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Application of Gps in Fisheries and Marine Studies

C. Hentry* and S. L. Rayar
Department of Physics, St.Jude's College
Thoothoor-629 176,
K.K.Dist ,India
ch_kk_tn@yahoo.com
slrayar@yahoo.com

S. Saravanan, N. Chandrasekar and A. Ponniah Raju
Centre for Geotechnology
Manonmaniam Sundaranar University
Tirunelveli, India
geosaravanan2000@yahoo.co.in, profncsekar@gmail.com,
ponniahraju19@gmail.com

K. Kulathuran
Department of Physics
A.P.A.College of Arts and culture,
Palani, India
pkkmaterials@gmail.com

***Abstract*—** In past decade the rapid Development of Information Technology and Management system has brought the information revolution all over the world. An emerging field of Geo-informatics is playing an effective role in this revolution. Geo-informatics, as an integration of GIS, GPS and remote sensing, is becoming popular with its diversified fields of applications. This paper focuses on the GPS as a tool to study the Geo-informatics on fisheries and marine studies. It covers the satellite based navigation system, location, Navigation, tracking, mapping and timing, GPS receivers, modernization and future scope of the technology. This paper discusses the real world applications of GPS in fisheries and marine studies.

Keywords: GPS, Fisheries, Potential Fishing Zone, Navigation, Mapping.

I. INTRODUCTION

Global Positioning System is a satellite based navigation system determining the accurate position or location of an object on earth's surface. It stands for NAVSTARGPS (Navigation Satellite Timing and Ranging Global Positioning System). A GPS receiver's job is to locate four or more of these satellites, figure out the distance to each, and use this information to calculate its own location. This operation is based on a simple mathematical principle called triangulation. In a sense it's like giving every square block on the planet a unique address. When people talk about a "GPS", they usually mean a GPS receiver in order to calculate the exact position on earth. GPS receiver measures the signal transit time between the point of observation and four different satellites whose positions are known. Each satellite transmits its exact position and its precise on board clock time to earth at a frequency 1575. 42 MHz. These signals are transmitted at the speed of light (300,000 km/sec) and therefore require approximately 67.3 m/s to reach a position on the earth's surface located directly below the satellites. Further 3.33micro second is required for the signals for each excess kilometre of travel. By comparing the arrival time of the satellite signal with the on board clock time, the moment the signal was transmitted, one can determine the transit time.

They were among 1200 GPS-Based CS established at present by the Geographical Survey Institute (GSI) of Japan in order to observe crustal movement for seismic prediction. And since December 2000 for about one year, three types of network-based RTK-GPS[1], the MultiRef of the Calgary University in Canada, the Virtual Reference Station (VRS) of the Trimble Terrasat and the Reference net of the Geo++ GmbH in Germany known as FKP[2] (flachen-korrectur- parameter) system, were operated experimentally and simultaneously in Tokyo area. The methods had been well tested and evaluated by many groups of surveyors and navigation engineers.

The Global Positioning System (GPS) is a world wide radionavigation system formed from a constellation of 24 satellites and their ground stations. It provides continuous three-dimensional positioning 24 hours a day throughout the world .The GPS technology has a tremendous amount of applications in GIS data collection, surveying, and mapping. The advent of geospatial information technologies including Remote Sensing (RS), Geographic Information System (GIS) and Global Positioning System (GPS), individually as well as jointly, are playing a significant role in the development and inclusive growth of the nation.

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II. APPLICATIONS IN FISHERIES

A. Navigation:

Mapping the fishery and the resources should be among the priority tasks when planning for fisheries management and should not be postpone until "complete" information is available, since redundancies or blanks in the information base will more readily appear in the process of elaboration [3]. GPS helps us determine exactly where we are, but sometimes important to know how to get somewhere else. GPS was originally designed to provide navigation information for ships and planes. So it's no surprise that while this technology is appropriate for navigating on water, it's also very useful in the air and on the land. It's

interesting that the sea, one of our oldest channels of transportation, has been revolutionized by GPS, the newest navigation technology. Today we can find GPS receivers on vessels the world over, from hardworking fishing boats and long-haul container ships, to elegant luxury cruise ships and recreational boaters. GPS can be used to locate the best fishing holes without wandering into the wrong waters in the process. By providing more precise navigation tools and accurate landing systems, GPS not only makes sailing safer, but also more efficient. With precise point to point navigation, GPS saves fuel and extends fisher's range by ensuring captains don't stray from the most direct routes to their destinations. GPS accuracy will also allow closer fishing vessels separations on more direct routes, which in turn mean more vessels, can occupy our limited fishing grounds.

