SATELLITE IMAGERIES AND GEOSPATIAL IN HANDLING SINKING CITIES IN ASIAN: A SYSTEMATIC REVIEW

Nur Hasnieda Zawawi[1], Norzailawati Mohd Noor*[1], Illyani Bt Ibrahim[1] M.Zainora Bt Asmawi[1] , Hasti Widyasamratri[2] and Mila Kamilah[2]

Department of Urban and Regional Planning, Kulliyah Architecture and Environmental Design, International Islamic University of Malaysia[1] and Universitas Islam Sultan Agung (Unisulla), Semarang, Indonesia[2]

**norzailawati@iium.edu.my*

Sea level rise can pose a threat to many low-lying and unprotected coastal locations leading to the sinking cities. Sea levels are expected to continue to rise at an ever-increasing rate and continue to have a major impact on coastal areas including the Asian region. The objective of this article is to provide a comprehensive overview and systematic literature to find the main formulas for the use of geospatial data and satellite imagery in dealing with sinking cities in Asian countries. This paper discusses various aspects of remote sensing and its applications in sinking city studies, particularly in Asian countries. The main focus of using satellite imagery for sinking cities is to monitor sink cities in crucial area and applications requires the analysis of remote sensing picture areas for climate detection and control. The finding shows that remote sensing technology can capture photos of Earth and is mostly used to detect calamities on the earth particularly forecasting analysis by ENVISAT or Topex/Poseidon. Earth pictures can be used to gather thorough terrain data using the control technique. Coastal cities are becoming increasingly susceptible to rising sea levels due to the growing threat of climate change, which can be further worsened by extreme weather. Low-lying Asian nations like Vietnam, Indonesia, the Philippines, and Thailand will be severely impacted by sea level rise in the future. Remote sensing technology has been able to identify the area that has the potential to be a sinking city since the acquisition of satellite and aerial imagery, and with increased convenience, sinking cities and sea level rise detection have grown more desirable in recent years.

Keywords: Remote sensing, sinking cities, urban planning, satellite imageries

1.0 INTRODUCTION

Climate change refers to changes in climate patterns caused by natural and anthropogenic factors that have an impact on human activity and natural ecosystems. Rising sea levels are one of the global consequences of climate change. The onset of global sea level rise is due to increased activities involving coastal areas. Extreme sea levels and how they are affected by climate change is a major issue for coastal communities around the globe (Hieronymus et al., 2018). Rising sea level is by and large accepted and broadly detailed to be the noteworthy driver of coastal disintegration of most low-lying sandy shorelines universally. Be that as it may, there's constrained data-driven proof of this relationship due to the challenges in evaluating shoreline flow at the same worldly scale as sea-level records (Adebisi et al., 2021). The causes of worldwide sea level rise are warm extension caused by warming of the sea (since water grows because it warms) and expanded softening of land-based ice, such as icy masses and ice sheets. Sea level rise in particular areas may be more or less than the worldwide normal due to nearby components such as arrival subsidence from characteristic forms and

withdrawal of groundwater and fossil powers, changes in territorial sea streams, and whether the arrive is still bouncing back from the compressive weight of Ice Age ice sheets. In urban settings, rising oceans debilitate framework essential for nearby employments and territorial businesses. For example, roads, bridges, subways, water supplies, oil and gas wells, power plants, sewage treatment plants, landfills virtually all human infrastructure is at risk from sea level rise. This research is dealing with the issues to analyses the issues on sea level rise on the urban development impact. Future sea level rise caused by climate alter would disturb the physical forms, financial exercises, and social frameworks in coastal districts. Logical prove proposes that climate alter and sea-level rise will possibly have noteworthy impacts on the coastal environment and human society. The foremost important set of devices that can be utilized to get it the forms related with these changes and to survey their natural and financial impacts is Geographic Information Systems (GIS).

