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Uses of Seas Shells for Civil Construction Works in Coastal Bayelsa State, Nigeria: A Waste Management Perspective

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Abstract: Shell fish forms a great part of the diet of the coastal communities in Bayelsa State, Nigeria. Owing to the consumption of shell fish and the disposal of the non-edible shells, waste shell abounds in many of the coastal cities of Nigeria. Meanwhile, communities in coastal Bayelsa State are challenged with the problem of erosion, flooding and the lack of civil construction materials particularly granite/chippings/gravels. Some communities in coastal Nigeria have started using the waste shell in civil construction activities. This study was carried out in ten selected coastal communities in Bayelsa State to find out about the various ways to which waste sea shells have been put to use using a combination focus group discussions and walk-through surveys. Result shows that the selected communities use waste sea shells for civil construction including building, pavement, gutters, foundation, filling, septic tank, grave site, shoreline protection etc. The utilization of waste shell that hitherto causes pollution for beneficial use in response to ecological constraints is a major plus for sustainable development.

Key words: Civil construction, coastal Bayelsa State, erosion, flooding, Niger Delta, sea shells, waste management, waste shells

INTRODUCTION

The entire Bayelsa State, Nigeria is a sedimentary basin that is virtually riverine and estuarine. The major occupation of the people is fishing. Both shell and fin fishes are caught, processed, sold or eaten by the fisher family. Among the commonest shell fishes consumed in coastal Bayelsa State are periwinkle, *Tympanutonus fuscatus*, clam (*Chione subrugosa*, *Geloina erosa*) and the mangrove oyster, *Crassostrea gasar*. These shell fishes are typically processed for consumption by removing the inedible shells. The waste shells are thrown away, which causes environmental pollution. Even in Korea, marine pollution by waste oyster shells has become one of the most serious problems of the aquaculture industry causing nasty odors as a consequence of the decomposition of fresh remnants attached to the oysters (Yoon *et al*., 2004; Jung *et al*., 2007). Fish and their products account for a large proportion of the people's diet and the intensification of fishing activities have led to the production of large quantities of these waste shells. Several dumps of sea shell are common in many cities in the Niger Delta including Port Harcourt, Warri, Yenagoa, Calabar, Oron, Uyo etc. Ansa and Bashir (2007) reported that the mean weight of the mangrove oyster in Port Harcourt to be 24.67 g (n = 100) with only 8.63% as edible meat, while the rest consists of mostly shell wastes.

As a way of waste management, a number of useful materials have been produced from sea shell wastes. Agoha (2007) produced useful biomaterials such as chitin and chitosan from waste periwinkle shells. Elsewhere, an arc based plasma torch operated at 25 kW was used to convert fresh oyster shells into a useful product such as calcium oxide, CaO (Chae *et al*., 2006). Malu and Bassey (2003) evaluated the suitability of periwinkle shells as substitute for lime in glass manufacturing. They did a proximate analysis of periwinkle shell, which showed that

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the shell contained important minerals suitable for glass production such as calcium oxide (38.4%), silicon iv oxide (0.014%), magnesium oxide (18.70%), aluminium trioxide (0.211%) and iron oxide (0.019%). Oribhabor and Ansa (2006) considered the use of periwinkle for the formulation of fish feed as a source of calcium. Malu *et al.* (2009) worked on the use of waste sea shells as calcium supplements in the food industry. Their result showed that these shell wastes contain a high percentage (95.54%) of Calcium Oxide (CaO), 2.52% of Magnesium Oxide (MgO) and trace amount of other oxides. Calcium oxide has been a major source of calcium. They concluded that *Egeria radiate* and *Thais coronata* shells are suitable source of raw materials for the production of calcium supplements by the indigenous food industry.

