

MAN-MADE FLOOD DISASTER IN THE SAVANNA TOWN OF GOMBE / NE NIGERIA
 THE NATURAL HAZARD OF GULLY EROSION CAUSED BY
 URBANIZATION DYNAMICS AND THEIR PERI-URBAN FOOTPRINTS

With 11 figures and 3 photos

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Zusammenfassung: Gefährdungspotenziale durch Erosionsprozesse im urbanen und periurbanen Raum am Beispiel von Gombe / Nordostnigeria in der Trockensavanne Westafrikas

Es sind besonders die armen Bevölkerungsschichten in der Altstadt von Gombe, der Hauptstadt des gleichnamigen Bundesstaates im semiariden Nordosten Nigerias, die infolge saisonaler Gully-Erosion und Überschwemmungen bei Starkregen sowohl durch die Zerstörungen von Häusern als auch städtischer Infrastruktur lebensgefährlich bedroht werden. Physio- und Sozialgeographen untersuchten gemeinsam die Ursachenkette. Zeitvergleichende Fernerkundung, insbesondere digitale Klassifikation der Gebäudestruktur und Kartierung des Abflusssystems mit Hilfe von einer IKONOS-Satellitenszene stellen die Grundlage dar. Die hieran anknüpfende systematische Erhebung von Sozialstrukturdaten in ausgewählten Stadtvierteln bildet die Basis für eine Gefährdungsanalyse der unterschiedlichen Sozialschichten. Hierbei werden besonders die hygienischen Lebensbedingungen berücksichtigt.

Summary: Physical and Social Geographers study hazards that affect mainly the urban poor in the fast growing town of Gombe in north-east Nigeria. Gombe, founded in 1919 grew mainly because of administrative activities from nearly 20,000 inhabitants in 1952 to 300,000 today. Caused by the peculiarities of the savanna climate, the low-level parts of the old town suffer seasonally from the menace of floods and destructive forces of gully erosion, destroying houses, bridges, urban infrastructure and even resulting in fatal casualties. By using remote sensing for change detection, the growth of the urban built-up area as well as the peri-urban foot-prints (such as the increase of farm land and firewood cutting) in the catchment area, can be documented. High resolution IKONOS satellite imagery supported the analysis of gully erosion and enabled a digital land use classification. A socio-economic survey revealed that the lack of sewage water treatment causes serious hygiene problems. Furthermore, the inadequate water supply was aggravated by the sinking water table of local wells due to channels cutting into the aquifer. The run-off in the catchment area needs to be regulated by efficient water management systems and a drainage system for sewage and surface run-off is urgently demanded.

1 Introduction

1.1 The topic

Destroyed houses, streets and bridges resulting from gully erosion are striking observations when mapping the built-up area of the rapidly growing capital of the newly created Gombe State. This fatal destruction caused a dialogue in the interdisciplinary research project "Cultural Change and Nature in the Savanna of West Africa" between the subdisciplines of social geographic urban research and the branch working on geomorphological erosion processes.¹⁾ This report documents a microregional example of man-made hazards in the Sudan Savanna. Though these large-scale studies have been so far widely ignored because of their local focus, the impact of these kinds of hazards can be currently observed in a growing number of places. They are basically attributed to the ongoing process of over-urbanization (MABOGUNJE 1968, 313²⁾) – in areas with rather low infrastructural standards.

Similar examples of man-made erosion are reported in semi-humid tropical climates in sub-saharan West Africa since the early 20th century, where settlements

¹⁾ The research was part of the interdisciplinary Collaborative Research Centres (SFB 268) of the German Research Foundation "Culture Development and History of Languages in the Natural Environment of the Savanna in West Africa" („Kulturentwicklung und Sprachgeschichte im Naturraum Westafrikanische Savanne“) a linkage project of the University of Frankfurt/Main, Germany and the University of Maiduguri, Nigeria. The special investigations took place between the sub-projects D1 "Persistence and Transformation of Regional Structures in West African Savanna" under Prof. W. FRICKE at the University of Heidelberg and D4 "Natural Potential and Landscape Development in West African Savanna" directed by Prof. G. NAGEL, University of Frankfurt/M. We are most grateful for the fruitful cooperation with Prof. J. IJERE and Dr. J. NYANGANJI, Department of Geography University of Maiduguri. The authors want to express their gratitude to the German Research Foundation (DFG) for most generous support of their fieldwork.



Photo 1: The old town of Gombe: isolation of wards by gully erosion and destruction of infrastructure
Source: BALZEREK 2000

In der Altstadt von Gombe: Erosionsrisse trennen Stadtteile und zerstören Infrastruktur

were already seriously threatened by gullies (GROVE 1951, 1952). In spite of this serious threat, official awareness and public enlightenment concerning the process, together with socio-economic limitations, result in habitual construction of settlements in the same endangered places (Photo 1).

1.2 The classification as natural hazard

So far, destruction is locally limited to single objects claiming only few human casualties at the city of Gombe (Fig. 1). The limited number of casualties does not offer headlines for the international press, because these hazards due to religious beliefs are perceived by those threatened as daily, inescapable events. Thus, the public does not comprehend the man-made origin of this danger.

This stands in contrast to other rather spectacular objects of hazard research where lava streams and avalanches destroy the settlements or where flood catastrophes like the one in Bangladesh in 1970 affected 300,000 people. GEIPEL (1977) refers to the earthquake in Friaul in 1976 with 1,000 casualties reported which is seen as the beginning of German hazard research.

Nevertheless, spectacular events like the collapse of the Tiga dam south of Kano (on the 28th August, 2001) with 75 drowned and 10,000 homeless have drawn only

national attention and interest in Nigeria, as it happened twice within two decades. In August 2001 it was the consequence of a torrential rain lasting for three days, combined with either the poor maintenance of the dam or a failure in regulating the water-level in time.

In addition to the examples chosen we must emphasize the importance of everyday hazards in many urban places in the West African savanna because of the accelerated process of urbanization.

1.3 Hazard research and the concept of vulnerability

Hazard research has up to now often neglected the human impact on nature leading to hazardous catastrophes. In many cases hazards are generated by the clash of two systems: the natural environment on the one hand and the local human community exploiting nature on the other.

By realizing that the damages in Gombe are concentrated in areas with lower social standard, the question about the reason of this uneven distribution was raised. Since the research of WATTS and BOHLE, one generally agrees upon the concept that social vulnerability is closely related to hazards.

“Vulnerability is defined in terms of exposure, capacity and potentiality. Accordingly, the prescriptive and normative response to vulnerability is to reduce exposure, enhance coping capacity, strengthen recovery potential and bolster damage control (i.e. minimize destructive consequences) via private and public means” (1993, 45).

²⁾ There are a number of reasons, why this thesis might be questioned (UNITED NATIONS CENTRE FOR HUMAN SETTLEMENTS 1996, 25).