Remote sensing is the science of obtaining data almost the Earth's surface without really being in contact with it. Typically done by detecting and recording reflected or transmitted vitality and handling, analyzing, and applying that information. In much of inaccessible detecting, the method includes an interaction moreover includes the between occurrence radiation and the targets of intrigued (Kumar, 2018). Remote sensing could be a procedure for getting data around a question without coordinate physical contact with the protest. The preferences of remote sensing strategies were actualized to screen the earth’s surface utilizing satellites (Hakim & Lee, 2020). The yield of a remote sensing framework is more often than not a picture speaking to the scene being watched. Numerous assist steps of advanced picture handling and displaying are required in arrange to extricate valuable data from the picture. Reasonable methods are embraced for a given topic, depending on the necessities of the particular issue. Since remote sensing may not give all the data required for a full-fledged appraisal, numerous other spatial qualities from different sources are required to be coordinates with remote sensing information. This integration of spatial information and their combined examination is performed through a set of computer software/hardware, known as Geographical Information System (GIS). (Navalgund et al., 2007)

The significance of remote sensing are worldwide and territorial natural checking depends intensely on remote sensing disciple and sensors which are competent of rapidly collecting spatial and ghastly data of large-extent substances on the Earth’s surface (Li et al., 2020). Remote sensing allows coverage of very large areas, allowing regional surveys to identify extremely large features of sea level rise and sinking cities. Besides that, remote sensing allows monotonous coverage, which comes in helpful when collecting information on energetic sea level rise within the coastal range. With the technology nowadays, remote sensing allows for easy collection of data over a variety of scales and resolutions through satellite images to measure the increase in sea level that can cause coastal areas to sink. A single image captured through remote sensing can be analyzed and interpreted to determine the sea level height. By using the GIS and remote sensing satellite, there is no restrain to the sum of information that can be extricated from a single remotely detected picture and added and examined. The main key of remote sensing is to monitoring the area that has the potential to be a sink city through the remote sensing satellite image such as Envisat and Topex/Poseidon, it is easier to locate sea level rise has spread over a large region which makes the city area sunk. Meanwhile, a systematic approach to gathering, critically assessing, integrating, and presenting data from various research papers on a particular research issue or topic of interest known as a systematic literature review (SLR). Therefore, this work presents a thorough analysis of the digital tool approach to monitoring sea level rise. The analysis is regarded as a sign of the rising sea levels in conjunction with the sinking cities. On remote sensing and Geographical Information System (GIS), papers, manuscripts, theses, and other publishing kinds are compiled. At the same time, various uses of digital tools in different parts of the world are described.

2.0 THE PHENOMENA OF SINKING CITY IN THE WORLD

A sinking city is a city that is on the verge of disappearing due to rapidly changing environmental land changes. The combined effects of climate change through sea level rise, land subsidence, and rapidly developing urbanization are the most significant contributors to these cities becoming uninhabitable. Continuous urbanization and populace development in delta ranges, in specific in coastal mega-cities, proceeds to fuel economic advancement in subsidence-prone zone (Erkens et al., 2015). Many of the world's largest and fastest growing cities are situated along rivers and coastlines, making them vulnerable to natural disasters including sinking city. As the country continues to invest in coastal city development and infrastructure, the potential losses in these areas will rise. Submerged cities must overcome significant challenges in order to be adequately prepared for today's dynamic environmental climate.

2.1 Phenomena Sinking City in Asian

The current circumstance is as self-evident as the current marvel. As climate alter compounds, worldwide sea level rise (SLR) will quicken. Besides, the quick increment in populace and destitute urban arranging will cause coastal cities in Asian nations such as Indonesia, Vietnam, and Thailand to sink increasingly each year (*Asia's Sinking Cities: Indonesia – Climate Tracker Asia*, n.d.). The increasing physical risk to many coastal cities of sinking is caused by the factors of rapid urbanization, climate change and land subsidence. Most of these natural hazards are largely of anthropogenic origin, where humans unknowingly care more about rapid urban change than preserving the natural environment. In many cases, the fundamental aspects that lead to sinking cities are a phenomenon that will always occur, and over time this phenomenon is becoming increasingly difficult to resolve. In Indonesia, major cities on Java Island's north coast (Pantura) are losing coastline at an alarming rate. Between 2013 and 2017, the cities of Brebes, Demak, and Semarang, the capital of the Central Java region, had to watch 8,023 hectares of land disappear into the sea. It is approximately 11,000 times larger than a football field (*Asia's Sinking Cities: Indonesia – Climate Tracker Asia*, n.d.). The area is also connected to the sinking city. Indonesia, Philippines and several other Asian coastal cities are sinking faster than the rate of sea level rise, a study that calls for strict regulatory measures to reduce groundwater extraction, identified as the main cause of land subsidence that causes sea level rise and the sunken city.