GPS technology helps with traffic routing, underwater surveying, navigational hazard location, and integrated mapping (Figure.1). Commercial fishing fleets use it to navigate to optimum fishing locations and to track fish migrations. Furthermore, the system is easier to operate than a traditional survey system as Total Station. So many applications of RTK-GPS have been investigated in Japan[4][5]. There were several GPS-Based Control Stations (GPS-Based CS) transmitting the correction data on a mobile radio communication system, called DMCA (Digital Multi- channel Access [6].

B. GPS in other Fields of Fisheries:

Fishing is the one of the primary producers and more profitable and sizeable% of GDP of coast based nations. With GPS applications, Fisheries Development can be done in many disciplines. Even the contour maps of productive grounds and existing fishery can be prepared and their magnitudes can be worked out. This will help to year- mark the targets of production and also to plan out resource exploration/exploitation. In exploration and exploitation of fishing grounds the spontaneous productivities during particular calendar months species-wise/size-wise. The Indian National Centre for Ocean Information Services (INCOIS), Hyderabad[7], an autonomous body of the Ministry of Earth Sciences (MoES) is the responsible agency for the generation and dissemination of PFZ information. INCOIS disseminates these advisories by Telephone, Fax, Internet, Email, Doordarshan as well as Electronic Display Systems. INCOIS forecast more than 300 stations of Potential Fishing Zone (PFZ) of entire country in its website www.incois.gov.in in two times for every week from the processed satellite images (Table.1). At present operational fishery forecast in India is based on the features observed in the SST (Figure.2) and Chlorophyll [8].

The information related to the PFZ will consist of the following.

a. GPS Readings: Latitude and Longitude in DMS format. (Ex: 17 25 55 N, 78 26 45 E)
b. Direction Information: One/Two Alphabetical characters like N,NE,E,SE,S,SW,W,NW
c. Bearing Angle Information: Maximum three numeric Letters (0-9). Ex: 154, 270, 90,265, 310, etc.
d. Distance Information: Maximum three numeric characters (Units in Kilometers)
e. Depth Information: Maximum four numeric characters (Units in meters/ local units)(weblinks).

By using even handheld GPS can identify the PFZ very easily which enhance the fish catch with less effort. For Example, Goa and Karnataka region's PFZ is given on 8th Feb 2010.

The data verified and validated by many scientists. The information was disseminated to Porbander for validation. Gill-netters used for experimental fishing. Suggested areas were located using GPS. The feedbacks received from fishing sites were analysed. The catch per gill net operation was normalised and compared with month wise normal catch available around Porbander. About 2-3 fold increase in the catch in PFZ area observed (figure.3) [9].

Table.1 Potential Fishing Zone (PFZ) of Southern Tamilnadu Coast from the processed satellite images (INCOIS)

