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Restoration of stream ecosystem integrity in Akwa Ibom State, Nigeria

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Abstract—A survey of six first-order streams in Akwa Ibom State revealed landscape modifications arising from agricultural practices and the construction industry as the major causes of perturbations of these aquatic ecosystem. Reduced stream width and depth due to prolonged siltation are common in all streams surveyed. Indices of some community parameters determined were low and many fish species rare, all of which seem to indict modifications of adjacent landscape. This paper used ecological principles to argue against such abuses and emphasizes strict adherence to the provisions of the Environmental Impact Assessments Decree irrespective of the scale of the project and location. The principles of ecology and its applied derivatives are to the environment what the political constitution is to a nation.

Keywords: headwater streams, degradation, restoration, Nigeria.

1 Introduction

Nature in its benevolence produced complex and interrelated environmental systems, both biotic and abiotic, whose functioning is coded in an unwritten constitution which has fortuitously been interpreted by scientists in the science of Ecology and other applied derivatives. These scientific endeavors have facilitated an understanding of the hitherto unwritten environmental constitution and the interrelated functions of the integral parts of the systems. Where these principles are properly applied, the environment remains stable, where poorly applied or not adhered to at all, disruptions occur. That there is a tremendous coherence in the functioning of environmental systems is not at all in doubt. Ironically we spite this knowledge and our environments are collapsing daily under the stress of unmitigated amendments to their constitution thereby reducing, and in many cases, destroying the integrity of the systems.

2 Problems

In 1995, the State Government announced that there are about three hundred (300) erosion sites in Akwa Ibom State. From observations, a high percentage of this number is man-induced directly. The severity of the ecological backlashes that result from these challenges reminds us (rather belatedly) of the radical amendments to the environmental constitution in the guise of development without observing the due process.

Odum (Odum, 1971) defined ecological backlash as an unforeseen detrimental consequences of an environmental modification which cancels out the projected gain or, as is too often the case, actually creates more problems than it solves. According to him, the situation is a double tragedy in that (1) the money spent on remaking the landscape has been lost to the bad investment, and (2) additional money must then be spent to correct all the new problems created. This is a dilemma indeed, especially to us here with no requisite technology to obviate the dangers, and the lack of Naira to finance the correction. It makes it timely to adhere to Moen's (Moen, 1973) warning that the important thing for the resource manager to realize is that dollars cannot successfully buy a violation of basic natural laws. This study was carried out to highlight the distressful conditions of some of our inland waters (the streams) and discover the factors responsible.

3 Surveyed environments

Akwa Ibom State has numerous streams and a few rivers that have made significant contributions to the economic and food needs of the residents in the State. Sadly, the streams in particular have been subjected in recent years to severe degradative processes that have threaten their continued existence. This section describes the degradative manifestations in some of these streams (Fig. 1). The survey was conducted between December, 1984 and March, 1990 inclusive. Assessments of the effects of the physical disruptions were made by observations and through interviewing the local residents of the adjoining areas of each stream on the change in stream status over the years. Recent visits to these areas confirm earlier observations. Materials and methods employed in fish sampling and statistical analyses were presented by Udoidiong (Udoidiong, 1988).