The impacts of future sea level rise are numerous and complex considering the physical, natural, and socio-economic perspectives of the issue. The evaluation of coastal powerlessness to ocean level rise may be inspected at a few levels with expanding complexity (Xingong et al., 2009). In numerous coastal and delta cities arrive subsidence presently surpasses supreme sea level rise up to a figure of ten. A major cause for serious arrive subsidence is intemperate groundwater extraction related to quick urbanization and population growth. Without action from the responsible party, parts of Jakarta, Ho Chi Minh City, Bangkok and various other coastal cities will sink underneath ocean level (Erkens et al., 2015). The number of publications on sink cities in the scopus database over the last five years was 33, which included journal articles, books, book chapters, conference proceedings, and so on. China reported 17 publications, the majority of which were research articles, while Algeria, Bangladesh, and Denmark produced the fewest research articles for sink cities. Figure 1a depicts the total number of publications from 2015 to 2022 based on scopus databases. From 2015 to 2021, only six documents were published on sinking city studies using geospatial remote sensing and GIS. Figure 1b also shows the tabulation.

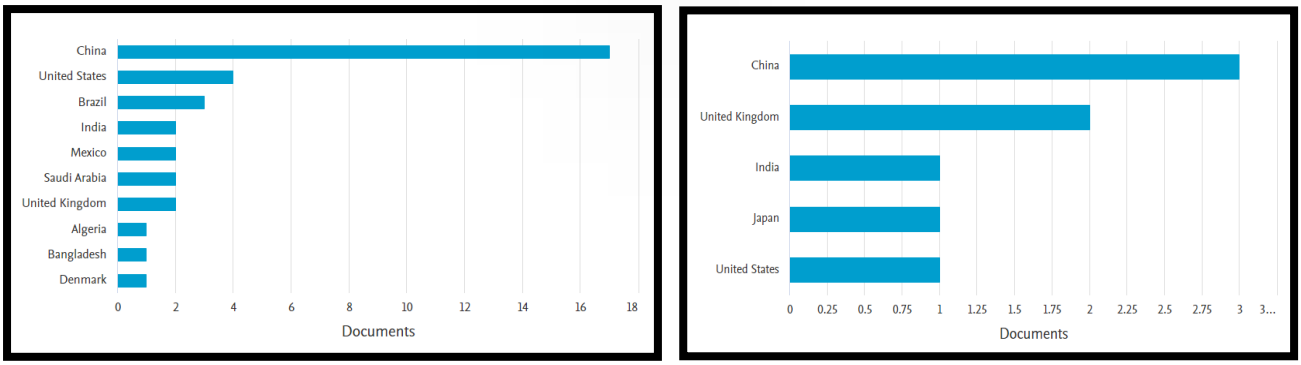

Figure 1: a) total publication on "Sink city" for year 2015-2022 in scopus database b) total publications on "Sink Cities + GIS and remote sensing" for year 2015-2021.

3.0 CROSS ANALYSIS FOR GEOSPATIAL DATA USAGE FOR SINKING CITY

Cross analysis or Cross-case examination could be a inquire about strategy that facilitates the comparison of commonalities and contrast within the occasions, exercises, and forms that are the units of investigations in case considers (*View of Cultivating the Under-Mined: Cross-Case Analysis as Knowledge Mobilization | Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, n.d.). Examiners actualize a cross-sectional investigation to distinguish extraordinary characteristics inside a gather of comparable organizations, instead of to set up connections (*Cross-Sectional Analysis Definition*, n.d.). Cross analysis is used as the main analysis to study existing case studies so that knowledge of rising sea levels or submerged cities can be used for a wider purpose in conducting research. In this paper, cross analysis was used to identify Asian countries that are more prone to sinking cities. This analysis is to classify the data obtained in terms of satellite data from the results of using remote sensing and geospatial in Asian countries.

