1st THAILAND GROUNDWATER SYMPOSIUM: KEY TO WATER SECURITY AND SUSTAINABILITY

DETERMINATION OF CONDITIONING FACTORS FOR MAPPING Ni CONTAMINATION SUSCEPTIBILITY USING A HYBRID MODEL OF RANDOM FOREST AND MAXIMUM ENTROPY. A CASE STUDY IN THE CENTRAL REGION OF KANCHANABURI PROVINCE, THAILAND

[1] Nguyen Ngoc Thanh[1,4*], Srilert Chotpantarat[2,3*], Ha Nam Thang[4], Nguyen H. Trung[5]

[1] Interdisciplinary Program in Environmental Science, Graduate School, Chulalongkorn University, Bangkok 10330, Thailand

[2] Department of Geology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

[3] Research Unit Control of Emerging Micropollutants in Environment, Chulalongkorn University, Thailand

[4] Hue University of Agriculture and Forestry, Hue University, 102 Phung Hung Str, Hue City, Thua Thien Hue 53000, Vietnam

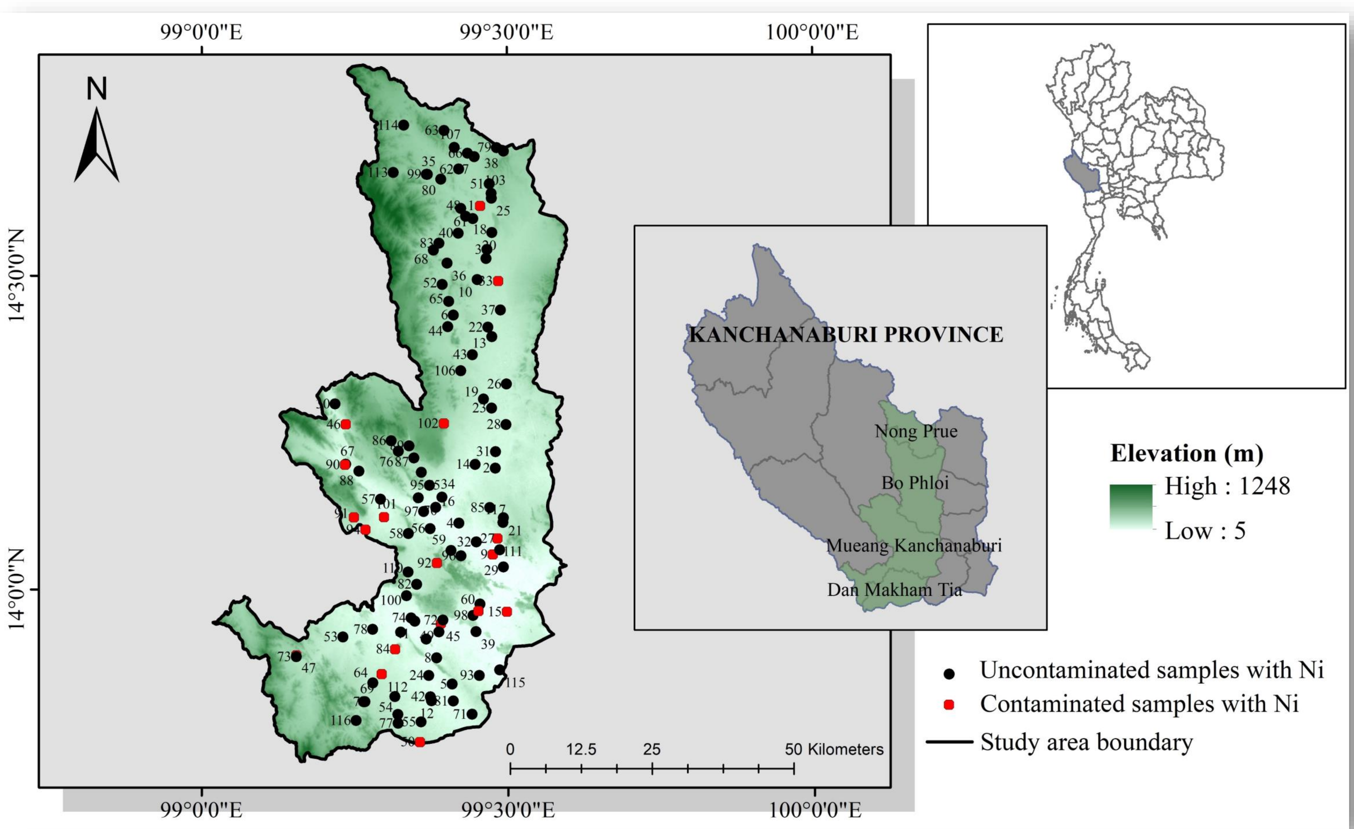
[5] Centre for Agriculture and the Bioeconomy, Queensland University of Technology, 2 George St, Brisbane, QLD 4000, Australia