Rather than causing environmental pollution, waste clam, periwinkle and oyster shells have been variously used as adsorbent materials for waste management. In Korea for example, oyster shells are processed and used as adsorbent media for the removal of SO_2/NOx. Jung *et al.* (2007) found that SO_2 removal activity and reaction rate of the calcined/hydrated waste oyster shells were higher than those of calcined/hydrated limestone. This finding clearly indicates that absorbents prepared from waste oyster shells are substitutes for commercial limestone and can be applied directly to reduce emissions of SO_2 and NOx. The use of oysters and clam shells for the treatment of arsenic and other heavy metal contaminated water was demonstrated (Rahman *et al.*, 2008; Badmus *et al.*, 2007). Periwinkle wastes have been used for the production of adsorbents for the treatment of high COD (Badmus and Audu, 2009) and lead (Badmus *et al.*, 2007) in industrial waste water.

One of the promising uses of waste gastropod shells is in civil construction as substitute for aggregates (chippings) especially in the coastal areas where these materials are lacking. Few researchers have conducted exploratory studies on the partial or total substitution of waste sea shells with coarse aggregates/chippings for the production of mortar and concrete used for civil construction.

In the study, carried out by Adewuyi and Adegoke (2008), they found out that the replacement of granite with 35.4-42.5% waste periwinkle shells did not compromise the compressive strength of the resulting concrete and was found adequate saving 14.8-17.5% of material cost. Osarenmwinda and Awaro (2009) carried out geotechnical analysis of concrete produced from periwinkle waste shells and found that the periwinkle shell had a bulk density of 517 kg m^{-3} and specific gravity of 2.05. Their results also showed that a design mixture of 1:1:2, 1:2:3 and 1:2:4 of cement: sharp sand: periwinkle shell ratios had a compressive strength of 25.67, 19.50 and 19.83 N mm^{-2}, respectively at 28 days hydration period, which met the ASTM-77 recommended standard minimum strength of 17N mm^{-2} for structural light weight concrete. Elsewhere in Korea, studies indicated there was no significant reduction in the compressive strength of the mortars containing small oyster shell particles instead of sand (Yoon *et al.*, 2004).

The entire coastline of Bayelsa State is dotted by several communities, which rely closely on environmental resources particularly fisheries for survival. However, the production of shell fish waste threatens the sustainability of the local fish industry and the environment in general. Also because of the far distance of these communities away from upland areas, construction aggregates, chipping, gravel, etc. are unavailable in these communities. Many communities in Bayelsa State are now converting waste crustacean shells for use in civil construction and other related activities.

The evolution of the modern Niger Delta started in Early Tertiary with sediments being supplied by the Niger-Benue River system which over the years have built a large delta. Because of the sedimentary nature of the terrain, there is lack of civil construction materials particularly aggregates, chippings, gravels etc. Most of these communities are remote, with only water transportation access. It is costly to transport construction materials to these communities. Ironically, these are the communities that require a lot of construction materials because of the heavy rainfall and the attendant flooding and erosion problems. The aim of this study is therefore to access how selected communities in coastal Bayelsa State, Nigeria make use of waste sea shell for civil construction activities, which incidentally result in the effective management of waste shells that were hitherto dumped into the environment.

MATERIALS AND METHODS

The study was conducted by carrying out a visit to selected communities in coastal Bayelsa State, Nigeria (Fig. 1). Focused group discussions (Cronin, 2001; Burningham and Thresh, 2001) were carried out in the communities to find out about the various ways to which waste sea shells have been put to use.

A walk-through survey (Feingold and Wasser, 2007) was also done to confirm the use of sea shells in the various communities.