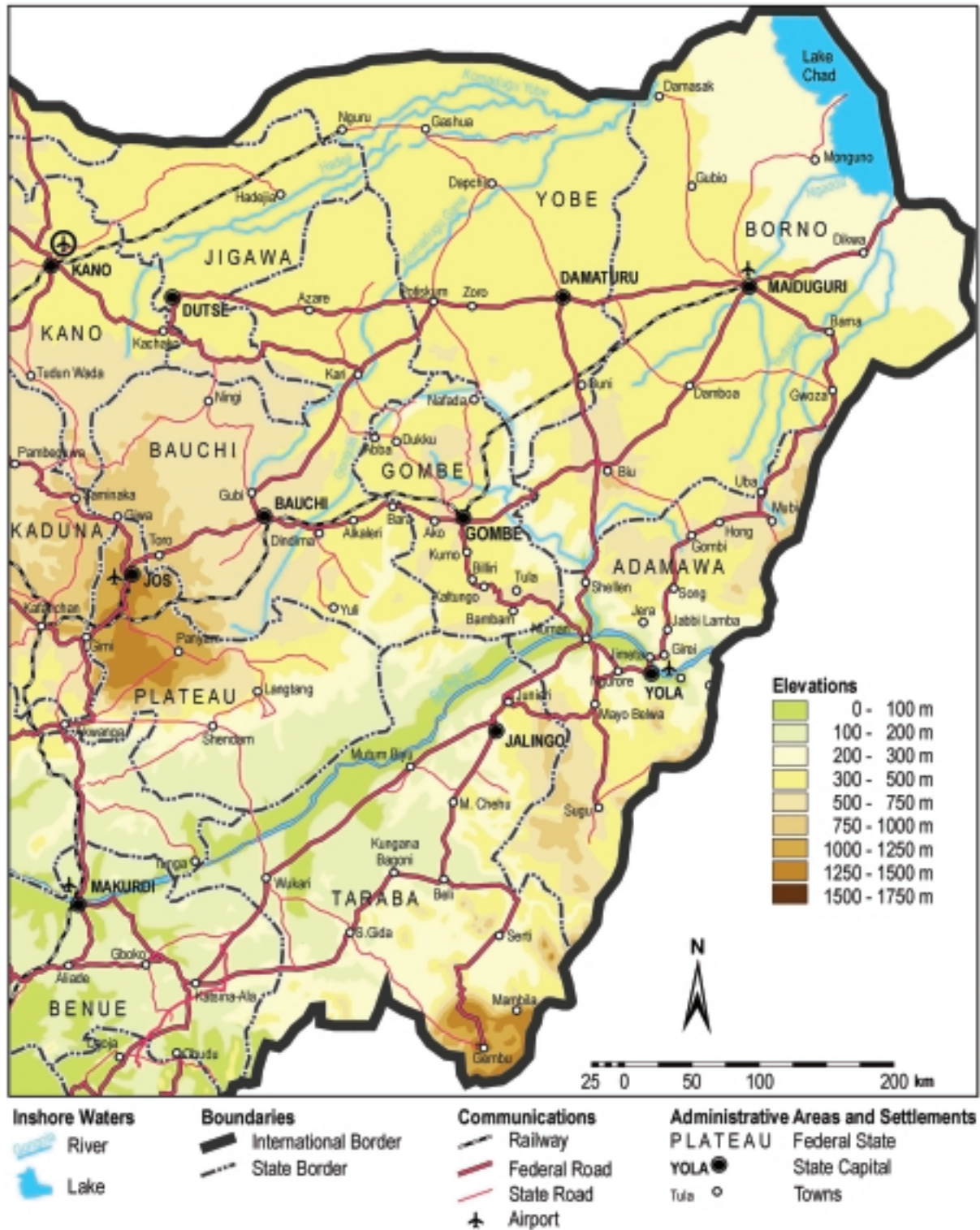


Fig. 1: Map of NE Nigeria
Übersichtskarte von NE Nigeria

As the concept of social vulnerability is closely related to hazard research, in our case we had to query whether these seasonal events and the damage they caused originate from the typical savanna climate or are the product of an ecologically unadapted urbanization.

When according to WEICHSELGARTNER (2001, 170) vulnerability is understood as natural hazard and at the same time as a problem of how to mobilize activities of a community in a certain regional or local area, then the events in Gombe are indeed not a surprise when we take into consideration that in the year 2000 Nigeria's GDP was only \$ 260 per head (BARATTA 2002, 583). Furthermore, Nigerian newspapers often report about the fact that a large number of the Nigerian population has to live below the poverty line. This leaves many people with few or no alternative choices of how to react to hazardous events.

2 The socio-economic analysis

2.1 Gombe – the dynamic growth of a savanna town

The roots of the urban system in the Sudan Savanna of northern Nigeria reach back to the first millennium A. D. when significant Trans-Saharan trade centres, e. g. the Hausa kingdoms Katsina, Kano, Zaria and Kukawa/Maiduguri in the Borno empire around Lake Chad, existed (Fig. 2). The Gombe Emirate, like a number of others at the southern fringe of that zone, had been founded during the Jihad of the Fulani religious leader Shehu Usman dan Fodio since 1804, replacing “a number of petty warring kingdoms by the Fulani empire” (HOGBEN a. KIRK-GREENE 1966, 121).

In contrast to the generally low rate of urbanization in Africa where only 25% of the people live in settlements with 20,000 and more inhabitants, Nigeria already shows with 36% in 1991 an accelerated process of urbanization; that means – compared with 15% in 1952 – a growth rate of 6% per year has to be considered as ‘very high’. Such a high urban growth rate is equivalent to a doubling of the urban population within 12 years. Especially the state capitals in the North of Nigeria – e. g. Kano and Maiduguri – grew sevenfold during that period.

Due to the dynamic development of the whole region (FRICKE 2001, 134) the town of Gombe, located 10.2° North and 11.1° East, has been chosen as a typical example representing many other fast-growing towns, situated in the semi-humid zone of the West African Savanna.

Originally Gombe (now called Old Gombe or

Gombe Abba) at the bank of the Gongola river 90 km north west of the present site of Gombe capital has been founded as a stronghold of Muslim conquest under Shehu Usman dan Fodio by one of his lieutenants, Emir Buba Yero, in the early 19th century (Fig. 1). The British shifted the headquarter of their Division and the residence of the Emir from Gombe Abba down to Nafada, where British trade companies had already established a seasonal entrepôt. In 1919, the British Colonial Administration transferred the capital of the Gombe Division a second time for strategic reasons, together with the traditional headquarter of the ‘Gombe Emirate’, to the southern limits of the Muslim conquest territory from Nafada to (Gombe) Doma, which was by then only a small village.

The new Gombe town has grown fast; in 1952 already 18,000 people lived there. Due to the new direct road access from the Provincial Headquarter Bauchi and the British Development Plans (since 1946) a systematic agricultural development took place. The tremendous change was the result of an accelerated agricultural extension work, especially by subsidizing the until then unknown ox-plough farming and modern cotton production on heavy black cotton soils less suitable for hoe cultivation. Gombe town became a booming agricultural centre of the region: cotton ginneries, international banks and depots established their premises in Gombe. By 1960 it had already 30,000 inhabitants. In 1962 the Nigerian Railway Corporation reached Gombe with the extension from Jos via Bauchi to Maiduguri (FRICKE 1965; TIFFEN 1976).

