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Importance of Participatory GIS (PGIS) Tool in Marine Fisheries

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Public Participation GIS (PPGIS)/Participatory GIS (PGIS) is a term that has been coined to express the adoption of GIS to empower indigenous and local communities. Through this the stake holders with contribution of their traditional knowledge and experience are directly involved in the planning and decision making on agriculture, forestry, fisheries, animal science *etc*., Most of the planning in rural and urban development, agriculture and forestry are being explained on the basis of mapping. So it is imperative that the stake holder should have say into the policy making and they should understand the significance of mapping. It is believed that without access to GIS and its analytical capabilities and popular appeal, ordinary people would find it difficult to respond to official policies that alienate them. PGIS initiative focuses on generic issues such as empowerment and equal representation. The movement represents the vision of GIS practitioners who have developed an interest in the socio-political contributions that the technology can make to empower less privileged groups in society. PGIS is therefore about the role of GIS in a broader consideration of the empowerment of communities. Recorded benefits of PGIS projects thus include advocacy of popular causes, a better understanding of local issues, and accessibility of communities to digital spatial information.

Some of the classical concept of the authors working on the possibilities of GIS in socio economic development are given below:

- Geospatial technologies place an inordinate amount of attention on quantitative data at the expense of qualitative information. They are also prone to obscure technical processes that go into the generation and representation of spatial data ("garbage in, garbage out"), leading to misinterpretations about their accuracy and validity (Pickles 1995).

- Geospatial technologies play a central role in surveillance, warfare, and invasion of privacy by government and business, which calls into question their scientific neutrality and objectivity (Curry 1995, 1998).
- Scientific researchers and policy makers have an ethical responsibility to ensure that geospatial technologies are developed and applied in ways that make them accessible to all communities, particularly socially disadvantaged groups, and that promote justice and progressive change in society (Chrisman 1987, 2005; Harris and Weiner 1998; Schuurman 2000).
- GIS is not simply a branch of information science of interest only to technology specialists. Over the last four decades, GIS has literally transformed how political, economic, cultural, and legal institutions function in the United States and around the world. It also has brought on a revolution in earth science, planning, and development research (Dobson 1993; Goodchild 1992).
- Given its importance, GIS cannot be analyzed simply as a technological phenomenon, but must also be understood in terms of its social context and the implications of its use (Harris and Weiner 1998; Poore and Chrisman 2006).

Throughout the world, there is a variety of systems that are employed to manage access to natural resources including private property rights, open access rights and community property rights. One of the PGIS mapping of coastal area of Caribbean coast of Central America is given as an example in Fig.1. Much of its coastline of Mosquitia is composed of lagoons, estuaries and mangroves fronted by miles of sparsely settled beach. This mapping was carried out to understand the resource availability, land use the human settlement and the status of forest cover, forest degradation etc., with the involvement of local population. With this PGIS mapping, policy makers could chart out programs for the overall socio economic development of the region and also could come out with measures for people participatory resource conservation.

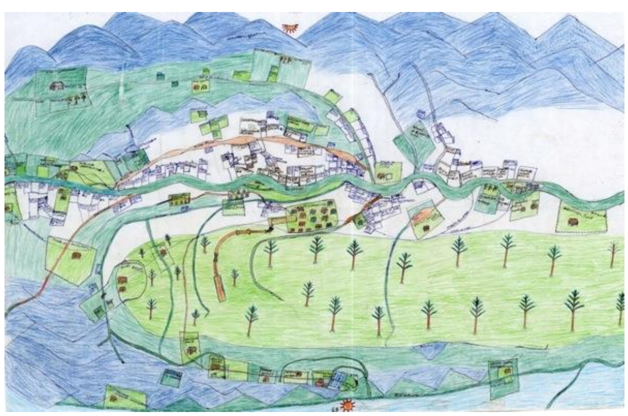

Figure.1. PGIS mapping of Río Patuca, the largest river system in the Honduran Mosquitia of Caribbean coast of Central America.