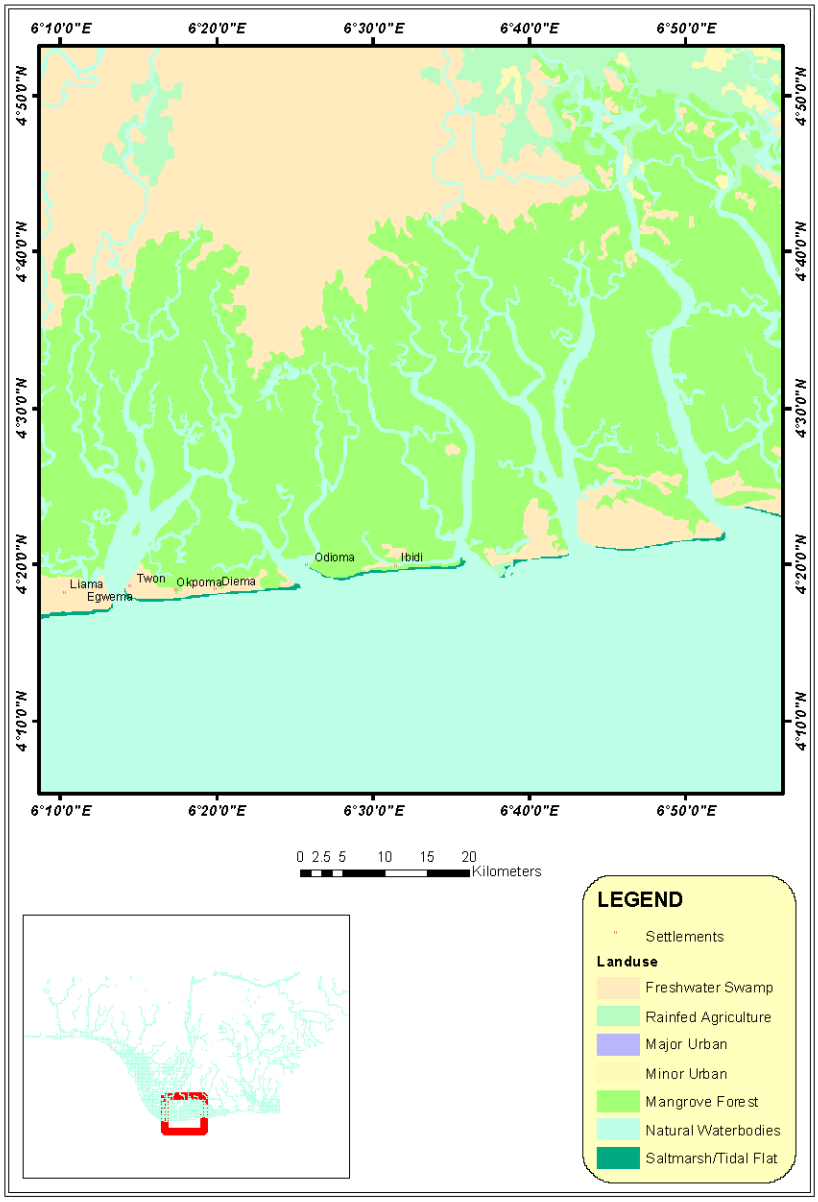

Fig. 1: Map of coastal Bayelsa State showing the studied communities

RESULTS AND DISCUSSION

Typically, the crustacean are caught and processed for food. While the fleshy portions are removed for consumption, the shells are discarded. Previously, the shells are thrown away freely causing environmental pollution, now they are gathered for re-use. Waste shells are now commonly used as filling materials and for other uses (Table 1). This is because of the ecological challenges of erosion, flooding and subsidence affecting the communities (UNDP, 2006; CEDA, 1997). Ibe (1990) reported that the vulnerability of the entire coastal area of Nigeria to coastal erosion caused by the increasing sea level as a result of the global climate change due to the increasing ambient level of CO_2 concentration. He reported that the Niger Delta will suffer disproportionately owing to its low relief and subsidence. Awosika *et al.* (1992) estimated that a 1 m rise in the sea level could flood an area of about 18,000 km^2 of coastal land. Anthropogenic activities particularly dredging, sand mining and mangrove clearance have exacerbated erosion problems in the Niger Delta (Ohimain, 2008). There is

