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The Rate of Modelling the Change of Hydrodynamic Components and Ecosystem Degradation due to the Existence of Coastal Reclamation Research in 2012-2022

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Abstract

Reclamation is defined as an action made to increase the use of land resources while considering environmental and socioeconomic factors, such as landfilling and land drainage. Unfortunately, as man-made structures in the waters, coastal reclamation has the potential to significantly caused a disruption towards nature processes. This research aims to examine the pace of inquiry into the negative effects of coastal reclamation. The search was conducted using Publish or Perish Software, which was used to choose data sources in the form of Google Scholar from 2012-2022, and we applied a systematic Literature Review method. Identification and evaluation were carried out using two types of software such as Publish or Perish and VOSviewer. This research showed that China and India are the most frequent countries to be chosen as the area of interest related to this topic due to their experiences in handling a lot of coastal reclamations in their territorial. Mean-while, other countries such as Indonesia, Singapore, Malaysia, Philippines and some Europe Countries counted as the low rate areas for this type of publication even though they had a huge number of similar projects.

Keywords: Coastal, ecosystem degradation, modeling, reclamation.

1. Introduction

Legally, reclamation is defined as an action made to increase the use of land resources while considering environmental and socioeconomic factors, such as landfilling and land drainage (Walyuo et al., 2016; Kristanti et al., 2019). Furthermore, land reclamation has played a significant role in the urban development process in many maritime countries' coastal areas, although it has some important impacts related to biological, sanitary, wastewater, ecological state, and water quality (Priyandes and Majid, 2009; Galanina et al., 2020). Despite the fact that marine reclamation has become a key method of harnessing the ocean for mankind, as well as for producing goods and providing living space, coastal areas are often heavily populated, resulting in tremendous strain. Due to the high intensity of exploitation and the fragility of the environment, coastland has become one of the most severely degraded ecosystems and has the potential to stymie future social and economic development in the surrounding area (Ge and Jun-yan, 2011). By this condition, coastal reclamation, as man-made structures in the waters, has the potential to significantly caused a disruption towards nature processes (Subraelu et al., 2022). Following this condition, the affected coastal areas will face the instability of constituent ecosystem components that increase the severity of flood disasters in some areas (Dube et al., 2022; Muktiali et al., 2023; Xin et al., 2017).

A comprehensive analysis and prediction of bad reclamation impacts must be held to prevent any further disadvantages that will also happen to society themselves (Li, 2014; Xiong et al., 2022). Thus, modeling and simulation can be chosen to be the most effective and efficient methods to achieve that goal. To be more specific, the nonlinear wave-induced bottom shear stress and sediment transport model revealed specific properties that can improve the accuracy of coastal morphological change (Uddin et al., 2020; Darwish and Smith, 2023). Furthermore, the overtopping of the waves could result in silt incursion into the Lagoon (Phillips et al., 2017; Finotello et al., 2023). Understanding and estimating hydrodynamic behavior, as well as measuring erosion, deposition, and sediment transport over wide or restricted areas, are all possible with hydrodynamic and sediment transport modeling (Wibowo

et al., 2020; Andualem et al., 2023; Visescu et al., 206). It has advanced quickly in recent decades from the 20th Century to the present, either experimentally or by model simulation, and is frequently used to predict the hydrodynamic response to low-crested buildings (Fattah and Damerianne, 2018). Moreover, a numerical technique based on a high-resolution hydrodynamic model based on the finite element method was created to simulate both tidal propagation and wind-induced water circulation in the vicinity of target locations (Cucco et al., 2016). By this condition, hydrodynamic investigations can be carried out using numerical models that only require data for validation purposes, making them more economical in terms of time, money, and energy (Lubis et al., 2020).

Research has suggested that coastal reclamation may lead to some bad impacts related to the change in hydrodynamic characteristics and the existence of the surrounding ecosystem (Nadzir et al., 2014). A systematic literature review on this topic would be quite fascinating to investigate. The differences in each type of hydrodynamic characteristics, including the direction and velocity of wind, currents, and waves, changes in bathymetry, and tidal intensity due to the existence of coastal reclamation buildings, are the initial motivation for this research. This research was based on publications that discussed hydrodynamic modeling and simulation to demonstrate the probability of its harm to coastal ecosystems. Identification and evaluation were carried out by taking into account the level of analysis development each year, the type of approach utilized, and the wide range of parameters that have been widely discussed.

