Urban Growth and Development of Soil Erosion in Part of Humid Region of Southwest Nigeria

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Key words: Urban growth, Land degradation

SUMMARY

Management of the urban environment is a key problem in many nations of the world. In most developing countries, development is attached to land degradation. There is therefore the need to control such occurrence. In the present study, inconsistency in government position to land development has initiated land degradation. The objective of the study is therefore to study the vulnerability to erosion as a result of the clearance of vegetation cover. About 45 erosion channels were investigated and measured for their width, length and depth using survey equipments. The study showed that the length of the channels varied from 4 to 76m, width from 22 to 104cm and depth from 9.8 to 65cm. Rapid channel widening of one of the selected sites (B) was attributed to the exposure of the land surface in the rainy season while the relatively low erosion effect in Site A was attributed to re-growth since the 2 years period of clearance. Site C was relatively of gentle slope and with no defined channel at the time of field work, probably due to reasons which the research has not detected. However, evidence of surface wash was observed. The study concluded that environmental assessment report should guide developmental projects and that only adequately informed projects will be sustainable.

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1. INTRODUCTION

Urbanization is not new in developing countries, especially Nigeria, and its impact is replete in literature. A number of caused of urbanization have been studied. For example, Onakerhoraye and Omuta (1994) have linked urbanization in Nigeria to unequal spatial distribution of population, economic and occupational allocation. The rapid pace of urbanization has been shown to be a global problem present in most of the developing countries. For instance, the urban populations in these countries have grown by 40% between 1900 and 1975 and 70% in 2006 (NPC, 1963 and 2006). There is also every indication that the trend will continue for a long time, adding approximately two billion people to the urban population of the presently less-developed nations at an interval of 3 decades or less (United Nations Environment Programme, 2002). Nigeria's urbanization rate was conservatively put at 5% as at 1973 (Olowu, 1985) and by 1980 nearly 30% of the total population has already been residing in urban centres. By 2005, approximately 60% of the populations in the Africa in general were urban. Nigeria's urban centres have been growing at double the national population (estimated at 2.5%) and at double the rate of urban information in several countries of Europe and America (Olowu, 1985).

Furthermore, many national and regional attempts have been made to reduce the social and economic imbalance between the urban and rural areas in Nigeria. For example, more states have been created since 1960, when Nigeria became an independent country, so that growth and development could be distributed. Another example is the government's proposal for development of the urban centers in the country as well as the 'bottom-up' approach of rural development through the local area governance. The earlier (before and at independence) urban areas have become overpopulated and the facilities have either become insufficient or obsolete. The number of migrants to the urban areas has also soared in the recent time. Some governors and administrators have thus declared their intention for cleaner and more organized urban centres; in fact some, including Abuja and Lagos have considered reorganization towards achieving a serene environment of a global standard. This is applicable to the medium size State Capitals that were created after; to decongest the colonial cities of the mammoth population in them.

Despite the good intention, the discontinuity in government policies, poor environmental assessments of intended project, corruption and bureaucratic bottle necks etc have disallowed many government policies to achieve their objectives. For example while many laws and policies have been enacted to promote the growth and development of Nigeria, such laws are either not often implemented or enforced; in some cases, governments have also been alleged to have broken her own rules. This was probably acceptable during the military leadership in this country. It should however not be acceptable in democratic rules because of the principle of accountability which the latter possesses but lacked by the former. An example of one of the most disregarded land related laws is the Federal Environmental Protection Agency Decree No. 86 of 1992 and the Nigerian Policy on the Environment (NPE)'s rule on the mandatory Environmental Impact Assessment (EIA) for every developmental project in Nigeria (Okorodudu-Fubara, 1998). Evidences have shown Nigerian government's lip service to this rule, has made its enforcement to either be selective or totally neglected, even by government agencies!

