APPLICATION OF SURVEY IN MARINE GEOLOGY AND OCEANOGRAPHIC STUDY

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ABSTRACT: The union between survey and marine geology in solving coastal problems cannot be underestimated; therefore the cooperation and the level of integration of these two unique areas will go a long way in achieving great feet in marine research. This work explains application of surveying in oceanographic studies and exposes the different areas in which survey principles can be applicable, such as waves, wind, longshore current, tides and tidal stream, sea level changes, low relief, rhythmic topography, human impact, oil and gas exploration and dredging of port channels. It also gives brief explanation on different areas of application of survey in marine geology and oceanography. The role of survey in solving the problem of coastal erosion is also discussed with some of the control measures used. Finally, some figures are presented to demonstrate how some survey instruments are being used in the field of oceanography.

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INTRODUCTION

Surveying is a technique of measuring, plotting and producing maps. Technological developments have led to rapid changes from the conventional methods of surveying to more sophisticated methods which are faster and less cumbersome, for example photogrammetric method and satellite image mapping. Survey is normally carried out with a high degree of precision to enable correct acquisition and analysis of data. The application of surveying techniques in marine geology has led to the solving of many coastal problems such as erosion, ocean surge and inundation hazards. In Nigeria, coastal erosion is experienced in almost all the sections of the country's coastal zone, thus there is need for constant monitoring and forecasting using adequate surveying techniques for proper management of coastal resources. There are several contributing factors that elevate or aggravate the extent at which coastal problems are experienced within a particular locality.

Some of these influences include coastal processes such as winds, waves, tides and currents, also the geological nature of the coastline, whether the land margin is elevated or low-lying, straight or indented, stable or mobile, homogenous or varied in character and the case of change in sea level relative to the land. Lastly, special features of some coastal areas, such as the existence of offshore sand ridges, growth of corals, impact of glaciers and ice-sheet proximal to the sea, influences coastal hazards. There is also the influence of man on coastal hazards such as deforestation, civil engineering constructions, mining and pollution.

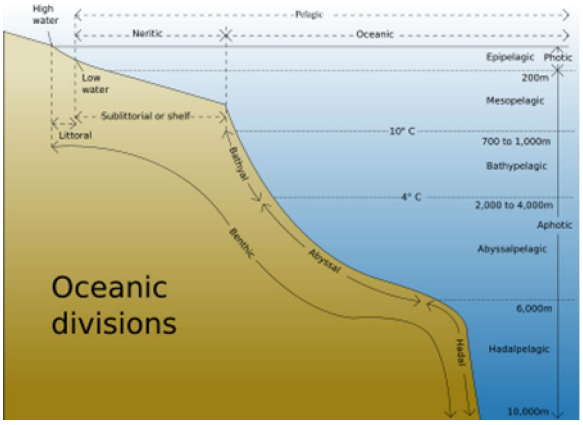

Fig.1: THE MAJOR OCEANIC DIVISIONS **(After Columbia Encyclopedia 2007)**

Oceans are divided into numerous regions depending on the physical and biological conditions of these areas. The pelagic zone includes all open ocean regions, and can be subdivided into further regions categorized by depth and light abundance. The photic zone covers the oceans from surface level to 200 meters down. This is the region where photosynthesis most commonly occurs and therefore contains the largest biodiversity in the ocean. Since plants can only survive through photosynthesis any life found lower

than this must either rely on material floating down from above or find another primary source, this often comes in the form of hydrothermal vents in what is known as the aphotic zone (all depths exceeding 200m). The pelagic part of the photic zone is known as the epipelagic. The pelagic part of the aphotic zone can be further divided into regions that succeed each other vertically. The mesopelagic is the uppermost region, with its lowermost boundary at a thermocline of 10^0C, which, in the tropics generally lies between 700 and 1,000m. After that is the bathypelagic lying between 10^0C and 4^0C or between 700 or 1,000m and 2,000 or 4,000m. Lying along the top of the abyssal plain is the abyssalpelagic, whose lower boundary lies at about 6,000m. The final zone falls into the oceanic trenches, and is known as the hadalpelagic. This lies between 6,000m (10,000m) and is the deepest oceanic zone.

