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Use of GIS and RS Combined with Artificial Intelligence Plate for Detecting and Analyzing of Aquatic Heavy Metals Threats for Environmental Sustainability of Green Ports

Alhassan Usman Gabi[1,2], Nazirah Mohamad Abdullah[1*]

[1]Environmental Management and Conservation Research Unit (eNCORe),
Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh Campus,
Pagoh Higher Education Hub, KM 1, Jalan Panchor, 84600 Panchor, Johor, MALAYSIA

[2]Department of Biological Sciences, Faculty of Natural Sciences,
Ibrahim Badamasi Babangida University PMB 11 Lapai, Niger State, NIGERIA

*Corresponding Author

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Abstract: With the technological development globally, Geographic Information System (GIS) and Remote Sensing (RS) has been used and reformed in providing reliable and useful data in the field of environmental studies advancement. There has been needed for GIS and RS in terms of biological and chemical elements in the aquatic environments to assess the concentration of trace metals in the tissue of aquatic species around the world. However, there is still inadequate information and exploration on the subject matter which calls for the use of artificial intelligence plates in acquiring data. There is a need for the use of the invented plate in green port sustainability in order to save time, money, life, less labour and availability of more multiple accurate data information that will have improved sustainability. The primary aim of this concept paper focused on using GIS & RS combined with artificial intelligence plate in Green port environmental sustainability to monitor, acquire data and identify biological and chemical elements data online for analysis. This aim was achieved by the application of qualitative research, that is synthetic literature review. Through the review, we are able to find out that artificial intelligence plates will be useful. Therefore, it requests for innovation of an artificial intelligent plate that will detect, analyze and recommend the concentration of heavy metals and other anthropogenic elements in the water bodies and species tissues without necessarily involving laboratory processes. In conclusion, to provide a theory from fusing past and present circumstances in order to forecast the future for coastal areas, GIS & RS applications and artificial intelligence plates were suggested. This review gives instances of GIS applications' used in the stages of assessment, conservation, maintenance, sustainability, and protection of the environment of marine areas. This study suggests the use of a digital plate that can be used with GIS & RS in monitoring, spatiotemporal distribution and identifying the concentration of biological and chemical elements in the environmental sustainability of port institutions and industrial organizations.

Keywords: GIS and RS, artificial intelligence plate, heavy metals, green port

Corresponding author: nazirah@uthm.edu.my

1. Introduction

Numerous oceanographic sectors have used GIS technology for a variety of purposes. They use information gathered in various ways, as well as integrating concepts from other technological sectors, to help solve the dynamics of the marine environment. Directors and administrators are required to participate in the use of GIS as a decision support system, which presents a significant opportunity for GIS applications in management processes [1].

Geographic Information System (GIS) is an electronic program that saves, accesses, manipulates, evaluates, and presents sets of geospatial data that can be utilized for various purposes [2-7]. It can process two fundamental data types described as geospatial data, which pinpoints the position of a component or item on the ground, and attribute values, which identify these objects' properties [6]. Three crucial steps are required to deploy georeferenced data in utilizing GIS. These include data entry and processing, evaluation, and presentation [3],[4]. GIS might be able to convey data in a way that is accurate and thorough for all users Mironga, 2004, [7] but requires *in-sute* data collection or Remote Sensing for acquiring data without physical contact.

Remote sensing is the science and art of collecting data about a feature of an object, place, or event while being physically separated from the objects or region being studied [7], [8], [9]. Assessments and evaluations conducted on remotely gathered data are typically saved as imagery data in the form of satellite or airborne photographs that may be merged and processed using GIS to reflect the physical aspects of the environment. However, remote sensing data can be analyzed and evaluated in isolation. The greatest outcome can be connecting remote sensing measures to other available observational processes [8]. Remote sensing is among the popular techniques for gathering physical data to be merged into GIS. GIS aids the process by which we may display, analyze, and understand this data. Without any physical contact, remote sensors gather data from earthly objects.

