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Geographic Information Systems (GIS) in Fisheries and its Recent Development

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SUMMARY

Aquaculture and fisheries are using Geographic Information Systems (GIS) more and more frequently. Geographic Information Systems (GIS) are computer systems that effectively collect, store, manage, analyse, display, and report spatially related data by integrating hardware, software, personnel, and data. Fisheries managers are using GIS technology more and more to better understand and manage fish populations. GIS technology is perfect for resource management in various industries because it makes data gathering, analysis, and visualisation from a spatial perspective possible. AI combined with location intelligence is how we can realize the promise of AI: save time, drive value from data and imagery, make informed decisions faster. Combining AI with geographic information system (GIS) technology delivers real-world context to operations.This essay will examine the various applications of Geographic Information Systems (GIS) in fisheries and aquaculture research and management.

INTRODUCTION

A computer-based tool for analysing geographic data is a geographic information system, or GIS. In order to build preferred maps, it contains a database of spatial data and characteristics, or descriptive information about features on a map. The Geographic Information System (GIS) has grown to be an indispensable part of contemporary life, and its role in day-to-day activities has only grown with new technological and methodological advancements. Originally intended to be used on land for purposes including watershed management, agriculture, forest conservation, and infrastructure development, GIS has evolved into a supporting tool used in a wide range of industries. By using its technology to obtain scientific results from the gathered data, GIS has given the fishing industry additional flexibility. Numerous fields are using Geographic Information Systems (GIS) in different ways. Up to the past ten years, there was very little use of GIS in marine fisheries; now, with the creation of effective protocols for GIS use in marine fisheries in India, the situation has entirely changed. Global fish production has greatly benefited from the use of GIS-based technology. Contemporary fishing vessels in India are outfitted with advanced technologies that enable them to operate at deeper depths, exhibit higher endurance in the sea, and accurately locate fish. Globally, GIS has greatly improved fish production. (M. F. Panthi and Ashish Hodar, 2021)**.**

Geographical data can be visualised, quantified, and analysed with great ease using GISs. Data related to ecosystems, like fisheries, are best suited for GIS analysis since they usually contain a spatial component. Fisheries publications started mentioning GIS in the late 1980s and became more common in the 1990s, with aquaculture-related topics predominating in the early studies. The fact that GIS is still of interest to fisheries biologists suggests that the technology is helpful for managing and studying fisheries. Numerous applications related to fisheries have been proposed for GIS implementation, including habitat mapping, fish population and habitat impacts at the watershed scale, and analysis of spatial telemetry data. There is limited evidence of GIS use within or among fisheries management agencies, despite the fact that there are multiple examples of its application in recent fisheries literature. GIS was used to help with daily chores like standardising sample placements and report writing, as well as to raise knowledge of the issues facing fisheries biologists today, such as habitat loss, managing threatened and endangered species, and fish passage. Claims that GIS use in fisheries science has advanced from primarily descriptive to exploratory applications are supported by a large number of responses to this topic. Geographic Information Systems (GIS) are computer systems that effectively collect, store, manage, analyse, display, and report spatially related data by integrating hardware, software, personnel, and data. (Butler, R. 1988).

Applications of GIS in Marine Fisheries Management:

Fish, shellfish, and other aquatic species are caught, processed, and sold as part of the commercial, recreational, and subsistence fishing industry. This covers aquaculture, which is the rearing of fish and other aquatic species, as well as the harvesting of wild fish. The practise of controlling and supervising these actions to guarantee the sustainable use of fish populations and to safeguard the ecosystems that sustain them is known as fisheries management. Fisheries managers are using GIS technology more and more to better understand and manage fish populations. Fisheries management makes considerable use of GIS technology, which has several uses. (Bari, 2022).

Fish population models that use environmental factors to predict how climate change may affect marine environments

Modelling the environmental elements that affect fish populations is another application for GIS. Fisheries managers can create strategies for managing fisheries resources in a way that is sustainable and minimizes adverse effects on the environment by knowing how elements like water temperature, salinity, depth, and nutrient levels affect fish.

Monitoring the Distribution and Behaviour of Fish Populations

Numerous spatial data sets, including capture, survey, and oceanographic data, are relevant to fish populations and can be analysed with GIS. Decisions about management can be made using the patterns and trends seen in fish populations, habitats, and distribution.