2. PROBLEM

One of the often cited land related problems is erosion and a number of publications exist on its various aspects (Jeje, 1973). In most of these literatures, especially those that have focused on the humid region of Nigeria, less attention was made on the use of relatively new technology in Nigeria- the Geographic Information System (GIS) and its complimentary technologies. The focus of most existing researches in the country is on earth material, erosion processes, the amount and rate of erosion from some urban environment (e.g. Okoye, 1988; Jeje, 2005; Jimoh, 2005 etc). Although the contributions of these studies to literature on land use and planning in Nigeria are noteworthy, their methodological approach of micro scale survey of point-based location from which generalization were made without necessary or adequate interpolation of the point-based (discontinuous) data sets. This is probably because technologies for interpolation that are now imbedded in the newer paradigm of GIS (as available in software such as ILWIS, ArcGIS, ArcView etc and third party software like Surfer, CAD) were not known, affordable or unknown as at the period that such researches were conducted. Kufoniyi (1995) noted that implementing GIS and the complementary technologies in Nigeria between 1960 and early 1990s was confronted by inadequate knowledge, poor finance (probably corruption and mismanagement), inadequate manpower and poor managerial efforts.

Yeh and Li (1996) noted that GIS and remote sensing are land related technologies that are useful in formulation and implementation of the land component of a sustainable development strategy. They can provide inevitable tools to use different datasets and models to support informed decision by land owners, property administrators and governments. Ability of GIS and other related land based technologies in processing of acquired data from digital surveys, aerial photography, remote sensing to infer decision making information has led to the increasingly use of the method in land administration in many part of the world. The present study focuses on the use of an important operation of GIS (i.e. Digital Terrain Model (DTM) for a land-based Environmental Impact Assessment (EIA) in proposed sites for development in Ondo State, Southwest Nigeria. The main objective is to highlight the importance of incorporating the use of GIS, especially the DTM operation in assessing the environmental impact for a proposed land based development.

Until in the recent time, the use of geo-information technologies in the enhancement of sustainable planning and development of urban cities in Nigeria has not been adequately employed. The study applies this concept and also demonstrates the ability to use these technologies to complement the traditional surveying techniques, in providing information on the terrain on the proposed sites for development in Ondo State, Southwest Nigeria. The conclusion in this study is based on the hypothesis of Canter, et al (2007) that GIS technology offers interesting alternative to the traditional method of field inventory, visual interpretation and statistics for producing maps of surface imperviousness and other land use change and that of Nasir et al (2008) that digital elevation model enables the prediction of the threshold contributing area and/or other topographic effects and limits on initiation, distribution and location of erosion vulnerable areas in different conditions.

The objective of this study is to assess the impact of attempts to develop a typical urban settlement in Nigeria on land ecosystem. The study uses the digital surveying system incorporated into the digital terrain model (DTM) approach to investigate the problem.

3. STUDY AREA

Three sites proposed for projects by the government of Ondo State, Nigeria have been selected for this study. They are, Ose-Oba in Oba-Akoko and Akure along Ilesa-Benin Road and along Oda Road. The three sites are being prepared for Starch Plant, Auto Village and Housing units respectively (Figure. 1). They have been referred to as sites A, B and C, respectively in this study.

The sites are in the rainforest belt, in the humid tropics and classified under the Koppen's Am Humid Tropical Climate. The mean annual temperature is 27^{0}C; the mean annual rainfall of 1500mm is distributed between March and October, and with peaks in July and September. There is short dry spell in August (Akinbode, et al, 2008). Akure, the capital city of Ondo State, where sites B and C are located is a fast growing administrative city which lies on a relatively flat plain of about 250m above the mean sea level within the Western Nigeria plain. Site A on the other hand is located in a rural area.

