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GEOECOLOGICAL ARGUMENTS FOR FIELD TERRACING IN PARTS OF THE SOUTHERN GONGOLA BASIN, TANGALE-WAJA REGION, NE-NIGERIA[1]

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Introduction

The paper presents a short introduction to the environmental factors, e.g. climate, geology, relief forms and soils of the study area in the southern parts of the Gongola Basin. The study area covers the high mountain range of the Tangale-Waja Uplands (BRUNK 1993)[2] and the adjacent pediplain, following in the north.

It is asked if the natural factors enforced former inhabitants of the area to develop special land use techniques like field terracing to ensure the essential crop production under insufficient geoecological conditions.

Natural factors, climate and geology

Climatically the study area belongs to the southern Sudan Zone. The mean annual precipitation is about 800 - 900 mm (Biliri 824 mm, Talasse 785 mm, (BSADP-Atlas after BRUNK & SCHNEIDER in press). The rainy season starts in April/May and ends in September/October. The mean annual temperature is about 26° C. Heavy rain falls with more than 20 mm/d and single events that often reach more than 50 mm/d are frequent and common in the area. This high rain fall intensity can be seen to be the main factor for the strong soil erosion processes affecting all relief units of the "Tangale-Waja Uplands", the "Tera Tangale" and "Waja Lowlands" (BRUNK 1993) today.

Geologically the study area belongs to the Benue Trough and is, therefore, characterized by tectonical movements from Upper Cretaceous probably until today. Tectonical movements are the main reasons for the great geological differentiation for they brought different types of formerly flat lying rocks into relief. The Mesozoic sediment series had been folded into large syncline and anticline structures during Cretaceous time.

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2 For the references see p. 172

Rocks change from granites of the exposed crystalline basement to sandy and clayey Cretaceous sediment series and basalt flows of Tertiary age. In the mountainous areas as well as on the adjacent pediplain - the transitional zone to the inner parts of the Gongola Basin - that follows in the north, outcrops of bedrock alternate with a thin loose sediment cover of Pleistocene (hillwashs) and/or of Holocene (colluvia).

The western part of the mountain range, the Kaltungo-Kufai Hills - the settlement area of the Tangale - has developed in rocks of the basement complex within the 'Kaltungo Inlier' (CARTER et al. 1963), a geological window surrounded by the Bima Sandstone, a deep sequence of Cretaceous sedimentary rocks. Besides the inselberg features of the Kaltungo Hill the development of some hills around Kufai is related to outcrops of morphological resistant basaltic plugs.

Further east, the Tula Plateau - the settlement area of the Ture and Tula - follows in Cretaceous sedimentary rocks. Flat lying sandstone strata alternate with thin clayey sediment layers, which represent the geological prerequisite for the development of a typically developed cuesta landscape. Besides the Tula Plateau the pediplain north of it has developed in sandy to clayey Cretaceous sediments of Bima Sandstone, Pindiga and Yolde Formation. Outcrops of clayey layers of the Pindiga and Yolde Formation are in most cases restricted to flat areas of some larger syncline structures.

In the very east of the study area the Cretaceous rocks are overlain by the basalt flows of the Longuda Plateau. In the northern surrounding of the plateau - the settlement area of the Hill Waja - all steeper slopes developed in Cretaceous rocks are covered by a thick weathering debris that derived from basalt flows by slope retreat during morphological active phases of probably younger Pleistocene. In parts of the western slopes of the Longuda Plateau, especially in the area of Sikkam (Hill Waja), the older sedimentary rocks are mantled, therefore, by deeply developed blocky weathering debris.

Relief units and soil distribution

As a result of the changing geofactor constellations, rocks, relief forms etc., the study area can be divided into a number of major land regions (cf. BRUNK 1993: Map 2). From a geoecological point of view it makes sense to divide at first the relatively homogenous developed flat or gently undulating pediplain from the more differentiated mountain range.

Relief forms, soils and actual geomorphodynamics of the pediplain

To compare the actual situation of the inhabitants in different parts of the study area it seems to be necessary to refer first of all to the environmental situation of the gently undulating pediplains that became the main settlement areas of the Tangale, Tula, Waja and two other small groups since their down hill migration during the last few decades of this century (cf. FRICKE 1965, 1993).

