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Commentary Article

Role of Geospatial techniques in Sustainable Management of Fisheries- A Review

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Abstract:
Fisheries is one of the natural resource of the world which contributes to agro-economic development, food security and foreign exchange earnings for both economic values and human sustenance and sustainable livelihood generation. The Fisheries productivity around the world has been declined due to global ecosystems are under pressure. Overexploitation and unregulated fishing, habitat degradation, pollution, climate change are threats to sustainability of fishery resources which causes significant spatially variable effects on aquatic environments that are best managed through use of Geospatial techniques. The study aims to explain importance of geospatial techniques such as remote sensing, geographic information system, and global positioning system helps in better planning and sustainable management of fisheries.

Keywords: Geospatial techniques, Remote sensing, Geographic information system, Global positioning system, Fisheries, Management

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Introduction

In global economy Fisheries play an important role to eliminate hunger and malnutrition through supplying fish and other products rich in protein, essential fatty acids, vitamins and minerals and can also make significant contribution to development by providing employment generation and increasing returns on resource use. In fisheries and aquaculture value chains in roles such as processing or marketing where millions of people are employed globally, for their livelihoods and can be a driver for rural development by mitigating risks to livelihoods and contributing to income generation and employment, has huge potential to enhance food security and be environmentally sustainable. (World fish organization, 2019).Site is one of the crucial component in location of fishery resources. It includes suitable qualities of soil, water, land use, land cover, topography and infrastructure facilities. (Ashok, 2014). During the past decades production of global capture fisheries was relatively stable and Aquaculture continued to increase (FAO, 2009). Fish stocks are becoming increasing under depletion in the world which recognizes that 57 percent are fully exploited, 30 percent overexploited and 13 percent are not fully exploited (FAO. 2012 and Ndour. 2014) which leads to exploitation of resources and creates social and economic problems. Overfishing threatens the sustainable livelihood and leads to food insecurity, poverty and unemployment (FAO, 2018b).

For management of fisheries, Geospatial techniques includes digital multidisciplinary tools contributes geographic mapping and analysis of earth system, resources and their interaction with human societies which provides significant input for management and analysis of huge volumes of data that allows better understanding of environmental processes to ensure sustainable development. The use of Geospatial techniques such as Geographic information system, Global positioning system and Remote sensing for fisheries aims to identify,analyze and possible allocation of specific geographic area to be used for fisheries which support sustainable utilisation and management of fishery resources and increases the productive capacity of fisheries. The 2030 agenda for sustainable development also prepare objectives towards contribution of fisheries and aquaculture for food security and nutrition and sector use of natural resources in a way that ensures sustainability in economic, social and environmental terms within the context of FAO Code of conduct for Responsible fisheries (FAO,1995) and its challenge is sustainability divide between developed and developing countries which led to increased economic interdependencies, limited management and governance capacity in developing countries. The global community needs to support developing countries to achieve their full fisheries and potential of aquaculture in order to eliminate the disparity for progress towards the target for restoration of overfished stocks by 2030 agenda of sustainable development. (FAO, 2019). Southeast Asian fisheries Development center aims to effective utilisation of FGIS and remote sensing to improve management of fisheries in Southeast Asia which put into effect during the year 2020 to 2024. To achieve Food Security for the ASEAN Region, ASEAN-SEAFDEC Resolution on Sustainable Fisheries for Food Security towards 2020 also adopted in June 2011.

Geospatial tools can be used very effectively for monitoring goals in achieving sustainable development which can provide a strong basis for policy making to promote sustainable development in communities at local and regional levels (United Nations Secretary, 2016) that provides a synoptic view with global and local coverage at various spatial resolutions and can be used to monitor the impact of climate change on different components of aquatic and terrestrial ecosystems(Maso et., al 2019 and Avtar et., al., 2013). Space technology plays an important role in monitoring and reliable geospatial information for sustainable development policy making, programming and project operations (United Nations, 2012a). Group on Earth observations (2015) launched an initiative known as Earth observations for sustainable development in service of the 2030 agenda .Geospatial techniques provides accurate and reliable information such as monitoring and protect fragile ecosystem, manage climate risks, enhance food security, reduce poverty and improve governance among others. Geospatial information and Earth observation from satellite, airborne and in situ sensors together with modern data processing and big data analytics offer unprecedented opportunities to modernize national statistical systems and consequently to make a quantum leap in country capacities to track efficiently all components of sustainability. Geospatial tools helps to identify geographical location of fishing regions and aims to protect and conserve biodiversity. United Nations Committee

on Global Geospatial information Management (2011) aims to make the use of geospatial technologies for sustainable development to address regional, national and global challenges. Geospatial techniques is a useful tool for biodiversity studies, resource mapping, temporal and spatial variations in fish production distribution, abundance, habitat, and estimating future capacity of fishery resources and support the decision making progress (Dineshbabu et al; 2012, Thomas etal ;2014).