Mapping Marine Habitats

Coral reefs, seagrass beds, and kelp forests are examples of marine environments that can be mapped and categorised using GIS. This can be used to determine the locations of crucial fish and other marine life habitats as well as evaluate the state of those habitats.

Evaluating Which Fish Species Are Most at Risk from Climate Change

GIS can be used to track fish and other marine life by utilising satellite tracking data and telemetry. Decisions about management can be made by using this information to comprehend the distribution and movement patterns of fish populations.

Creating Protected Marine Areas

Management of fisheries: GIS can be used to develop management plans for fisheries, which include managing fishing operations and designating marine protected zones.

Examine How Fishing Affects Marine Ecosystems

Models and maps that evaluate the effects of fishing on marine ecosystems can be made using GIS. This can involve the effects on marine habitats, fish populations, and the ecosystem's general health. It is possible to detect illicit, unreported, and uncontrolled fishing by keeping an eye on the movements of fishing vessels and the locations of fishing equipment.

Forecast the Algal Bloom's Growth

In order to prevent and lessen dangerous algal blooms, as well as to assist water management choices, GIS can be an effective tool for forecasting the growth of algae in a body of water. GIS may be used to track changes in water quality, such as pH, temperature, and nutrient levels that may cause algal blooms.

Evaluation of Fish Stocks | Locate Possible Fishing Areas

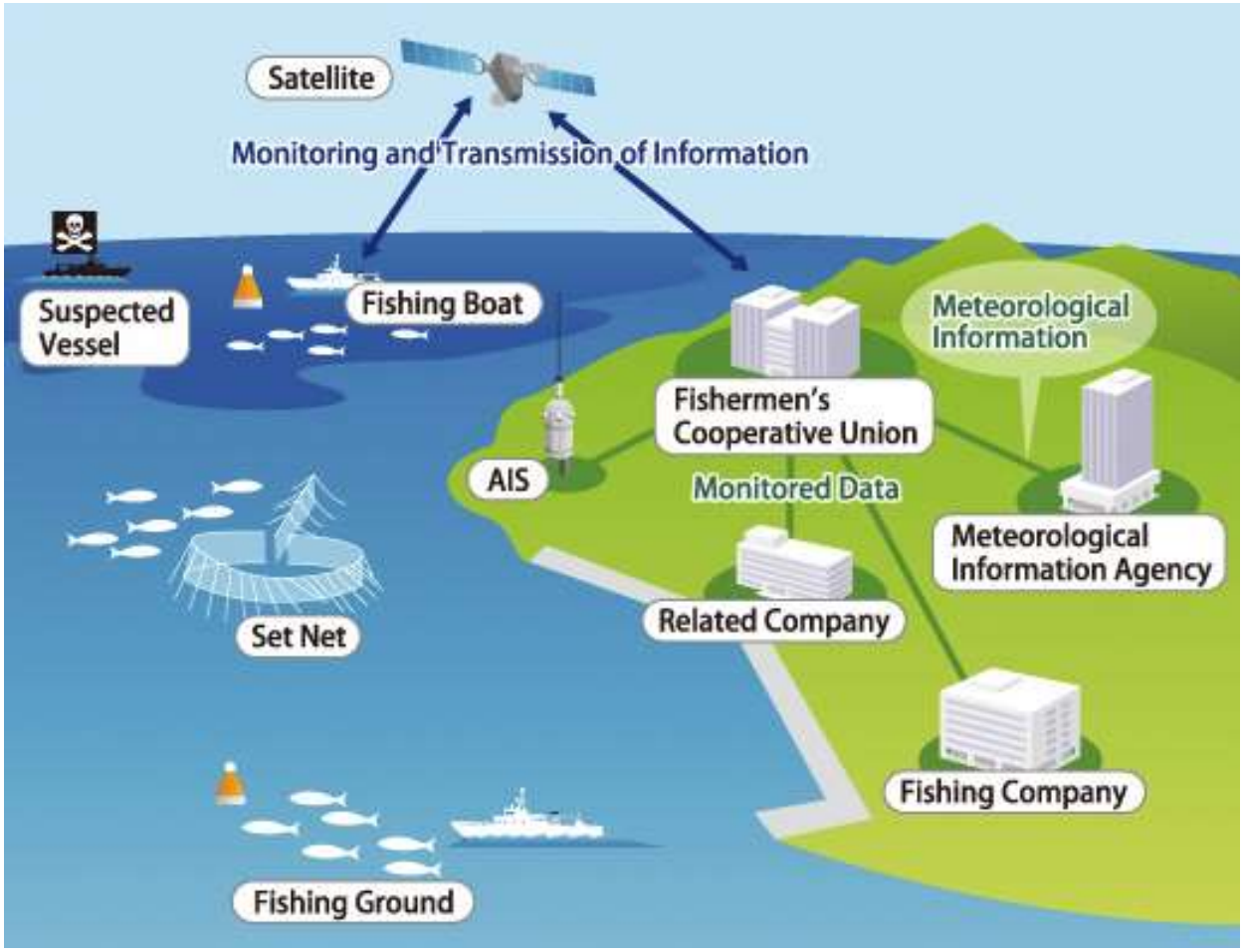
Fish stock movements may be monitored using GIS in a number of methods, including:

Telemetry: Fish movement data from telemetry devices, such satellite and acoustic tags, may be mapped using GIS. Researchers can receive location data from fish that have these tags implanted to them. GIS may be used to evaluate this data and produce fish movement maps and visualisations.

Satellite imagery: GIS may be used to evaluate satellite data and follow fish stock movements. This may involve tracking changes in these locations over time and identifying regions with high fish densities using imaging.

Catch data: Fish migration patterns may be found by analysing capture data, such as records from commercial fishing, using GIS. This might involve figuring out where there is a lot of fishing pressure and evaluating how fishing affects fish populations.

Oceanographic data: GIS may be used to examine oceanographic data, including salinity and temperature of the water, to determine which regions are ideal for a given type of fish. This may be used to monitor fish stock migrations in response to alterations in ocean conditions.



GIS in Marine Fisheries Management

Types of data used in GIS:

Spatial data: The geographic position, shape, size, orientation, and limits of features found on the surface of the earth, such as lakes, forests, mountains, town boundaries, etc., are contained in this data, which is accessible in raster or picture form. Another name for it is geographical data.

Non-spatial data or Tabular data: Another name for it is attribute data. It contains detailed descriptions of geographical aspects, such as how India is split into different states, natural areas, populations, and religions, among other things. The data is organised in tabular style since these variables are not affected by India's geographic location. (M. F. Panthi and Ashish Hodar, 2021).

Advantages in the application of GIS:

- **Enhanced communication:** Maps and visualisations based on geographic information systems (GIS) assist comprehension in various contexts. These are the kinds of words that facilitate better communication inside and across various departments, fields, professions, teams, organisations, and the general public.
- **Improved decision-making:** GIS is a tool that helps with location-related decision-making. Real estate site selection, route selection, evacuation planning, conservation, resource exploitation, etc. are typical examples.
- **Cost savings through increased efficiency:** Maintenance schedules and fleet movements are regularly optimised with the help of GIS. By using less gasoline and staff time, typical implementations may save operating costs by 10–30% while also improving service through more effective scheduling.

- **Improved record keeping:** One of the fundamental responsibilities of many organisations is to keep accurate records on the status and changes in geography. With comprehensive transition assistance and reporting capabilities, GIS offers a robust foundation for handling these kinds of information.
- **Managing geographically:** Knowing what is and will happen in geographic space requires a grasp of geographic information systems, or GIS. After it is comprehended, suitable measures could be suggested.
- **Quick information retrieval:** Since GIS uses computers to do information retrieval, it is quicker. Traditionally, information is retrieved from maps by browsing them. Information retrieval is considerably simpler and automated in GIS.
- **Interactive and virtual output:** GIS allows for the preparation of interactive and virtual output. In the event that the component mappings are changed, the virtual output is updated automatically. The output from the convention technique is created in hardcopy. Maintaining these kinds of maps is hard. (M. F. Panthi and Ashish Hodar, 2021).

Disadvantages of GIS:

- The department will probably be impacted by the GIS implementation, which will call for organisational changes. This method could produce "losers."
- Whether it comes to digitising, obtaining pre-existing digital data, or putting up and managing data gathering systems, data inputs will surely be costly. Now, the costs can come as a surprise. Because of this, figuring out the real advantage of using a GIS is difficult.
- There will be restrictions on the techniques and degrees of access to data sources. Sometimes the law is confusing or too stringent on this. There are copyright concerns when releasing newly created data to the public. (Butler, R. 1988).