The literature research shows that wide gaps need to be filled in terms of applying GIS and RS in the field of environmental sustainability to achieve green port sustainability around the world. GIS and RS are technological tools that require upgrades every one or two years due to the high level of advancement and expectations in technology. Therefore, there is a need for constant research on GIS and RS application in heavy metals concentration in the aquatic environment.

2. Literature Review

2.1 GIS and RS Concept

Several authors highlighted the significance of using GIS and RS in the aquatic field for the development of a sound marine GIS by assessing the degree to which watercourse environmental conditions could be measured dependably via remote sensing applications, evaluating a sizable and comprehensive set of ecological predictors, and resolving the issue of import restrictions by establishing the compartment system, all of which involved the use of GIS and RS [10-13].

According to [14] marine GIS assesses key aspects of spatial data management for marine applications. It connects time-dependent information with in-situ datasets for maritime attributes and climate change estimation [15]. Marine GIS was upgraded to include the development of a revolutionary conceptual data structure for sea bathymetry [16], ocean expelling and ecosystem impact monitoring [17], the discovery of waste charging sites on the seafloor [18], as well as a new spatial analysis structure [19] to estimate the concentrations of nitrogen and phosphorus within European coastline seas, Beusen et al. (1995) [20], created a GIS-based model that included geo-hydrological data.

Numerous authors have already presented techniques for modeling sensitivity analysis and data uncertainty measurement in GIS investigations [21-23]. Li et al. (1998) [24] developed a management and surveillance GIS for Malaysia's coastline. The tool combines spatial data (which include topography, seashore and marker placements, hydrographic, and parcel), time series records (such as recordings of wind and wave), aerial pictures, and spatial data (such as bathymetry).

Table 1 - Literature matrix table

S/N	Author/Years	Title	Research Aim	Area Of Remote Sensing Application	Linkage With The Current Study	Data Acquiring Source Of The Rs	Recommendation
1	Damanik-Ambarita (2018). [25]	Ecological Models to Infer the Quantitative Relationship between	To select 39 peer-reviewed model-based scientific papers that study the	To acquire land-use information	Similar	Regional database, field sampling, and Remote Sensing or a geographic information system (GIS) data source	Combine source of data: (Field and remote sensing)

		Land Use and the Aquatic Macroinvertebrate Community	relationship between land use and aquatic macroinvertebrates.				
2	Dias-Silva et al 2021. [11]	Measuring stream habitat conditions: Can remote sensing substitute for field data?	To evaluate the degree to which stream environmental conditions could be measured reliably via remote sensing.	Land used, channel dimensions, and water quality	Similar	Remote sensing indicators. HII applied in situ. Landsat 5 TM	Combine source of data: (Field and remote sensing)
3	Thamaga, & Dube, (2017). [26]	Applications and challenges, Remote Sensing Applications: Society and Environment,	To draw attention to new insights in the detection, mapping, and monitoring of invasive water hyacinth using multispectral remote sensing.	Mapping, and monitoring of invasive water hyacinth	Similar	Multispectral remote sensing. Use of sensors like Sentinel 2 and Landsat 8 sensors,	Only remote sensing data
4	Feng, Ishizaka & Wang, (2022). [27]	A simple method for algal species discrimination in East China Sea, using multiple satellite imagery	Bio-optical model, a backscattering indicator, *b*bp-index (*green*), to be useful for specie identification (*Karenia mikimotoi* and *Prorocentrum donghaiense*) combined with the red tide index (RI) in water blooms in the East China Sea (ECS).	Data for Marine Disaster and Oceanic Forecast,	Similar	Satellite data for the study.	Only remote sensing data
5	Hotaling, et al., 2017. [28]	Climate change and alpine stream biology: progress, challenges, and opportunities for the future	To describe the current state of alpine stream biology from an organism-focused perspective	Water body and its biology	Similar	integrate remote sensing and geographic information system (GIS) technologies, and apply genomic tools	Integrating Multiple Approaches: Only remote sensing data

