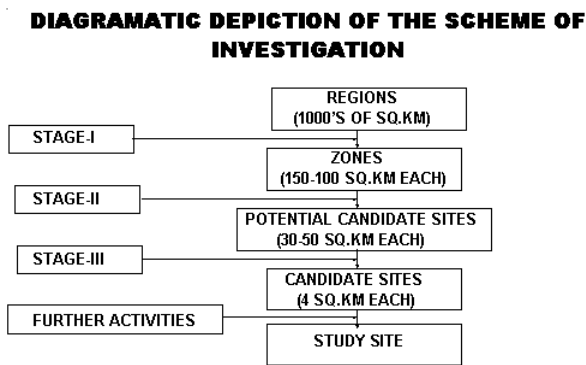


2006, Bajpai et al 2006). A reasonably safe geological repository is required to be located in areas of seismic and tectonic stability, devoid of substantial groundwater and surface water, absence of economic mineral deposits etc. A rock to qualify as suitable host rock is expected to possess good homogeneity in terms of mineral composition, geochemical characteristics and mechanical strength. Stable shield areas and thick sedimentary basins are few such potential geological setup where as granites, clays, basalts, tuff, salt beds are few suitable host rocks under consideration worldwide. The most important site requirements and selection criteria are listed below.

Table 1: Diagram showing scheme of investigations for site selection



As the investigations in later stages are mainly ground based studies, only stage I investigations are elaborated in this paper.

Stage I Investigations

In this stage mainly remote sensing and GIS based studies are used for information generation. The site selection for geological repository is carried out on the basis of extensive remote sensing based geological interpretation of large regions spanning over thousands of square kilometers exposing homogeneous rock mass in the initial stages of investigations. In Indian case, three potential regions spreading over about 0.1 million square kilometers, in Indian shield lying in tectonically stable areas were subjected to these studies. The LISS III images were used to prepare regional geological, hydrogeological, structural and land use map. Figure below depicts a typical LISS II image of the area under investigations.

Subsequently the regions were divided into a regular grid of 10kmx10km size as shown in the figure 3.

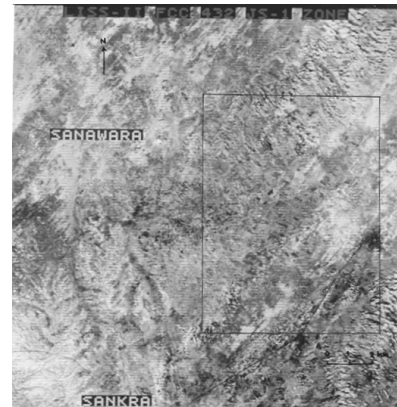


Fig 2. A satellite image of a region under investigations

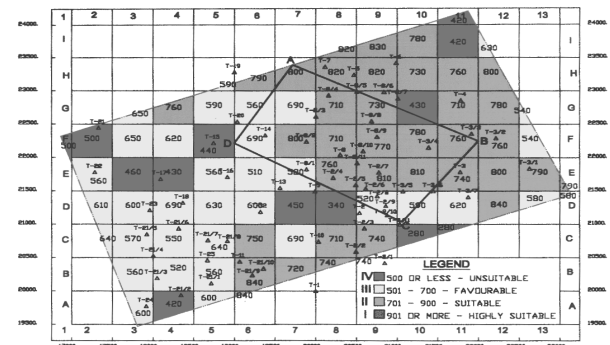


Fig 3. A potential region divided into 10 km x 10 km grid

For each grid cell, major attributes of significance considered includes lithological formation, seismicity, economic minerals occurrences, geohydrology, vegetation cover, population, archaeological monuments, besides rainfall, infiltration, drainage parameters, lineament intensity, population distribution, soil thickness, slope etc. The table below shows important attributes considered during the initial stages of site selection.

The data base on these attributes is collected for individual grid cell. Each attribute is assigned suitable weightage depending on its importance and total scorable points are calculated for individual attribute. The table 3 depicts relative weightage assigned to individual attributes for GIS based zonation maps.

These were obtained through Survey of India toposheets and satellite data. The information was processed using ARC VIEW and ILWIS GIS to prepare a large number of thematic maps. The total score points of individual zones are calculated using the scheme shown in the figure 4.