This general research will be extremely beneficial to regulators (i.e., governments) in planning the next coastline reclamation project for other locations. By considering the consideration of bad impacts of this project, they could formulate a roadmap that is more sophisticated, ecological-based, and minimum risks for both environment and the people who live there.

2. Materials and Methods

2.1. Scientific Article Data

In this research, we chose and identified literature focusing on the change in hydrodynamic characteristics caused by the presence of coastal reclamation structures for review. These materials have concentrated on many types of hydrodynamic modeling, such as wind, bathymetry, current, tidal, and waves. The articles utilized were gathered from various sources indexed by Google Scholar. The data used were articles obtained from several sources indexed by Google Scholar. Moreover, the items considered to be literature material were published between 2012 and 2022 and exclusively took the form of journal articles. The search was conducted using Publish or Perish Software, which was used to choose data sources in the form of Google Scholar. To be more specific, the keyword that has been used in this selection was in the form of “Modeling”, “Hydrodynamic”, “Coastal”, “Reclamation”, and “Ecosystem.” Following this condition, the maximum number of results chosen was 1.000, with publication years ranged from 2012 to 2022.

2.2. Selection of Literature Database

The Publish or Perish, Software literature data were chosen by excluding literature in the form of books or topics judged irrelevant to the research conducted. The total number of results from the literature search for the keywords "Modeling" and "Hydrodynamic" was 999. After checking and sorting, articles that focused on keywords “Modeling”, “Hydrodynamic,” and “Coastal Reclamation” comprised 780 results. The final checking and sorting step in this article selection ended up with articles that focused more in keywords “Modeling”, “Hydrodynamic”, “Coastal Reclamation,” and “Ecosystem Degradation” comprised 673 results, which were entered into the analysis detailed in this research. Based on the used literature, the literature review was carried out by mapping the gathered article data, including the deterioration of coastal eco-system risk management from 2012 to 2022 and types of hydrodynamic feature changes due to the existence of coastal reclamation buildings. The process in this selection method is given in the form of a flowchart in Figure 1.

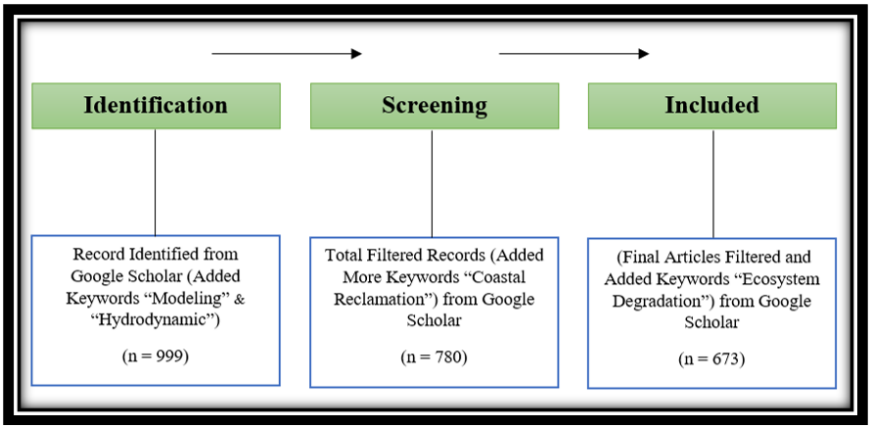

Figure1: Systematic literature review flowchart

2.3. Method and Systematic Data Analysis

This research considered a systematic literature review method based on journal articles that were discovered and interpreted to be relevant to the specific issue (i.e., The Rate of Modeling the Change of Hydrodynamic Components and Ecosystem Degradation due To the Existence of Coastal Reclamation). However, a systematic evaluation stage is also required in the systematic literature review method for performing research so that the source articles are ideally relevant, connected, and have the least amount of overlap with previous research. Following this situation, VOSviewer Soft-ware was used to visualize the article database as well as the correlation between the article database and the most-discussed topics.

3. Results

There are 3 stages in using The VOSviewer software. The first stage was mapping the relationship between article keywords, including "Modeling" and "Hydrodynamics." The second stage was mapping the relation between article keywords, including "Modeling", "Hydrodynamic" and "Coastal Reclamation." The third stage was mapping the relationship between article keywords, including "Modeling", "Hydrodynamic", "Coastal Reclamation" and "Ecosystem Degradation." The form of this relation map-ping includes “Network” which has a topic connectivity function and “Overlay” which has a publication time function of the article topic. All the topics published also represent reclamation study areas that are dominated by several countries.

