Title of dissertation			
Comprehensive Study on the Sand Spit Elongation at Tidal Inlets in Vietnam			
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Tidal inlets along the central coast of Vietnam are located in a micro-tidal, wave-dominated coastal environment with wide seasonal variations in river flow and wave climate. They often suffer from periodic entrance shoaling and/or mouth closure – barrier breaching. Due to distinct differences in the direction of wave-induced longshore sediment transport (LST) between the two monsoon seasons, the morphologies of the tidal inlet entrance frequently undergo dynamic evolution. As the main reasons for the increase in the risk of coastal flooding and the obstruction of navigation, the migration or closure of tidal inlets has caused a lot of problems for the socio-economic development in the region. Thus, it is essential to study and analyze the morphological processes of the inlets and build up scientific foundations for future development plans. This study investigates on the sand spit elongation phenomenon at 6 tidal inlets in Central Vietnam by employing both satellite image analysis and numerical methods. Firstly, satellite imagery was applied to investigate the long-term morphological changes of the sand spits. Afterward, a coupled model (Delft3D) was established to simulate the complex dynamic processes leading to the elongation of sand spits, i.e., river discharge, tidal discharge, and wave impacts. One of the most important objectives of this study is the prediction of the morphological changes of sand spits in the long term, which can be achieved via the aforementioned numerical models. However, this task requires a huge dataset to simulate the hydraulic regime and sediment transport mechanics of the regions. Remarkably, the estimated LST rates from the numerical model are in order of magnitude comparable to the results from the satellite imagery analysis for most study cases. Therefore, it is possible to develop a simple formula for the prediction of the unrestricted sand spit growth rate as a function of the LST and the sand spit width. Undoubtedly, this has great practical significance to the support of the management strategy for coastal zones along the central of Vietnam. In the final step, this research not only explained the relationship between the shape of the sand spits and the wave regime but also developed a time correlation equation of topography characteristics. From the results of this study, it is found that among all the factors affecting the development of the sand spits, the elongation mechanism qualitatively and quantitatively determines the morphological change of sand spits.

Based on the conservation equation for sand and the data analysis from 6 case studies, a new simple empirical formula for the prediction of the sand spit elongation rate is developed. The equation was calibrated using the comprehensive data for the central coast of Vietnam, Japanese coastal areas, and 3 sand spits in Senegal, U.S, and Sweden. In all case studies, the sand spit growth rate R_s is inversely proportional to the sand spit width B_s.

$$R_s = \frac{Q}{\left(D_B + D_C\right)} \frac{1}{B_s} = \alpha \frac{1}{B_s} \tag{1}$$

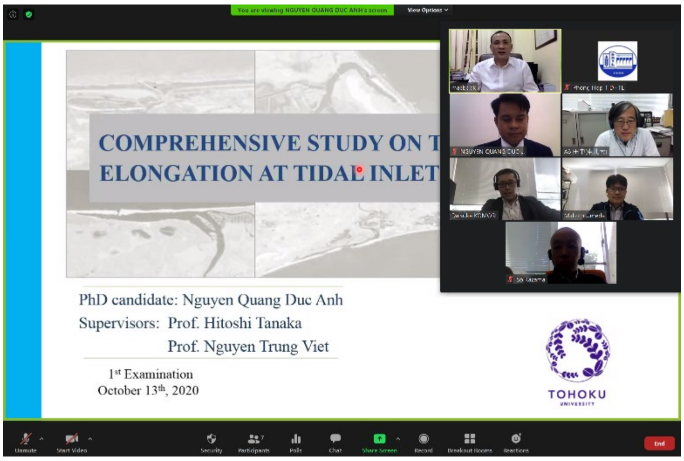
By assuming that the magnitude of LST Q along the central coast of Vietnam receives a value in the above-limited range and the sum of ($D_B + D_C$) equals 10 m, the sand spit growth rate is obtained as $R_s = 1.1\text{x}10^4/B_s$ *m/y*. This value can be applied to predict the sand spit growth rate using a single unknown parameter for the inlets in the center of Vietnam. Overall, an effective method to estimate the unrestricted sand spit growth rates is provided for regions where wave forces are the dominant factor for the spit morphology. This is especially practical in areas with limited data such as in central Vietnam.

To examine this equation, firstly, we proceed to identify morphodynamic characteristics of the unrestricted sand spit growth rates at the Sangomar spit in Senegal, the Badreveln spit in Sweden, and Fire Island Inlet in the U.S., as reported in studies by Palalane et al. (2014) and Hoan et al. (2011). Subsequently, by applying the new equations and parameters i.e., D_C, D_B, and Q at 25 coastal areas in Japan, the changing rate coefficient α was determined. It is seen that the value $\alpha = 1.1\times10^4 m^2 / y$ of the current study corresponds to the second-most frequent value of the total observed data in Japan. This proves that the value of α in the present study is a highly common value and can be regarded as a representative value for other places with similar conditions. In addition, the α value for 5 extra Vietnamese coastal regions was calculated based on the wave data of the numerical simulation models for the entire South East Sea and the CERC formula. This value is comparable to the result which uses the parameters D_C, D_B, and Q of Hung (2010).

Based on the results obtained in this study, some suggestions for the application of this study as well as the necessary improvements in the upcoming study are proposed. Firstly, the outcome of this study cannot be applied for the cases of the river-dominated and tidal-dominated inlets (e.g., Red River and Mekong River) or restricted sand spit elongation (for example, by a jetty construction). Secondly, the uncertainty of the estimated α is unavoidable due to the uncertainties of Q, D_C and D_B parameters. Researchers often face the lack of a basic database when studying morphological changes in river mouths, tidal inlets, or sand spits in Vietnam. With sufficient data, the validation and calibration of the model can be conducted more reliably, especially for simulating morphological changes of sand spits or inlets.

Photos

Field visit to Halong Bay, Vietnam, with Prof. Hitoshi Tanaka and Prof. Nguyen Trung Viet



Online examination (1st examination)