Corresponding Author(s): nguyenngocthanh@hueuni.edu.vn, srilert.C@chula.ac.th.

1. INTRODUCTION

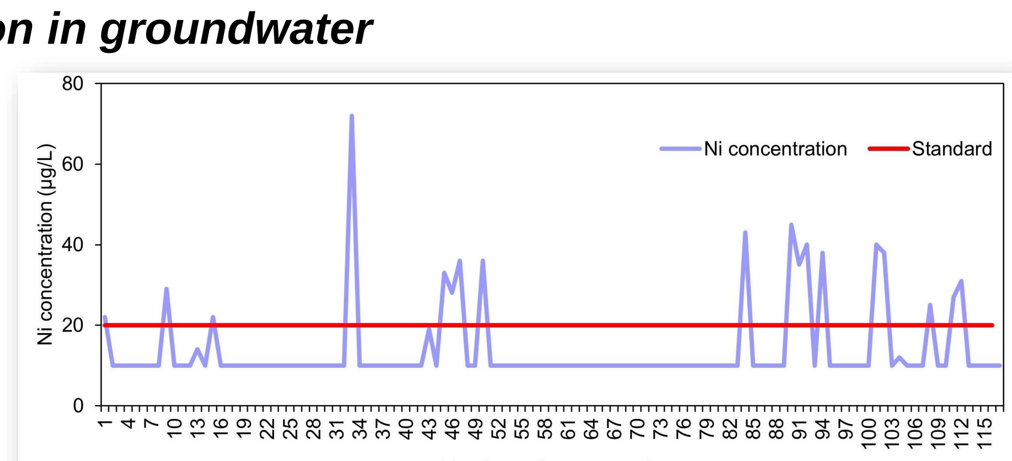
- In the water, nickel (Ni) element is a toxic pollutant to human health, living organisms, and plant development. Ni might exist in the water, yet it is non-biodegradable element. It can be from the Earth's materials, mining, industrial and agricultural activities (Hayyat et al., 2020; Shankar and Prabhat, 2013). Therefore, delineation of susceptible zones with toxic Ni contamination in groundwater is an urgent need in many regions to protect global one health.

- In this study, we proposed a hybrid model between RF and Maxent to determine the effect of conditioning factors on Ni contamination and map the nickel contamination susceptibility in groundwater as a groundbreaking contribution to the field. In this model, the RF algorithm acts as a Recursive Feature Elimination function to select conditioning factors (CFs) for the model and the Maxent served as a statistical function to predict spatially the occurrence probability (predicted value) of the Ni contamination and optimize the selection of these factors