From the Coast of	Direction	Bearing In Degrees	Distance in Kilometres		Depth in Metres		Longitude / Latitude
			From	To	From	To	
Point Calimere	NE	64	78	83	200	500	80 31 29.75 E 10 35 47.47 N
Vedaranniyam	NE	70	77	82	200	500	80 31 36.95 E 10 37 14.13 N
Velanganni	SE	93	72	77	200	500	80 31 44.12 E 10 39 16.89 N
Nagappattinam	SE	101	72	77	200	500	80 31 29.75 E 10 37 28.57 N
Nagore	SE	103	75	80	200	500	80 31 44.16 E 10 38 40.79 N
Karikal	SE	110	77	82	200	500	80 31 58.56 E 10 39 31.34 N
Tranquebar	SE	117	81	86	200	500	80 31 44.16 E 10 40 29.11 N
Kaverippattinam	SE	124	87	92	200	500	80 31 44.16 E 10 39 31.34 N
Covelong - Kovalam	NE	33	74	79	200	500	80 37 58.66 E 13 22 00.42 N
Cathedral - Madras	NE	53	47	52	200	500	80 37 51.46 E 13 18 59.88 N
Madras	NE	57	42	47	200	500	80 37 58.66 E 13 20 12.10 N
Ennur	NE	69	33	38	200	500	80 37 51.46 E 13 21 31.53 N
Pulicat	SE	102	32	37	200	500	80 37 44.26 E 13 21 09.87 N