(Ref: David M. Cochran, Jr. (2009) Placing geographic power in the hands of the people: the potential for participatory GIS in economic development, Journal of Applied Research in Economic Development , Volume 6, issue 2, 2009)

For sustainable agriculture in India application of PGIS was proposed as an effective tool creating spatial data base on natural and socio-economic resources with the participation of farmer community. In Indian agriculture sector, there is a coordinated effort being experimented in which farmers are contributing the information regarding physical and chemical properties of the soil, water availability and irrigation facility, crop pattern in their land holding with the geo-location (latitude and longitude) to the policy makers and researchers. This in turn enable the researchers and policy makers to integrate the information to come out with solutions regarding fertilizer requirement, irrigational needs and appropriate crops for the soil and cropping pattern in GIS mapping in wider scale. This coordinated program with geospatial information eventually help in strengthening the database and there by the overall development of the region. More the involvement of the farmers, the better resolution was observed in database which helped in more precise mapping of each component. This participatory effort in GIS platform is leading to tremendous impact in agricultural sector. Similar PGIS activities help the government agencies to understand the needs of the region with minimum expenditure. Offlate the PGIS is used in fisheries in various countries which is generally limited to aquaculture and livelihood related issues in fisheries sector. In India classic example of PGIS in fisheries sector is demonstrated in Chilka lake fisheries (Mishra, 2010).

Agriculture is a land based activity and the resources have specific geo-spatial address. The farmers are more organized sector and the managers and policy makers in agriculture are often have the opportunity to check the validity of the data with onsite inspection. Unlike in agriculture, fishery managers and policy makers in marine fisheries sector have little chance in conducting onsite observation in the fishing grounds where commercial fishing operation is going on. Fish landed at fisheries harbours are not representing the resource status of the fishing ground, since only a portion of the catch which is commercially important is brought to the shore and rest is discarded for which no information is available. Unless the fishermen themselves decide to contribute the information to the government agencies, the government agencies which are involved in the policy making in fisheries sector had to depend on the information available from secondary sources which often lack the sea truth. Many of the prediction models on the fishery potential and determining sustainability issues are based on the data available for the analysis and the accuracy of the predictions and related restrictions on fishery depend on the accuracy of the dat available for the analysis. Fishermen are the majour stakeholder who is impacted by marine fisheries regulations and also due to lack of it. So it is the responsibility of the fishermen to provide the most accurate sea truth data for the researchers and policy makers to have most appropriate policies which reflect the reality. In present fishing scenario it is absolutely impossible to have an Institutional mechanism to collect spaio-temporal data on the fisheries resources. Due to these intricacies in data collection, practice of participatory GIS program extremely important and effective tool in marine fisheries management. This will enable the fishermen to impart effective influence in decision making in fisheries with their traditional know how and the actual fishing information. In Indian fisheries scenario where the sea is considered as common property any regulation in marine sector can meet success only with the cooperation of fishing community. For this tools like interactive maps are effective. Geographic information science can provide useful and powerful tools, by which fishermen themselves could decide about future and the projection made out of the GIS information could illustrate the probable fate of the fishery if it is continued in present state. PGIS will act as a “community based natural resource management (CBNRM)” for overcoming present management obstacles and for establishing sustainable resource management policies.

With rapid technological development, marine fisheries production from coastal waters of India reached almost its predicted potential. There is an immediate need for management interventions to make the production sustainable and to conserve the marine living resources. It is a fact that most of the management options evolved during different periods of fisheries development for sustaining marine fisheries did not yield the desirable results because of non-acceptance and non compliance of management regulations by the fishermen. Enforcement of regulations was not successful as the fishermen believed that the policies do not represent ground realities and research findings were not presented in a convincing manner. Trawlers are the major mechanized fishing fleets which contribute to the fisheries production especially along the west coast of India. Analysis of Indian marine fisheries production trend showed that 80% of the marine fisheries catch was from trawlers and during last decade trawlers are further equipped with modern gadgets and more engine capacity to fish more vigorously leading to increased contribution from these fleets. Intensity of trawl fishing has a vicious impact on benthic ecology and biodiversity. Ever since the operation of fishing fleets extended beyond 30m to 50m, spatial characteristics of the fishery remained unknown for the researchers and policy makers and without incorporating the knowledge about the spatial distribution of fishes, no fishery management policies were comprehensive. In this scenario data sharing of spatial component of the fishing ground and fishery by the fishermen has become a crucial component in the formulation of acceptable fishery management policies. Participatory approach in fisheries research can provide most of probable solution in fisheries management by providing illustrative research support in spatio-temporal fishing effort restriction, avoidance of juvenile exploitation, reducing the bycatch and applications of ecological and trophic relations in fisheries management. The analysis of the data also provide information on fish assemblages, biological loss due to bycatch/discarding, spatio-temporal biodiversity changes in fishing grounds. Ignoring the spatial component often ads to inaccurate estimate and often leads to misleading interpretation on the distribution and biology of species like growth, feeding, reproductive pattern etc. GIS is a powerful tool which integrates the spatial component with the present temporal studies. GIS rarely appears within the institutionalized system of science in many countries. Off late fishery scientists are utilizing the possibility of this science and GIS is now being used as a tool for fisheries management and fishery resource conservation measures. Socioeconomic constraints such as levels of education and financial resources with which GIS and allied instruments can be procured and operated, was the major lacuna in incorporating spatial data in fisheries research but the present fishery fleets and fishermen have acquired and got acquainted with GPS, which can give basic input for GIS, which in turn should work as an encouragement for the scientists to incorporate spatial component of the fishery in fishery resource management.