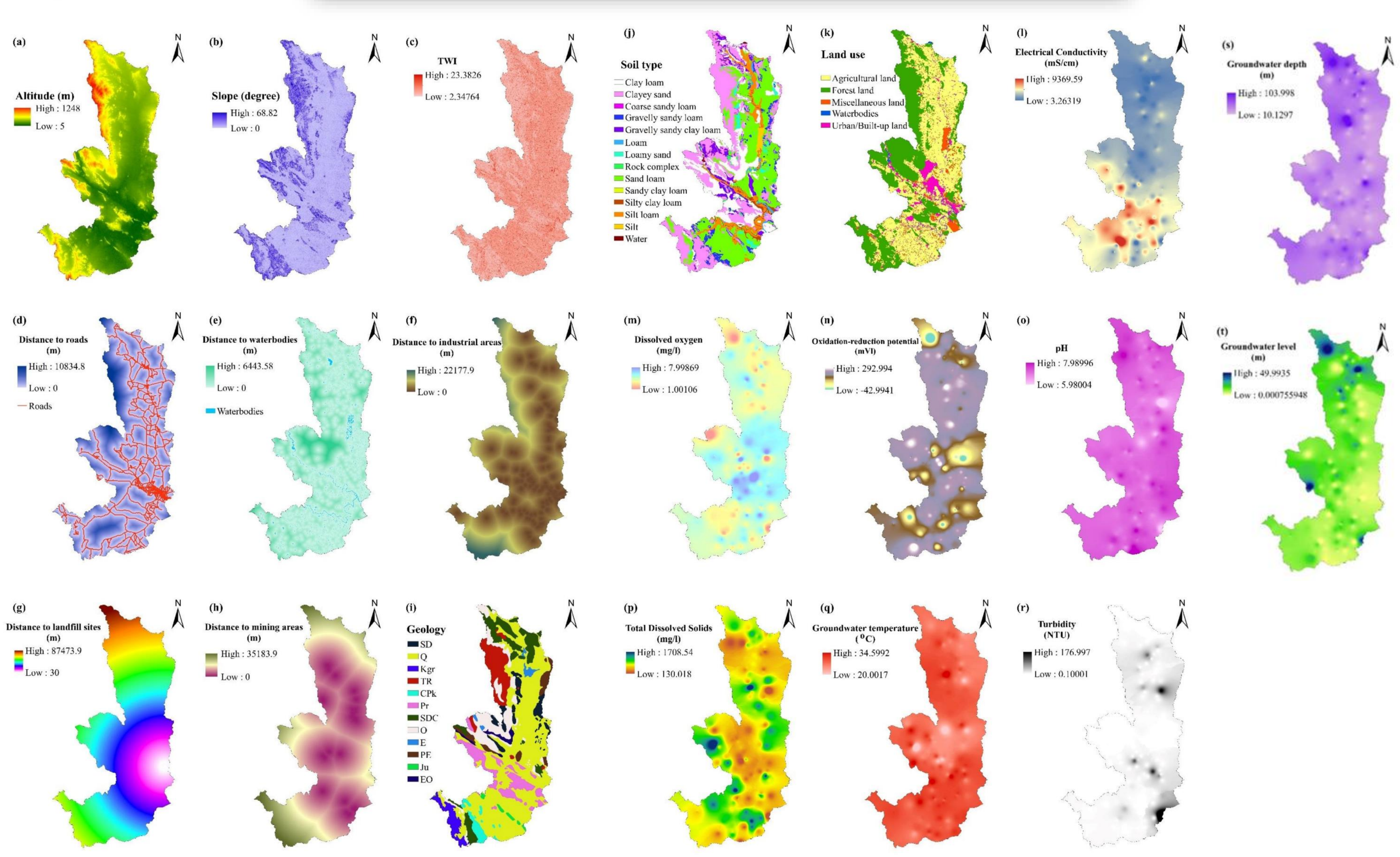


2. DATA AND METHODOLOGIES

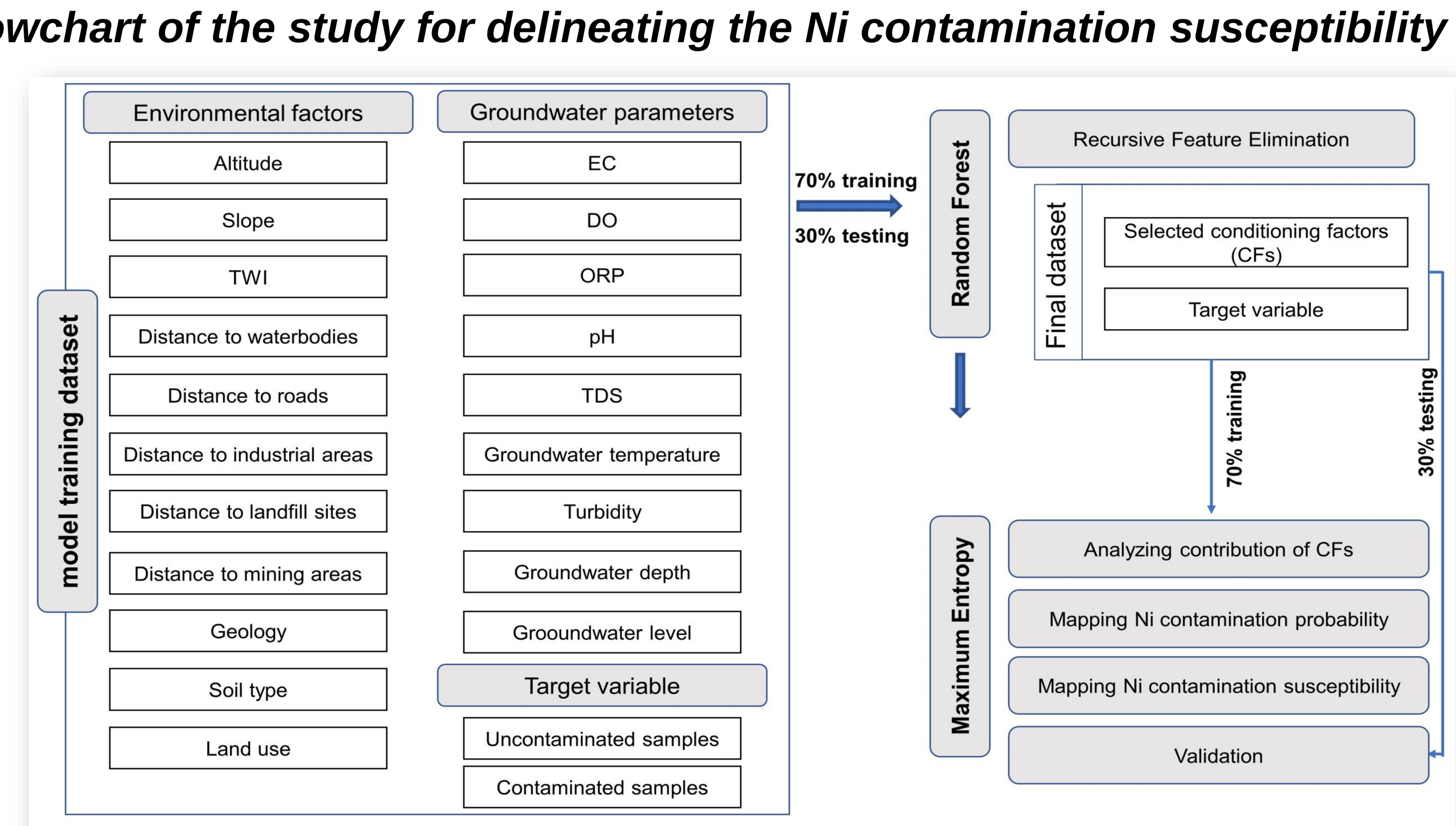
Ni contamination in groundwater



Input CFs

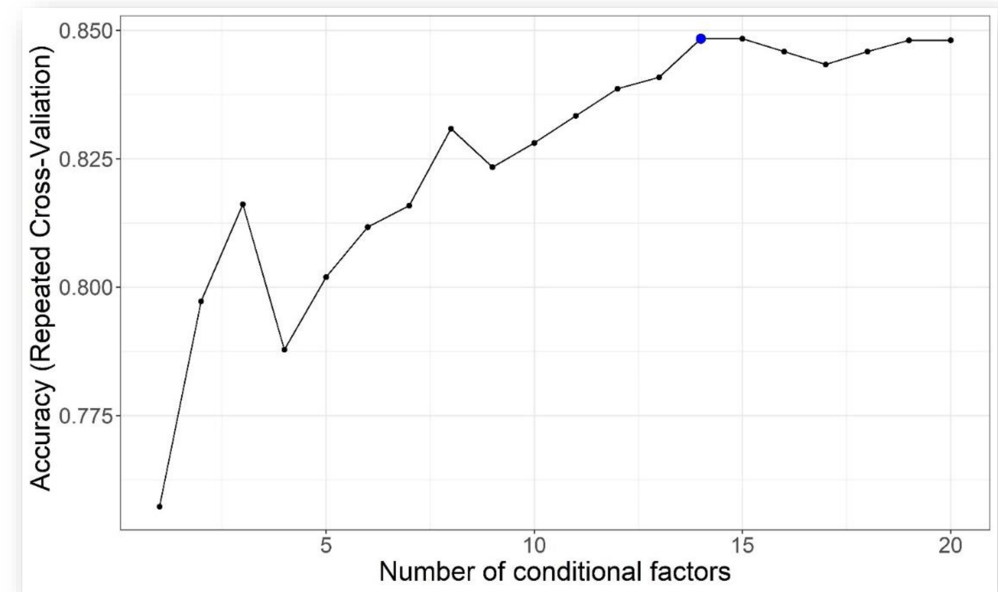


Flowchart of the study for delineating the Ni contamination susceptibility zones



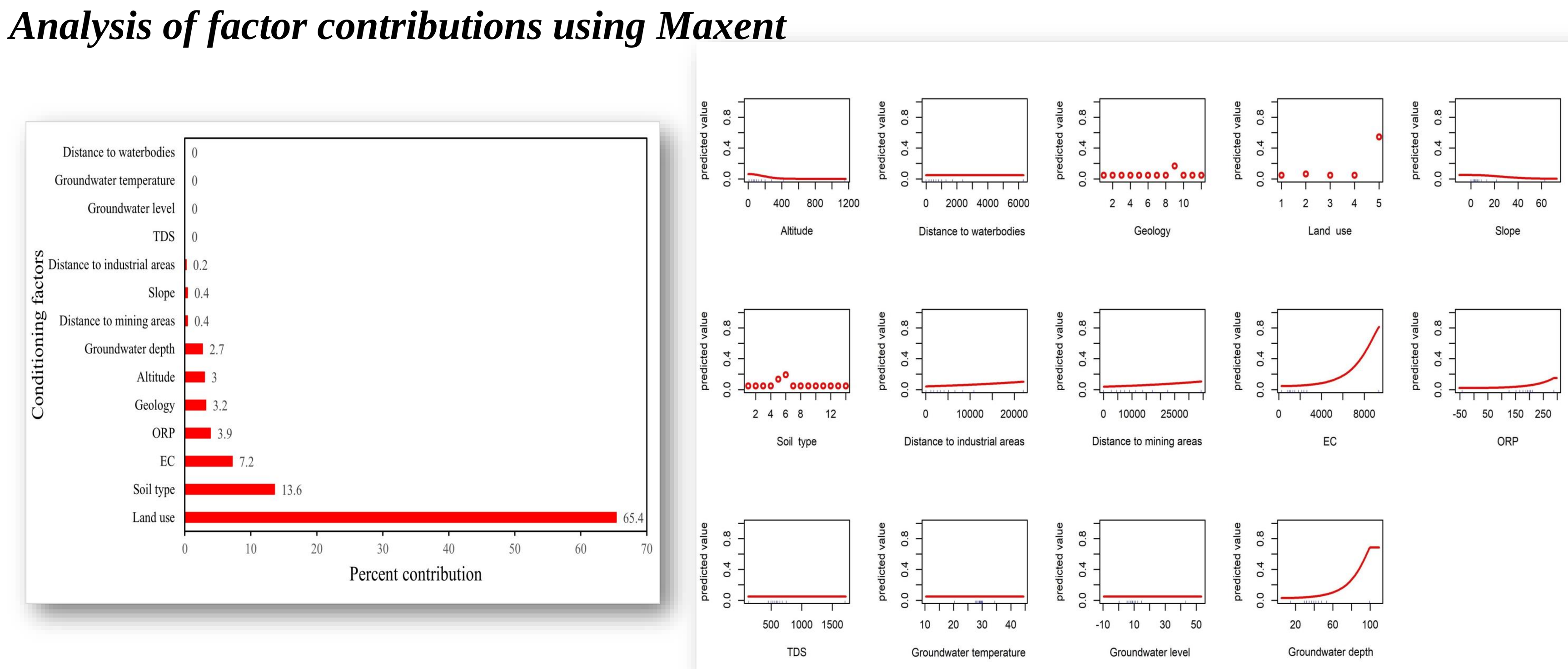
3. RESULT AND DISCUSSION

Selected input CFs

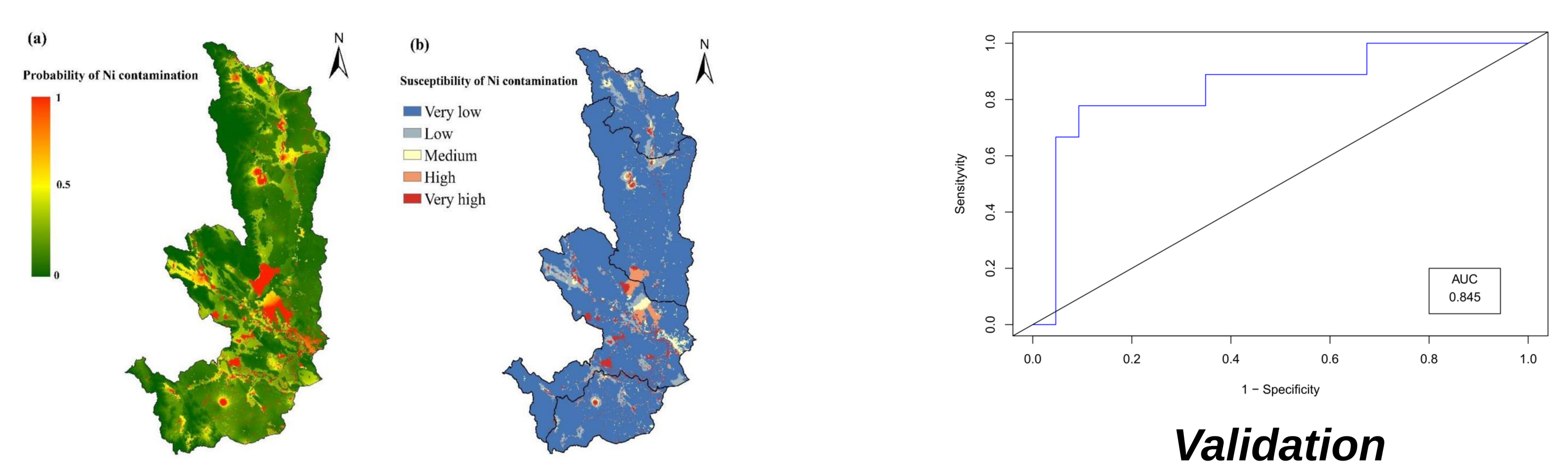


- The optimal number of CFs was identified from the results the RF-RFE approach. The RF-RFE output shows that theory with fourteen CFs, including distance to waterbodies, soil type, distance to industrial areas, geology, groundwater depth, groundwater level, slope, altitude, land use, distance to mining areas, EC, ORP, groundwater temperature, and TDS, had the highest accuracy (0.8483) and Kappa index (0.54286)

