of research findings:

- Considering the actual spatial distribution of the gravel layer when establishing the 3D Vs30 model, the Vs30 values will be higher.
- Dividing the K1 zone based on the presence or absence of sand layers can aid in the assessment of soil liquefaction potential.
- Dividing based on sedimentary facies variations will result in more natural boundaries during future modal simulation.
- The volcanic sediments zone must have higher Vs30, as in some of EGDT borehole testing the N value is very high.

1. Taking into account the historical flow direction of the ancient Jingmei River and the drilling data, the subdivision of the southeastern part of the basin was completed.

2. Completed the spatial distribution of the volcanic sediments from Datun Mountain.

3. Regarding non-gravel areas or volcanic rock areas, reference will be made to previous research results on zoning and several geological profiles to identify regions with geological characteristics. Subsequently, well data will be compared to progressively complete the zoning.

Thanks for your listening

References.

台北市政府業化潛勢查詢系統
https://soil.taipei/Taipei/Main/pages/survey.html

臺北盆地五萬年來之沉積體系與盆地下陷演育研究(蘇品如，2018)

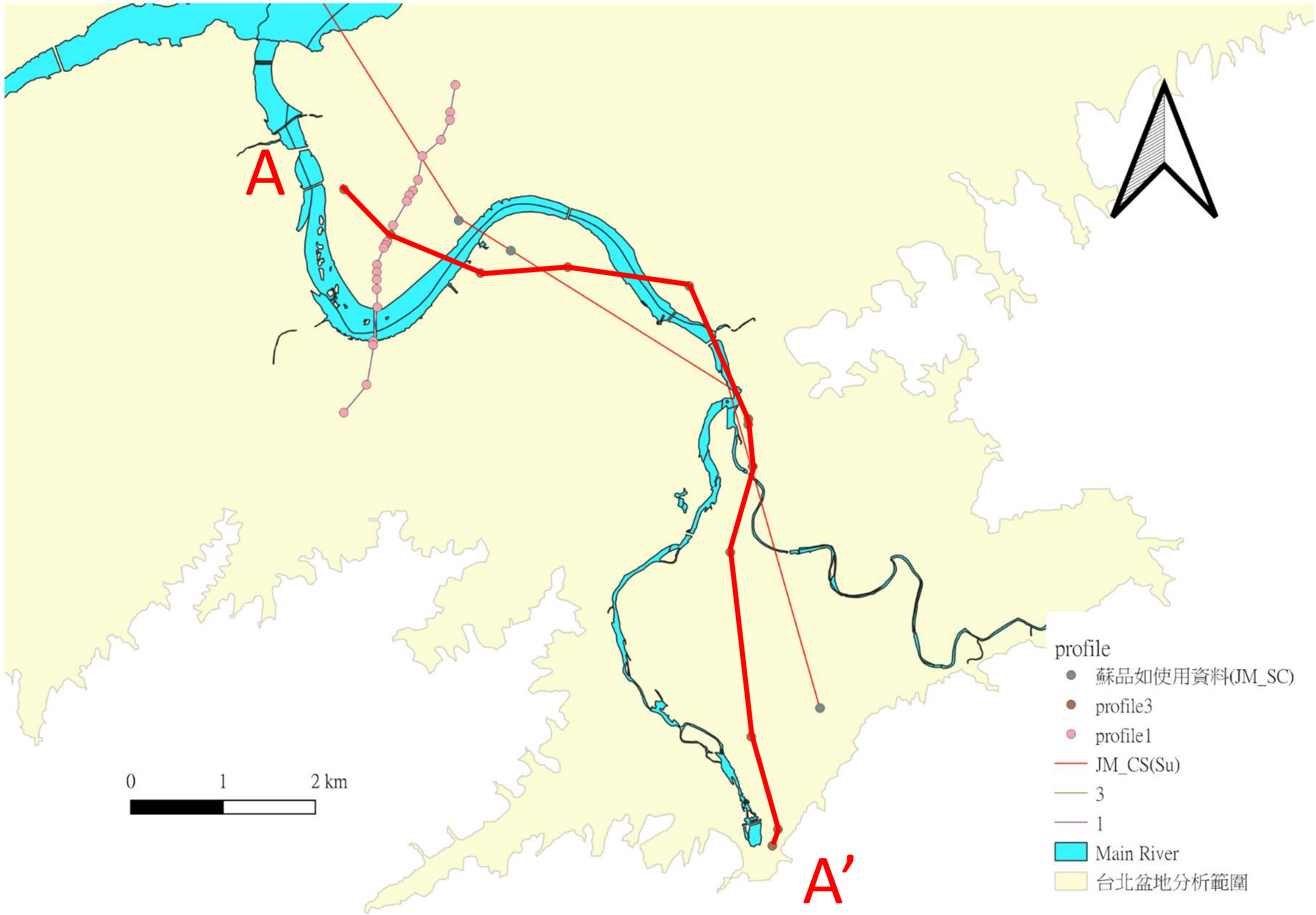
臺北盆地松山層岩相特徵與沉積環境演化(蘇品如，2018)