Along with pelagic aphotic zones there are also benthic aphotic zones, these correspond to the three deepest zones. The bathyal zone covers the continental slope and the rise down to about 4,000m. The abyssal zone covers the abyssal plains between 4,000 and 6,000m. Lastly, the hadal zone corresponds to the hadalpelagic zone which is found in the oceanic trenches. The pelagic zone can also be split into two sub regions, the neritic zone. Neritic encompasses the water mass directly above the continental shelves, while the oceanic zone is the open waters. In contrast, the littoral zone covers the region between low and high tide and represents the transitional area between marine and terrestrial conditions. It is also known as the intertidal zone because it is the place where tide level affects the conditions of the region. Therefore this work will highlight areas in which survey is applicable to Oceanography and marine research, explaining and demonstrating how the necessary and related measurements of survey in oceanography are being carried out, understanding the importance of surveying in marine geology and oceanography

AREAS OF INVOLVEMENT OF SURVEY IN MARINE GEOLOGY

Waves / wind, long shore current, tides and tidal stream, sea level changes, low relief, rhythmic topography, human impact, oil and gas exploration, dredging of port channels and beach construction.

HYDROGRAPHIC SURVEY

Hydrography deals with the mapping of the sea bed and the gathering of other data that may be necessary for a better understanding of the sea environment. Just like on land, the coordinates of points on or above the sea level are determined. One major difference between the survey on the sea and that on the land is that in the case of the sea, most of the time especially when it has to do with the sea bed, the hydrographer does not see what he is surveying. That makes hydrographic operations more of a deductive exercise. The other is that the sea is a dynamic surface.

Basic Applications: The determination of the position in hydrographic has two components namely: The horizontal component and the vertical component.
The operations were done independently using theodolites, sextants and Echo-sounders especially in situations where the survey is not too far into the ocean. These days, however, hydrographic boats are equipped with integrated position systems where the horizontal and vertical coordinates are determined simultaneously and the result displayed digitally. For these reasons accurate requirements in hydrographic are less stringent than for the operations on land.

Hydro Equipments

Equipments that can be integrated in hydrographic include: Echo-sounder, current meter, Side Sonar scanner, Magnetometer, Boomer, pinger, Tide Gauge, Salinometer, Wave Meter G.P.S etc. These equipments can measure instantaneously and their data stored in digital forms. The state of the sea is now monitored with satellites and the data is available in digital forms.

The G. P. S. Techniques

The Global positioning system GPS is an extra terrestrial positioning system. It can be used on both dynamic and static surfaces. The main features of the GPS techniques include high accuracy of point positioning, relatively low operating cost, unified coordinate system and wide spread use of a GPS by positioning professional to replace or supplement existing techniques in the society at large. The concept of the GPS is therefore based on the fact that satellites are put in orbits in space and their geocentric positions are known accurately at any time. With the GPS receivers, the distance between the receiver and the satellite in the orbit is measured. From these distances, the geocentric coordinate of the point is determined. These satellites were put in the orbit by the American Department of Defense (ADOD).

It is important to mention that the first NAVSTAR GPS satellite was launched in 1978.

The data obtained by GPS method can easily be used in GIS. Most countries embarking on the development of map database now use the GPS to provide the necessary control. The GPS data are normally obtained in digital forms and the receivers are provided with facilities for the storage of the data obtained. The data can then be downloaded into a computer in the office for necessary processing and analysis. The GPS techniques are already in use as a means of establishing or extension of controls in

Nigeria. The GPS has apart from its application to surveying and mapping has been used for warfare, air and sea navigation and monitoring of the environment.