Table 1: Uses of sea shells for civil construction works in selected communities in Coastal Bayelsa State

Contents	Beletiama	Diema	Egwema	Ibidi	Liama	Obioku	Odioma	Okpoma	Sangana	Twon
Pavement slabs	x	x	x	x	x	x	x	x	x	x
Building construction	x	x	x	x	x	x	x	x	x	x
Filling materials	x	x	x	x	x	x	x	x	x	x
Erosion control	x	x			x		x			
Grave construction							x	x		x
Water well casing		x		x				x		
Shoreline protection							x			
Road								x		x
Bridges								x		x

Table 2: Types of sea shells used for civil construction in selected communities in Bayelsa State

Type of organism	Common name	Scientific name	Native Ijaw name
Periwinkle	Periwinkle	*Tympanutonus fuscatus*	Isamdi
Oyster	Mangrove oyster	*Crassostrea gasar*	Imgba
Clam	Common galatea clam	*Egeria radiata*	Gbou
Clam	-	*Chione subrugosa*	Gbou

also a geological explanation to erosion, flooding and subsidence problems in the Niger Delta. The entire Nigerian coastal zone consists of young sedimentary rocks, which are still undergoing the process of compaction (Allen, 1964, 1965; Allen and Wells, 1962). Natural resource extraction particularly water and petroleum has been recognized as a major cause of subsidence in sedimentary basins (Poland, 1984). The large volume of oil production in the Niger Delta over 50 years, may have contributed to the subsidence problem in the region.

Ibe (1988) reported a subsidence rate of about 2.5 cm year^{-1} in the Niger Delta. In response to the ecological problems in the Niger Delta, some of the communities are using waste shells as filling and erosion control materials.

In Odioma, waste shells are used as shoreline protection material (Fig. 2d) to control shoreline erosion. Also, because of the low topographic terrain and the flooding problems, access streets into the communities are typically flooded, hence elevated concrete slabs made from waste shells are commonly used to pave access paths. However, in the more developed communities, there are access roads. Of particular importance is the access road linking Twon Brass and Okpoma communities (Fig. 2a). Concrete for the construction of parts of the road and speed breaks, were made from waste shells. Also, a new bridge construction in Okpoma revealed that the concrete was made from waste shells (Fig. 2c).

Among the commonest use of waste shells in all the communities is in the area of building construction (Fig. 2b).

A visit to building construction sites during the study revealed that waste shells were used completely as replacement for granite. Concrete prepared from periwinkle-cement-sand mixture was used for various aspects in the building construction including as blinding material, filling material and flooring mortar for foundation construction.

Periwinkle concrete was also used subsequently in other aspects of building requiring granite including pillar, lintel and in few cases, decking.

Dahunsi (2002) tested the compressive strength of concrete made from periwinkle shell in combination with chippings and reported that concrete with periwinkle shells alone as coarse aggregate were lighter and of lower compressive strengths compared to those with periwinkle in combination with granite and concluded that periwinkle shells could be used as partial replacement for granite in normal construction works especially in places where granite is in short supply and periwinkle shells are readily available.

At Odioma, a community that was ravaged during conflicts, it became easy to observe the various use of waste shells in the damaged houses. Hard core from cement concrete were basically made of periwinkle shells (Fig. 2f).

Other civil constructions that the waste shells were used include the construction of grave site (Fig. 2g), soak away septic tanks, gutters, water well casing ring etc.

Examination of waste shell dumps show that the shells of periwinkle, clams (Fig. 2h) and the mangrove oyster (*Crassostrea gasar*) are common (Table 2). These organisms are commonly found in the mangrove areas, where they are caught and their fleshy bodies used as sources of protein and the waste shell discarded.

Fig. 2: The use of waste shells in civil construction works

CONCLUSION

Waste shells of shell fish abounds in the coastal communities of Bayelsa State, where they cause environmental pollution.