Figure 2 marks the stages of Gombe's urban development from 1919, the year of its foundation, till today. It shows the urban/peri-urban development around the core of Gombe. As only a few outdated topographical maps were available the figure was facilitated by a multi-temporal approach, using maps, aerial photographs from 1950, 1964 and 1978 and satellite images from 1986 (SPOT XS) and 2000 (IKONOS 2).³⁾

The expansion of the urban area in respect to the stages and the corresponding number of inhabitants, as indicated by the area size of the adjacent circle diagrams, describes the dynamic of the urbanization process.

Due to continuous immigration, the number of inhabitants of Gombe has grown sixteen-fold since 1952, reaching 300,000 in late 2000 (i. e. average annual

³⁾ “Temporal and spatial effects might be the keys to glean the information sought in an analysis. The process of change detection is premised on the ability to measure temporal effects” (LILLESAND a. KIEFER 1987, 173).

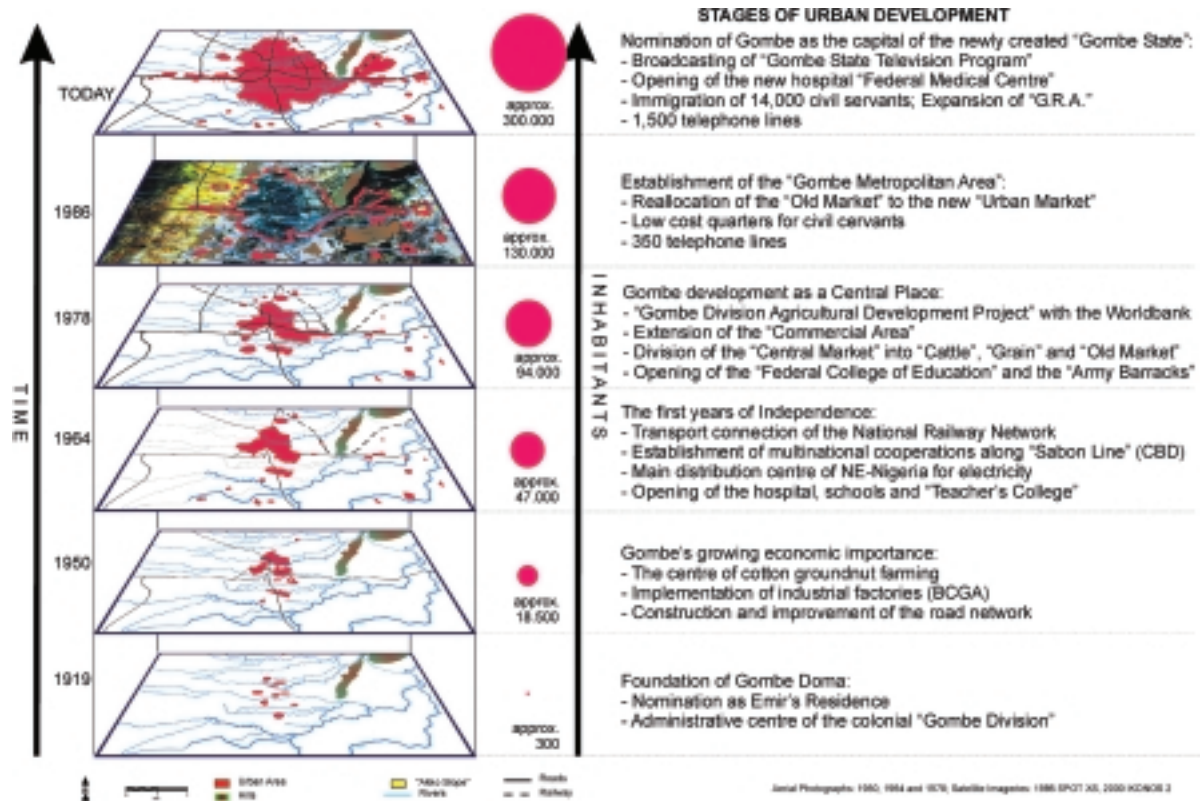


Fig. 2: The urbanization process in Gombe from 1919 to today. Source: BALZEREK 2001 a
Die Phasen der Stadtentwicklung von 1919 bis heute

growth rate of 5.9%). This demographic development is mainly based on dynamic intra- and inter-regional migration and significantly indicates the development of the economy – predominantly the tertiary sector. In 1996, Gombe was designated the capital of the newly established Gombe State, which mirrors the exceptional improvement of the functional and political position of the region.

2.2 Spatial segregation and urban structure

In Nigeria, recent data on urban population are generally not available, since the latest population census took place in 1991 (published in 1998). It was the first reliable count since 1952 (FRICKE a. MALCHAU 1994, 163). Unfortunately, master plans for urban development, lay-out plans or simple street maps hardly existed. Those maps and aerial photographs available were mostly produced in the 1960s and 1970s. For the

last decades, satellite imageries offer topographic information on African towns, as KAWKA (1997) had already shown for Maiduguri / Nigeria and Bobo Dioulasso / Burkina Faso.

For urban areas in West Africa, the application of urban satellite remote sensing is therefore utterly necessary for fast data access, i. e. urban boundaries, lay-out structures, building densities and sealing degrees. Since the launch of the IKONOS satellite in 2000, satellite images with high ground resolutions of up to 4 x 4 meters in multi-spectral and 1 x 1m in panchromatic mode are available, enabling for the first time a reasonable intra-urban interpretation and classification.

Figure 3 shows the IKONOS satellite scene of Gombe in near infrared, green and blue channels. The vegetation/trees are visible in red, geological outcrops in brown, roads in black, fields and unsealed surface in grey or yellow and urban dwellings in light-, medium- or dark blue colours.