6	Kerfoot et al., 2021. [29]	Coastal Remote Sensing: Merging Physical, Chemical, and Biological Data as Tailings Drift onto Buffalo Reef, Lake Superior	To illustrate the subtle importance of particle classification as an effective, alternative approach to bottom reflectance studies.	Elevation and bathymetric data	Similar	LiDAR and sonar surveys	Only remote sensing data
7	Friedland, et al., 2021. [13]	Machine learning highlights the importance of primary and secondary production in determining habitat for marine fish and macroinvertebrates	To evaluate a relatively large and comprehensive set of ecological predictors	Fish and macroinvertebrate distribution	Similar	Moderate Resolution Imaging Spectroradiometer (MODIS) Terra-sensor (https://oceancolor.gsfc.nasa. gov/data/terra/).	Only remote sensing data
8	Hossain, et al., 2015. [30]	The application of remote sensing to seagrass ecosystems: an overview and future research prospects	To evaluate various methods employed to produce seagrass habitat maps using optical and acoustic remote-sensing (RS) techniques coupled with in situ sampling to highlight recent advances and to define areas where potential future research should be focused in applying RS technologies.	Seaglass ecosystem	Similar	Landsat imagery	Combine source of data: (Field and remote sensing)
9	Teo, et al., 2021. [31]	Landscape-scale Remote Sensing and Classificatio	To inventory lentic habitats at the landscape-scale are	Land scalping and Classification of Lentic Habitats in a	Similar	Google Earth Engine (GEE) was used to generate Sentinel-2 visual	Combine source of data: (Field and remote sensing)

		n of Lentic Habitats in a Tropical City	needed to support science and conservation.	Tropical City		and infrared (IR) bands	
10	Lokman, et al., 2019. [12]	Use of GIS and Remote Sensing on or Namental Fish Farm's Activities Monitoring in Layang-Layang, Kluang, Johor	To solve the issue of import restrictions by establishing the compartment system, using GIS and remote sensing	Monitoring fish ponds	Similar	Spatial data (GIS) and Spot-6 images	Combine source of data: (Field and remote sensing)

The above table with headings: author/year, title, the aim of the research, Area of remote sensing application, Link with the current study, Data acquiring source of the RS, and Recommendation revealed few out of many articles reviewed. The recommendation analyzed whether secondary data was combined with primary data or only secondary data. We observed that determining the concentration of trace metals in the aquatic environment, aquatic relationship with macroinvertebrates, water quality, and fish pond monitoring requires both field data and GIS and RS data. Researchers such as [10], [11], [25], [30] used combined methods of analysis.

2.2 The Role of Remote Sensing and GIS in Biodiversity

In the past decades, gathering the essential data to produce knowledge on the dynamic ecosystem has taken time and money. As a result, our understanding of globally significant ecosystems, particularly those located in developing nations, has been lacking. However, since the development of remote sensing satellite methods, these regions have drawn attention from around the world with in-depth research aimed at monitoring biodiversity and ecosystem conservation [9]. Rapid and sophisticated technologies are required for ecosystem management, biodiversity assessments, environmental monitoring, and analysis of species' habitat appropriateness.

The development of technology cleared the door for habitat mapping, which offers information on the kind and extent of vegetation cover, the physical environment, and human interactions. The promise of technological advancement in the fields of remote sensing and GIS is the ability to gather and combine various levels of data [3]. For the implementation of various challenges, remote sensing data provide information regarding the size, location, and spatial distribution of available lands. Due to improvements in imaging spectroscopy, the relationship between remote sensing and ecology has grown dramatically in the modern era [2], [32].

Geographically speaking, GIS is linked to a strong reference base of areas comprising maps of the terrain's topography, hydrology, vegetation cover, and distribution of various flora and animals. In order to create new linkages between environmental variables and the various biota, it may be possible to locate various features linked with their properties. This will allow diverse data to be combined, compared, and analyzed in a single database. In order to present a broad spectrum of data in the shortest amount of time feasible, GIS is a powerful and effective tool [5].