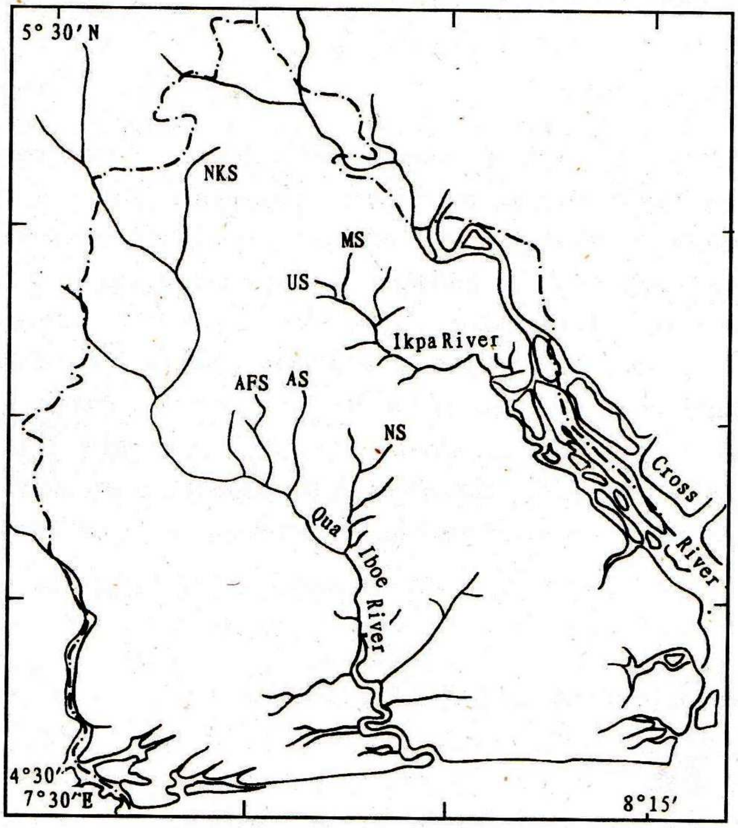

Fig. 1 Qua Iboe and Cross river basins showing streams studied
—·— state boundary; —— Rivers/Streams; NKS: Nkap Stream; US: Udom Stream; MS: Mission Stream; AFS: Alaha Obong Stream; AS: Abak Stream; NS: Nung Oku Stream

3.1 Nung Oku Stream

The stream originates from a lowland area opposite the Lutheran High School, Obot Idim, Uyo. A few decades ago, the water used to accommodate large canoes used for transportation of palm produce to beaches on the Qua Iboe River into which it flows, and for fishing. Presently, much of the headwater has been reduced to slow-flowing rivulets, leaving large areas completely taken over by terrestrial plants. Exploitation of the gravel reserves on the banks leads to bank instability especially where the gravel has been exhausted. The unstable banks easily erode and cause more silting of the stream bed.

3.2 Mission Stream

This is one of the several small streams draining the lower half of the Cross River Basin, with its source of water from seepage from a lowland area at Ikot Akpan, Ikono Local Government Area. The upper reaches are affected by erosion of the adjoining lands laid bare for cultivation during cropping seasons. This had led to appreciable reductions in width and depth of the stream, followed by uneasy flow due to obstructions by woody debris.

3.3 Udom Stream

Located in Ikono Local Government Area, it forms one of the headwaters of Ikpa River. Initially, the stream originated from a hill (Obot Atan) opposite Archibong Memorial Grammar School, Ukpom, but presently, this source is extinct. For about 0.5 km from this old source the stream channel has become dry land and the water now seeps through at a different point. The disappearance of the initial source of this stream is clearly the result of uncontrolled cultivation of the adjoining hills right to the edge of the stream over many years. That siltation irreversible is shown by the dried portion being colonized by terrestrial plants.

Tahal Consultants (Tahal, 1982) reported that the Ikono soil series is generally subjected to water erosion of varying degrees, and cautioned that as the potential productivity of the area for agricultural development is slight, the land should be left undisturbed. However, it appears that either the Cross River State Government which received this report, and now the Akwa Ibom State Government in whose territory the area belongs, has not notified the residents of this area of the warning, or the people have taken no heed.

3.4 Nkap Stream

This stream originates adjacent Goreti Girls' School and the Government Reservation Area (GRA) in Ikot Ekpene. It flows through a non residential area and midway receives the Sunshine Batteries Factory effluents before discharging into the Qua Iboe River further down. Its point of origin and immediate vicinity are under stress from eroded sand. About 100m from this source, there is a laterite excavation site, and the terrain of the area facilitates the deposition in the stream of eroded sand and silt during spates. Enquiries revealed that this source used to be larger than what it is today——a small, shallow semi-stagnant pool (10m^2 in area).

The stream in an apparent attempt to rebuff the siltation erodes recently deposited sand at the land-water interface and further deposits same on the stream bed. Eroded material from cultivated lands adjoining this headwater stretch certainly adds to, but is not the significant source of, the silted sand.

3.5 Afaha Obong Stream

Initially, the stream originated from a lowland area adjacent the Queen of Apostles Seminary, and is one of the first order streams that drain the Qua Iboe River basin. This initial source has since dried up, and some years ago, the current origin close to the bridge along Etim Ekpo Road also dried up, with a substantial portion of the channel below it. The drying of this current source was attributed to siltation caused by the construction of the road and bridge, and cultivation around the area.

The inconvenience of this drying on the immediate community must have informed the reclamation effort made by Mr. Victor Akpan, then the Chairman of Abak Local Government

Area. Although this attempt met with stiff opposition especially from the local press which construed it as a wasteful political venture, it turned out to be a success because the source of the stream was rejuvenated. Presently, the water is clear and corers a wide area and is used intensively by the residents. The success achieved here gives the impression that other silted headwater streams could be restored by evacuating the silted sand and other debris.