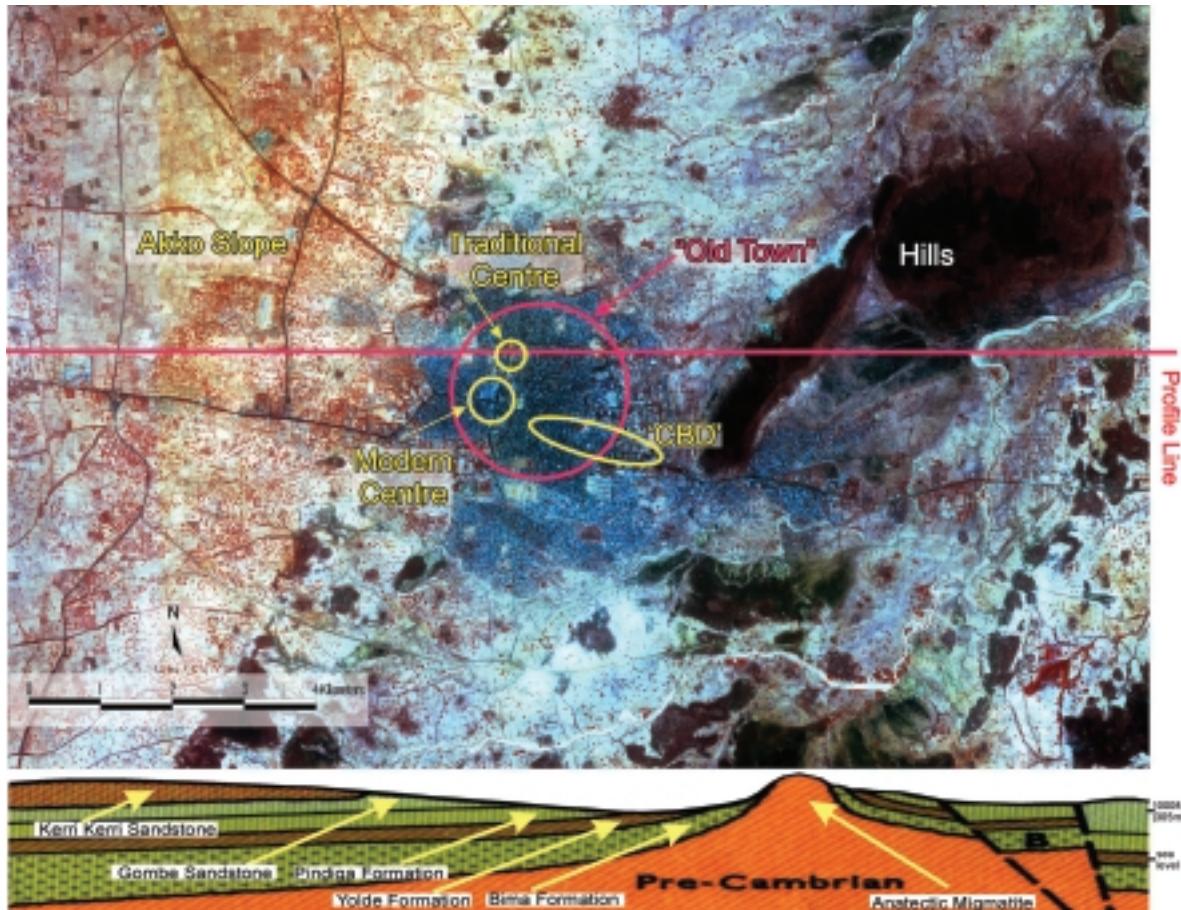


Fig. 3: IKONOS satellite scene of Gombe and geological profile. Source: IKONOS 2 from 26/04/2000; 9.37 a.m.; Ch: 4-2-1; Geol. Profile: Geological Survey of Nigeria 1936; BALZEREK 2003

Satellitenszene von Gombe und geologischer Schnitt

Due to the reflection of the roofs of corrugated iron sheets, most African towns seen from space, appear in blue luminosity. The spectral attributes of these metal roofs differ with age (BALZEREK 2001b), which is an important peculiarity allowing the differentiation of the urban structure and the monitoring of its development. Dark blue pixels represent the older buildings and, therefore, indicate the location of the old town. Here, the 'Central Mosque', the 'Emir's Palace' and the 'House of Law' with the prison symbolise the traditional centre of Gombe. The 'Old Market' and the environs of the roundabout 'Cross' locate the modern centre of today. In an easterly direction, along the west-east main traffic axis of the town called 'Sabon Line' (Sabon means in Hausa the new quarter of the foreigners, in this case the shops and stores of the Southerners, especially the Igbo businessmen), the 'Central Business District' (CBD) developed, where banks and chain companies were constructed.

2.3 The social structure of the wards of Gombe

With the help of a sample survey of 1,056 households⁴⁾ focussing on the socio-economic household conditions in all parts of Gombe, the wards can be distinguished in three classes of a statistically generated 'Living Standard Index': 'Low', 'Medium' and 'High Living Standard', symbolising the access to modern facilities and hygiene within the family compound. Figure 4 indicates four areas, where 'Low Living Standard' can be monitored.

The first area contains three wards, 'Pantami', 'Gabuka' and 'Madaki', situated along the southern margins of Gombe with 50–60% building density (for ward

⁴⁾ The household survey was conducted by H. BALZEREK and M. ROSENBERGER in 2000.



Fig. 4: The dominant social structure and sites of gully erosion in Gombe. Source: Own survey; BALZEREK 2003

Dominante Sozialstruktur und Gully-Erosionsschäden in Gombe

names see Fig. 5). The age of these wards vary from 80 years in the case of 'Pantami', which still hosts many farmers, to 20 years for 'Madaki', hosting mainly urban poor.

Three sparsely populated and very heterogeneous wards, approximately 25 years old, form the second area along the northern margins. Their dwellings occupy around 10–40% of the total surface, with peoples from different origins and belief. The third area of 'Low Living Standard' can be identified in the south eastern fringe of Gombe. It is the very remote ward 'Bogo Missau', which is highly isolated beyond a seasonal river without any bridge or road connection. 'Bogo Missau' is a very homogenous settlement of Muslim Fulani, who are cattle rearers and farmers. The settlement, 30 years old, consists only of clay buildings. The building density reaches 30%. The level of education is the lowest of Gombe since only 'Arabic education' is accepted.

The fourth area in the centre encloses most wards of the 'old town'. Its colonial lay-out, a grid-system, was planned and constructed by the British. Beside the 'Emir's Court' the first settlers were traditional counselors, traders and craftsmen, who were attracted by the proximity to the rulers. Their compounds altogether form the 'Native City'. Today its inhabitants are predominantly Hausa-Fulani families, whose household size is the largest in town, containing ten persons on average. Further, their level of education must be classified as rather low compared to other areas of the town.

Focusing on the drainage system of Gombe the destruction of urban building structures by gully erosion is symbolised by red segments along the gullies. Figure 5 identifies that most extraordinary damages affect the inhabitants of the 'Low Living Standard' areas. Many households of those areas belong to the very vulnerable groups, who are not in the position to overcome the results of the hazards but are caught in the vicious circle of poverty.

On the other hand, it becomes obvious, that the three wards, 'Bauchi Road', 'Hospital' and 'Government Residential Area' (GRA), located west and southwest of the city centre and belonging to the 'High Living Standard' areas, are hardly hit by gully erosion. As the lay-out of the GRA was done by the British, who included in their design an elevated area with a 'cordon sanitaire' of a one mile distance to the 'Native Town' to live segregated from the local people. By this the single plots are spacious and the buildings still at some distance from the gullies.⁵⁾

3 Analysing the physical environment

3.1 Climatic factors

The climatological situation of Gombe is characterised by a dry season of six months, alternating with a six months rainy season (see Fig. 6). As in other parts of the West African Savanna this precipitation distribution is mainly triggered by a seasonal shift of the Inner