SL. NO.	ATTRIBUTE
1	Lithological Formation
2	Seismicity
3	Distance From Structural Discontinuities
4	Distance Form Surface Water Bodies Viz. Dam/ Rivers / Lakes Etc.
5	Ground Water Level
6	Rain fall
7	Surface Water Run-Off
8	Population
9	Distance From Economic Mineral Occurrences And Mining Activities
10	Distance From Industrial / Archaeological / Tourist / Religious Spots
11	Flood
12	Soil Cover And Weatehring Pattern
13	Vegetation Cover
14	Accessibility Of The Area
15	Intensity Of Intrusives, Veinlets, Etc.
16	Joint Pattern, Fracture Pattern Etc.
17	Topography
18	Dip Of Formation / Foliation
19	Homogeneity Of Rock Mass
20	Political Awareness

GRADING OF ZONES

THE FORMULA FOR GRADING THE ZONES IS AS GIVEN BELOW :

$$GIS = \sum W_i \times P_i$$

W_i = WEIGHTAGE OF ATTRIBUTE

P_i = SCORE POINT OF SOME ATTRIBUTE

GIS = GRADE INDEX FOR SUITABILITY

SCORE POINT	GRADE	SUITABILITY
>750	I	HIGHLY SUITABLE
500-750	II	SUITABLE
250-500	III	FAVOURABLE
< 250	IV	UNSUITABLE

Fig.4 : Calculation of total score points on individual zones for their suitability

These studies render zones of smaller size (100km) as potential zones with highest score points (>750). These zones were subsequently subjected to detail geological, hydrogeological and structural mapping to delineate subzones of still smaller size (25 sq km). The spatial geological data on rock types obtained by deep drilling at grid pattern (6000m in 30 boreholes), were also studied with the application of ILWIS to prepare various pattern maps. The figure shows a few typical maps produced with the application of GIS.

Attributes	Weightage	Maximum Scorable points
Lithological Formation	10	100
Seismicity	10	100
Tectonic & Structural Features	8	80
Economic Mineral Areas / Mines	8	80
Industry / Archaeological / Tourist / Religious Spots	8	80
Surface Hydrology	6	60
Rainfall	6	60
Groundwater Hydrology	6	60
Population	6	60
Runoff	3	30
Flood	3	30
Topography	3	30
Vegetation Cover	3	30
Accessibility	3	30
Homogeneity	3	30

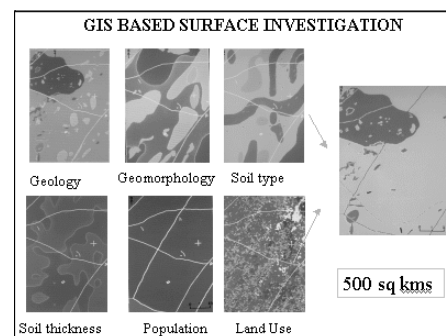


Fig.5: Attribute maps prepared using GIS

These subzones have been further investigated by geophysical surveys using seismic, magnetic and electro magnetic methods to generate three-dimensional geo-structural model of the sites. Such models are refined by subsurface data obtained through drilling borehole of varying depth. GIS based analysis has also been used to predict future evolution of such sites as well. This requires extensive studies on palaeoenvironment, palaeoclimate, and palaeo-seismicity. Probability of disruptive events like earthquakes, volcanoes, flooding and uplift are also estimated.

Conclusion

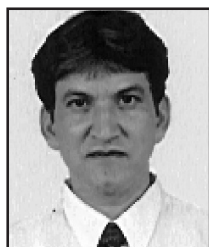
Site selection of geological Repository is a

lengthy process and huge volume of spatial geological, geohydrological, structural and socio economical spatial data is generated. Geoinformatics contribute immensely to manage such dataset and their meaningful interpretations for locating waste disposal facilities worldwide.

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Sri R. K. Bajpai obtained his Master of Technology degree from Center of Advanced Study in Geology, University of Sagar in 1987. After serving as Assistant Professor in the same department for a brief period, he joined Aerial Survey and Remote Sensing Group of AMD in 1990 and subsequently joined Bhabha Atomic Research Center, Mumbai. His expertise lies in the field of geological disposal of radioactive wastes, safety assessment and environment impact assessment of such facilities. Currently Sri Bajpai, scientist "F" holds the responsibility of site selection and characterization for radioactive waste disposal facilities, reactor sites and geotechnical evaluation of other nuclear