The pediplains can be divided into two main levels that probably have already developed by strong erosional processes during two geomorphological active phases at the end of Pleistocene. During that time bedrocks had already been partly exposed at the surface and became overlain by a thin loose sediment cover.

In areas with rocks of the basement complex more or less clayey weathered grits are widespread and cover with different thicknesses the pediment surfaces. In the sandstone areas sandy hillwashs predominate. At some places they change into more clayey sediments, if claystones or shales are exposed at the surface. Usually these loose sediments of Quaternary age are the parent materials for the soil development.

The levelled pediment surfaces can be distinguished by altitude (few metres) or by typical variations in soil development. The latter have to be seen as an effect of different soil forming processes like drainage etc. and time for development.

In our opinion the different intensity of rock weathering and soil development has to be regarded as a result of a more or less long lasting time. And it was primarily on a chemical weathering process disposal. Therefore, deeply weathered, reddish coloured Acrisols are widespread at the surface of the older pediment level. At some places these far developed ferruginous tropical soils change into brownish Cambisols that seem to be of younger age. With the step downward onto the younger pediment level the soils always change into mottled, sometimes clayey Planosols.

During younger Holocene the two pediment levels became dissected by erosional processes. As a result of the change in the morphological dynamics incision was followed by sedimentation. Therefore, sediments of younger Holocene accumulated along river beds (terraces) and also at the pediment surfaces (colluvia). Until today, these young sediments have only been little transformed by soil forming processes. At some places the sediments and soils show a weak mottling that probably derived from ground water influences. Poorly developed humic A-horizons are typical, and it is therefore possible to classify these younger soils as (gleyic) Regosols.

It is also very typical for these soils that the top soils became impoverished in their humic and clay content. The major reason for this fact has to be seen in erosional processes, especially a selected wash out of the finer fractions by surface run-off. As a result of these processes all soil types that derived from sandy sediments are characterized by a medium water capacity and a very low natural fertility.

Compared to these soils the available plant nutrient content is much higher in Vertisols that developed from clay stones or shales interbedded into some sandstone series. At the pediments the distribution of Vertisols is closely related to outcrops of clay stones of the Pindiga and Yolde Formation. Vertisols, therefore, cover large areas on the distal parts of the pediments.

Most of the areas with these different soil types are used as farmland today. Vertisols are useful to grow cash crops, e.g. cotton, and all the other soils are used to farm all different types of crops (cf. FRITSCHER 1995; HEINRICH & KLEINEWILLINGHÖFER 1995).

As a result of an extensive clearing of the natural vegetation cover for land utilization most parts of the pediplain are today affected by strong erosional processes and soil degradation. Typical erosional forms are rills and gullies, and the consequence of these numerous linear forms is an extensive loss of arable land (thicker sediment and soil covers) and an increase of outcropping bedrocks. The consequences of this degradation with an edaphical aridification come close to desertification (cf. HEINRICH 1994).

Field terracing or other measures to keep erosion under control are not practised (any more) by the different ethnic groups in these flat areas.

Some ages of colluvia and sediments from river terraces that could be estimated (^{14}C-dating on charcoal) give us some ideas about the dynamics of the erosional processes during the younger Holocene. The presence of human beings and their activities are provable for a period of more than ca. 700 years BP in the area. An accumulation of colluvia seems to have taken place during that period until the 50s of our century. Relatively stable conditions until this time can also be interpreted from air images of 1950 that still show a thick vegetation cover on most parts of the pediments (cf. BRUNK 1995). From the 50s until today erosional processes changed and enforced the strong dissection of all pediment surfaces. Explanations for this change of the actual geomorphological dynamics have to bring anthropogenic disturbances of the natural vegetation cover etc. into discussion. The younger land degradation might result from the intensification of land utilization since the 1950s.

Geoecological factors and land utilization of the mountain range

Up to the 1950s the inselberg-landscape of the Kaltungo-Kufai Hills were the settlement area of the Tangale. Later, new settlements have been established at the toe slopes of some steeper mountains, e.g. the mission of Kufai and some others at the surrounding flat plains (e.g. Biliri).