Researchers can monitor natural trends of various types of long- and short-term environmental phenomena, such as El Nino and other environmental events, using the data that orbital platforms gather and send from various electromagnetic spectrum regions in conjunction with more extensive ground-based detecting and analysis. As a result, knowledge in a range of industries, including agriculture, health, catastrophe early warning, and many others, has quickly adapted to the opportunity that remote sensing and GIS have created. Remote sensing data has been employed for monitoring the consequences of global warming as well as other environmental challenges, in addition to land management, aquatic ecology, biodiversity evaluation, and wildlife ecology [9].

Information about species status, and distribution is crucial for animal study and conservation efforts. More and more, GIS and remote sensing are being used to monitor wildlife habitats. To identify possible habitats for species like the Hamadryas baboons (*Papio hamadras*) in Eritrea, for instance, topographic maps forming digitizing the distribution information of key habitat elements including water supply, food sources, steep cliffs, and altitude of the area. Sites with a mix of these elements are demonstrated to be possible habitatwith a mix of these elements demonstrated to be possible habitats for the species in question [33]. As a result, it is common practice to discover possible habitats using remote sensing and GIS, digitize the data, and then map the most suited habitats. It would be simple to determine how to comprehend better land degradation, urban growth, crop, and other aspects and processes. Numerous industries have been able to investigate remotely sensed products and pinpoint issues with early warning systems for disasters, health care, deforestation, land management, coastal ecology, research into biodiversity, monitoring the effects of global warming, and a variety of other issues thanks to the expansion of powerful computers and GIS technology.

Recent development as shown the possibility of acquiring the concentration and impact of heavy metals in aquatic habitats using software from the Satelytics company. This software uses sophisticated satellite, drone, and aircraft spectral imagery of the Earth's surface in combination with machine learning to monitor environmental changes. It has been used to identify and quantify the presence, concentration, and impact of biological (Phycocyanin, Chlorophyll-a) and chemical constituents of large water bodies, such as arsenic, barium, copper, iron, manganese, in order to prevent harmful changes to the natural flow, identify regions that need to be dredged, have their environment remedied, or have their vegetation managed [34]. Additionally, measuring tree height, speciation, and general health can be used to evaluate the health of remote farm plots. Determine where the yield is low for necessary action. Utilize data and alarms that are nearly real-time to improve your silviculture protocol. A precise evaluation of source volume changes is assured with integrated shoreline change analysis and bathymetry [34].

2.3 Remote Sensing's Drawbacks

The use of remote sensing technology for monitoring and managing habitats in ecosystems is expected to encounter some practical challenges, despite its essential applications in various fields of interest. These include practical restrictions typically built into the technology itself, such as the limited ability of light to pass through water and the atmosphere. The difficulty of accurately determining a sensor's compatibility is remote sensing's second limitation. For instance, remote sensing typically provides geomorphological rather than biological information on reef structures. Due to numerous environmental barriers, such as turbidity and water depth, the sensors' spectrum and spatial resolution are constrained. Additionally, a more severe disadvantage of remote sensing is the issue of cloudiness, which drastically lowers the number of appropriate photographs that are available throughout the year [7].

2.4 The Need For Using Artificial Intelligence Plate

Using artificial intelligence plate technologies, physical devices that will provide digitized information data and connection between GIS and RS in order to and have encouraged an entirely new ecosystem evaluation need to be a call for. In recent years, remote sensing and GIS have been commonly integrated for analyzing and mapping land use and land cover changes [35-38]. Driving land use and land cover change maps into GIS applications has been done using supervised classification algorithms through remotely sensed software [39], [40]. Utilizing ancillary data with satellite imagery, (e.g. digital elevation models and soil maps) provides more accuracy in detecting change [41]. The use of GIS has also been recognized for detecting and mapping land use and land cover changes. Spatial statistical analysis and advanced functions (e.g. hotspots) have been used for change detection [42]. In addition, screen digitizing of satellite images and previous land use and land cover maps have been used to detect land use and land cover change [43, 44].