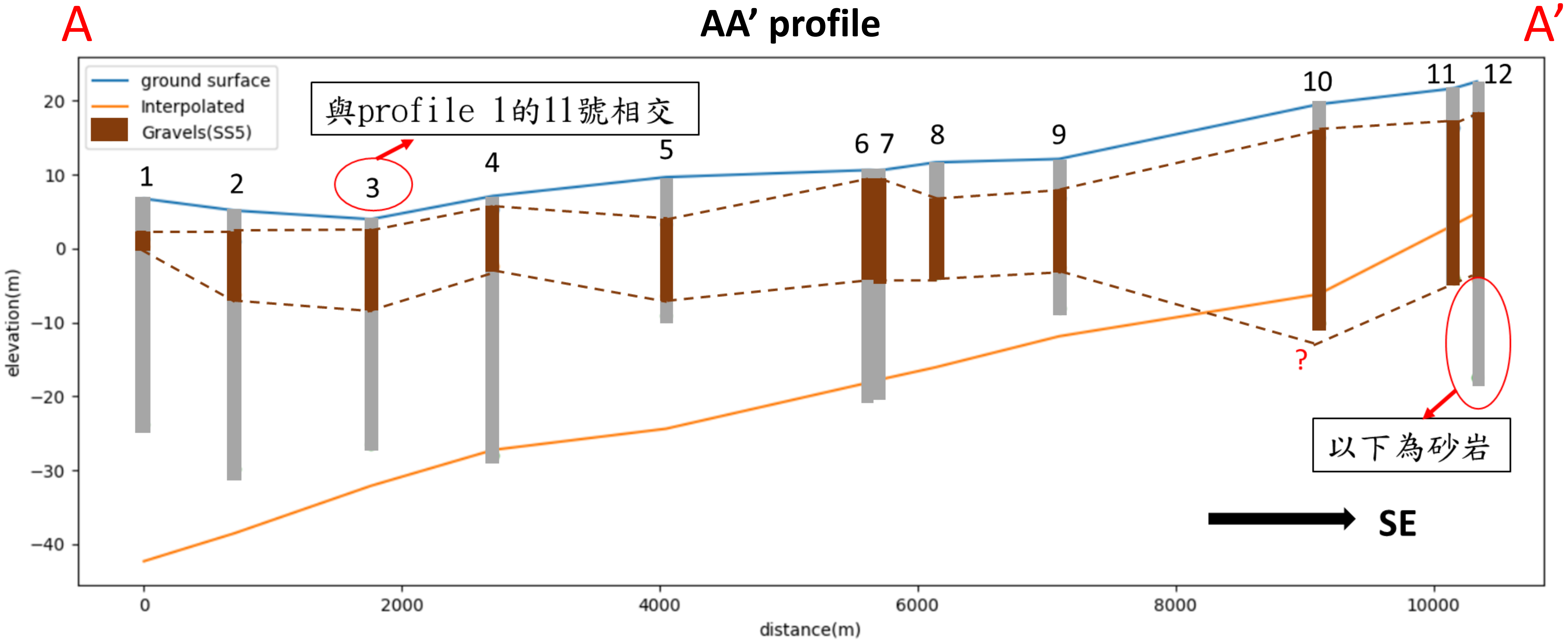
Scale effect on the determination of spatial correlation factor used in Markov random field(Han,2024)