Analysis of factor contributions using Maxent



Mapping Ni contamination susceptibility



Validation

Levels	Probability	Number of pixels	Area (km^2)	Percentage (%)
Very low	0 - 0.2	3661763	3295.59	85.65
Low	0.2 - 0.4	316566	284.91	7.40
Medium	0.4 - 0.6	94669	85.20	2.22
High	0.6 - 0.8	96281	86.65	2.25
Very high	0.8 - 1	106075	95.47	2.48

- In our case study, both environmental factors and groundwater parameters were considered as conditional variables for predicting Ni contamination. However, only ten CFs have effect on Ni contamination in groundwater, including altitude, geology, land use, slope, soil type, distance to industrial areas, distance to mining areas, EC, ORP, and groundwater depth.

- The analysis results indicated that land use, soil type, EC, and ORP explain approximately 86.4% variation in Ni contamination in groundwater in Kanchanaburi, Thailand, in which land use of urban and built-up areas contributed most to pollution.

4. CONCLUSION

- This study attempted to produce a map of Ni contamination susceptibility using a hybrid model of the RF-RFE and Maxent modeling approach, and to reveal the predicted value of CFs to Ni contamination. This hybrid model worked well with an AUC value of 0.845 for the geographical distribution of Ni contamination in groundwater.

- Ten factors, including altitude, geology, land use, slope, soil type, distance to industrial areas, distance to mining areas, EC, ORP, and groundwater depth, were selected to set up the model.

- Areas of the low-susceptibility zone and very low-susceptibility zone accounted for the majority of the study area, meanwhile minority was areas of high and very high susceptibility zones. Muong Kanchanaburi district was the most likely Ni contamination in groundwater, especially in urban and built-up regions.

- The Ni contamination susceptibility map in groundwater could provide information for residents and decision-makers in using groundwater resources for various purposes. It could help Thailand's groundwater resource management agencies grasp the practical basis and find solutions for the protection of groundwater resources in areas with high Ni contamination susceptibility.