3.6 Abak Stream

Rising from Abiakpo in Otoro Clan of Abak Local Government Area, the stream flows through Abak Urban and is believed to empty into the Qua Iboe River at Ibagwa. Along the "Urban stretch" there is intensive cultivation of the slopes and near-stream lowland banks, leading to tremendous erosion of the slopes and immediate banks and subsequently deposition of sand in the stream. In the late 1980s and early 1990s when the present bridge was constructed, part of the Urban stretch was subjected to severe stress. Erosion of the laterite used to fill the road to the level with the bridge denatured the stream the more. The wooden scaffolds erected in the stream channel to aid in the construction trapped large quantities of debris which impede the flow velocity, enhancing the siltation process.

The local authority on purely economic grounds helps to destroy the stream more, and qualifies it as the most abused stream in the State. By allowing large scale removal of riparian vegetation along an appreciable distance of the urban stretch to open up the quarry sites and enhance evacuation of the sand/gravel, the local authority is destroying the stream. Over 90% of the residents of Abak Urban drink the water from this stream and when fetched quarrying is going on, the water becomes very cloudy with large quantities of suspended solids. Recently, some families lamented their expenses on the treatment for typhoid contacted through drinking the stream water. The water indeed is not safe for drinking and the aquatic habitats with the near-stream vegetation have been largely destroyed.

4 Fish composition

Of the six streams reported here, fish collections were made in three of them and a summary of the data is presented in Table 1. Seventeen species from 10 families were collected from Udom Stream while Nung Oku Stream produced 19 species from 12 families. In Mission Stream 22 species were recorded and belong to 12 families. The rarity of a species was considered on the basis of its percentage contribution to the overall catch in each stream. Thus species with 5% contribution were adjudged rare. From our data, 14, 15, 15 species are rare in Udom, Nung Oku, and Mission Streams respectively. The species considered relatively abundant are listed in Table 2. In Udom Stream, pools occur where the water flows through a relatively shallow ground with a high density of Raphia hookeri. In these pools, the fresh water shrimps *Desmocaris trispinosa* and *Macrobrachim dux* occur and are exploited for subsistence. Also found in Mission Stream is the crab Sudanonautes.

5 Community parameters

Some indices of community parameters (Table 3) were calculated to enable a comparison of the fish populations of these streams. Mission Stream exhibited the highest indices of diversity, and evenness (or equitability), with the least index of dominance (11.72%). Dominance was highest in Udom Stream (35.58%) with the least indices of diversity, and evenness. Fish assemblages of

Table 1 Fish composition of three of the streams surveyed, numbers in parenthesis refer to percentage composition per stream

Family/Species	Stream US	Stream NS	Stream MS	Family/Species	Stream US	Stream NS	Stream MS
Amphilidae				Clariidae			
Pharctura clauseni	2(0.6)	–	–	*Clarias sp.*	–	–	1(0.44)
Anabantidae				Cyprinidae			
Ctenopoma kingsleyae	2(0.6)	7(2.6)	–	*Barbus callipterus*	–	45(16.6)	–
Bagridae				Cyprinodontidae			
Auchenoglanis akiri	–	–	9(3.93)	*Epiplatys bifasciatus*	47(13.4)	50(18.5)	23(10.04)
A. fasciatus	1(0.3)	7(2.6)	–	*E. sexfasciatus*	39(11.1)	11(4.1)	30(13.10)
A. occidentalis	2(0.6)	–	–	*Procatopus sp.*	6(1.7)	3(1.1)	–
Parauchenoglanis sp.	–	–	17(7.42)	*Eleotridae*			
Cichlidae				*Eleotris vittata*	–	–	3(1.31)
Chromidotilapia batesii	4(1.1)	1(0.4)	–	*Malapteruridae*			
C. guntheri	13(3.7)	65(23.9)	1(0.44)	*Malapteruris electricus*	1(0.3)	2(0.7)	5(2.18)
C. caudifasciatus	–	–	3(1.31)	Mastacembelidae			
Hemichromis elongatus	–	–	3(1.31)	*Caecomastacembelus*	–	–	1(0.44)
H. fasciatus	1(0.3)	47(17.3)	1(0.44)	*Longicauda*			
Nanochromis robertsi	–	–	7(3.06)	Mormyridae			
Pelvicachromis pulcher	–	1(0.4)	–	*Brienomyrus brychyistius*	198(56.0)	2(0.7)	56(24.25)
Pematochromis sp.	–	1(0.4)	–	*Gnathomemus petersii*	–	2(0.7)	56(24.25)
Thysia ansorgii	3(0.9)	5(1.8)	–	*Isichthy henryii*	11(3.1)	–	17(7.42)
Channidae				*Marcusenius abadii*	–	–	4(1.75)
Parachana africana	–	1(0.4)	2(0.87)	*M. isidori*	–	–	14(6.11)
Characidae				Notopteridae			
Alestes chaperi	–	–	3(1.31)	*Papyrocranus after*	2(0.6)	9(3.3)	1(0.44)
A. Leuciscus	17(4.8)	–	–	*Xenomystus nigri*	–	3(1.1)	–
Brycinus longipinnis	–	10(3.7)	–	Polypteridae			
				Erpetoichthys calabaricus	1(0.3)	1(0.4)	4(1.75)