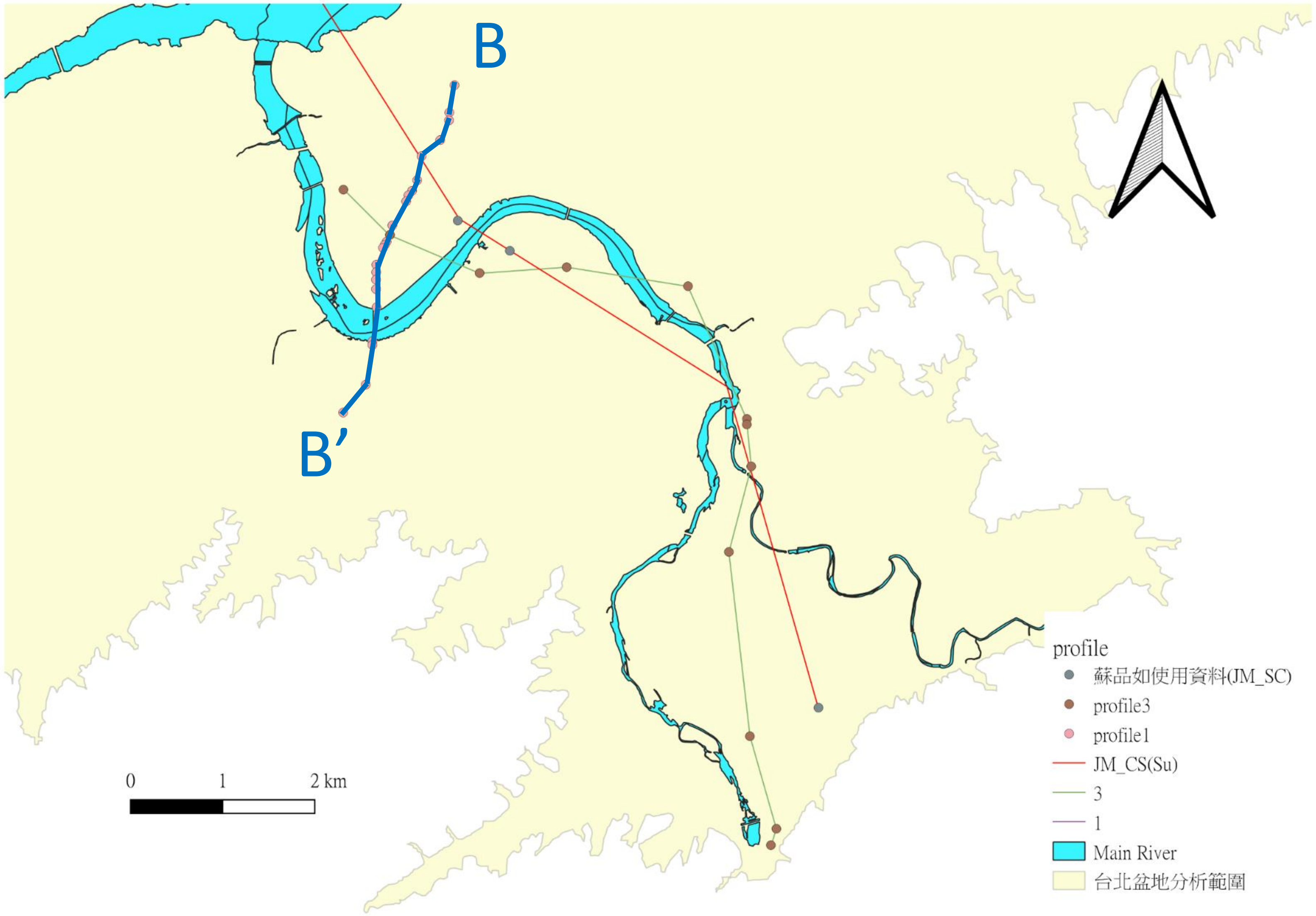
考慮地質模型與地質模型不確定性，提升Vs30分布圖之可靠度—以台北盆地為例(林頤謙，2023)