By using "Modeling" and "Hydrodynamics" keywords, the highest number of articles publication were happened in 2014 to 2015 that is given to the form of map as shown in Figure 2. In 2014, most frequently used keywords for the main topics of articles were "Validation", "Wind" and "Hydrodynamic Effect". Six months later, most frequently used keywords for the main topics of articles were "Hydrodynamic", "Hydrodynamic Model", "Numerical Model", "Wave", "Time", "Numerical Simulation", "Hydrodynamic Force ”, “Parameter”, “3D Model”, “Modeling”, “Evolution”, “Hydrodynamical Model” and “Hydrodynamic Interaction”. In 2015, most frequently used keywords for the main topics of articles were "Data", "Effect", and "Mechanism". Six months later, most frequently used keywords for the main topics of articles were "Process", "Fluid" and "Hydrodynamical simulation".

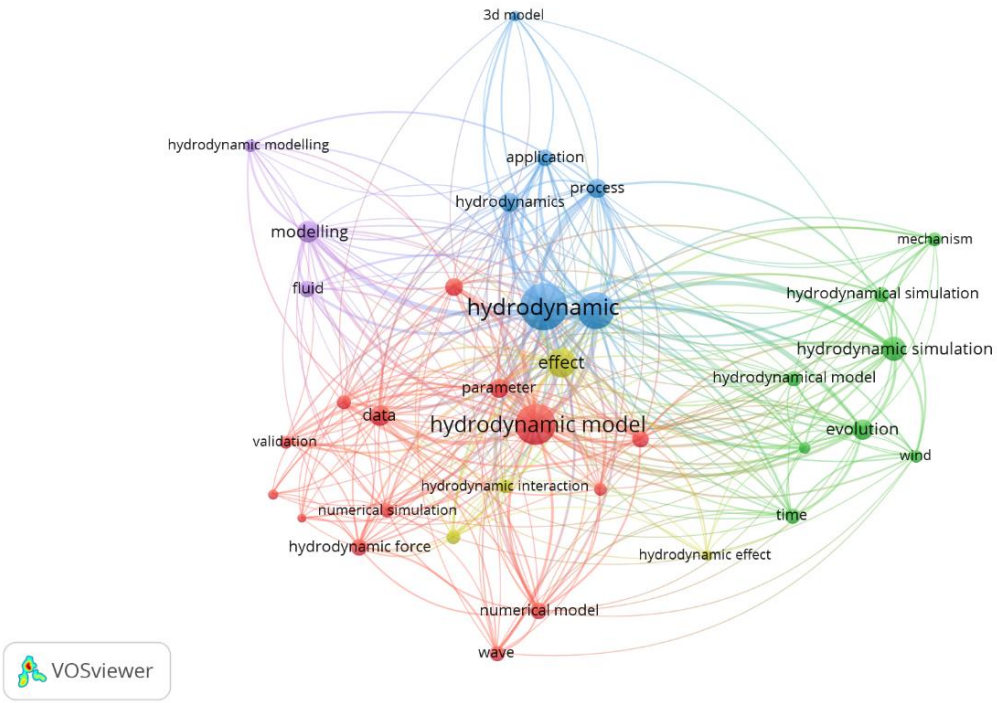

Figure 2: Keywords mapping relation for “Modeling” and “Hydrodynamics”

By using "Modeling", "Hydrodynamics" and “Coastal Reclamation” keywords, the highest number of articles publication were happened in 2017 to 2019 that is given to the form of map as shown in Figure 3. In 2017, most frequently used keywords for the main topics of articles were “Tidal Flat”, “Region”, “Sea”, “Change”, “Land”, “Sand”, “Hydrodynamic Modeling”, “Sediment Transport”, “Tide” and “Numerical Modeling.” In 2018, most frequently used keywords for the main topics of articles were “Reclaimed Land”, “Area”, “Model”, “Modeling”, “Hydrodynamic”, “Land Reclamation”, “Influence”, “Beach”, “Process, Wave”, “Island”, “Development” and “Hydrodynamic Force.” 6 months later, most frequently used keywords for the main topics of articles were “Coastal

Area", "Estuary", "Hydrodynamic Condition", "Effect", "Impact", "Year", "Analysis", "Coastal Boundary" and "Flow." In 2019, most frequently used keywords for the main topics of articles were "Sea Level Rise", "Climate Change", "Numerical Simulation", "Water" and "Structure."