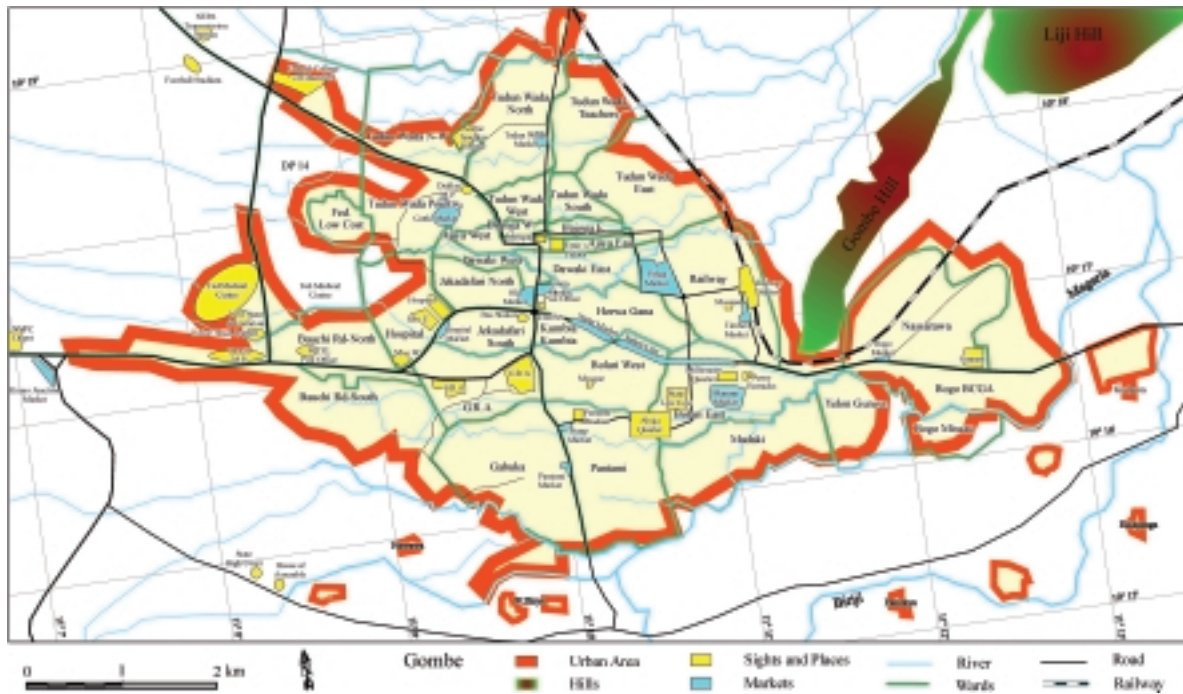


Fig. 5: Overview of Gombe in 1998. Source: BALZEREK 2003
Übersichtskarte von Gombe

Tropical Convergence Zone (ITCZ). For the years 1977 to 1995, the mean annual precipitation is 835 mm, whereas the mean annual temperature is about 26°C (BRUNK u. SCHNEIDER 1998).

Although precipitation is the most important input-factor in triggering soil erosion and fluvial morphodynamics, average values alone are not sufficient to determine the erosivity of individual rainstorms. Previous investigations on overland flow and soil erosion in Savanna environments carried out on test plots with sandy top soils gave evidence that run-off and sediment transport only occur when the total precipitation depth exceeds 10 mm combined with rainfall intensities greater than 0.2 mm/min (NYANGANJI 1997). About

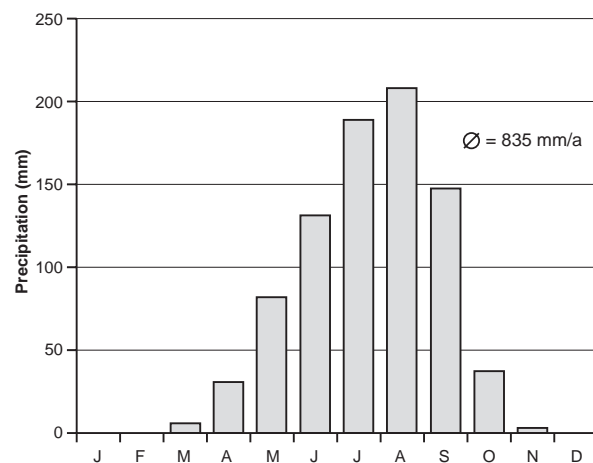


Fig. 6: Mean monthly precipitation depth at Gombe for the years 1977-1995
Source: MOLDENHAUER u. NAGEL 1998
Monatliche Niederschlagsverteilung in Gombe in den Jahren 1977-1995

⁵⁾ The cordon sanitaire is characteristic for most of the towns in former British and German Colonies (MANSHARD 1977). MORGAN a. PUGH (1969, 458) trace this back to the policy of Nigeria's first Governor Lord Lugard. Another example for such a lay-out in a new town is published by KAWKA (2002) for Maiduguri.

70% of the rainfall events, documented with a precipitation recorder between 1991 and 1996 some 50 kilometres south of Gombe, meet these threshold values. Moreover, analysis of these records reveal distinct seasonal variations in duration, amount and intensity of the rainfall. The cumulative curves show that rainfalls starting with high intensities – compared to events having their intensity peak later – are more frequent in the beginning and end of the rainy season. Also the intensity values calculated for 30 minute intervals alter in the course of the rainy season. The lowest values occur when monthly precipitation reaches its annual climax in August. Hence, precipitation characteristics related to erosivity contrast with precipitation frequency and amount (MOLDENHAUER 1997; MOLDENHAUER u. NAGEL 1998) (Fig. 7).

Traditional farming activities on dryland in the Savanna climate are well adapted to the seasonal change of precipitation and depend strongly on the soil moisture available. Planting and harvesting take place at the beginning and end of the rainy season while the crops ripen during the summer months. Towards the end of the dry season, the fields and adjacent areas are usually burnt to enhance nutrient supply and to control parasites. Therefore, an increased rainfall erosivity appears regularly in times when the protective vegetation cover of the land surface is sparsely developed. Besides this, extreme rainfall events yielding more than 100 mm in one day can be expected for this part of the Gongola-Basin every five to ten years (see Fig. 8).

3.2 *Geomorphological and pedological conditions*

The town of Gombe is situated on the lower part of an east-facing (2° – 3°), gently undulating slope. This denudation surface is separated by a disconformity of the bed rock, visible at the western margin of the satellite image (see Fig. 3).

The upper parts of the Akko slope are developed in weakly consolidated sandy sediments of the Tertiary Kerri Kerri Formation, whereas the tow slope consists of sand- and siltstones belonging to the Cretaceous Gombe Formation. The central parts of the town were founded on these older sedimentary rocks. A few mesa-like hills covered by a residual debris of ironstones appearing within the town, are part of a small cuesta dividing the Akko slope, striking north-south. The cuesta developed from some more geomorphologically resistant iron-encrusted sediment strata embedded into sandy beds of the Gombe Formation (HEINRICH 1995). In accordance with the geological conditions, soils with a sand-dominated grain size spectrum characterize the area (Fig. 9).

From this combination of the erodibility of the soils and relief characteristics it can be deduced that especially cultivated areas are highly endangered by erosion processes. This is proved by numerous gullies dissecting the upper parts of the Akko slope, nowadays used for agriculture.

One of the most important factors considered to be responsible for the severe soil erosion in this area is the clearance of formerly extended dry forest formations. Also, the apparently dense vegetation, visible in the satellite image, covering the west of Gombe, actually constitutes an open park-savanna. However, the scattered trees of this vegetation type have only a minor protective effect, so that the impact of heavy rains reaching the soil surface remains undampened.

The huge input of rainfall often exceeds the infiltration capacity of the shallow soils. The results are surface run-off and sheet erosion. The overland flow concentrates in rills and shallow channels, which further combine to form deeply incised gullies especially where foot paths or cattle tracks cross the fields, that then become initial forms for linear deep cuttings. Many of these anthropogenic structures are orientated towards the town and several gullies converge in this direction. All these forms are collecting the surface run-off from the vast surrounding areas. Consequently, the centre of the town is affected by flash flood events and strong gully erosion, too, that developed on farmland in the surrounding area. Hence, the risk of hazards is mainly caused by intensified land use under fragile environmental conditions (e. g. relief, high erodibility of soils and precipitation characteristics).

