Promoting Aqua-silviculture in Niger-Delta Region of Nigeria using RS and GIS Technology

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Abstract
Aqua-silviculture (AS) has been considered as one of the most promising options of combining forest conservation with rural development, community empowerment and poverty reduction objectives. But studies have shown that more than 75 % of the coastal area have been degraded by human activities. Therefore, this paper was aimed at promoting AS in Niger-Delta region of Nigeria using RS and GIS technology. This paper studies five states out of nine states that comprise the Niger-delta region using Remote Sensing (RS) and Geographic information (GIS). NigeriaSat-1 imagery of Akwa Ibom, Bayelsa, Delta, Cross River and River states was imported into ILWIS version 3.1 software installed in HP TouchSmart 300 PC. States boundaries and drainage patterns were digitized in GIS environment from NigeriaSat-1 imagery. In addition, suitable sites for aqua-silviculture were equally digitized and the resulted maps were exported to ArcGIS version 9.3 software where the Geospatial analysis was carried out and the map of states in the study area were composed. The coordinates, that is the Eastings and Northings (UTM system) of the states were carried out in ArcGIS software. Topographic map used were on 1:50,000 scale. The result shows vast areas of Delta that are suitable for AS and great variation exist among states in terms of number and pattern of drainage channels. RS and GIS technology can be used to map areas of Delta (even the inaccessible area) that are suitable for AS thereby making it easier for the stake holders within and outside the region to practice AS.

Keywords: Aquaculture, eco-system, environmental degradation, Mangrove, Remote Sensing.

Introduction
The Niger Delta, was officially demarcated by the Nigerian government, extends over about 70,000 km² and makes up 7.5% of Nigeria’s land mass (Isumonah, 2013), and large part of the area consists of salt water swamp, fresh water and further inland have limited agricultural possibilities (Oteh and Ezeh 2012). The Niger-Delta region is composed of the following states: Abia, Akwa-Ibom, Bayelsa, Cross-River, Delta, Edo, Imo, Ondo.
and Rivers state. The widespread loss and degradation of mangroves, as well as other ecosystems, may be largely attributed to an underestimation of their value together with the impact of human activities. The Niger Delta is an area that is richly endowed with abundant rivers and streams that should be harnessed for wealth creation. In facts the region is most suitable for aqua-Silviculture. Over the past 20 years, coastal areas in the Niger-delta have come under increasingly severe threats due to human activities (Lawal and Ese, 2012). Studies have shown that more than 75 percent of the coastal area in the country have been degraded from human activity. In fact, mangrove forests are declining at a rate of 2,000 ha/year with only 120,000 ha of mangrove forest remaining today from the 160,000 ha 20 years ago and 450,000 ha at the turn of the century (Primavera, 2005). In view of the vast range of uses, small dams like AS were developed to uplift people’s living standards especially in communal areas where frequent flooding, livelihood centred on agricultural production, high population figures and with least infrastructural development characterised (Zirebwa and Twomlow, 1999). It should be established that AS can increase biodiversity, providing a sanctuary for wildlife and birds (Purcell et al., 2006). Truong et al. (2008) revealed that AS has been considered as one of the most promising options of combining forest conservation with rural development, community empowerment and poverty reduction objectives. Nkhoma, (2011) opined that small dam in Nigeria has never been given serious attention talk less of aqua-silviculture. From the ongoing, it can be established that AS is a strategy to alleviate poverty, restoring riparian vegetation and improve quality of life for the community that are hitherto not properly integrated into Nigerian agricultural system. Therefore, the thrust of this paper is to assess and promote the adoption of aqua-silviculture in the Niger-Delta region of Nigeria using RS and GIS technology. The reason for this is that scholars such as Burrough and McDonnell (1998), Thornes (2005) have defined and revealed the importance of satellite remote sensing and Geographic Information System in handling, processing, transforming and displaying large volume of data from the real world for a particular purpose. According to Thine, (2004) this technology provides new opportunities for large area rapid assessment that has not be utilised with special reference to Nigeria.

Materials and Method
The research was carried out in 2013 at the Advanced Space Technology applications Laboratory Uyo, Akwa Ibom state. Satellite imagery (NigeriasatSat-1), Geographic Journals, Topographic map, Geological maps of the five states (NGSA), HP TouchSmart 300 PC, Software: ILWIS version 3.1 and ARCGIS version 9.3.

Method
NigeriaSat-1 imagery of Akwa Ibom, Bayelsa, Delta, Cross River and River states was imported into ILWIS version 3.1 software installed in HP TouchSmart 300 PC. States boundaries and drainage patterns were digitized in GIS environment from NigeriaSat-1 imagery. In addition, suitable sites for aqua-silviculture were equally digitized and the resulted maps were exported to ArcGIS version 9.3 software where the Geospatial analysis was carried out and the map of states in the study area were composed. The coordinates, that is the Easting and Northings (UTM system) of the states were carried out in ArcGIS software.