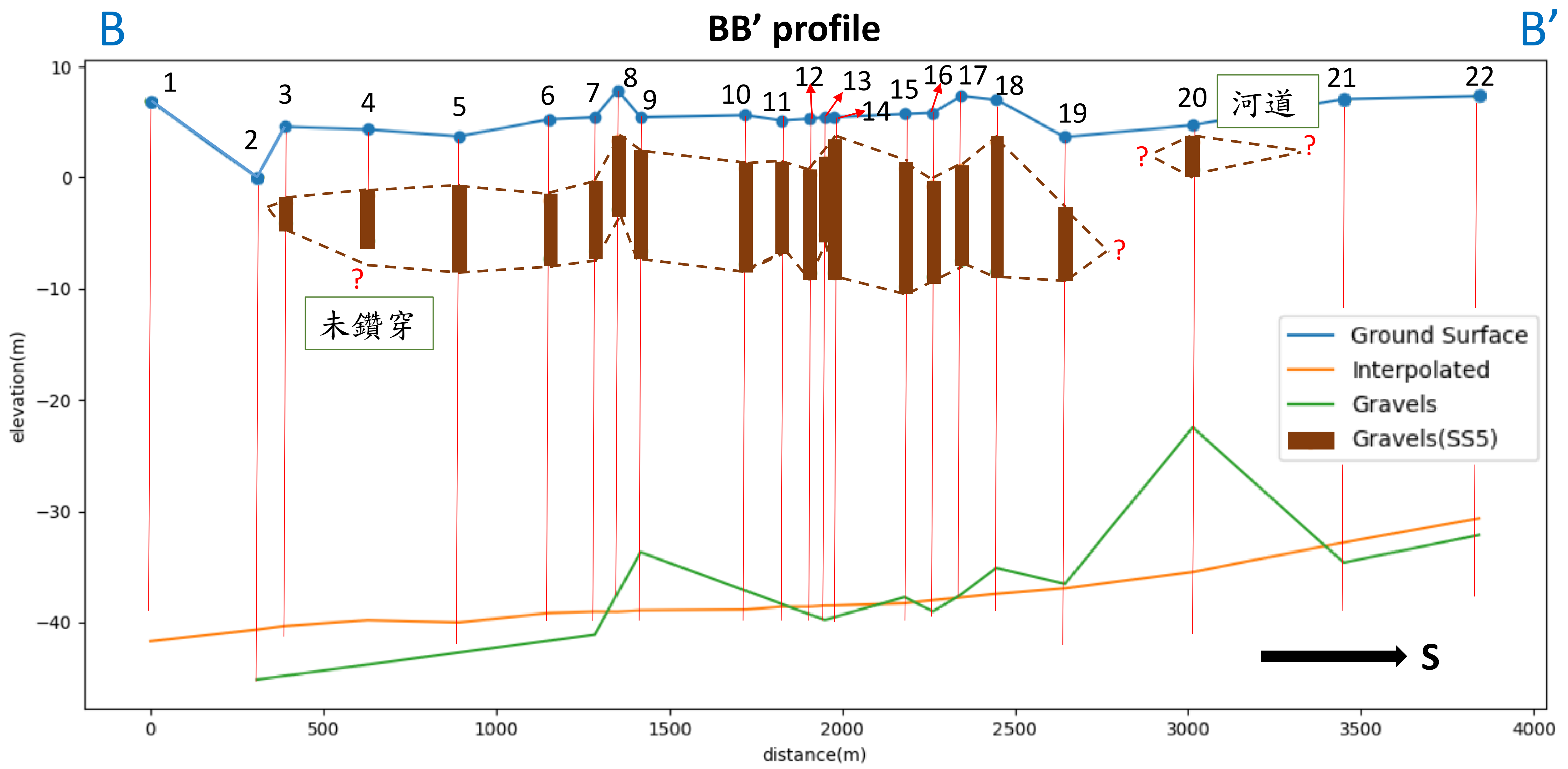
台北市區工程地質分區(李咸亨，1996)

Appendix


A
A’
0
1
2 km
profile
蘇品如使用資料(JM_SC)
profile3
profile1
JM_CS(Su)
3
1
Main River
台北盆地分析範圍


A
AA’ profile
A’
ground surface
Interpolated
Gravels(SS5)
與profile 1的11號相交
1
2
3
4
5
6 7
8
9
10
11
12
?
以下為砂岩
SE
20
10
0
−10
−20
−30
−40
elevation(m)
0
2000
4000
6000
8000
10000
distance(m)


B
B’
0
1
2 km
profile
蘇品如使用資料(JM_SC)
profile3
profile1
JM_CS(Su)
3
1
Main River
台北盆地分析範圍


B
BB’ profile
B’
elevation(m)
distance(m)
10
0
−10
−20
−30
−40
0
500
1000
1500
2000
2500
3000
3500
4000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
河道
未鑽穿
?
Ground Surface
Interpolated
Gravels
Gravels(SS5)
S