4 *Synoptic interpretation of physical and anthropogeographical factors*

4.1 *Peri-urban land use change*

Figure 10 reveals the change of land use within the catchment area of the Gombe gullies. The 'Akko Forest Reserve', situated along the watershed of the Akko slope drainage basin area, was installed by the British in 1933. On the Kerri Kerri Plateau, a thick vegetation cover expands downhill towards Gombe, monitored on a 'Corona' satellite imagery of 1968. In the northern, western and southern directions this more or less closed cover of natural dry savanna vegetation is surrounded by a fringe of isolated savanna trees and shrubs. In the southern and in part to the eastern directions small agricultural fields mixed with shrub fallow are attached to the common dry savanna formation, also covering the slope surface of the catchment area.

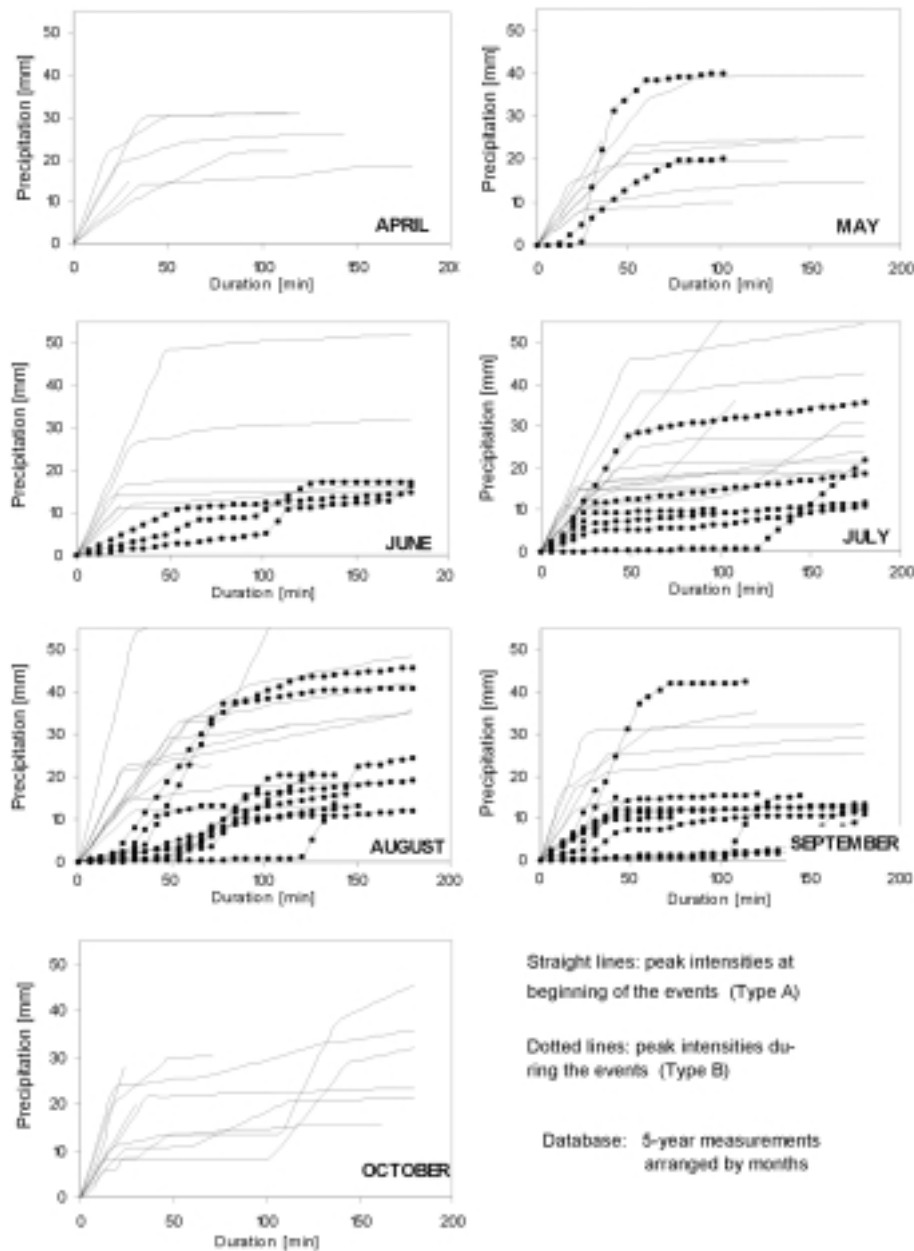


Fig. 7: Cumulative curves of amount and duration of precipitation depth
Source: MOLDENHAUER u. NAGEL 1998

Summenkurven der Menge und Dauer des monatlichen Niederschlags

This recent land use pattern has been transformed in steps. First, the forest reserve and the light savanna and bush formation have been cleared for agricultural use and fire wood collection⁶⁾. Later, these agricultural fields became the object of speculation, since the growing demand for future urban expansion had been recognised. Finally, speculative transactions changed most of the

cultivated fields into 'speculative fallow'. A real estate market was established. The last step started in the middle of the 80s, when huge official complexes like the 'Federal Medical Centre' were constructed. Until today the number of buildings and official complexes on the Akko slope is constantly growing.