An observational study design is a cross-sectional study design. In a cross-sectional study, the investigator simultaneously measures the outcome and the exposures in the study participants. (Setia, 2016). Observational studies are the most common type of research in health. The researchers in this type of scientific research did not interfere with the phenomena under study, but instead observed it in a systematic and standardised manner, collecting and recording information, data, or materials that spontaneously occur at a specific time of the health-disease process, or along its natural evolution, and then proceeding with its description and/or analysis. (Zangirolami-Raimundo et al., 2018). A basic tool for empirical research is cross tabulation of qualitative data. Cross tabulations (also known as contingency tables) are used to test hypotheses about how some variables are dependent on others, or how increases in one affect increases, decreases, or curvilinear changes in others. (Yount, 2006).

The goal of cross-sectional studies is to collect reliable data that allows for the generation of robust conclusions and the generation of new hypotheses, and can be investigated with new research. Analytical studies seek to establish relationships and associations between two or more phenomena (referred to as variables in the analysis process). The descriptive studies are only concerned with the detailed and organised description of one or more phenomena, the quality of data required for study, in addition to the systematisation and standardisation of the collection methods, as well as the strategy used to obtain them, which is referred to as the design or, more accurately, the study design. Besides that, cross-sectional design is additionally valuable in studies that examine causal and impact connections, which look for, at slightest for starters, to analyse the connections between chance variables, determinants and what are assumed to be their results or impacts (results) (Zangirolami-Raimundo et al., 2018)

Table 1: The cross analysis on Remote Sensing and GIS for sinking city in Asia.

Author	Year	Country/Continent	City Name	Type of Data Satellite	Type of Data Geospatial
An T. N. Dang et al	2021	Vietnam	Mekong Delta	Landsat	Remote Sensing
Naheem Adebisi et al	2021	Malaysia		Multi-Sensor Optical Satellites	Remote Sensing
Tanutdech Rotjanakuso et al	2018	Thailand	Sakhon Nakhon	MODIS/Terra Satellite	Remote Sensing
Jianhua Wan et al	2018	China	China Sea	Satellite Altimeter Data TOPEX/Poseidon	Remote Sensing
D. Ariana et at	2017	Indonesia	Dumai,Riau	Satellite Altimetry Data	Remote Sensing
Le Van Trung et al	2015	Vietnam	Ben tre	Landsat images	Gis and remote sensing
Md. Ashraful Islam et al	2015	Bangladesh	Bola Island	Landsat ETM +	Remote Sensing and GIS.

4.0 ANALYSIS AND FINDINGS

Despite some constraints related to data availability, an assessment of the relative vulnerability of the shoreline area to SLR and sinking city, considering both physical and socio-economic variables was attempted. The result that using GIS and remote sensing will show the mapped of shoreline is classified as being at very high risk due to future sea-level rise. The areas occur particularly in the open-ocean shoreline along the thin barrier of the lagoon, where the slope is low and the wave energy important. Values mapped after using GIS and remote sensing will indicate that the coastline is at high to very high risk occurring mainly along with coastal areas.