Present day mechanized fishing fleets are equipped with the GPS and other highly scientific gadgets and the need is creation of awareness with regard to the utility of the participatory program. From the participatory trawling experiments in Gujarat conducted by national fisheries research Institutes such as CMFRI and CIFT with participation of fishermen of Gujarat,it was obvious that fishermen are more concerned about the sustainability of marine fish production and they are ready to cooperate with researchers. Mangalore Research Centre of CMFRI conducted participatory research program with trawl fishermen of Karnataka coast and data collected from the research was illustrated in resource maps and the success of this participatory research program, by sharing the geological information and biological information on the trawl fishery. During the participatory research program at Mangalore, fishers shared the information collected in each cruise with the scientists, who is involved in resource conservation and resource management. Data base in resource distribution in different fishing grounds was illustrated with maps time to time to the fishers to make them aware about the importance of their contribution and also to ensure their involvement in the process. Database thus created could act as a handy tool for the policy makers for participatory management policies. The spatio-temporal data on distribution and abundance based on geographic information will enable in evolving policies for the improvement of the fishery in terms of restriction in fishing period, fishing pressure etc. It will also help the policy makers to implement restrictions regarding fishing ground and fishing season on the basis of similar strong database of juvenile abundance in space and time. “No fishing zones” and “marine sanctuaries” can be marked on the basis of spatio-temporal data of fish distribution.

Case study:***Applications of participatory GIS program in fisheries in marine fisheries management and conservation in Indian scenario (based on preliminary studies along Malabar and Konkan coast)***

The case study given below showcases the possibilities of participatory GIS in marine fisheries in India. In this program commercial fishermen engaged in trawling who is having GPS in their boats shared their fishing information and fish samples to the Researchers of Central Marine Fisheries Research Institute for a period of five years from 2007-2012. During this period 1035 days of fishing information and fisheries resource details are collected by the two contributors (fishermen and researchers)of the program. The program could come out with very important informations on the fishing area fishing intensity, resource distribution and biodiversity of the fishing grounds with spatial and temporal variations. Some of the major findings from PGIS program in marine fisheies of Malabar and Konkan coast is given below.

Spatio-temporal distribution of fishes

Till early eighties, when the trawling depth was restricted to 30 to 40 m depth, the species distribution of marine fishes was well understood and documented. But when the fishing depth was extended to deeper waters and fishing operations extended from single day to multi-day, the fish landing data could not provide a distribution of marine resources by depth. Even though experimental trawling provided some useful data, these data were not sufficient to conclude about distribution of fishes. Fishery researchers and managers who is involved in evolving management policies has left with no option other than assuming that the fishes landed were uniformly distributed in the fishing ground. The results from the present study can give the status of distribution and abundance of the resources which can give an additional information for evolving successful management of these resources. Central Marine Fisheries Research Institute, Kochi have a comprehensive time series database on the species caught by trawlers from 1960 onwards, but the spatial distribution of the species in each season was not clearly understood. 246 species of fin fishes/shellfishes were recorded from trawl landing of Mangalore Fisheries Harbour during 2007-2010. The fishing grounds from which the species were caught remained unknown during regular landing based fishery estimations. But the PGIS program provided a definite information on spatio-temporal distribution of many of these fishes. More than 200 species of finfishes/shell fishes and many un-identified fauna like jelly fish, gorgonids, echinoderms, coral fishes, juveniles of shark and ray were recorded from the catch. Spatial distribution of reef related fishes mapped with the information provided by fishermen under PGIS program is given in figure 2 as an example of to show the utility of PGIS tool in resource mapping.