BASIC CONCEPT IN GEOGRAPHIC INFORMATION SYSTEM (GIS)

A Geographic Information System (GIS) is concerned with data management and analysis of large volumes of geographically related data. It is a decision support system as well. Basically, the components of a GIS include hardware and software. The system can be designed to function as stand-alone or in a network environment. Often a GIS is used to integrate spatial data residing in various Databases (or distributed Databases). GIS can be defined as a computerized information System for capturing (acquiring, collecting) storing, checking, integrating, manipulating, analyzing and displaying of geographic data. Computerized GIS involves the handling and manipulation of alpha numeric data, which can be related to specific location and are stored along with the map data in a computer environment. The essence of GIS is to provide information in varied forms. It is a tool and resource for data manipulations in order to provide information in a geographic context.

SURVEYS ASSOCIATED WITH COASTAL EROSION

The accurate delineation of the coastline and coastal features is an essential feature of survey. The main method of coastline surveys is enumerated below:

1) Visual Examination.
2) Photogrammetric Method
3) Traverse Method.
4) Profiling Method

VISUAL EXAMINATION

This entails just going to the site without any instrument. The features are accessed with the eye and a sketch made. After sometime one goes back there and do the same thing. The sketches are compared and rate of erosion could roughly be determined.

TRAVERSE METHOD

A much-used method of fixing the coastline is by means of traverse between adjacent surveying marks. The method of traversing described is very suitable to control work of a long expanse of beach, gives a very reasonable degree of an accuracy using the minimum of equipment.

DETRERMINATION OF RATE OF EROSION

The rate of erosion could be defined as the distance (or depth) eroded over the time. Though only one is discussed here, there are many ways in which erosion could be monitored and the rate determined Surveyors were to monitor coastal erosion at the Bank using the pillars (A-L), a line of levels will be run along each transit far into the sea. The spot heights will be taken at a regular interval (10m). The high water mark and vegetation boundary will also be noted.

PRESENTATIONS AND INTERPRETATION OF RESULTS

On a base map, the control pillars will be plotted. The reduced level of each heighted spot will be plotted along the transits. The high water marks (HWMS) and the vegetation boundary will also be plotted.

A plot on the same base map of the results of surveys done at the different times will enable the surveyor to determine the height difference over a period of time and hence, calculate the rate of erosion with the values of the reading. The inference from the plot will lead to these observations.

1) Eroded portions or siltation are easily noticeable.
2) Rate of erosion or siltation can easily be determined.
3) With depth contour profile, required frequency of observation could be determined thus Optimal use could be made available personnel and equipment.
4) The profiles different times could be plotted together thus reducing storage problem.

THE SURVEYOR'S ROLE IN EROSION CONTROL

The Surveyor's role in erosion control could not be over emphasized. Various professionals are involved including the Surveyor. The Surveyor's role is vital because he is the only one that can coordinate effectively with other professionals in the team and give accurate information of the area of interest that is the erosion site. The surveyor is also the one that provides the engineer with one of the vital information he needs for his designs and constructions.

REQUIRED MEASUREMENT

- Observation/Measurement of Current, Direction and Speed.
- Velocity, Water Temperature, Density and Salinity.

CURRENT METERING

The current meter provides a means of measuring the rate and direction at any depth. Velocity can be accurately determined at nearly all points in the cross-section and over a sufficient period of time.

The DNC-3 current meter can be used. It consists of three parts. The recorder, the fish (towed in water) and the cable. It works on the principle that a propeller of certain pitch is turned by the water particles equal to the pitch of the propeller. The number of revolution in a certain time-lapse gives the

velocity of the current according to the calibrationa. Astronomical factor
b. Topographic influences.
c. Climatic conditions and other meteorological factors.

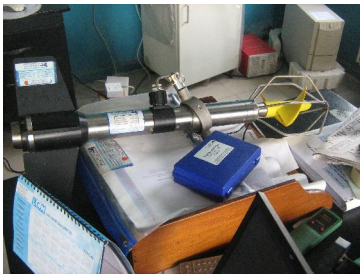

Fig. 2: Current meter instrument

The information obtained with the current meter would determine baseline information for predicting stresses acting on the erosion site and also as design criteria for construction purpose

CURRENT OBSERVATION

Generally, current may be regarded as the horizontal movement of water. Its magnitude is measured by its velocity in meters per second. This movement may be said to be caused by one or a combination of the following factors.