A terracing of the steep slopes was necessary to get levelled areas for the construction of the compounds. Constructing terraces was easy in these ancient settlements of the Tangale of Biliri, for the Kufai Hill is caped by basaltic rocks that provided enough blocky weathering debris. But at least field terraces have not been observed at Kufai Hill and even the ancient settlement terraces are not used to grow crops there today.

As we could observe, the descendants of the former inhabitants are still visiting the ancient settlement today to pray at the shrines of their ancestors. These shrines are built up from basaltic rocks and are situated at the foot of the basaltic plug on hill top. In comparison to other former settlements of the Tangale, 'ancient Biliri' seems to be the only fallow in this area. This is quite different at some other places in the Kaltungo Hill. One example is the former settlement of Shongom, where we observed relicts of both, settlement and field terraces, being all used as farmland today.

The stone settings of the terraces are going to be destroyed totally by soil erosion in the near future, for maintenance does not take place any more since the former inhabitants have settled down onto the pediments south of Kaltungo Hill.

Field terracing at the food slopes of Kaltungo Hill around the former settlement of Shongom seems to have been necessary to increase the shallow sediment and soil cover (dystric Acrisols and Cambisols), to ensure crop production on sites with a high enough water and plant nutrient capacity.

If the typical weathering mantle of crystalline rocks and shallow soils are considered, it is understandable why terracing was concentrated only at these few areas within the mountains. The weathered granites do not provide moderate blocky material for the construction of field terraces and there might have been no intention to protect soils against erosion. As a result nowadays most places in the Kaltungo Hill are strongly affected by erosional processes and large areas of former farmland are already devastated (cf. HEINRICH 1994).

The environmental situation is completely different at the Tula Plateau that follows in the mountain range further east. Formerly, the settlement area of the Tula covered the cuesta and plateaus developed in rocks of the Bima Sandstone. As an effect of probably late Pleistocene erosional processes bedrocks are exposed at the surface of all steeper slopes and even in large flat relief units. Besides these outcrops of bedrocks blocky weathered materials are common and they alternate with shallow sandy and stony sediments that seldom reach more than 20 - 30 cm in depth.

Typical soils that have developed from these coarse grained hillwash sediments and stone pavements are shallow Regosols and Cambisols. Under natural conditions these soils are characterized by a low water capacity and by a very low plant nutrient content (cf. HEINRICH 1992). Therefore, around the settlements of the Tula the natural sediment and soil cover had to be completely transformed into field terraces in order to increase the depth of the sediment cover up to 50 cm and at some places even more. In addition to the higher water capacity of these artificially created soils (cumulic Anthrosols) they also became enriched in plant nutrients by fertilization with manure and mulching.

The foundation of settlements on the Tula Plateau with these poor environmental provisions enforced settlers to develop or adapt to the use of field terracing to ensure a successful food production. On the other hand the construction of field terraces might have been the only possibility to keep erosion under control and to guarantee the preservation of the soil resources for the following generations.

A third and last example shows the environmental conditions at the northwestern slopes of the basaltic Longuda Plateau. They belong, as already mentioned, to the settlement area of the Hill Waja (cf. HEINRICH & KLEINEWILLINGHÖFER 1995).

Most slopes in this area are covered by a thick blocky debris that derived from the weathered basalt flows. Farming seems to be impossible and a transformation of those block fields into arable land is only possible and practised at places, where the blocky sediment cover contains enough fine grained loamy or clayey material (detritus). To bring these places under cultivation the stones have to be collected and accumulated in heaps or in lines.

The fine grained materials of these shallow Regosols or eutric Cambisols have a very high base saturation and allow the planting of several kinds of crops. Water capacity of cause depends on the thickness of the material but is in most cases high enough for successful food production. An artificial accumulation of fine grained materials beyond stone walls like on the Tula Plateau has not been observed there.

Conclusions

It may be concluded from these few examples that in most parts of this mountainous environment with its poor natural provisions and resources it was necessary to develop specially adapted land use techniques like terracing the slopes or collecting fine grained weathering debris to increase water and plant nutrient capacity for successful food production as a prerequisite to survive in these areas.