Many researchers used GIS and RS in studies of heavy metal concentration in the water body, vegetables, sediments, and aquatic invertebrates. However, this was not possible except through online data and field data. The use of artificial intelligence plates can bridge that gap. The artificial intelligence plate Should be able to detect all the types of heavy metals concentration in the water body and tissue of macroinvertebrates in real time. It Should have signals that can penetrate matter to achieve noncontact measuring and capturing of heavy metals present. It should possess a high speed nuclear pulse signal that processes and improves equipment change in response. Should possess data storage that would keep the information with time. The plate would be connecting to Software that would read the data and send it to the web page where the information will be saved, processed, and analyzed. Processed, and analyzed data will be used for recommendation and future references.

Therefore, the development of ports and the associated activities may have a detrimental effect on the environment due to the potential impact of port design and operations on the value of the soil, water, sediments, and air in marine and terrestrial environments [45]. The environment is generally severely impacted by several activities, including logistics and distribution, energy generation and distribution, industrial and semi-industrial operations, maritime and land transport network connectivity, and cargo handling [46-50]. In order to achieve "green port," or port sustainability, framework tools for managing, controlling, and monitoring environmental effects that change through time and operational stages are required.

Green port sustainability requires a digitalization technological invention strategy through the use of artificial intelligence that will save time, money, life, less labour, and availability of multiple accurate data information, improving sustainability. Within the framework of said "green port" principle, the natural ecosystems, port economic security, and human development are the three key elements of sustainability [51]. The idea of "green ports" encourages ports to reduce or completely avoid environmental impacts while increasing port productivity. The negative effects of port operations are numerous. Detrimental effects take many forms, including heavy metal pollution and environmental deterioration, which also impact macroinvertebrates and human communities. Geographic information systems (GIS) are thought to be effective, powerful, and affordable tools for combining and connecting the systems approach [52-54]. Numerous measures of analysis are common techniques to decision analysis in GIS tools [55-57]. The availability of data through the use of GIS databases makes it possible to manage marine resources, which involves enhancing marine ecosystem productivity, limiting marine pollution, preserving seafood quality, and safeguarding habitats like mangroves and corals [58].

3. Methodology

This concept paper aimed to focus on using GIS & RS combined with an artificial intelligence plate for the environmental sustainability of Green port to monitor, acquire data and identify biological and chemical elements data online for analysis. A systematic and comprehensive literature review was used to accomplish the study's objectives. The following academic research databases were used: Research Gate, Google Scholar, Science Direct, and Emerald, where systematic literature searches were done using the years and pertinent keywords. The collected literature and its contents were each given a qualitative analysis using an exploratory and descriptive technique. Sources of articles are Scopus, Emerald, Springer, Research gate, Google scholar, and others.

4. Result and Discussion

4.1 Result

This research makes an effort to sightsee the use of GIS & RS combined with an artificial intelligence plate for the environmental sustainability of Green port to monitor, acquire data and identify biological and chemical elements data online for analysis. Several studies are revised related to the study subject from the different databases and different years. The findings were discussed as follows.

Table 2 - Reviewed papers

Total Collected Papers	120	100%
Screened Papers	82	68.3%
Papers not used	62	51.7%
Papers used	58	48.3%

The statistics of the number of prior studies on the topic that were gathered for reviews are shown in Table 2 above. It stated that 120 articles were acquired, 82 had 68.3% of the papers inspected, and 58 had 48.3% of the papers utilized in the survey evaluation. However, 62 articles with a 51.7% usage rate were not used. The outcome is also explained in Figure 1 using the bar chart above.