Due to ecological problems of flooding, erosion and the lack of granite in the coastal communities, waste shells are now used for civil construction activities, thus effectively managing the wastes.

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REFERENCES

Adewuyi, A.P. and T. Adegoke, 2008. Exploratory study of periwinkle shells as coarse aggregates in concrete works. J. Eng. Applied Sci., 3 (6): 1-5. http://arpn-journals.com/jeas/research_papers/rp_2008/jeas_1208_136.pdf.

Agoha, E.E.C., 2007. Biomaterials from Periwinkle Shells: Composition and Functional Properties. Paper presented at the World Congress on Medical Physics and biomedical Engineering, Aug. 27 to Sept. 1. COEX Seoul, Korea Imaging the Future Medicine. Springer Berlin Heidelberg. http://www.wc2006-seoul.org/scientific/program_by_track_20060823.pdf.

Allen, J.R., 1964. The Nigerian Continental Margin: bottom sediments, submarine morphology and geological evolution. Mar. Geol., 1 (4): 298-332. DOI: 10.1016/0025-3227(64)90018-0.

Allen, J.R., 1965. Late Quartenary Niger Delta and adjacent areas: Sedimentary environments and lithofacies. A.A.P.G. Bull., 49: 547-600. http://aapg-bull.geoscienceworld.org/cgi/content/abstract/49/5/547.

Allen, J.R. and J.W. Wells, 1962. Holocene coral banks and subsidence in the Niger Delta. J. Geol., 70: 381-397. http://www.journals.uchicago.edu/doi/abs/10.1086/626832.

Ansa, E.J. and R.M. Bashir, 2007. Fishery culture potentials of the mangrove oysters (*Crassostrea gasar*) in Nigeria. Res. J. Biol. Sci., 2 (4): 392-394. http://www.medwelljournals.com/fulltext/rjbs/2007/392-394.pdf.

Awosika, L.F., G.T. French, R.J. Nicholls and C.E. Ibe, 1992. Impacts of Sea Level Rise on Nigeria: In: Proc. IPCC Symposium on the Rising Challenge of the Sea, Mar. 14-19. Margarita Island and Venezuela.

Badmus, M.A.O. and T.O.K. Audu, 2009. Periwinkle shell: Based granular activated carbon for treatment of Chemical Oxygen Demand (COD) in industrial wastewater. The Can. J. Chem. Eng., 87 (1): 69-77. http://www3.interscience.wiley.com/cgi-bin/fulltext/122212698/PDFSTART.

Badmus, M.A.O., T.O.K. Audu and B.U. Anyata, 2007. Removal of lead ion from industrial wastewaters by activated carbon prepared from periwinkle shells (*Typanotonus fuscatus*). Turk. J. Eng. Environ. Sci., 31: 251-263. http://journals.tubitak.gov.tr/engineering/issues/muh-07-31-4/muh-31-4-6-0703-2.pdf.

Burningham, K. and D. Thresh, 2001. Exemplar: The Environment Concerns of Disadvantaged Groups. 2nd Edn. In: Gilbert, N. (Ed.). Researching Social Life. Sage Publications Ltd., London, pp: 178-193. ISBN-13: 978-0761972457.

CEDA, 1997. Coastal Profile of Nigeria. Centre for Environment and Development in Africa. http://www.globaloceans.org/icm/profiles/nigeria/nigeria.pdf.

Chae, J.O., S.P. Knak, A.N. Knak, H.J. Koo and V. Ravi, 2006. Oyster shell recycling and bone waste treatment using plasma pyrolysis. Plasma Sci. Technol., 8: 712-715. DOI: 10.1088/1009-0630/8/6/19.

Cronin, A., 2001. Focus Groups. 2nd Edn. In: Gilbert, N. (Ed.). Researching Social Life. Sage Publications Ltd., London, pp: 164-177. ISBN-13: 978-0761972457.