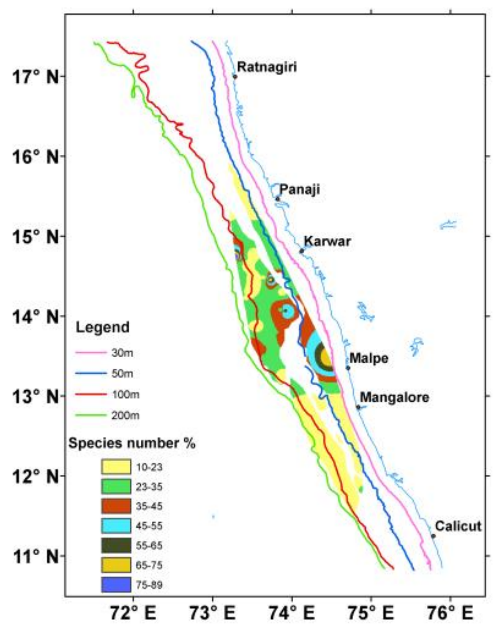

Figure 2. Distribution of reef related species mapped from PGIS program in marine fisheries along west coast of India

Utility in studies of damage assessment in fisheries

These maps when it is drawn by pooling all data points collected irrespective of months/seasons may look less informative, probably giving a picture of overall distribution of species or area of fishing operation. For decision making in fisheries management, monthly or seasonally resource mapping is essential. Based on monthly and annual resource mapping, effort restrictions in particular fishing grounds can be suggested to reduce the resource damage. Intensity of fishing pressure mapped on the basis of the information provided by fishermen under PGIS program is given in the figure 3. This example emphasizes the role of PGIS decision making in fisheries management.

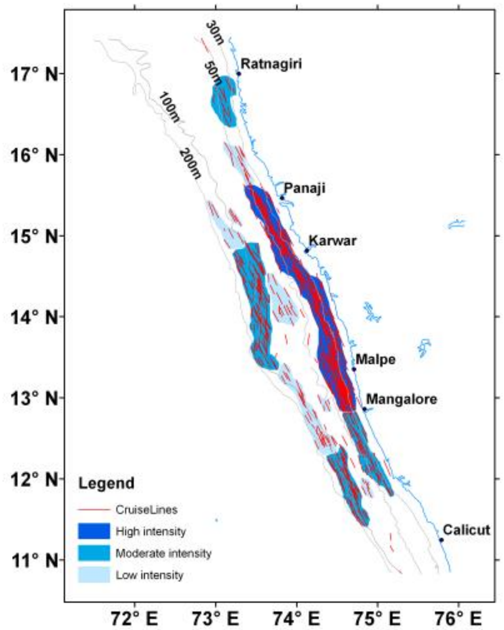

Figure 3. Extend of fishing ground and intensity of fishing at different fishing grounds mapped from the data provided by commercial trawlers operated along west coast of India under PGIS program.

Conclusion and way forward

Spatial and temporal distribution pattern from the catch and discard of commercial trawlers, which use non selective gear (trawls), can give a clear picture of resource distribution in commercial fishing grounds. The data base created in GIS platform with illustrations in the form of maps will work as a tool for the policy makers to find mutually agreeable solution to tackle problems in conserving and managing the fishery with the active participation of fishermen. Today many of the findings by scientific methods could not be presented in a convincing manner to the policymakers and end users, due to incapability of visual projection. GIS can provide visual projection of spatial and temporal distributions and abundance of fish populations and juvenile abundance. The fish populations are controlled by the interactions between organisms and their surrounding environmental characteristics. Hence oceanographic data on temperature, salinity, bathymetry, wind pattern, currents and water mass movement and productivity can be integrated into the routine application of this software. Spatio-temporal distribution of species and its juveniles (species-wise), spatio-temporal resource maps of all species (adults and juveniles) from different fish grounds, fish assemblages with reference to the depth and season, dependencies of different group of fishes, biological loss and biodiversity loss due to fishing can be derived from such studies.

More involvement from fishermen, will fill the lacuna in data faced in the present study, by which multiple spatial data from different fishing grounds for a single day would be possible and the results will be comprehensive. Based on the qualitative and quantitative availability of all these components of the fishery, each fishing ground can be evaluated seasonally in economic and biodiversity terms. Such overall information on fishing ground and resource mapping will enable the policy makers to demonstrate the impact of fisheries to the fishermen in visual format and make most appropriate policies in restricting particular fishing ground in particular period. This participatory decision making could also create awareness, to avoid capturing juveniles without causing much difference in their income. Spatio-temporal resource mapping for long term basis will also help in conservation of human and fuel resources which is spent in search of fishes.

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