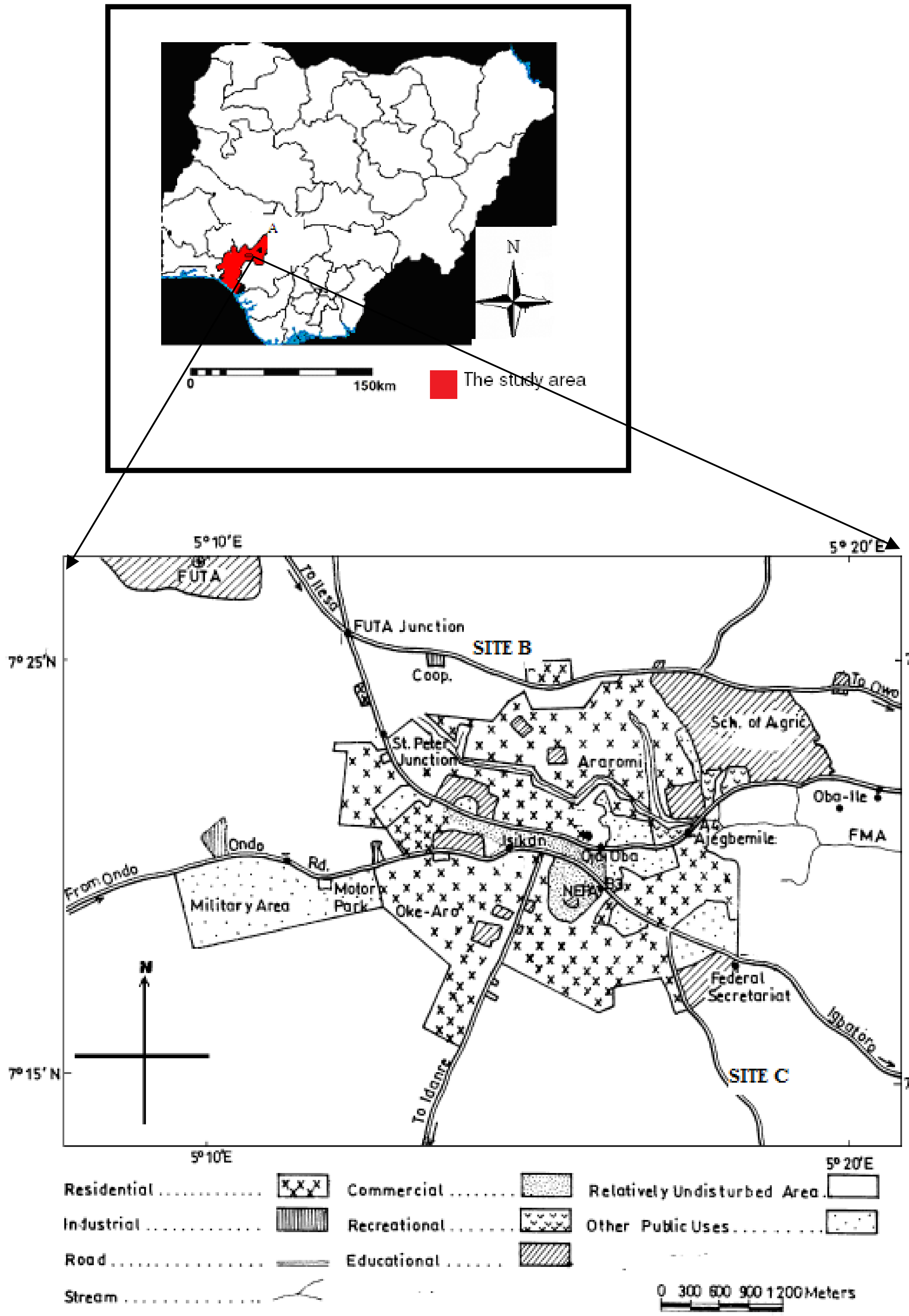


Figure 1: Map showing the selected sites, Ose – Oba (A) and Akure (B & C) in Ondo State, Southwest Nigeria

4. MATERIALS AND METHODS

Land monitoring involves two processes: land use change detection and land use change impact analysis (Yeh and Li, 1996). Land use change detection entails finding the type, amount and locations of land use changes that are taking place, and land use change impact requires evaluation of the effects of such changes on the environment. As a result of difficulties of obtaining high resolution satellite imageries and also limitation to which poor resolution satellite imageries and aerial photograph could be used for the assessment of land use changes in terms of erosion initiation and development in a small catchment, land use change in this study was determined by using digital survey instrument, GPS and Total Station, of the selected sites before the vegetation was cleared. Land use change type was measured in terms of the vulnerability to erosion and the extent of gully in the period of inactivity. This was done bearing in mind that many project sites have laid waste in many parts of the country due to abandonment of such project by governments or individuals after surface clearance.