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Global Positioning System

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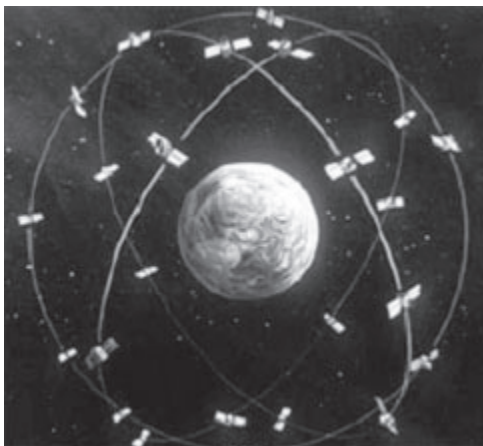
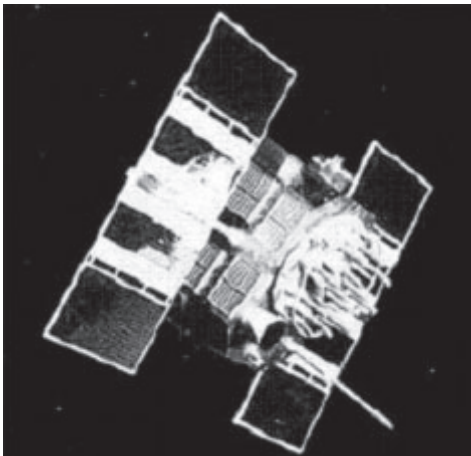
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Abstract

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. It covers the satellite based navigation system, location, Navigation, tracking, mapping and timing, GPS receives, modernization and future scope of the technology. This paper discusses the real world applications of GPS.

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 system). 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 approx. 67.3 ms 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 kilometer 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. Distance can be calculated, with the formula.

Distance = speed of light X signal transit time

Signal transit time can be correctly determined only when the terrestrial clock and the atomic clock on satellites are synchronized. If transit time is out by just 1microsecond, it produces a positional error of 300m. If the time measurement is accompanied by a constant unknown error, we will have four unknown variables in 3-d space:

- . Longitude (x)
- . Latitude (y)
- . Height (z)
- . Time error (t)

It is therefore essential to have four satellites to calculate an exact position in three-dimensional space.

GPS Satellites

Earth observation from space, though started mainly as a support to military and weather programmes has matured over the years to become a kind of natural resources and environmental management.

ECHO I, was the first satellite to be launched in 1960 to serve as a naturally illuminated moving target on the sky. The first practical satellite positioning system was the form of TRANSIT launched in 1963, providing geodetic positioning details. This system had several active satellite in circular polar orbits of an altitude 1074 Km and orbital period of 107 minutes. four years after its launching it was made available for civilian use.

The user was equipped with TRANSIT satellite receiver and the geodetic position calculation was possible for the US naval ground control station. But this system was not a success for the moving receiver.

In late 70's US military experimented with NAVSTAR (Navigation Satellite Timing & Ranging System) with the principal of GPS.

It was developed by the U.S. Department of Defense (DOD) in 1973, with its first satellite launched in 22nd Feb. 1978. There onwards both civilians & military started using this technique. SPS (Standard Position System) can be used freely by general public whilst the military signal PPS (Precise Positioning Service) can be used only by authorized government agencies.

There are currently 28 operational satellites orbiting the earth at a height of 20180 km on 6 different orbital planes. The orbits are inclined at 55 to the equator, which ensure at least 4 satellites in communication with any part on the planet. The satellites are solar powered and are moving at a speed of 2700m/sec. Each satellite orbits earth in approximately 12 hours and has 4 atomic clocks on board.

There are 28 active GPS satellites orbiting the earth at an altitude of 20,000 Km. spaced equidistantly in orbital planes. With orbital period of 12 hrs. Atomic oscillators (cesium and rubidium) on these satellites generates two highly **coherent** cross polarized signals at frequencies 12, 227.60 and 1575.42 MHz. Two pseudo random timing sequences of frequencies 1.023 and 10.23 MHz are generated, they are called P-code (for restricted users) and C/A code (for common uses).

With its increasing awareness and need several countries and regions have established the global network of tracking stations. As a result of technological and logistical improvements in last 20 years, GPS is now cheap accurate and very commonly used, for both positioning and precise navigation. The absolute position, with stand and error of 1cm, at the most, is now possible to determine using small, heavy, high orbits, spherical, passive satellites with their retro-reflectors and laser ranging (eg. LAGEOS1, LAGEOS2, AJISAI, STARLETTE etc.). This technology is now popularly known as satellite laser ranging (SLR). This technique gives very accurate results but is much more expensive and employed only for scientific investigations.