Coromandel	SE	103	34	39	200	500	80 37 58.66 E 13 22 50.97 N

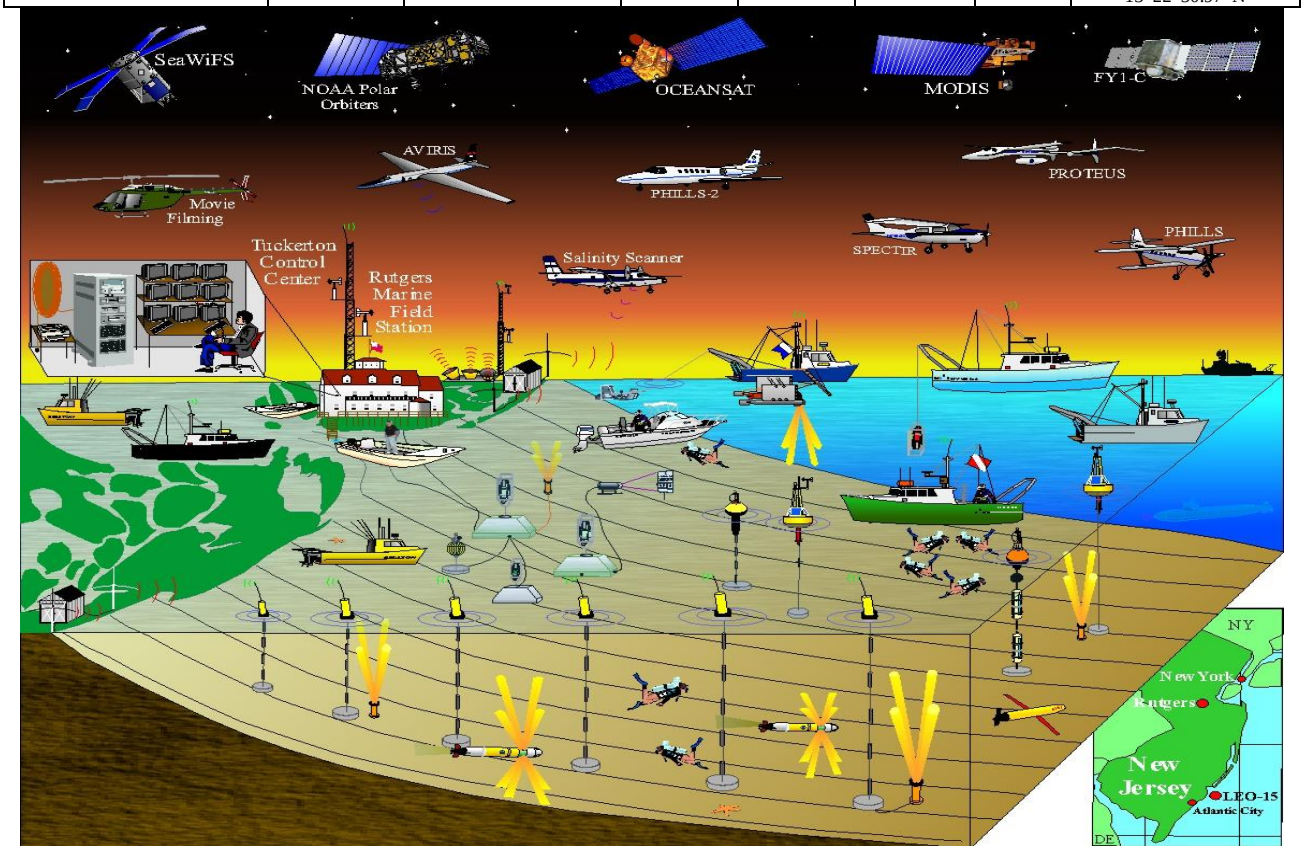

Figure: 1

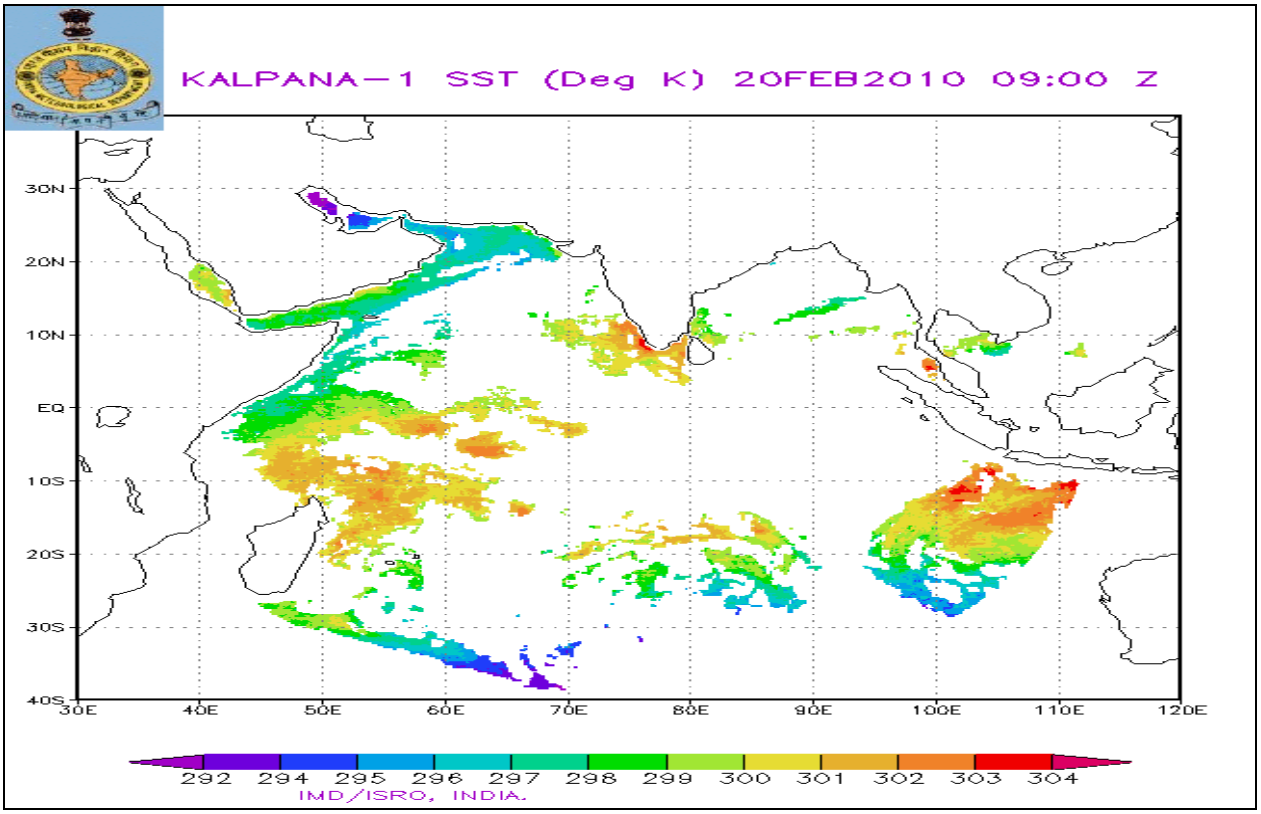

Figure: 2 Sea Surface Tempe rapture (SST)