The devastation of the forest reserve (6 km²) and the

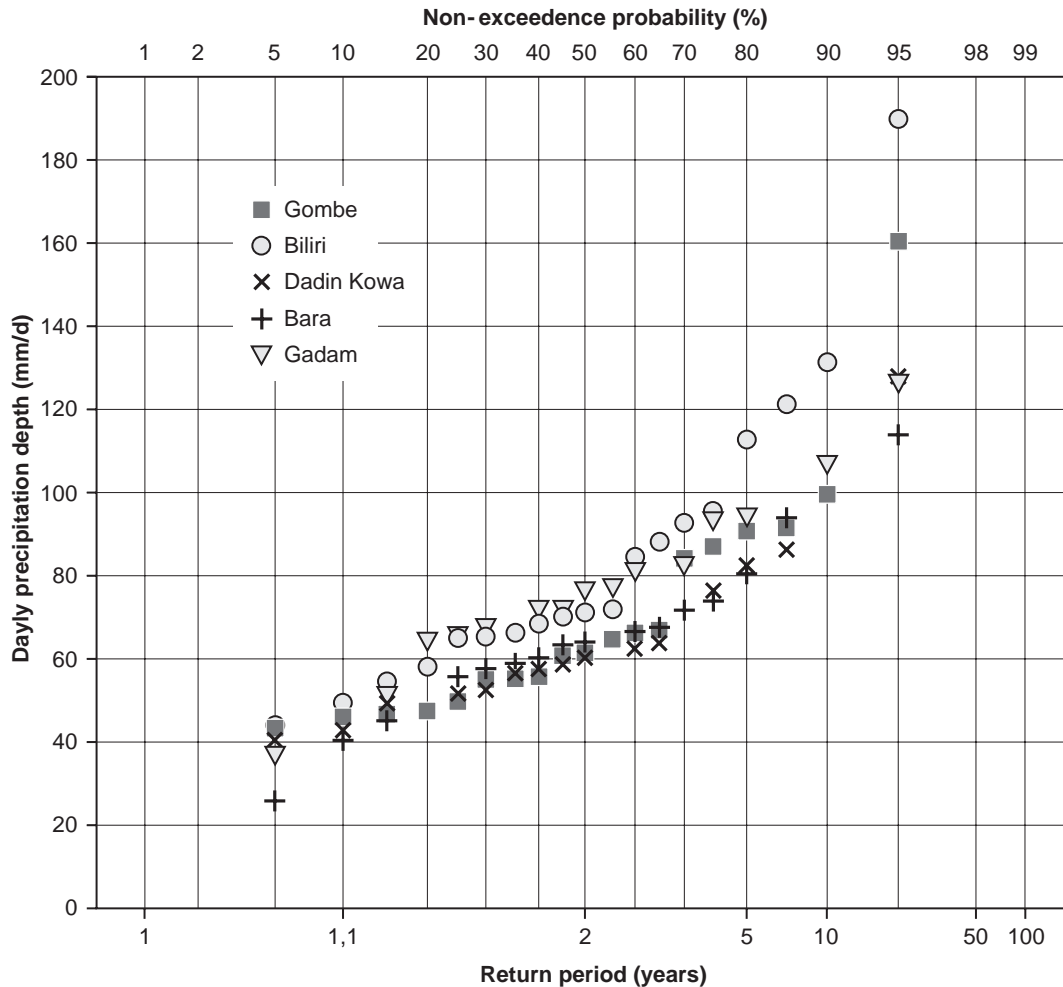


Fig. 8: The probability of extreme daily rainfall events. Source: MOLDENHAUER
Die Wiederkehrwahrscheinlichkeit extremer Niederschlagsereignisse

surrounding savanna and bush formation, as well as the transformation of former farmland with bush fallow into urban built-up plots (an area of about 20 km²), decreased the infiltration rate and caused an accelerated surface run-off through gullies. The dimension of this change of land use as monitored by remote sensing plays the key role in a process generating flood hazards, but it is definitely enlarged by the effect of an increasing run-off on sealed surfaces in urban areas expanding at a fast rate.

4.2 Effects of surface sealing and the growing risk of flood and erosion

The supervised classification of the IKONOS satellite scene of Gombe (Fig. 11) reveals the different surface cover within the city of Gombe. The total built-up area plus the area of the road network make up a sealing area of approximately ten square kilometres. The highest sealing rate of 75% can be found in the 'old town', whereas the marginal wards, containing more newer buildings, reach sealing rates between 20 and 50%.

The built-up area of the colonial planned grid layout becomes more and more compressed by spontaneous private construction activities, especially within the 'old town'. Further, official buildings, like schools, hospitals, quarters for civil servants (low-cost-areas),

⁶⁾ The trees had been used as fire wood, a praxis which is still common. Even today 75% of the households use fire wood for cooking reasons.

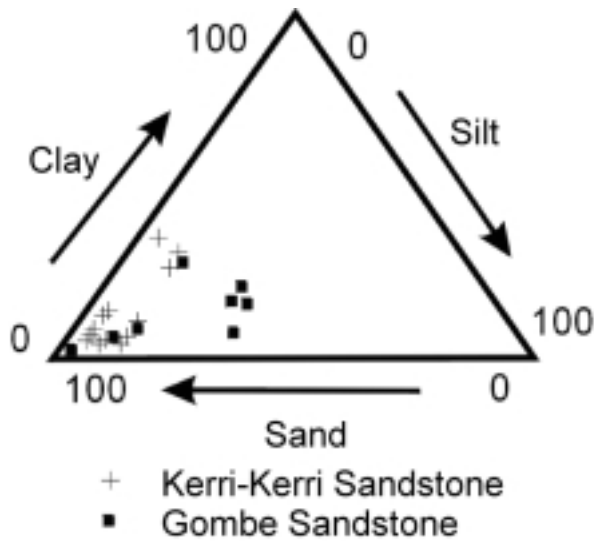


Fig. 9: Grain size distribution
 Korngrößenverteilung am Akko-Hang

sports facilities, ministries, secretariats, etc., have been attached to the former urban area. But most private buildings are informal dwellings which have been erected by immigrants, who founded their homes in one of the newly created wards along the fringe of Gombe.

Floods and streams undercut buildings near the banks of gullies, they destroy roads and drown people and animals. Some of these gullies measure shoulder widths of 50–75 m and reach depths between 3.5 and 18 m⁷⁾. The protection of channel banks with concrete and stone packages for erosion control, and sometimes only simple stone walls, do not prevent the gully extension at all, but are undermined and subsequently flushed away during a hazardous event.

Today the ‘old town’, once founded on the tow of the Akko slope because of an easier access to groundwater, suffers most from this gully erosion. It brings the urban poor closer to a vicious circle of poverty and exacerbates their vulnerability. The reason why people construct their compounds next to a dangerous gully is the scarcity of land, the limited socio-cultural integra-

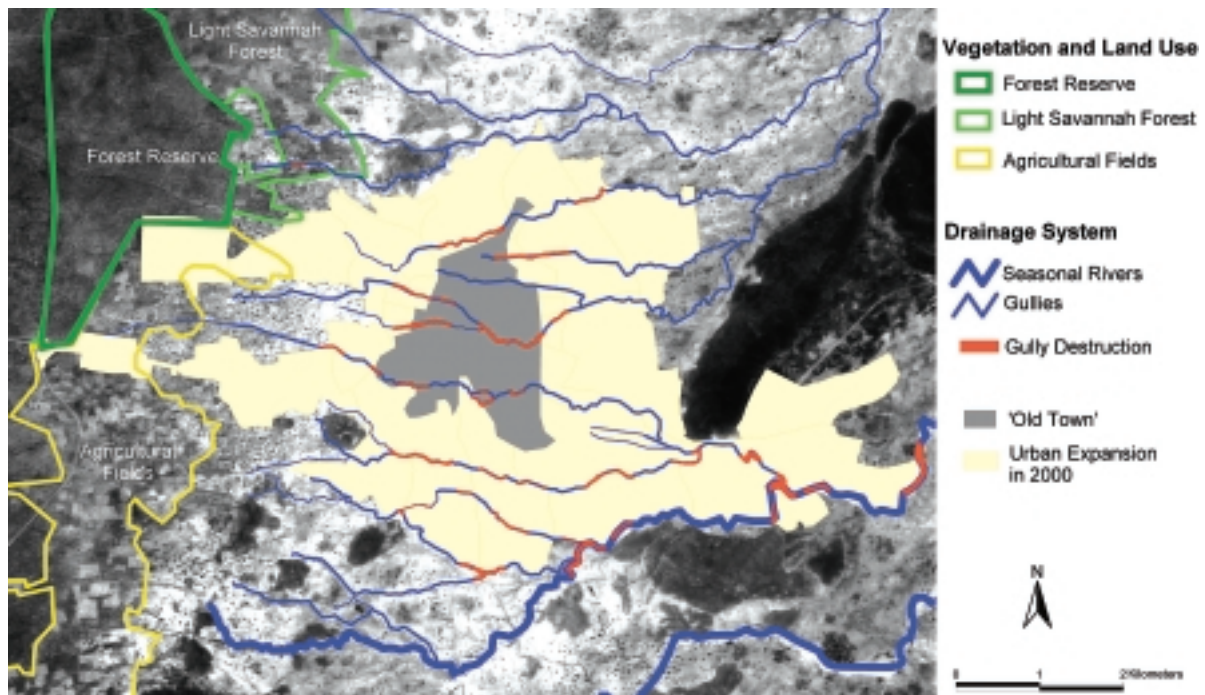


Fig. 10: Change of agro-forest land use within the catchment of the Gombe gullies since 1968. Source: Corona satellite image 1968; own survey