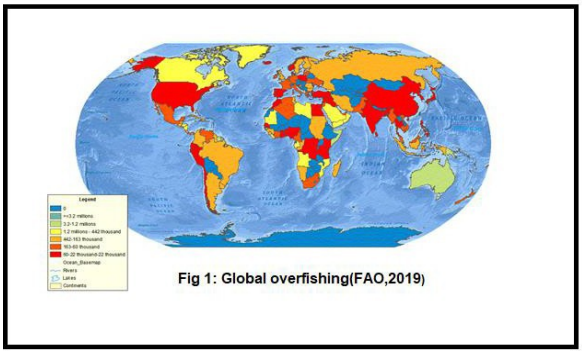

Fig 1: Global overfishing(FAO,2019)

MATERIAL AND METHODS

In this study literature review method was used which includes articles and publications that are related to the theme. We conduct a systematic literature identified through role of geospatial techniques in sustainable management of fisheries. For the purpose of this review, both bibliographic and citation databases were the fruitful sources of information such as HEAL-LINK, Pub Med, Google Scholar, Scopus material, Science Direct and web of science.

Geospatial techniques

Geospatial techniques such as Remote sensing, Geographic information system, Global positioning system which revolutionized natural resource management over a period of time and are capable of handling spatial data. Remote sensing can be defined as measurement of object properties on earth surface using data acquired from aircraft or satellites, provides a repetitive and consistent coverage of earth which monitors land surface changes, natural resource management and impact of human activities on earth(Joseph, 2005 and Schowengerdt,2006). It acquires and analyses information about objects or phenomena from distance by making use of electromagnetic radiation for the purpose of improving natural resource management, land use and the protection of environment (United Nations, 2002 and Jenson, 2000). It provides reliable information regarding spectral, spatial and temporal information about physical objects and environment through the process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from sensor systems (American society of photogrammetry and remote sensing, 2015). Remote sensing detects and classify objects on earth surface as well as in atmosphere and oceans based on propagated signals (electromagnetic radiation).

The sensors used in remote sensing are Active and passive sensors. Active sensors sends out its own electromagnetic radiation at a specified frequency and wavelength to the target on the ground and then samples the portion of reflected energy from the objects through its detecting devices. Synethic aperture radar is a typical example of active sensors and passive sensors makes use of the energy from some natural sources such as emitted and reflected radiation which it receives from the sun and does not have its own source of energy which can be analog and digital. Important passive analog sensor is aerial camera which produces high quality aerial photograph for topographic and thematic mapping which can be converted to digital form for input to computer. For this purpose high accurate photogrammetric scanners are used. In passive digital sensors a scanner like multispectral scanners, linear, area sensors and spectroradiometric sensor are used.

Geographic Information System can be defined as a system of hardware, software and procedures designed to support for capture, retrieval, manipulation, analysis and display of spatial data for solving complex planning and management problems and are computer based systems that can deal information regarding features that can be referenced by geographic location which are capable of handling both locational data and attribute data about features (USGS, 2005 and Rhind, 1989). It stores, analyses and displays both spatial and non-spatial data which involves integration of geographical referenced data in a problem solving environment (Parker and Cowen 1988). It allow users to store retrieve and manipulate data and is considered as database management system integrated with a series of routines allow and display sophisticated spatial analysis (Burrough, 1986).It includes integration of large datasets and organizes spatial information to produce and manage maps that have been created in digital format and is a tool for querying, analysing and producing maps to support decision making process.(Graaf, Jeness 2003).Ground

positioning system is a satellite ground based navigation system from a constellation of 24 satellites and their ground station and location system that enables user to determine accurate locations on earth surface which consists of space segment, user segment and receiver segment and is important source of spatial data collection (Henry et al, 2011 and Al- Mardi, 2014) . The principle of GPS is based on triangulation which provides continuous three-dimensional positioning 24 hours a day throughout the world and has a tremendous importance in GIS data collection, surveying, and mapping.

Importance of Geospatial techniques in sustainable management of fisheries

Geospatial techniques plays an important role for management of natural resources and sustainable management of fisheries. The potential of GPS plays a key role for improving productivity of fisheries and can be used to identify fishing hotspots, track patterns of migration, spawning locations and preferred habitat using NOAA AVHRR SST (Goddard et al 1995; Gaffar, 1996). In inland fisheries geospatial techniques involves role of spatial decision making which emphasis importance of spatial data. It involves physical, biological, social or economic in guiding decisions about fisheries management and planning and identifies function of spatial variable production and necessary data to explain and converts these data into thematic and derived maps in a GIS and provides locations for fishery production. (Meaden and Kapetsky 1991). GIS including mapping, distribution, abundance of fish species and modelling habitat in rivers, reservoirs and lakes (Caton and fisher 2007, kailola and Hollingsworth, 2004). Geospatial techniques (GIS, GPS, and RS) in inland fisheries provides a mapping, visualization, efficiently allocate resources for fisheries. It aims to identifying land use land cover types, physiography, and elevation, hydrography and water body relating these features to fish population and communities which allows for integrated fisheries management and mapping fish locations and movements and provides information for management of fish habitat. It is essential tool for determining marine allocations and identify ecosystems disequilibrium and to predict and depict scenarios for improved management practices (fisher, 2007 and Meaden Megrey, Moksness 2009).

