Applications of GPS and GIS in Aquaculture and Fisheries

Alum-Udensi, O.*; Egesi, C. O. and Uka, A.
Department of Fisheries and Aquatic Resources Management.
Michael Okpara University of Agriculture,
Umudike. Abia State, Nigeria.
*Email: okeyalum@yahoo.com

ABSTRACT
Global positioning system (GPS) and Global information Systems (GIS) are becoming a widely used tool in agriculture. Its usefulness in aspects of aquaculture and fisheries such as land and water mapping, flood and pollution management, management of inland capture fisheries, disease monitoring, species ecology and conservation studies is only limited by the proficiency of the users. In addition to its ease of use, and worldwide all weather operation, GPS owes its popularity to its versatility, the dependable high accuracy with which positions, time and direction can be determined. This paper highlights current areas of application of GPS and potential application of GPS to aquaculture and fisheries.

INTRODUCTION

The Global Positioning System (GPS) is a precise worldwide radio-navigation system. Global Positioning System is a satellite based navigation system determining the accurate position or location of an object on earth's surface (Hentry *et. al*, 2011). GPS and Satellite remote sensing is increasingly gaining recognition as an important source for data collection (Al-Mardi, 2014) and has become an integral part of aquatic science and limnology. The development of the publicly available Global Positioning System (GPS) has opened new doors of opportunities for spatial data collection. In combination with GIS, the application of GPS is limitless. With over 12.5 million hectares of Nigerian land estimated to be suitable for aquaculture development in freshwater and marine environment (Gaffar, 1996), we can increase aquaculture productivity by properly harnessing the potentials of GPS to aquaculture.

The system is based on a constellation of 24 orbiting radio-navigation satellites (the space segment) owned by the United States government, an earth control segment and the receiver (the user segment). They provide continuous position data provided the receivers have a line of site access to the satellites (Goddard *et. al*, 2011). The receiver synchronizes its code with the satellites by adjusting the timing of its code generation until the intersection of all the satellite ranging spares converge on a single point.

Differential GPS (DGPS) uses a stationary monitor receiver to calculate the difference between the true position and the determination of a position from the satellites for a point in time. This allows the positions of a roving receiver to have a three dimensional accuracy of 20cm or better

(Goddard et al, 2011).

Potential application of GPS and GIS in aquaculture

GPS can be applied to almost all aspect of aquaculture. In combination with GIS, which is a computer based system that input, store, retrieve, analyze & display geographically referenced information useful for decision making, its usefulness in land and water mapping, flood and pollution management, management of inland capture fisheries, species ecology and conservation studies is only limited by the proficiency of the users proficiency of the users.

Site surveys: One of the most common reasons for the failure of aquaculture
projects and for adverse environmental effects is locating developments on inferior sites (Boyd and Clay, 1998). Survey data capture using GPS are very useful in aquaculture site selection. With the development of the geographic information system (GIS) and availability of remote sensing data, it is now possible to select environmentally suitable areas rapidly and systematically (Radiarta *et.al* 2011). Slope, soil characteristics, vegetation and water supply of aquaculture lands can be pinned accurately and used in both decision making and farm design.

River mapping: the entire course of a river, streams, lakes can be mapped with useful information as depth, flow direction at each point, width, etc. Species occurrence and abundance maps are also easy to generate on such water bodies using GPS. This makes ecological studies easy. Apps such as Navionics boating and fishing have been developed to aid capture and sports fisheries.

Species studies: GPS tracking system based tags can be used to track invasive species, endangered species, fish migrations and population changes. These information on GIS systems can be shared and updated at any time through the use of web-based data management. Using radio and hydro acoustic telemetry, biologists and scientist are able to build up large amount of data on species, which can be used to track patterns of migration, spawning locations and preferred habitat (Goddard, *et.al,*1995).

Water quality monitoring: GPS could be an invaluable utility tool in water quality monitoring. In South-East Asia, GPS has been used in surveys to determine the impact of tsunami on aquaculture. This was possible because GPS had been used to previously capture aquaculture data in the area. In a study Arul (2010), the impact of tsunami on water quality parameters was easily highlighted using GPS. The study revealed that the biochemical parameter for the post tsunami conditions increased the performance/growth of shrimp aquaculture after the impact of tsunami (Arul, 2010). This may be due to the recharge of salt water as well as intrusion of surface salt water during the high altitude tsunami waves along the pond region.