Synthetic Aperture Radar interferometry (INSAR) is another such technique. Which is used to map relative local deformations is used for information on e0-seismic activity.

Galileo is the European Global Navigation satellite system designed for multiple civilian uses. It comprises of 30 satellites orbiting at an altitude of 23, 616Km. It operates on 10 navigation signals in 3 main radio bands, E5 (E5a and E5b), E6 and E2-L1-E1 band.

It provides several positioning services some open and some encrypted includes its commercial services. India has agreement of using Gallileo program, but Galileo can not be used for many years.

Augmentation systems

A user of any positioning system expects an accurate, reliable, repeatable and 24 hrs. a day and 7 days a week service Augmentation systems (satellite or ground based) are basically designed to meet these expectations.

Satellite Based Augmentation systems (SBAS) may be of commercial space based, charging the fees (e.g omnistar for oceanic user and landstar for land

based uses) or open space based.

Most well known open space based systems are US based WASS (wide area augmentation systems), EGNOS (European Geostationary navigation overlay system), MSAS (Japanese multifunctional satellite augmentation systems) SNAS (Chinese satellite navigation augmentation systems) and India's own GAGAN (GPS aided geo augmented navigation systems).

There will be more and more national and multinational systems emerging in near future.

Putting GPS to work

GPS technology has matured into a resource that goes far beyond its original design goals. These days scientists, sportsmen, farmers, soldiers, pilots, surveyors, hikers, delivery drivers, sailors, dispatchers, lumberjacks, fire-fighters, and people from many other walks of life are using GPS in ways that make their work more productive, safer, and sometimes even easier.

Here are few examples of real-world applications of GPS. These applications fall into five broad categories.

- Location - determining a basic position
- Navigation - getting from one location to another
- Tracking - monitoring the movement of people and things
- Mapping - creating maps of the world
- Timing - bringing precise timing to the world

Location – Where am I?

The first and most obvious application of GPS is the simple determination of a “position” or location. GPS is the first positioning system to offer highly precise location data for any point on the planet, in any weather. That alone would be enough to qualify it as a major utility, but the accuracy of GPS and the creativity of its users are pushing it into some surprising realms.

Knowing the precise location of something, or someone, is especially critical when the consequences of inaccurate data are measured in human terms. For example, when a stranded motorist was lost in a South Dakota blizzard for 2 days, GPS helped rescuers find her.

GPS is also being applied in Italy to create exact location points for their nationwide geodetic network, which will be used for surveying projects. Once in place it will support the first implementation of a nationally created location survey linked to the WGS-84 global grid.

Sometimes an exact reference locator is needed for extremely precise scientific work. Just getting to the world's tallest mountain was tricky, but GPS made measuring the growth of Mt. Everest easy. The data collected strengthened past work, but also revealed that as the Khumbu glacier moves toward Everest's Base Camp, the mountain itself is getting taller.

Navigation – Where am I going?

GPS helps you determine exactly where you 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 you will 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. A New Zealand commercial fishing company uses GPS so they can return to their best fishing holes without wandering into the wrong waters in the process.

Flying a single-engine Piper Cub or a commercial jumbo jet requires the same precise navigation information, and GPS puts it all at the pilot's fingertips as safely as possible.

By providing more precise navigation tools and accurate landing systems, GPS not only makes flying safer, but also more efficient. With precise point-to-point navigation, GPS saves fuel and extends an aircraft's range by ensuring pilots don't stray from the most direct routes to their destinations.

GPS accuracy will also allow closer aircraft separations on more direct routes, which in turn means more planes can occupy our limited airspace. This is especially helpful when you're landing a plane in the middle of mountains. And small medical evacuation helicopters benefit from the extra minutes saved by the accuracy of GPS navigation.

High-Precision Crane Guidance –

This is a practical application for mining and earth moving industry. In such cases the driver of the monster truck can not see the surroundings and he needs a guidance for the truck movement as well as material movement. GPS technology comes in handy use for such applications. For such application we need Ultra-high precision GPS software, which can give an accuracy of less than 2 meters. We also need a local wireless communication network for alarms.

GPS on the International Space Station and Crew Return Vehicle

Space ship navigation is the very first application of GPS technology. This is used in both the satellite launching vehicles as well as ground returning space shuttles. These space vehicles require stringent pointing requirements for roll, pitch, heading, position and velocity. GPS receivers can provide all this information with high level of accuracy.