Results
This study illustrates the successful use of RS and GIS in the generation of spatial information such as maps to show the drainage pattern and the prospects of AS in the states in Niger-Delta region of Nigeria. From the maps, one cannot but acknowledge the fact that the region is indeed endowed with abundance water resources. Figure (1) shows a map of Akwa Ibom state, Figure (2) Bayelsa state, Figure (3) Cross River state, Figure (4) Delta state and Figure (5) River state drainage pattern and possible sites for aqua-silviculture. The Niger-delta region is located at lower end of the river Niger where the big river empties into small rivers and streams and is therefore suitable.
for construction of small/medium dam for multipurpose use such as AS. The possible site for AS (drainage channels) is mostly condensed in the southern parts of Akwa Ibom, Bayelsa and Rivers states than the other parts (fig. 1, 2 and 5) compared to Cross River state that tend to have even distributions of drainage channels across the state (fig. 3), while in Delta state drainage channels were condensed in South/western part than other parts of the state (Fig. 4). The studies shows differences within-state and between states in term of suitable site for construction As. For example the drainage pattern of the stream networks in some states were mainly dentritic type while others were not. The degree of drainage dentritic varies within-state and between states. RS/GIS has given solution for decision making with strong analytical and visualization capability to all the stakeholders.

Figure 1: Akwa Ibom drainage pattern and possible site for Aqua-silviculture
Figure 2: Bayelsa state showing drainage pattern and possible site for Aqua-silviculture

Figure 3: Cross River state showing drainage pattern and possible site for Aqua-silviculture
Figure 4: Delta state showing drainage pattern and possible site for Aqua-silviculture

Figure 5: River state showing drainage pattern and possible site for Aqua-silviculture
Discussion
Remote Sensing and GIS have proved to be an important leverage towards understanding spatial trends and generation of geospatial information of states within the Niger-Delta Region. The results showed vast area of Niger-Delta sites suitable for establishments of aqua-silviculture. AS is a management strategy that combines and harmonizes fish production and mangrove development. The strategy has become a favourable livelihood opportunity to sustainably augment fishers income and, at the same time, reforest the mangrove (Rusere and Senzanje, 2005). Moreover, the Nigerian fishing industry provides a great deal of employment and economic opportunity because it is labour intensive and dominated by the small fishermen and fish production is a cardinal objective of AS (Green et al., 2003). The drainage pattern of the stream and networks in states of the study area were mainly dentritic type which indicates to some extent homogeneity in both physical and chemical property of the water body which are critical factors in river basin evaluation for the establishment of aqua-silviculture. Mangrove-associated aquaculture has worldwide importance in providing subsistence-level of food and income, as well as commercial benefits, for a wide range of stakeholders (Rosie et al., 2013). Through restoration of riparian vegetation, markets and other economics activities will multiplies and rural poverty will declines in downstream of delta where the AS is/are built. With the use of RS and GIS technology to produce accurate maps, Niger-Delta that have suffered environmental degradation from oil spillage can be reclaimed by the use of mangroves as filters for absorbing effluents of spilled oil if properly incorporated in AS system (Phillips, 2002; Limson, 2007). In light of this, when AS is carefully exploited, the multiple uses can go a long way in uplifting people’s livelihood especially in rural areas. AS provide a means to most rapidly free growing plantation when combined with plantation forestry techniques and fast-growing shade-intolerant species (Akinyemi, 2001; Rusere and Senzanje, 2005). Environmental services, such as biodiversity, shore protection and flood mitigation, need to be priced very high when constructing AS (Wu et al., 1999). AS has been considered one of the most promising options of combining forest conservation with rural development and community empowerment and poverty reduction objectives. Small dam (AS) can improve biodiversity and providing a sanctuary for wildlife and birds (Rusere and Senzanje, 2005). It can form part of a strategy to alleviate poverty and improve quality of life for communities. In light of this, when carefully exploited, the multiple uses of AS can go a long way in uplifting people’s livelihood especially in rural areas.

Conclusion
Remote sensing techniques are used to measure and monitor the real extent of Delta areas, to efficiently target suitable site for aqua-silviculture. AS is an environmental friendly program that aims to protect, conserve and rehabilitate the mangroves areas along the riverbanks of Niger-delta, and at the same time giving alternative source of income for coastal dwellers. RS/GIS have made enormous contributions to regional and global geophysical surveys. Incorporating remotely sensed data into a GIS allows for quick calculations and assessments of water levels in Delta areas suitable for AS. We need another paradigm shift to redress environmental imbalance by reverting pond and resort areas and settlements along vulnerable coastlines back to lush mangrove-beach forests by practicing AS with the use RS and GIS technology. This study shall help planners/managers make adequate decision and also helps a layperson to know and understand their own surrounding too. RS/GIS has given solution for decision making with strong analytical and visualization capability.

References