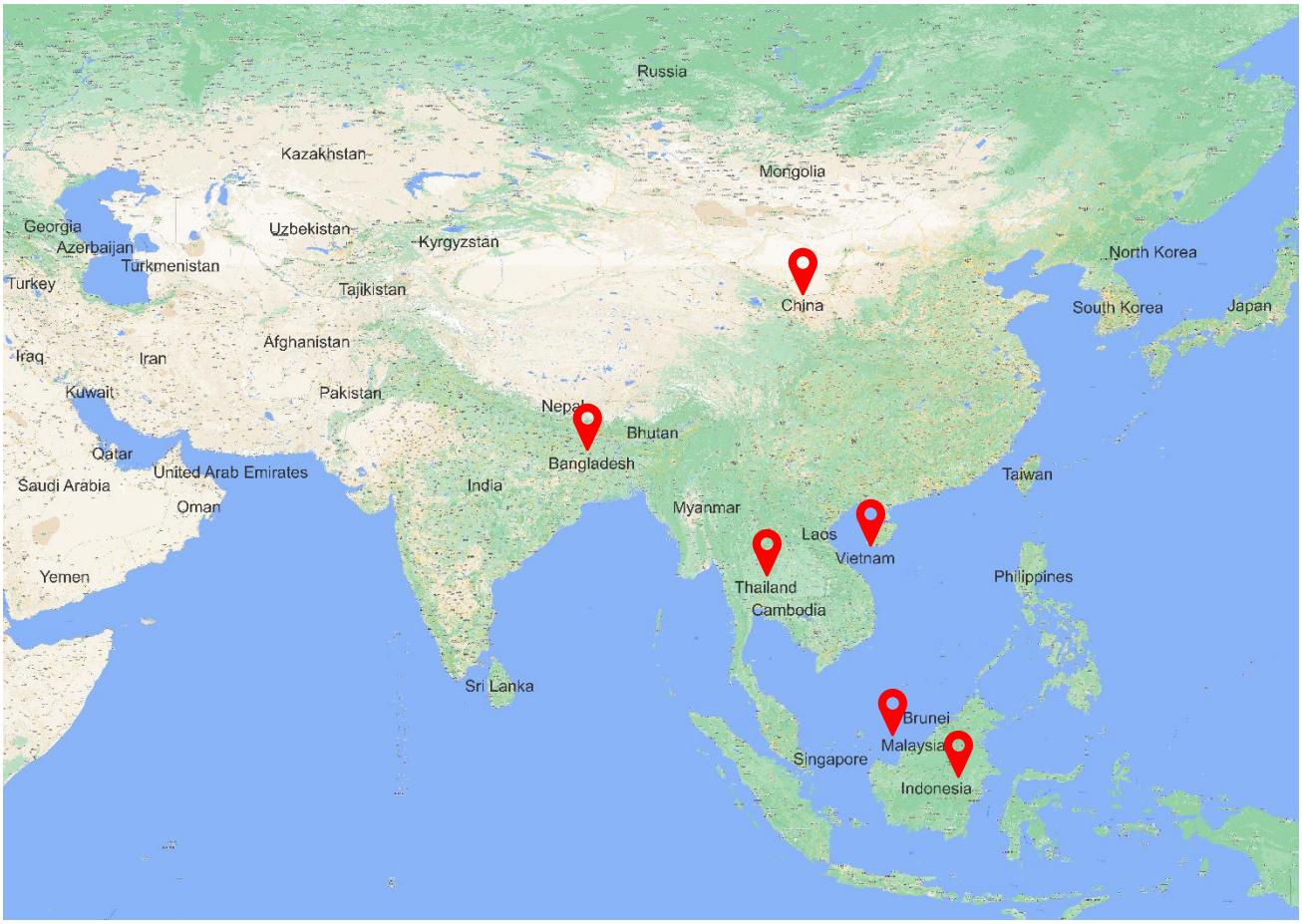

Figure 2: The map showing location of articles that related with RS and sinking city in Asian Countries.

Based on the data from Scopus, the global relative vulnerability represented GIS and remote sensing for the result was assessed by various satellite image for example satellite altimeter data, Topex/Poseidon and Multi-Sensor Optical Satellites. With all the various satellite image that represented the GIS and remote sensing, it will show that overall, about the shoreline of the lagoon is at high to very high risk to SLR. This information may have coordinate application in coastal improvement programs in both the brief and long-term and can help the decision-makers within the usage of preventive administration techniques within the most sensitive areas. The hardstanding of the coastline, a lack of sand due to the small amount of sediment discharged by the few rivers that flow into the coast, and over-extraction of sand from dunes and beaches are the main factors that influenced the evolution of sea-level rise and increased the coast's vulnerability to storm surges. Furthermore, the high rate of erosion observed in the final time period of the survey could be explained by an increase in the strength and frequency of storm surges, which is likely related to global warming.

4.1 Challenges in Using Geospatial Data for Sink City

Data availability for remote sensing and satellite images on various Web sites are highly heterogeneous. Challenges in using remote sensing for research are quite heavy for the sink city. Remote sensing is an expensive method of analysis, particularly when it comes to measuring or analysing smaller submerged urban areas that must be monitored. In order to analyse satellite images, remote sensing requires special training to survey areas that have the potential to sink, especially areas near the coast. In a research study, the sensors that will be used to collect data for research will be selected by someone experienced in handling data collection through specification of data resolution

and sensor calibration. By using sensors, as a result it is easier to make mistakes when analysing the rise in sea level that causes the city potentially to be sank.