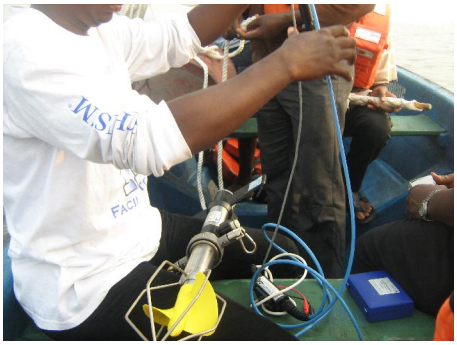

Fig. 3: Current meter fixing, ready for

Fig. 4: Fixing of weight to be deployment deployed

Fig. 5: Deployment of weight

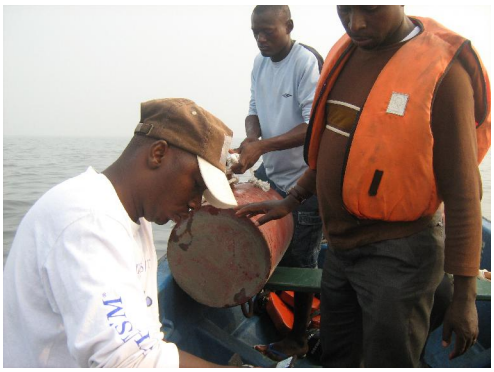

Fig. 6: Floater attached to the weight

Fig. 7: Echo sounder instrument being

BATHYMETRIC SURVEY OPERATION

The bathymetric survey is an essential part of coastal / shore erosion study as it gives information about the bottom configuration; the cross sectional profiles in the coast, an insight into sedimentation and gives therefore the basic information to the engineer of the area under study. It is therefore important to carry out this survey as accurate as possible and special attention should be given to the calibration of the echo sounder, the position fixing, and the water-level measurements to establish an accurate reference of echo sounder attuned to the purpose of the study.

For the study, the Raytheon DE-719c fathometer can be used. Depths of water will be determined using the time required for sound waves to travel from a point near the surface of the water to the bottom and back echo. High frequency super-sonic sound waves are produced in the boat and transmitted to the bed of the water body. The waves are then reflected back to the sounding instrument. The transmitted pulses are regularly repeated at the interval of a fraction of a second.

Fig. 8: Fixing of Transducer support calibrated

Fig. 9: Marking of Echo roll, ready for

Fig. 10: Taking GPS position at start of

Line fixing

Prior to carrying out the sounding operation, the echo sounder is calibrated. The bar check is the most common method, and is carried out at the area of interest (i.e. area to be surveyed). The system has to be calibrated at the starting of sounding (SOS), end of sounding (EOS) and in between soundings by means of a bar-check lowered to a set depth .The calibration is necessary due to the fact that the speed of sound in water and thus depth measured is affected by the temperature and salinity of the water. Hence the echo sounder is calibrated to arrive at the correct factor for the speed of sound

TIDE OBSERVATION

Tidal levels can be observed relative to a **fixed mark ashore** in order to obtain the necessary information. The information was used to adjust soundings to correct for the effect of tides.

Fig.11: Tidal Lag observation using leveling staff

To achieve this, a tide pole was read regularly by an observer at regular interval.

Tidal observations were carried out during the period of the survey in order to interpret the soundings and reduce the results to a standard datum.

DISCUSSION AND CONCLUSION

The action of the sea cannot be allowed to continue unchecked. To find the solution, the 'first – man' (the Surveyor) is called upon to provide the necessary data and information about the strength and severity of the phenomenon. He does this by regularly taking level and other measurements in the affected area. With these the rate of erosion could be determined and the suitable control measure recommended.

Surveyors have the knowledge, the expertise and the experience to take the initiative in advising the

government and engineers. If new directions are needed, if new control measure is to be taken, it is the Surveyor who will provide this information.

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