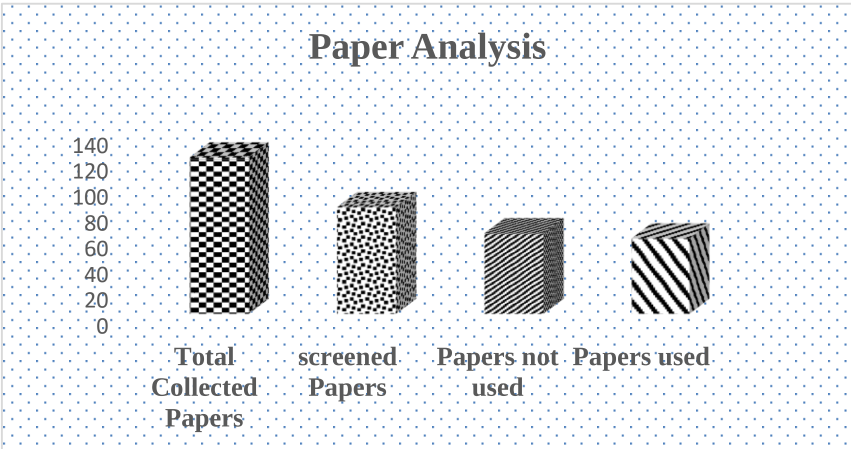

Fig. 1 - Result of collected papers

4.2 Finding The Use of GIS & RS Combined With An Artificial Intelligence Plate For The Environmental Sustainability of Green Port

Various research has been done in the area of aquatic environmental sustainability utilizing GIS and RS with *in-situ* sampling to get analyzable data that will produce informative results. We found that monitoring fish ponds required both field data and GIS and RS data in order to establish the number of trace metals in the aquatic environment, aquatic relationships with macroinvertebrates, water quality, and fish pond monitoring. However, conducting in-situ sampling and laboratory analysis requires a lot of time, and money, and increases the risk of data-collecting errors. The systems might be unable to keep up with the abrupt climate change and the current exponential rise in pollutants. As a result, artificial intelligence plates are required to take the place of in-situ sampling and laboratory analysis.

The likelihood of bridging unbridged gaps in environmental sustainability has increased with the use of GIS and RS. Examples include assessing the concentration of heavy metals in aquatic fauna and flora tissue, water quality, sources of anthropogenic activities, and having information available prior to the occurrence of natural disasters.

Since the creation of remote sensing technology, ecosystem management, biodiversity evaluations, environmental species monitoring, and analyses of species habitat suitability have drawn attention from all over the world. The connection between remote sensing and ecology has significantly expanded in the present period because of the application of numerous difficulties, GIS, and RS advancements in imaging spectroscopy. GIS is a strong and useful tool that shows a wide range of data quickly.

To use the information that orbital platforms collect and transmit from various electromagnetic spectrum regions in conjunction with more thorough ground-based detection and analysis, researchers can track natural trends of different types of long- and short-term environmental phenomena, as well as other environmental events.

GIS and remotely sensed products are also used by many businesses to identify problems with early warning systems for disasters, health care, deforestation, land management, coastal ecology, research into biodiversity, monitoring the effects of global warming, and a range of other challenges.

5. Conclusion

The primary aim of this review focused on using GIS & RS combined with an artificial intelligence plate for the environmental sustainability of Green port to monitor, acquire data and identify biological and chemical elements data online for analysis. The research was a quantitative systematic review paper, with the study containing the introduction, literature review, methodology, result, discussion, and conclusion. From the articles reviewed, numerous research using GIS and RS combined with modelling and field sampling data for detecting and analyzing aquatic heavy metals threats on environmental sustainability has been conducted. This review gives instances of GIS and RS applications' used in the stages of assessment, conservation, maintenance, sustainability, and protection of the environment of marine areas.

A greater understanding and use of the GIS and RS combined artificial intelligence plate may lead to more exploration and prospects in environmental sustainability studies that can serve the current world. It will save time, money, and life, less labour, and availability of more multiple accurate data information that will improve sustainability. If we can't create a fast and cheap means of obtaining data, then with the unimaginable increased level of pollution in the globe, our aquatic species, riparian and port communities that depend on the maritime habitat for food are in great danger that will lead to extinction, ill community, and death.

Artificial Intelligence Plate is required to monitor spatiotemporal distribution and identifies the concentration of biological and chemical elements in the environmental sustainability of port institutions and industrial organizations. In conclusion, GIS & RS applications and artificial intelligence plates were suggested to provide a theory from fusing past and present circumstances to forecast the future of coastal areas.

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