Fish Ecology: Developments in sensor-controller Technology, computers and position systems now bring new opportunities for farm management and aquaculture (Goddard et al, 1997). GIS analysis of fish habitat has become more sophisticated often combining numerical or statistical models of fish abundance, growth and prey availability with the physical characteristics of the habitat in a GIS framework (Al-Mahdi *et. al.*2014)

Updated maps provide watershed managers with the tools they need to effectively monitor water quality. GPS data capture generates geo-database with the capability to provide decision makers and managers with information on tools for analyzing key decision criteria that support the selection of sites suitable for different types of aquaculture: marine, coastal and inland fish farming and eliminate areas unsuitable for aquaculture. GPS based data can help governments and licensing agencies to allocate and approve the appropriate aquaculture projects and guide investors to aquaculture potentials in a state, country or region.

Other areas of application of GPS to fisheries include Disease and pest mapping, fisheries and aquaculture infrastructure enumeration and satellite based navigation systems in capture fisheries. GPS technology helps with traffic routing, underwater surveying, navigational hazard location, and integrated mapping (Hentry *et. al*, 2011). Fishing fleets are able to navigate to fishing locations, digitally and easily mark specific locations (docks, fishing hotspots, boat drifts, trolling paths, and more) and track fish migrations with ease using GPS aided fish finder devises. Use GPS to mark locations of

Conclusion

Global positioning system has revolutionized positioning concepts, though it started primarily as a navigation system for the military. Today the global positioning system (GPS) has become an international utility. In addition to its ease of use, and worldwide all weather operation, GPS owes its popularity to the dependable high accuracy with which positions, time and direction can be determined. As a tool of precision agriculture, GPS satellites broadcast signals that allow GPS receivers to calculate their position. This information is provided in real time, meaning that continuous position information is provided while in motion. Having precise location information at any time allows crops, soils and water measurements to be mapped. GPS receivers, either carried to the field or mounted on implements allow users to return to specific locations to sample or treat those areas.

REFERENCES

Adedotun, O. B. 2004, GIS application to boost fish production in Nigeria. Fisheries Society of Nigeria Conference Proceeding. Lagos. Pp 677-682.

Al-Mahdi A. M.; Ezekiel M.S. Ndahi, B. Y.; and Muhammed L. M. 2014. Integrated GIS and Satelite Remote Sensing in Mapping the Growth, managing and Production of Inland Water Fisheries and Aquaculture. *European Scientific Journal 1857 – 7881.*

Arul, P. 2010. Asian tsunami: Ecological Implications and Rehabilitation Processes along Nagapattinam Coast. Thesis submitted to the Bharathidasan University for the award of Doctor of Philosophy in Geography. BharathidasanUniversity India.

Boyd, C. E. and Clay, J.W. 1998. Shrimp aquaculture and environment. *Scientific American 1998*;278:58–65.

Gaffar, J.A.1996. Twenty years of Fisheries Development in Nigeria. FISON proceedings

1996. Lagos.

Goddard, L., and N. E. Graham, 1997: El Nin˜o in the 1990s. *J. Geophys. Res., 102, 10 423–10 436.*

Goddard, T; Kryzanowski, L; Cannon, K; Izaurralde,C and Martin, T (2011). Potential for Integrated GIS-Agriculture Models for precision Farming systems. Retrieved from http://www.ncgia.ucsb.edu/conf/SANTA_FE_CD-ROM/ sf_papers/goddard_tom/960119.html Aug.2015.

Goddard, T.W., Lachapelle, G., Cannon, M.E., Penney, D.C., and McKenzie, R.C. (1995) The potential of GPS and GIS in precision agriculture. Proc. Geomatique V: November 9-10, Montreal, P.Q., Canada

Hentry, C.; Rayar, S. L.; Saravanan, S.; Chandrasekar, N.; Raju, P. and Kulathuran, K. 20011. Application of Gps in Fisheries and Marine Studies. International Journal of Advanced Research in Computer Science. Volume 2, No. 6, Nov-Dec 2011.

Radiarta, I N., Saitoh, S-I., and Yasui, H. 2011. Aquaculture site selection for Japanese kelp (Laminaria japonica) in southern Hokkaido, Japan, using satellite remote sensing and GIS-based models. – *ICES Journal of Marine Science, 68: 773–780.*