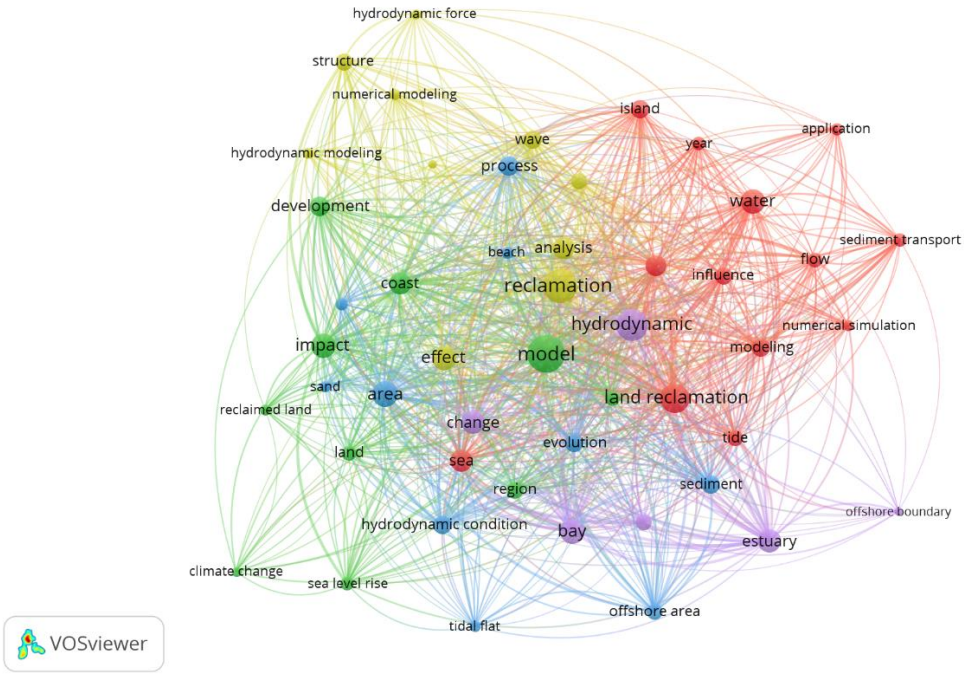

Figure 4: Keywords mapping relation for "Modeling", "Hydrodynamics" and "Coastal Reclamation"

To be more specific, several combinations of keywords that frequently used for the topic of articles indexed by the Google Scholar database based on the number of citations can be shown in Table 1.

Table 1: Number of citations for keyword combinations

Indexed Database	Keywords	Citation
Google Scholar	Aquifer, Groundwater, Organic Matter, Soil, Sediment, Water.	196
Google Scholar	Coastal Aquifer, Coastal Erosion, Coastal Wetland, Coastal Reclamation, Coastal Ecosystem, Coastal Area.	103
Google Scholar	Application, Comparison, Implication, Problem, Influence, Loss, Management, Year, Process, Effect, Activity, System, Change, Development, Impact.	701
Google Scholar	Transport, Decomposition, Sedimentation, Sediment Transport, Deterioration, Climate Change, Water Quality.	243
Google Scholar	Hydrodynamical Process, Hydrodynamic Force, Hydrodynamic Characteristic, Hydrodynamic Condition, Hydrodynamic.	189
Google Scholar	Numerical Model, Hydrodynamic Modeling, Hydrodynamic Simulation, Numerical Simulation, Modelling, Hydrodynamic Model, Simulation, Modeling, Model.	480
Google Scholar	Land Use Change, Land Degradation, Environmental Degradation, Wetland, Land Use.	110
Google Scholar	Beach, Coast, Estuary, Bay, Lake, Environment, River, Area, Ecosystem, Land.	537
Google Scholar	Erosion, Sea Level Rise, Destruction, Pollution, Degradation.	358
Google Scholar	Human Activity, Reclamation Project, Construction, Land Reclamation, Reclamation.	432

Moving forward to the area of interest based on the graphic given in Figure 5, China scored 82% as the country that focusing themselves for study of coastal reclamation, changes in hydrodynamic characteristics and the ecosystem degradation. On the other hand, India scored 17% and the remaining 1% of this calculation scored for other countries including Indonesia, Singapore, Malaysia, Philippines and several European countries which were also starting to carry out large-scale coastal reclamation projects for their own territories.