GIS and GPS is an important component for site suitability analysis which includes soil, slope, vegetation, and water quality that plays an integral role for decision making and management of fisheries (Radiarta et al .,Saitoh, Yasui, 2011).NAVIC (Navigation with Indian Constellation) developed by ISRO enabled communication devices provides position, navigation and timing services to fishermen which aims to improve the safety of fishermen and strengthen the capacity to reach out to them quickly in case of unexpected calamities in regions of coastal area in India. The application of GIS in fisheries aims to classify and mapping of suitable habitats , potential fishing grounds, monitoring water quality, pollution ,fish movement, fluctuations in water levels, distribution of fish mapping, change and monitoring of shorelines(Kale 2014, Ascarli 2017). In Aquatic environment GIS has great potential for fisheries management especially in reservoirs for visualizing marine spatial data and marine biodiversity. (Kale, Ozen 2014 and Paukert, Fisher 2004).GIS in inland fisheries has commonly augmented since late 1980 and in marine environment, GIS technology has been commonly used. In Srilanka, to explain relationship between yield of fishery and environmental parameters where GIS was used to integrate fishing intensity, fisheries yield data and limnological data (De silva, Amarasinghe, Nissanka 2001).

Remote sensing need to be integrated with Geographic information system for predicting productivity which estimates characteristics of aquatic environment by collecting chlorophyll concentration from satellite imageries (kale and Acarli 2018).GIS Fish obtains depth and breadth of global experience and is one stop site on GIS and remote sensing and mapping as applied to aquaculture and inland fisheries that have contributed to solving important problems that affect sustainability of aquaculture and inland fisheries (Manjarrez and Kapetsky , 2006). Remote sensing and GIS tools monitors fishing effort, tracking pollutants, mapping bathymetry and seabed habitats and providing measurements of physical and biological properties in water column(caroccietal.,2009).

Remote sensing provides comprehensive understanding on fish distribution, abundance, migration necessary for monitoring and management of ocean ecosystems and aims to identify potential zones of fishing (Stuart et al 2011).IRS LISS II data set was used for revealing wetland features and site selection for brackish water aquaculture(Nayik, Singh ,Kumar 2010).

IRS LISS III with Panchromatic (PAN) merged data can also be used for identification of fishing zones in marine and coastal biodiversity (Nayak et al. 1996; Shah et al. 2005). SAFARI (societal applications in fisheries and Aquaculture using Remote sensed imagery initiative in 2007 and intergovernmental GEO aims to provide comprehensive coordinated earth observations such as improvement and management of terrestrial,

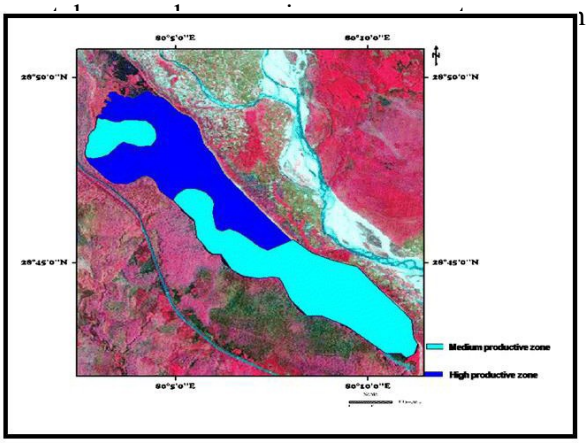

Fig 2. Fishing zones of Sarda Sagar Lake in Uttar Pradesh (Kumar et al. 2008)

CONCLUSION

Geospatial techniques aims to socioeconomic and environment sustainability for sustainable management of fisheries and could serve as an important tool for managing various sources of information that could be used as basis for formulating appropriate management monitoring, control and surveillance programs and is useful for forecasting fishing grounds and reduce the inefficiency in fishing activities, GIS and remote sensing aims to inventorization of fishery resources for a suitable site analysis and enhances the fish production with socioeconomic development and ecological stability and plays an integral role for sustainable development and fisheries management.

Conflict of interest: The authors confirm that this article content has no conflict of interest.

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