The perimeter survey for each site was collected from the Ministry of Lands and Housing, Akure for the determination of the area and extent of each site. Field measurements were carries out to determine morphometric attributes and terrain characteristics of the studied sites using both manual and electronic measuring devices. Spot Heights and coordinates from where contour maps, DTMs and other geometric properties of the terrain, such as slope gradient and slope length were derived were obtained to the highest possible degree of accuracy of the instruments (±1mm for GPS and ± 2mm for Total Station). At Site A and Site B, 14 and 37 rills/incipient gullies respectively were measured using measuring tapes at the interval of 2 meters because of variations in the depth and widths of the gullies. The measurements were averaged to get the mean depth and width.

5. OBSERVATIONS

The sites have been cleared of their original vegetation of light forest (site A and B) and cash crops, predominantly Cocoa and Kolanut (site C) in preparation for the construction of the new projects between July, 2007 and May, 2009 using bulldozer and other heavy tractors. This has generally exposed the surface areas to direct influence of rainfall except where there was quick re-growth of vegetation (Figure 2aiii, 2bi and 2bii). The characteristics of a number of selected erosion channels in the sites are plotted against their order in Figure. 3. Other characteristics are shown in Table 1. The table (Table 1) also revealed that the surfaces exposed to erosion are more at Site B, which was graded towards the beginning of rainy season. The effect of erosion on site A was probably reduced by the re-growths that have occurred after 2 years of grading. At Site C only surface wash was observed in some portion of the site. Further study will however be required to firmly conclude on Site C, especially as related to the soil materials and slope analysis. The result of the study is similar to the observation made by Jeje (1973) that showed that surfaces exposed to rain wash is susceptible to erosion, with the tendency of causing channel widening and deepening. It was also revealed that rapid runoff and grain detachment are associated with slopes bare of vegetation while minimal erosion occurs in vegetated areas. This is further illustrated by Figure 4 in which third party GIS software (Surfer) has been used to depict a visual appreciation by creating a digital terrain model to reveal the slope.

Moreover, erosion is widespread on all the exposed surfaces in the selected sites. At many of the places, rain wash has removed the fine materials leaving the surfaces covered by a thin layer of soil. At the sites where channels were measured, the channel depths ranged from 9.8 to 66.0cm, and the lengths vary from 4.0 – 76m; the widths are between 16.7 and 940cm (Figure. 2). This is however different from what is obtained in the part that was not cleared of vegetation, and at period preceding the period of clearance (Figure 3ai). Figure 2 also shows the profile of the selected erosion channels comprising a number of furrows and ridges, exacerbated by rain wash along the slope. The measurements used for this study were taken in August 2009 after the areas have been cleared, but the effect is increasingly worsening because the areas have been left vacant, thereafter.

Table 1: Location and topographical characteristic of the studied sites

Site	***Size (ha)***	***Geographical location***	***Topographical characteristic***	***Date of exposure***	***Purpose***
Ose-Oba (A)	7.6	5^0 40’ 17”E 7^0 19’ 17”N	4^o 55’ 38’’	July, 2007	Starch Plant
Auto Village, Akure (B)	12.7	5^0 10’ 45”E 7^0 18’ 30”N	$13^0$34’13’’	March, 2009	Mechanic Workshops, Auto business
Residential Housing Unit, Akure (C)	32.6	5^0 13’ 17”E 7^0 12’ 00”N	1^0 14’ 28”	April - May, 2009	Residential Housing

Surface wash, Rill erosion and gully development are widespread on cleared surfaces. Apart from the removal of vegetation, the creation of artificially steep slopes and heavy precipitation equally contribute to soil erosion. As seen in Figure. 2 some second and third order segments of incipient gullies have developed, apart from the numerous first orders. This, especially on Site B, will increase the runoff rate on the land and make construction more expensive later on. Well developed gullies, according to Jeje (1975) could caused slumping down of large blocks of soil, increase runoff and reduce habitability.