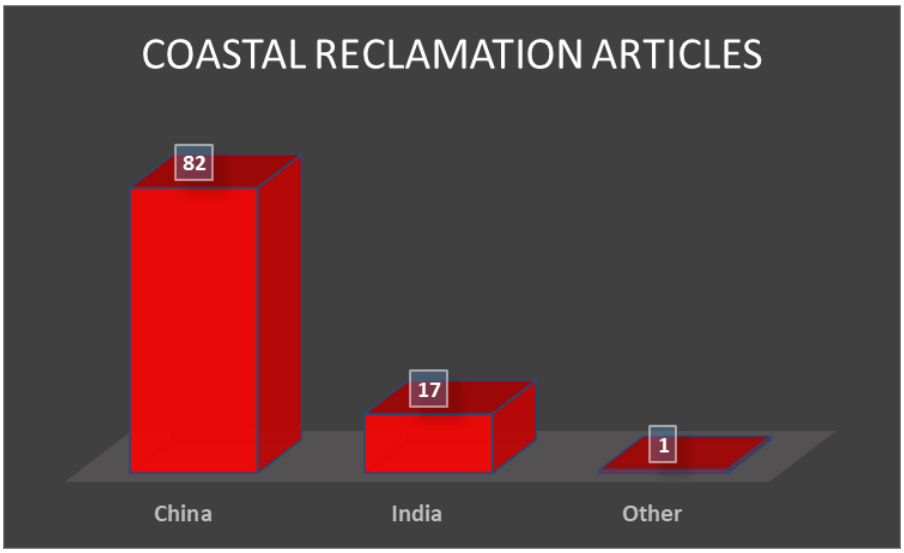

Figure 5: Rate of coastal reclamation article journal publications around the world

4. Discussion

There are some particular reasons behind China reaching the first rank as a country with the most frequent research publication about coastal reclamation, characteristic hydrodynamic change, and ecosystem degradation. First of all, nearly 52% of all megacities with populations over 10 million are found along the coast, and several of them have started various projects to reclaim the coast. Along with this condition, coastal areas are essential for social and economic development in China. Between 1991 and 2015, more than 6418.9 km2 New land was reclaimed from the sea and used for agriculture, industry, and urban development (Tang et al., 2022). To be more specific, China's coastline region covers 13% of its total area, hosts 43.5% of the population and accounts for 60.8% of the country's GDP (a metric that attempts to capture the country's economic production). Unfortunately, due to the negative effects of coastal reclamation structures, about 69% of China's mangrove ecosystem and 80% of its entire area of coral reefs have vanished since 1949 (Tian et al., 2016; Jiang et al., 2021; Chen et al., 2017). On the other hand, almost similar to China, India as the second rank, initiated its first coastal reclamation in the 1860s for leaching and drainage methods (Nayak, 2015).

The long journey that has been through by China and India in carrying out coastal reclamation projects provides greater opportunities for their countries to criticize the various problems and experiences. This condition also provides greater opportunities for researchers to make their countries as the area of interest in coastal reclamation research. Whether it's about the changes in hydrodynamic characteristics, increasing the intensity of disasters or degradation of coastal ecosystems, all of them have been studied in various research modeling methods with high value for China and India. Meanwhile, on the other hand, the 1% quota that was related to coastal reclamation modeling for Indonesia, Singapore, Malaysia, Philippines, and several European countries (Azwar et al., 2013; Bai et al., 2023; Sukirman et al., 2021; Limbo-Dizon, and Dagamac, 2023; Sengupta et al., 2018), has proven to have not reached an optimal level for elaborate between the existence of reclamation buildings, changes hydrodynamic characteristics, increased intensity of disasters and degradation of coastal ecosystems even though the intensity of these projects are increasing from year to year for their countries.

5. Conclusions

Reclamation is defined as an action made to increase the use of land resources while considering environmental and socioeconomic factors, such as landfilling and land drainage. Unfortunately, coastal reclamation, as man-made structures in the water, has the potential to significantly caused a disruption towards nature processes. By screening, filtering, and sorting 673 article journals indexed by Google Scholar Data-base, we found that China and India are the most frequent countries to be chosen as the area of interest related to this topic due to their experiences in handling a lot of coastal reclamations in their territorial.

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