Tracking

If navigation is the process of getting something from one location to another, then tracking is the process of monitoring it as it moves along.

Commerce relies on fleets of vehicles to deliver goods and services either across a crowded city or through nationwide corridors. So, effective fleet management has direct bottom-line implications, such as telling a customer when a package will arrive, spacing buses for the scheduled service, directing the nearest ambulance to an accident, or helping tankers avoid hazards.

GPS used in conjunction with communication links and computers can provide the backbone for systems tailored to applications in agriculture, mass transit, urban delivery, public safety, and vessel and vehicle tracking. So it's no surprise that police, ambulance, and fire departments are adopting systems like Trimble's GPS-based AVL (Automatic Vehicle Location) Manager to pinpoint both the location of the emergency and the location of the nearest response vehicle on a computer map. With this kind of clear visual picture of the situation, dispatchers can react immediately and confidently.

Chicago developed a GPS tracking system to monitor emergency vehicles through their streets, saving precious time responding to 911 calls. And

on the commercial front, two taxi companies in Australia track their cabs for better profit and improved safety.

Mapping – Where is everything?

It's a big world out there, and using GPS to survey and map it precisely saves time and money in this most stringent of all applications. Today, Trimble GPS makes it possible for a single surveyor to accomplish in a day what used to take weeks with an entire team. And they can do their work with a higher level of accuracy than ever before.

Trimble pioneered the technology, which is now the method of choice for performing control surveys, and the effect on surveying in general has been considerable. You've seen how GPS pinpoints a position, a route, and a fleet of vehicles. Mapping is the art and science of using GPS to locate items, and then create maps and models of everything in the world. And we do mean everything. Mountains, rivers, forests and other landforms. Roads, routes, and city streets. Endangered animals, precious minerals and all sorts of resources. Damage and disasters, trash and archeological treasures. GPS is mapping the world.

Timing – When will it happen?

Although GPS is well known for navigation, tracking, and mapping, it's also used to disseminate precise time, time intervals, and frequency. Time is a powerful commodity, and exact time is more powerful still. Knowing that a group of timed events is perfectly synchronized is often very important. GPS makes the job of "synchronizing our watches" easy and reliable.

There are three fundamental ways we use time. As a universal marker, time tells us when things happened or when they will. As a way to synchronize people, events, even other types of signals, time helps keep the world on schedule. And as a way to tell how long things last, time provides an accurate, unambiguous sense of duration.

GPS satellites carry highly accurate atomic clocks. And in order for the system to work, our GPS receivers here on the ground synchronize themselves to these clocks. That means that every GPS receiver is, in essence, an atomic accuracy clock.

Astronomers, power companies, computer networks, communications systems, banks, and radio and television stations can benefit from this precise

timing. One investment banking firm uses GPS to guarantee their transactions are recorded simultaneously at all offices around the world.

National Resource / International Utility

GPS technology provides Enormous benefit to military, civilian and scientific users worldwide. Originally designed to serve the armed forces of the U.S. and its allies GPS has later evolved into a dual-use system, with civil uses greatly outnumbering military. Today there are more than 10 million GPS users worldwide. the most important part of the whole system is it is freely accessible. There is no user fee for receiving the GPS signals. The end-user has to buy just the GPS receiver equipment and corresponding software like maps and navigation systems.

GPS Modernization

GPS services are in use from a long time. The GPS system is launched almost 25 years back. Typical life of a satellite itself is around 7.5 years, hence there is lot of opportunity to upgrade and replenish the old satellite systems. Modernization of GPS is also taken at a priority project by US Department of Defense. There is going be a special military spot beam, which overcomes jamming by increasing power over a limited area. The new satellite launches will start in 2013 for GPS Block III.

Issues / Concerns: Radio frequency Interference

Some of the issues fo GPS technology are -

Conventional transmissions like High-power TV transmitters, Television receiving antennas and Amateur radio operators can create radio frequency interference. This causes trouble for the GPS receiving equipment to determine the correct location. Second trouble is receiver suddenly loses track of satellites or displays an unexpectedly low SNR. In such situation receiver looses the location information.

For the commercial navigation systems the city map also has to be very accurate so that GPS can help the card drivers for the desired destination.