6. CONCLUSIONS

From the above study, it is evident that prominent and measurable landforms on newly exposed surfaces include rilling, gullying and debris movement. In this study, the land has become exposed to agents of erosion, predominantly running water, after it has been cleared of the natural protection of vegetative cover prior its construction. A large portion of the investigated pieces of land is still unused, making it vulnerable to erosion in the rainy or wet season. This is a common phenomenon in Nigeria and many other developing countries where government priority is not adequately guided by good planning, cost evaluation, environmental impact assessment, and where corruption among contractors and government representatives has caused many good intention projects to either derailed or abandoned. Examples of this abound in Nigeria, and it includes the numerous poorly constructed roads and abandoned ones. In addition, because governments in Nigeria has not shown concern for continuity, projects started by a government are often discarded by the successive ones, causing many projects to either be completed half way or abandoned, probably to 'slight' the previous government, especially when the political parties differ.

When projects are abandoned or made to derail owing to poor planning or change in government or insincerity from government, the land that had been prepared become exposed to agents of erosion. This may eventually become a death trap for the people when it degrades to a gully or causes the deterioration of facilities around it. The study also showed that the recent development and application of digital surveying equipment in spatial data collection, manipulation and information presentation have encouraged adequate land use/land cover study and analysis within the confinement of time. Lastly, although, the duration of the fieldwork and the number of measurements carried out for this study were limited by time, the study nonetheless has been able to show that planners of development project should realize the impact of neglecting such project after land clearance.

ai. Part of Site C that was not cleared

bi. Aftermath of clearance of Site B

aii. Construction taking place in Site C

bii. Aftermath of clearance of Site B

aiii. Aftermath of Vegetation Removal in Site C

Figure 2: Some effects of vegetation clearance of the proposed sites for development in Ondo State, Southwest Nigeria