The issue is indeed more awful for geological information with regard to conventional information since they are very straightforward to visualize for the user (they see like decent pictures or coloured drawings depicting parcels of our planet). In spite of this clear effortlessness, they ordinarily have a complex structure (space and frequently time measurements are included) and it is exceptionally difficult to examine and combine them utilizing existing representation and handling benchmarks. Regularly, substances of intrigued to particular applications have very distinctive representations at different sites (Belussi et al., 2007). Dynamic remote sensing systems that emanate their electromagnetic radiation, such as radar, can meddled and influence the wonder of the submerged city being considered. Instruments used in remote sensing may sometimes be out of calibration, resulting in inaccurate remote sensing data. During the measurement, the analysed submerged city phenomena may appear the same, which can lead to classification errors. Other unmeasured phenomena can sometimes interfere with the analysed submerged city image, which should be considered during the analysis to avoid inaccurate data. Remote sensing data may provide incomplete or provisional information of potentially submerged cities. Another significant issue to be tended to in a disseminated environment is the improvement of strategies for effective information transmission and visualization of spatial information at the client conclusion. In expansion, it is imperative to note that numerous inventive applications, such as location-based administration frameworks, require get to to spatial and topographical information from versatile clients. It is in this way vital to back productive get to to information from both settled and portable clients and to ensure simple understanding and handling of those information by turning to appropriate data visualization and human–computer interaction strategies (Belussi et al., 2007).

5.0 WAY FORWARD AND RECOMMENDATION

The elemental component of economic improvement is finishing social and financial implies to move forward human individual fulfilment whereas observing and directing common resources. Feasible applications of RS and a geospatial information system for Earth observation (EO) have gotten to be more basic in understanding the biological, natural, hydrological, geographical, and physical characteristics of Earth surfaces for the SDGs (Acharya & Lee, 2019). Remote sensing provides impartial data, whereas GIS plays an important role in the decision support system for spatial analysis and the database management of sink city. According to lot of countries sink city is considered a very big issue that must be addressed to ensure the well-being and harmony of the people living on the coast. Throughout the global issue that which worries all countries, especially Asian countries, there are a few recommendations that should be take action by all local authorities in each country to mitigate the sink city that continuously happen. Among the actions that can be taken are giant sea wall project for sea block to prevent the sea level from rising sharply and causing cities to sink, especially in coastal areas. Other than that relocation of placement for the community that are live near coastal shoreline that have potential to be sunk will be one of good methods to prevent the city from sinking. Therefore, along with the various issues of global sea level rise and the well-being of coastal communities, the issue of sinking cities must be addressed to help shape liveable and sustainable cities in the future.

6.0 CONCLUSION

This research has created a set of Geospatial of remote sensing analysis tools for estimating the location, extent, and implications of potential inundation caused by various sea-level rise estimates on a worldwide scale in context of Asian. These methods correct a number of flaws in previous studies. The methods were used to identify potentially sinking cities areas or the potential area that sea level

will rise continuously. High-precision information on sea-level rise rates and patterns is much needed especially for coastal management, urban development also as an early preventive measure. Therefore, more comprehensive adjustment measures are essential to diminish the conceivable effect of sea-level rise, particularly within the coastal zone. In addition, high-accuracy topographic data in addition to the use of local vertical datum models used to see the effects of sea-level rise more clearly in coastal areas in Asian nation. An effective use of intelligent technologies in sea level rise forecasting would be the development of the digital approach. A geospatial or remote sensing method can help to solve much of this issue if the sink cities problem was being researched. In this article, we looked at how geospatial techniques used to apply digital technologies. When designing effective sink city technologies, GIS and remote sensing may handle both spatial and non-spatial data. Both are also capable of offering affordable, effective, and preferred short routes. Sinking cities is a recent global issue. Many studies was published and focusing on sink cities and sea level rise that are specific to Remote Sensing usage between 2015 and 2022. Because the potential of remote sensing tools is well recognised, the tools and technique explored in order to promote future applications in sink city management.

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