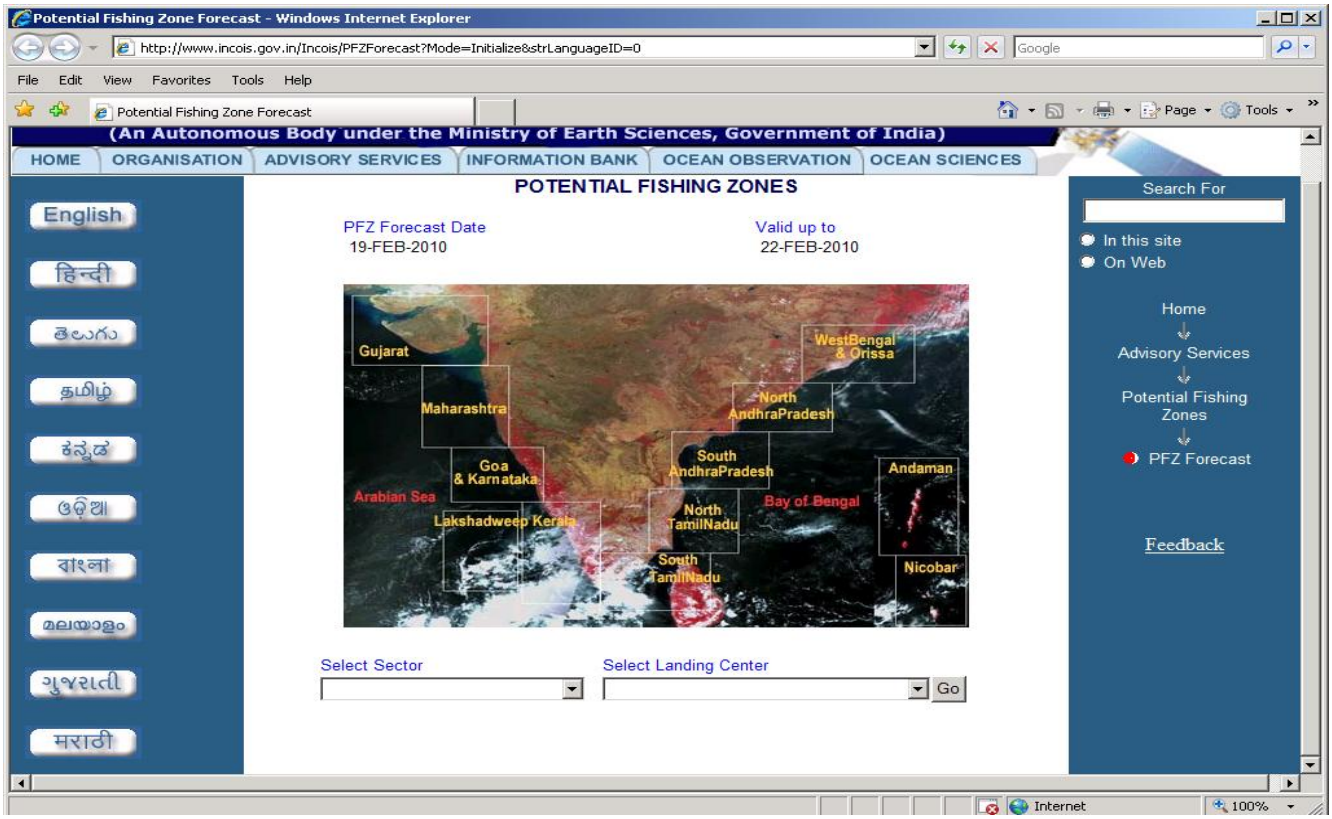

Figure.3 Potential fishing zones

C. Preparation of navigational charts:

GIS and GPS technologies have been used in the field by the Naval Hydrographic Department (NHD) for the preparation of electronic navigational charts (web links). Data streams from several sensors onboard survey ships and boats are digitally logged on a common GPS position and time stamp. A wide range of GPS methodologies are used for surveys. GPS, DGPS (Differential GPS) and RTK (Real Time Kinematic) GPS are used for afloat surveys. For geodetic control ashore, point positioning methods and baseline methods are used. For mapping the coastline, DGPS and RTK GPS are normally used. The latter is used onboard a helicopter increasingly. We today have system which packs sensors like echo sounders, sonar and GPS in the same portable box. A novel application of GIS, GPS and satellite communications now allows both the processes to be executed digitally in real time. The product of this application is called an Electronic Navigational Chart (ENC). This is a GIS produced and GIS enabled version of the paper navigational chart. The Electronic Navigational Chart (ENC) and GPS position of ship, when input to a computer system called an Electronic Chart Display and Information System or ECDIS provides a real time graphic display of ship's position on a video screen along and with respect to the geographical information contained in the ENC.

D. Identify and Periodical Investigation of Coastal Landforms:

For marine studies, the locations on ground (study area) were identified with the help of the SOI topographical maps and GPS [10]. The following studies can be conducted with the help of GPS.

a. Bio-shields (promote – how, where and to what extent)
b. Artificial Barriers Vs regeneration of natural barriers (Working out the optimal balance)
c. Mangroves (Are we overselling? Where, when, how does this work)
d. Casuarinas plantations (Should they be promoted at all, ecological impacts, social impacts)
e. Sea walls and embankments (When are they appropriate?)
f. Sand dunes/ coral reef (their roles and impacts of destruction)
g. Identify marine siltation and debris
h. Monitoring of estuaries
i. Seasonal Shoreline changes, submergence of low lying coastal areas and formation of new beaches
j. damage to coral reefs
k. Monitoring the different ecosystems of coast in different periods
l. Effect of sand mining in coastal regions
m. Study of coastal geomorphological changes before and after event occurs like tsunami, storm, hurricane, earthquake etc.

