MACHINE LEARNING AND BIG DATA ANALYTICS OF SEA LEVELS FOR EVALUATING FORMATION LEVELS OF RECLAIMED LAND IN HONG KONG

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Inundation due to seawater intrusion may occur when high storm surge levels are superimposed on high astronomical tides, especially during the passage of tropical cyclones. This sea-level study applies big data analytics, machine learning with cloud computing, and diverse STEM knowledge to revisit a controversial social issue regarding infrastructure development — whether to reclaim land from the sea to form artificial islands to increase Hong Kong's land supply. Problems associated with this controversy include diverse predictions on the sea-level rise under climate change and the dilemmas of flood resistance and reclamation costs. They all depend on the formation levels of reclaimed land, which are challenging to raise once developed. However, extensive discussions on this topic are subjective that lack scientific grounds supported by data.

Therefore, there is a strong need for reclamation-oriented and data-based sea level research that focuses on the tide gauge data of the waters suitable for reclamation in Hong Kong so that visionary policymakers can understand the public's acceptance regarding the flood resistance and reclamation costs of the proposed reclamation works.

Chek Lap Kok in Hong Kong's western waters and Cheung Chau in its southern waters are two tide gauge stations on outlying islands that the author investigated. The waters around them are potential sites for reclamation because of their shallow water depths. All of the collected data were generally categorized into: (1) normal weather conditions, (2) the strong monsoon signal, or (3) tropical cyclone warning signals. The author applied the philosophy of the lunisolar calendar to investigate the relationship between lunisolar dates and astronomical tides, which are closely related to flood risk during storm surges. He also created several heatmap series to visualize meaningful data such as the daily highest sea levels, astronomical tides that corresponded to lunisolar days, and the height of storm surges for each tropical cyclone warning signal. These analyses may pragmatically help relevant practitioners formulate their design principles of formation levels. On the other hand, machine learning is a powerful tool for studying massive historical records for data-driven storm surge modelling without developing complicated mathematical models. Last but not least, cloud computing also plays an essential role in analyzing big data efficiently and accelerating the modelling process.

This dissertation demonstrates the significance of interdisciplinary research and the urgent need for contemporary technology applications in an era of big data. With the popularization of Internet of Things technology, there is no lack of datasets that are continuously monitored on a real-time basis in cities. They are treasures waiting to be unlocked by researchers with relevant knowledge and analytical programming skills. Today, adopting innovative technologies to stay competitive seems inevitable in all walks of life in this era, including industries that emphasized specialization before.