Major obstacles to GIS use in fisheries::

Spatial and temporal variability is a significant barrier to the use of GIS in the maritime environment. Biological activity and spatial scales are often erratic. For instance, there might be significant differences in the temporal and geographical life cycle patterns of fish species. In the water column, fish species can migrate both vertically and horizontally. Features in the maritime environment are extremely dynamic, in contrast to the terrestrial environment where features have relatively stable geographic positions. Before analysis is done, marine data may become out of date. To identify certain patterns, the sources of spatiotemporal variability must be located and taken into consideration. For marine fisheries, data collecting is also quite expensive. It is challenging to gather data related to fisheries management in the maritime environment, particularly farther offshore. Socioeconomically speaking, marine fisheries are also quite different. Diverse sectors, sizes, gear types, locations, mobility, target species, and total capital investment can be found in a single fishery. The worldwide fisheries are diverse, which complicates the use of GIS in management applications. The overall field of GIS is undergoing advances that happen too quickly for the ordinary worker to keep up with, which results in a very high rate of system obsolescence. There are currently no global standards for GIS data that would facilitate seamless data transmission across nations and systems. Finding out exactly which databases exist or what the accessibility guidelines are remains a difficult task. (M. F. Panthi and Ashish Hodar, 2021).

AI GIS:

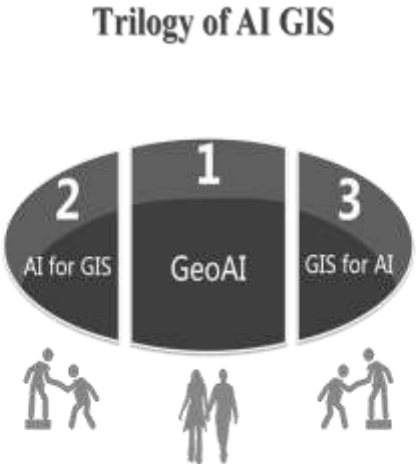
These days, artificial intelligence GIS (AI GIS) technology is a major area of research. However the majority of studies only address one or a few application scenarios; they seldom ever investigate and explore the AI GIS technology system, and a review and synopsis of the AI GIS software technology system is insufficient. AI GIS is a phrase used to refer to a set of technologies that enable AI and GIS in tandem. It combines AI technology with different GIS tasks, such as spatial data processing and analysis algorithms (GeoAI) that use AI technology. Over the past few years, AI GIS has steadily taken center stage in geoscience applications and research. (Song Guanfu, 2020). With its help, we may find previously unknown patterns in geographic data, turning landscapes into spatial intelligence libraries. To put it simply, machine learning finds patterns in noisy data that you would not have imagined to exist.

Trilogy of AI GIS

AI GIS technology consists of 3 parts:

GeoAI: It is a spatial data processing and analysis algorithm that integrates AI, and is the product of AI and GIS.

AI for GIS: Using AI capabilities to enhance the functions and user experience of GIS software.
GIS for AI: Using visualization and analysis technology of GIS to perform spatial visualization and further spatial analysis of AI output results. (Song Guanfu 2020)



CONCLUSION

Applications of geographic information systems (GIS) to fisheries management have undoubtedly advanced scientific understanding and made it possible to identify significant temporal and geographical trends within fisheries. The use of Geographic Information Systems (GIS) in aquaculture and fisheries has increased dramatically in recent years. With the use of cutting-edge technology, GIS has established a significant presence in the identification of fishing areas' geographical locations, the creation of digital databases featuring improved methods of presentation such as maps, graphs, diagrams, and layer illustrations, and the analysis of species databases with oceanographic environments to preserve the marine ecosystem and preserve marine biodiversity. However, its applicability to scenario testing and socioeconomic research in marine fisheries is still unclear. However, there are a lot of challenges with GIS applications in the maritime environment. The maritime environment has seen a slower development of GIS applications than the terrestrial environment, despite the rising demand for these applications in fisheries management. The potential for using GIS in fisheries management applications is endless. Fish populations may be sustained to a large extent with the use of GIS. Fish distribution, abundance, and habitat modelling, as well as capacity estimation, are all very amenable to GIS modelling. Enhancing the educational, experiential, and data-accessible options for fisheries scientists regarding GIS technology and data might potentially maximise this potential. One efficient way to address the present intelligence problem of GIS system is to use AI GIS to construct and enhance the next generation of GIS technology system.

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