US = Udom Stream; NS = Nung Oku Stream; MS = Mission Stream

Table 2 Species of fish considered relatively abundant in the 3 streams and their percentage composition, 5.0%

Family/Species	Stream US*	Stream NS	Stream MS
Chromidotilapia guntheri	–	65(23.9)	–
Hemichromis fasciatus	–	47(17.3)	–
Barbus callipterus	–	45(16.6)	–
Epiplatys bifasciatus	47(13.4)	50(18.5)	23(10.04)
E. sexfasciatus	39(11.1)	–	30(13.10)
Brienomyrus brachyistius	198(56.0)	–	56(24.45)
Gnathonemus petersii	–	–	24(10.48)
Isichthys henryii	–	–	17(7.42)
Marcusenius isidori	–	–	14(6.11)
Parauchenoglanis sp.	–	–	17(7.42)

* Stream abbreviations as in Table 1

Udom and Nung Oku Streams were highly similar (72.22%) with 13 species occurring in both streams. Nung Oku and Mission Streams showed the least similarity (43.9%) with 9 species found in both streams. A low index of similarity (46.15%) was obtained between Udom and Mission Streams, both of which have 9 species in common.

Table 3 Indices of community parameters for the 3 streams

Index	Stream		
	US	NS	MS
Shannon index (H) of general diversity	1.5609	2.1597	2.4948
(Scaled)	0.5509	0.7335	0.8071
Evenness index (E)	0.2802	0.4562	0.5508
Dominance (D)	0.3558	0.1554	0.1172
Similarity	(i) US & NS = 0.7222 (ii) US & MS = 0.4615 (iii) NS & MS = 0.4390		

6 Discussion

The removal of riparian vegetation leads to increase in temperature regimes in streams and, as water temperature increases, the capacity to hold oxygen decreases. If such water is secondarily polluted by organic wastes, it cannot effectively degrade these materials without its oxygen level being reduced, leading to hypoxia which is detrimental to fish (Karr, 1978). In headwater streams (such as the ones reported here) most energy utilized by the fish and macroinvertebrates is of terrestrial origin. Thus, if the vegetation near stream is removed, a substantial energy input from fallen leaves and other allochthonous sources would be cut off in the upstream areas and this would lead to significant reductions in invertebrates and fish production Siltation resulting from erosion of the exposed slopes has destabilizing effects on the stream, making it shallow and narrow. In addition, reduction in width leads to obliteration of the littoral zone where conditions are more favorable for many fishes and macroinvertebrates to inhabit.

Disruptions of these habitats, therefore, lead to severe reductions in the number and types of fish and other aquatic animals (Karr, 1978). The large number of rare species in all streams could be a reflection of the habitat disruptions going on in these streams. For example, species diversity and evenness of distribution in any ecosystem is directly correlated with stability of that system and tends to be low in physically controlled ecosystem (i. e. subjected to strong physicochemical limiting factors) and high in biologically controlled ecosystems (Odum, 1971). Values of the community parameters obtained from these streams point to an appreciable degree of physical control, e.g. in low evenness of distribution.

Loss of biotic diversity (i.e. the number of species present and their numerical composition) erodes biotic integrity, i.e. the state or condition of being complete. Moreover, reduction or loss of biotic integrity interferes with biosperic integrity or biotic redundancy (Angermeier, 1986). These two lines of deductive reasoning based on empirical evidences, conflate into a single fact of the natural environmental constitution, that ecosystem processes such as energy flow and nutrient cycling do not usually hinge on only one species (Angermeier, 1986). Thus when in-stream and near-stream abiotic factors of stability are disrupted or destroyed through human-induced influences, they are bound to affect the faunistic and floristic composition of the streams adversely.