n. Coral reef, sea grass beds, sand dune, mangrove status, ecological benchmark
o. Study of coastal water bodies like swale, dune aquifers etc seasonally
p. Vulnerability of Coastal Communities and Ecosystems
q. LEO (Littoral Environmental observations) data periodically

E. Marine Engineering:

Differential GPS and RTK services is really the only economical way to obtain the repeatable positioning accuracy in 3 dimensions that is required for the following applications.

a. dredging for the maintenance of channels and port areas with very stringent horizontal and vertical absolute accuracy requirements
   i. cable and pipe laying
   ii. construction works
   iii. port approach, port manoeuvres

F. Mapping of Different CRZ:

a. Resetting of people in 200m, 400m and 500m in Coastal Regulation Zone I,II,III and IV of entire coastal regions of the country.
b. Assessment of activities along the coastal zone being undertaken by govt. /other agencies for rehabilitation during calamities.
c. Mapping for CZMP (Improve quality and accuracy of information; identify and facilitate approval processes to ensure all activities internalize environmental , social and economic concerns)
b. Mapping Coastal and marine ecosystem impacts

III. CONCLUSION

The Global Positioning System (GPS) is a revolutionary technology that is changing the way businesses operate in the field. From its origin as a military navigation technology to its use for "black box" tracking of trucks on the road, GPS technology has proven its worth to enterprises worldwide. The combination of GPS, GIS and remote sensing offers solutions that can reach into and improve every aspect of enterprise field operations. GPS and GIS are not only enabling Hydrographic Offices to enhance safety of marine transport by more effective and versatile products and services. It is also shifting the focus of hydrography to data processing ashore from data collection afloat. In addition to navigational safety, GIS has also enabled Hydrographic Offices to discharge their roles effectively in the fields of delineation of maritime boundaries. In recent years, most of the organizations engaged in geospatial technologies activities have felt the need for establishing control points, especially in marine studies. For these tasks, acquisition of Global Positioning System (GPS) has been increasing. Synoptic maps of the main concentrations of fisherman villages, fishing ports and beach landing points, markets, processing, freezing and transhipment points, coastal landforms can be studied with the help of GPS.

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