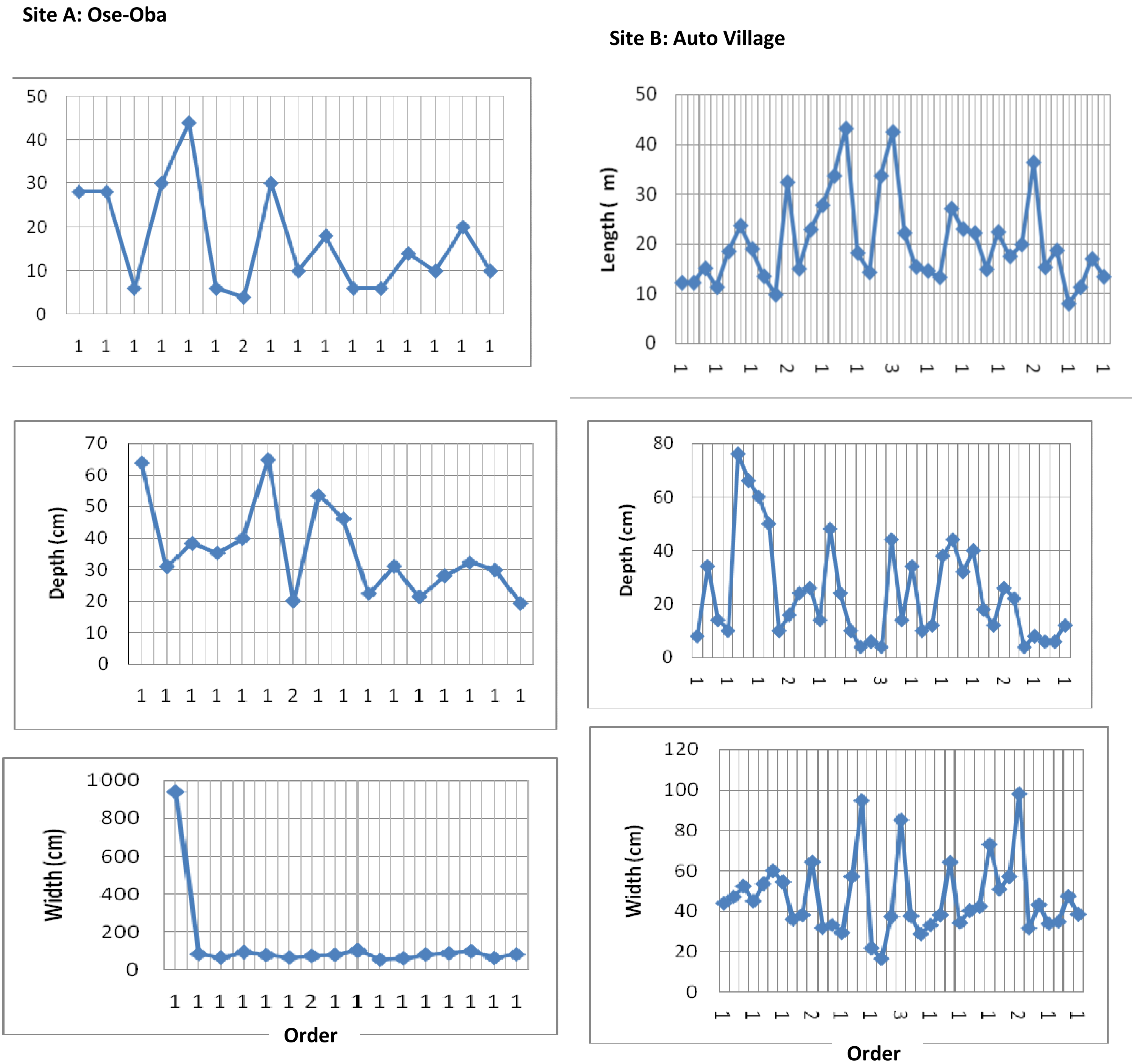
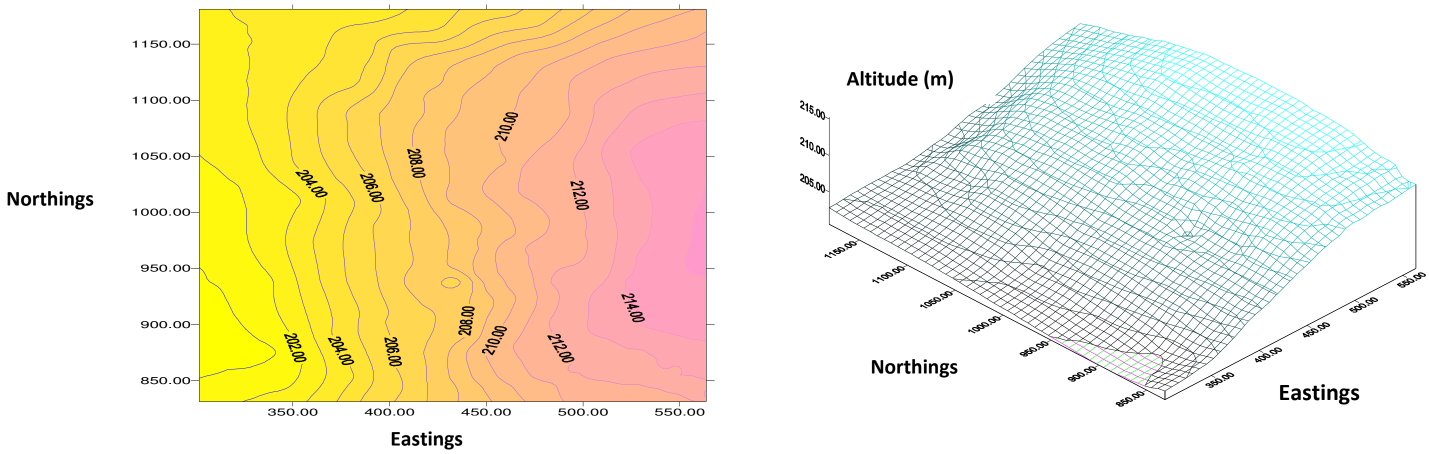
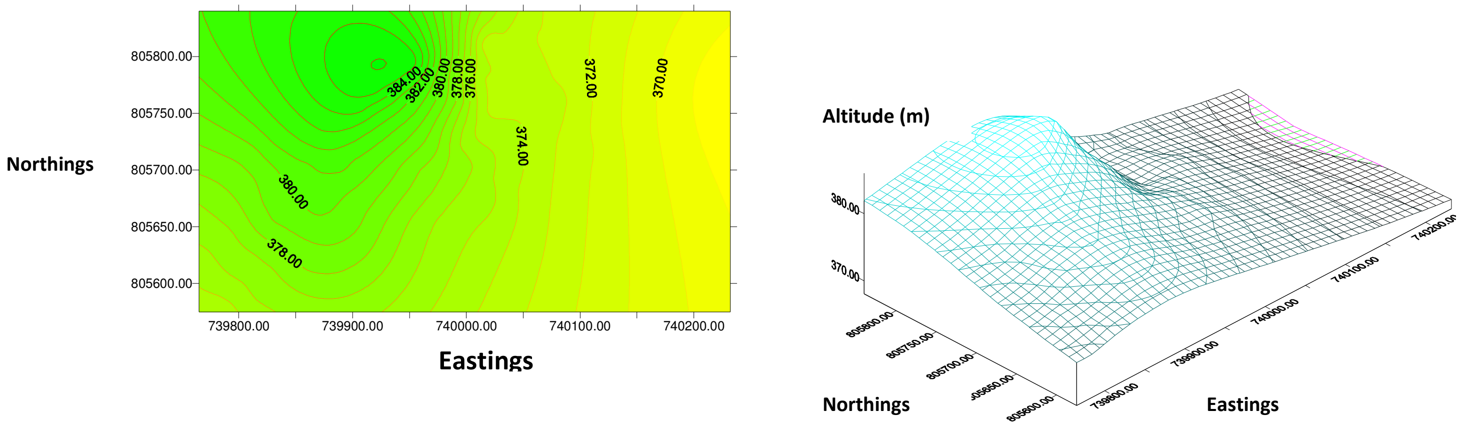


Figure 3: Some characteristics of the erosion channels on Sites A and B (on x –axis is the order of the channel investigated)

Site A



Site B



Site C

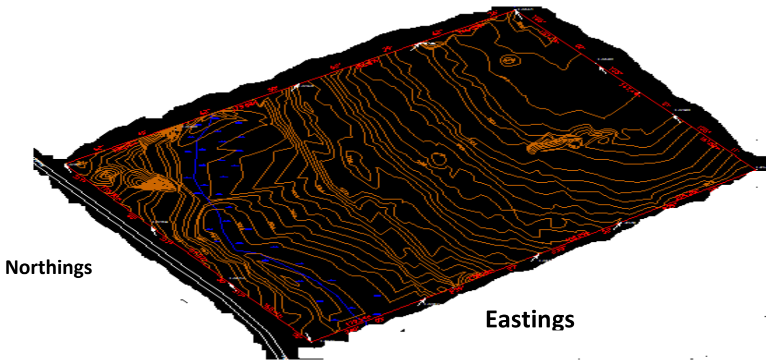


Figure 4: The topography of the studied sites, after the removal of the vegetation (elevation models of C could not be retrieved)

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