The index of similarity between these streams indicate that no single stream can harbor all fishes found in a given ichthyofaunal region, and thus stresses the need to preserve these species through proper management of their habitats. Many natural resources are finite and the concept of inexhaustibility of oceanic fishery resources was laid to rest at about the turn of the 20th century (Nielsen, 1976) after a protracted debate on the merits and demerits of regulating exploitation of these resources hitherto believed to be infinite. Thus, if oceanic fishery resources have been found to be inexhaustible (e. g. the collapse of the Peruvian anchovy, *Engraulis encrasicholus* fishery through overfdishing; Paulik, 1981), then the fishery resources of the unmanaged first order streams of this state and nation face even grimmer pressures unless management procedures are employed to save them from extinction.

Of interest to Government should be the fact that policy and legislation can be conducive to environmental degradation (Ferguson, 1992). This occurs most glaringly when they are aimed at creating a favorable climate for commercialization such as occur in the case of timber production, cultivation of export crops, denudation of stream banks to enhance quarrying, excavation of laterite for road construction and so on. All these are aimed at generating revenue to Government. In an attempt to meet revenue targets (missed in the first instance through mismanagement), the local councils frantically exploit natural resources in their areas of jurisdiction without recourse to rational exploitation ethics, leaving in its trail monumental ecological disruptions which, an amount ten times the value of the revenue derived therefrom cannot correct. Since landscape modification arising from agricultural practices and the construction industry appear to be the major cause(s) of stream degradation in Akwa Ibom State, amelioration of the effects of these amendments is feasible. The most logical approach is total adherence to the provisions of Decree 86 or the Environmental Impact Assessment Decree.

Environmental Impact Assessment (EIA) is defined as a process or study in which the potential physical, biological, economic and social impacts of a proposed development on the immediate and more distant environment are identified, analyzed, and predicted. According to Odiette (Odiette, 1993), EIA ensures that potentially significant environmental impacts (adverse or favorable) are satisfactorily assessed and taken into account in the planning, design, authorization and implementation of all relevant types of development projects.

It is interesting to note that of the 19 projects for which EIA is mandatory in Nigeria, Fisheries, Forestry, and Quarries are included. However, there are snags in: (1) the explanation of what EIA ensures, and (2) restriction in the mandatory application of EIA in agricultural projects.

The loophole in the explanation of what EIA ensures is with the adjective "relevant" which, by implication, makes its provisions not comprehensive. A project that may seem irrelevant today for the application of EIA may produce the greatest devastation of the environment especially in the rural areas and what may be termed "small-scale" projects, of which many examples abound in this state and beyond.

The next loophole relates to the restriction in the application of EIA for agriculture requiring land of an area of 500 hectares or more. This provision is out of tune with reality. The numerous hilly slopes in this State that have been subjected to erosion through denudation by farming practices do not require land up to 500 hectares before being denuded and eroded. Most Nigerian farmers are small holders and many of these cultivate for subsistence. Yet it is their activities, individually or severally, that contribute a significant number of the 300 erosion sites mentioned earlier as occurring in this State. The indiscriminate choice of land for laterite excavation should be viewed seriously since these sites contribute a significant proportion of the erosion sites in the State.

The threat of drastic reductions of aquatic life in our inland waters, especially small streams, is real. The destabilization is exacerbating yearly (if not daily), but our knowledge of full complement of these resources is still rudimentary. The resilience of aquatic systems is not unlimited (e.g. in the eutrophication) and should not be abused. As shown in this paper, events occurring in the terrestrial ecosystems usually have reverberations in the aquatic ecosystems which serve as sinks for terrestrial drainages.

7 Recommendations

The following recommendations have been made on the reality and severity of the degradations facing our small, inland waters (streams) as a result of human-induced influences:

• Initiate a comprehensive study to ascertain the degree of exploitation pressures on our natural resources (both in water and on land), and the effects of these pressures on the resources.

• Stop or reverse policies and legislations that are conducive to environmental degradation. Such policies and legislations are always aimed at creating a favorable climate for commercialization.

• Encourage awareness of the citizenry to the fact that events occurring in the terrestrial environments and the air, almost always have reverberations in the aquatic ecosystems which therefore, stand to be adversely affected if inputs into these systems are harmful to the life and life-support systems in these aquatic environments.

• Stop the removal of vegetation along stream banks. This action, in simple terms exposes the stream to various hazards and reduces both the productivity and biotic diversity (that is the number of species present and their numerical composition) of the system.

• The provisions of the Environmental Impact Assessment Decree (No. 86) should be strictly adhered to, and should be practised without discrimination. No Government nor its agencies has been exempted from complying with its provisions.

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