GIS applications in aquatic environment

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What is GIS?

Geographic information system (GIS) is a tool for making and using spatial information and it is mainly concerned with location of the features as well as properties/attributes of those features. It helps us gather, analyse and visualize spatial data for different purposes. A GIS quantifies the locations of features by recording their coordinates which are the numbers that describe the position of these features on Earth. The uniqueness of GIS is its ability to do spatial analysis. GIS helps us analyse the spatial relationships and interactions. Sometimes, GIS proves to be the only way to solve spatially-related problems and it is one of the most important tools that aid in decision making process. GIS basically helps to answer three questions; How much of what is where? What is the shape and extent of it? Has it changed over time?

Globally, on an average, GIS tools save billions of dollars annually in the delivery of goods and services through proper route planning. GIS regularly help in the day-to-day management of many natural and man-made resources, including sewer, water, power, and transportation networks. Applications of GIS in marine and coastal ecosystem study is an emerging field today. GIS help us identify and address environmental problems by providing crucial information on where problems occur and who are affected by them. It also helps us identify the source, location and extent of adverse environmental impacts. GIS enable us to devise practical plans for monitoring, managing, and mitigating environmental damage. Human impacts on the environment, conflicts in resource use, concerns about pollution, and precautions to protect public health have spurred a strong societal push for the adoption of GIS.

GIS is composed of hardware, software, data, humans and a set of organizational protocols. The selection and purchase of hardware and software is often the easiest and quickest step in the development of a GIS. Data collection and organization, personnel development and the establishment of protocols for GIS use are often more difficult and time consuming endeavours. A fast computer, large data storage capacities and a high quality, large display form the hardware foundation of most GIS. GIS software provides the tools to manage, analyse, and effectively display and disseminate spatial information. GIS as a technology is based on geographic information science and is supported by the disciplines like geography, surveying, engineering, space science, computer science, cartography, statistics etc.

In GIS, we handle the spatial and attribute data sets. Spatial data describes the absolute and relative location of geographic features while the attribute data describes characteristics of the spatial features. These characteristics can be quantitative and/or qualitative in nature. Attribute data is also referred to as tabular data. Vector and raster are two different ways of representing spatial data. Raster data is made up of pixels (or cells), and each pixel has an associated value. A digital photograph is a simple example of a raster dataset where each pixel value corresponds to a particular colour. In GIS, the pixel values may represent elevation above/below sea level, or chemical concentrations, or rainfall etc. The key point is that all of this data is represented as a grid of (usually square) cells. Vector data consists of points, lines, and polygons. The

individual points are stored as pairs of (x, y) co-ordinates. The points may be joined in a particular order to create lines, or joined into closed rings to create polygons, but all vector data fundamentally consists of lists of co-ordinates that define vertices, together with rules to determine whether and how those vertices are joined.

As with many other systems, GIS basically works on the principle of '*GIGO'* that is *garbage in garbage out*. Hence the quality of data that you feed into GIS is very important and it determines the quality of the end products. But, when used wisely, GIS can help us live healthier, wealthier, and safer lives.

Examples of GIS applications in aquatic environment

GIS can play an important role in the monitoring and management of aquatic environment. GIS is ideally suited as a tool for the collection, collation, analysis and visualization of data derived from diverse sources including those from distributed measurement stations (e.g. field-based water quality sensors). The ability of GIS to aggregate data from various inputs and present them in map form is unique and helps in strengthening the awareness about the conditions of our environment. GIS is also a valuable tool in the decision-making process.

Monitoring of environmental parameters

The environmental parameters like temperature, salinity, dissolved oxygen, nitrate etc. are very important and affect the species distribution and abundance of that aquatic system. GIS helps to analyse and make the depth and time profiles of different aquatic environmental variables which in turn aid us in better understanding the nature and properties of the system under study. For example, contour plots of temperature and salinity profiles of the coastal waters help us to understand the process of coastal upwelling in a better way.

Applications in habitat mapping and change detection

Remote sensing, due to its advantages like synoptic view, multispectral data, multi-temporal coverage and cost effectiveness, plays a major role in habitat mapping and change detection. It has proved to be a practical approach to study complex geographic terrain types and to collect data from diverse, inaccessible ecosystems. Integrated GIS and remote sensing have already been successfully applied to map and monitor marine and coastal ecosystems. Satellite imagery is available for most of the world since 1972, with the launch of LANDSAT by USA. This treasure trove of information help us to map and monitor the changes that happened to our coastal areas like land reclamation, destruction of mangroves, shrinkage of estuaries, lakes and other water bodies that are directly linked to fisheries. The multi-date nature of satellite imagery permits monitoring dynamic features of landscape and thus provides a means to detect major land cover changes and quantify the rates of change. GIS and remote sensing are widely used to monitor and map the habitats namely seagrass/seaweed/coral reef.

Aquaculture site selection

A suitable site is a pre-requisite for any successful aquaculture activity. Optimal aquaculture sites aids in better management of the resources and ensuring sustainability of the farming

activity. There are lot of reported works on the identification suitable sites for aquaculture using GIS. There are many criteria, guideline and essential factor for selection of site for aquaculture. The parameters such as reported water flow, volume availability, water quality, weather parameters, access and location of utilities, topography of site, slope of land, legislation concerning water rights etc. goes into the decision making process. GIS offers the best platform to combine all these information and identify the areas that qualify optimal set of parameters which would be the best suited areas for aquaculture. Weighted overlay is one of the most used operations in GIS in such analyses.

There are many more applications of GIS in the field of aquatic environment and the reader is advised to go through the references sited below to get an idea about the use of GIS in general and in the study of aquatic environment.

References

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