The Future of GPS

If we look into the future of GPS technology then there are further major development expected. The accuracy and reliability of the system is improving. The military grade GPS equipment can give an accuracy of 1 meter. Receiver equipment is changing drastically in terms of sensitivity. With the advent of technology the receiver size as well as prices are going down. Another expected development in GPS is interoperability. Today there are multiple GPS satellite systems and they do not talk to each other. With future development it will be possible to exchange the location information thereby improving the accuracy further.

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Applications of GPS in enhancing Fish production of Saurashtra

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Abstract

Many molluscan varieties are on the verge of extinction in intertidal areas. Over exploitation of fish varieties in the sea also has led to ideal lying of a large fishing fleet and tremendous unemployment in fisheries sector. The present article highlights on applications of GPS in overcoming the problems of fishing industries of Saurashtra.

Introduction

The GPS, totally being a new concept in the latest electronic equipments, has brought a tremendous revolution in the field of Navigation. There are many fields of Fisheries development in which GPS can play and rather is playing a key role in development of Fisheries viz. Mariculture, capture fisheries, exploration of new fishing grounds, artificial reef technology, contour-mapping of potential aquatic resources, sub-merged danger-zones etc.

GPS in Aquaculture

The Saurashtra coast and especially the coastal belt in Gulf of Kutchh has a rich fishery of molluscan varieties viz. edible oysters, pearl oysters, windowpane oysters, clams, brown and green muscles and other varieties. Sustainable fishery of pearl oysters and windowpane oysters existed over more than half a decade before and just after independence. The then Jamnagar state had a special department of "Moti Fishery" which was evident to sustainability of rich fishery of pearl and windowpane oysters. However, at present this fishery is on the verge of extinction. The Fisheries Department of Government of Gujarat has officially imposed a ban on windowpane oyster fishery looking to the this fishery of Medical Importance. The population of edible oysters which was dominant in the intertidal area along Saurashtra coast is also almost extinguished. Hardly at certain locations a few edible oysters are observed whereas population of perna and muscles are almost extinguished.

The Fisheries Department in Govt. of Gujarat has continued to lease out unanimously to private entrepreneurs the coastal belt of Saurashtra to exploit dead edible oysters shells along Saurashtra coast over more than 30 years. Casual observations of

exploitation at the site indicate exploitation of over 5 tons a day of shells. The average weight of dead shell of *Crassostrea gryphoides* being 100 gm/no., it is estimated that over 3.6×10^8 no. of dead edible oysters have already been exploited. There is nothing wrong in exploiting and putting this volume to productive utilization. The fecundity of *Crassostrea gryphoides* is about 7×10^5 no/ adult/ year. The huge number of dead oysters must have been ranched into local basin during their life span at least once by each and even more than once their young ones. Due to natural and man-made changes occurred in this coastal eco-system, in spite of this, population of all these varieties is fast diminishing.

Remedies

The old natural habitats of all these varieties viz. Somnath (Triveni), Navi Bunder, Miyani creek and some islands in the Gulf of Kutchh viz. Pirotan, Narara, Goose, Kalumbhar, etc. have been over again confirmed to bear but very meagre population. The Sikka research station of Junagadh Agricultural University has rehabilitated spats of *Crassostrea gryphoides* over a large number in the inter-tidal areas, their population being monitored by them periodically. But many times difficulties are faced to reach to the same spot of ranching either because they are submerged and not exposed due to human limitations or the grown up live numbers are robbed by local fishermen for their own consumption.

Role of GPS

With the help of GPS over 200 memorized spots of ranching can be identified precisely at the aforesaid centers. Though the specimens remain submerged and are exposed for a very short while, with memorized GPS locations their spotting can become very easy.

Conclusion

The GPS memorized locations of naturally/ otherwise ranched habitats help to enhance the population of edible oysters and other molluscan varieties by over coming constraints in spat identification and recognition of theft of the live adults.

GPS in other fields of Fisheries

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

and location-wise can be memorized to over 200 spots, which can become a guideline for a more profit worthy exploitation/ expedition in the coming years to the fishermen community of that region. This technique can also be utilized for working out the “Trend” of productivity of a particular fishing ground in working out seasonal Indices by Moving Average method by the Statisticians.

The GPS can also be utilized in estimating potential areas not only in marine fishing grounds, but also in inter-tidal areas for enhancing coastal fish production .It can also warn to a fishing vessel about sub-merged wreckages and can save life and property.

At last a new and less popular area of Indian fisheries is Artificial Reef Technology. The new artificial reefs can be developed and through GPS, they can be installed at known locations. This will help in developing the extinguishing fish-species of commercial and academic importance.

About Author



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