Dahunsi, B.I.O., 2002. Properties of Periwinkle-Granite Concrete. J. Civil Eng., 8: 27-36. http://ajol.info/index.php/jce/article/view/18993.

Feingold, E. and J. Wasser, 2007. Walk-through surveys for child labor. Am. J. Ind. Med., 26: 803-807. http://www3.interscience.wiley.com/journal/114079616/abstract.

Ibe, A.C., 1988. Coastline erosion in Nigeria. Ibadan University Press, Ibadan, Nigeria, pp: 217. ISBN: 978 2345041.

Ibe, A.C., 1990. Global climate change and the vulnerability of the Nigerian coastal zone to accelerated sea level rise: Impacts and response measures. NIOMR Paper No. 51. Lagos. http://iodeweb1.vliz.be/odin/bitstream/1834/2406/1/NIOMR%20TP-52-.pdf.

Jung, J.H., K.S. Yoo, H.G. Kim, H.K. Lee and B.H. Shon, 2007. Reuse of Waste Oyster Shells as a SO_2/NOx Removal Absorbent. J. Ind. Eng. Chem., 13 (5): 512-517. http://www.cheric.org/PDF/JIEC/IE13/IE13-4-0512.pdf.

Malu, S.P. and G.A. Bassey, 2003. Periwinkle (*T. fuscatus*) shell as alternative source of lime for glass industry. Global J. Pure and Applied Sci., 9 (4): 491-494. http://ajol.info/index.php/gjpas/article/view/16056.

Malu, S.P., A.E. Abara, G.O. Obochi, B.I. Ita and C.A. Edem, 2009. Analysis of *Egeria radiata* and *Thais coronata* shells as alternative source of calcium for food industry in nigeria properties of Periwinkle-Granite concrete. Pak. J. Nutr., 8 (7): 965-969.

Ohimain, E.I., 2008. Environmental impacts of dredging and canalization in the Niger Delta. Paper presented at the 2008 Annual workshop of the Nigerian Mining and Geosciences Society, Port Harcourt Chapter, titled impacts of sand dredging in the Niger Delta, Aug. 21. Niger Delta Development Basin, Port Harcourt.

Oribhabor, B.J. and E.J. Ansa, 2006. Organic waste reclamation, recycling and re-use in integrated fish farming in the Niger Delta. J. Appl. Sci. Environ. Manage., 10 (3) 47-53. http://www.bioline.org.br/abstract?id=ja06051&lang=en.

Osarenmwinda, J.O. and A.O. Awaro, 2009. The potential use of periwinkle shell as coarse aggregate for concrete. Adv. Mat. Res., 62, 64: 39-43. http://www.scientific.net/AMR.62-64.39/preview.

Poland, J.F., 1984. Guidebook to Studies of Land Subsidence Due to Ground-Water Withdrawal: Vol. 40 of UNESCO Studies and Reports in Hydrology: Paris, France, United Nations Educational, Scientific and Cultural Organization, pp: 305. http://wwwrcamnl.wr.usgs.gov/rgws/Unesco.

Rahman, M.A., M.A. Rahman, A. Samad and A.M.S. Alam, 2008. Removal of arsenic with oyster shell: experimental measurements. Pak. J. Anal. Environ. Chem., 9 (2): 69-77. http://www.ceacsu.edu.pk/PDF%20file/Journal%20Volume%209,%20Issue%202/03. pdf.

UNDP (United Nations Development Programme), 2006. The Niger Delta Human Development Report. Abuja. http://hdr.undp.org/en/reports/nationalreports/africa/nigeria/nigeria_hdr_report.pdf.

Yoon, H., S. Park, K. Lee and J. Park, 2004. Oyster shell as substitute for aggregate in mortar waste. Manage. Res., 22 (3): 158-170. http://wmr.sagepub.com/cgi/content/abstract/22/3/158?ck=nck.