Landnutzungswandel im Einzugsbereich des Abflusssystems seit 1968

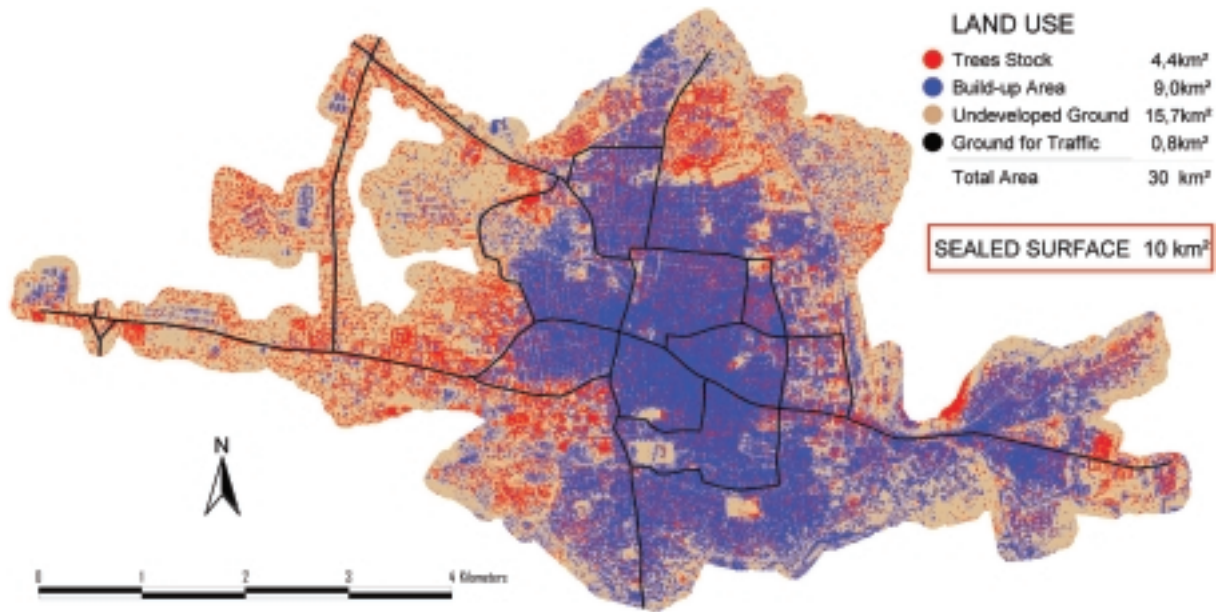


Fig. 11: Urban land use classification of Gombe
Flächennutzung innerhalb des Siedlungskörpers von Gombe

tion or influence or power of these households, and their inadequate financial basis (Photos 2 and 3). HORLICK-JONES et al. (1995, 122) describe four factors shaping the vulnerability of the population:

- the local proximity to the hazard;
- the social constellation of the position and temporary economic situation of the people (monetary capacity, gender, health);
- the ability of families to mobilize self-help and self-protection and to gain access to rescue aid and information;
- the community could provide protection by offering precautions, resources and technical know-how.

In Gombe city this scenario has to be seen as an expression of individual and institutional poverty in general.

Oil converted Nigeria – according to WATTS (1997, 40) – “into a strikingly mono-commodity economy on which the state directly depended”. The multiplication of federated states in Nigeria from originally three to six in 1960 and to twelve in 1967, to thirty in 1978 and even to thirty six in 1996 created numerous regional capitals without a solid economical basis beyond their share of petrodollars from the federal administration. Unfortunately, the Nigerian Government neglected the development of the rural economy apart from some large-scale projects e. g. River Basin Development Authorities, which failed.

Based on such a weak economic structure, a high percentage of rural immigrants stay below the poverty-line because of the lack of productive jobs. This causes a breakdown in the traditional mechanism of assimilation, as can be indicated by a riot of the followers of a radical Muslim brotherhood – the Maitatsine – in Kano, Kaduna, Gombe, Yola and Maiduguri in 1980.

4.3 The sinking ground-water table and the water supply system

The continual process of deep-cutting and out-curving linear erosion in already deeply cut gullies results in a fast drainage of the ground aquifers. Results of this are the lowering of ground-water tables and the subsequent drying-up of wells.

Since the public water supply system was totally neglected by the administration, it is outdated, inefficient and frequently hit by energy and fuel shortages. The availability of unpolluted piped water is mostly limited to certain wards characterised by a higher social standard. Most inhabitants are forced to buy their water from water traders, who transport untreated water in tankers from sources 15 km outside Gombe. It is distributed to the urban poor by water sellers (Hausa: Amalenke) pushing wheel barrows loaded

⁷⁾ Gombe State Government 2000, 7pp.

with 16 to 20 jerry cans filled with water. Because of the high water prices, many households depend on their private or public wells, with water decreasing in quantity and quality. Limited access to wells in the neighbourhood force households of low social standard to use alternative water sources from gully beds, dirty ponds, ditches and, of course, rainwater. The scarcity of water leads to a decline of water consumption to 27 litres per person and day⁸⁾.

It should be considered, that the lack of sewage discharge leads to infiltration of faeces and subsequently to acute ground water contamination. Unfortunately, the percentage of households treating their 'drinking' water is very low (20%). The high price for fire wood is one of the reasons, another one is carelessness. The existing annual outbreaks of cholera and typhoid fever prove the very realistic threat to the health of the whole community, and especially the low income groups, whose vulnerability is the highest.

5 Conclusion

5.1 Cause and effect: the imbalance of nature and the urban community

An expansion of the cultivated area, under circumstances which disregard sustainability and the deterioration of the vegetation cover under the conditions of a tropical semi-arid climate, amplifies the natural processes of land forms. Accelerated erosion is mainly caused by the change of land use on the slopes of the catchment area. After the step-wise transformation of savanna vegetation into agricultural cultivation, the production technique changed. Small-scale hoe-farming under shifting cultivation was replaced by large scale plough-farming. Then parts of this cultivated land were sold and transformed, first into 'speculation fallow', subsequently into an urban built-up area. This land use change was increased by the rapid growth of population and their demand for land during the last generation.

Complex interdependent mechanisms between precipitation patterns, soil erodibility and reduced infiltration caused a higher surface run-off and increased deep-cutting gully erosion, drainage of aquifers and the sinking of the ground-water table – all are exacerbating the imbalance between nature and man. This chain of cause and effect hits most the low income groups of the community, especially in the old town, where the popu-

lation density is highest and where the worst damages of gully erosion are found. Because of the changing ground-water condition and the inadequate water supply, as well as the non-existent sewage discharge, the hygiene standards for the population are falling below the limits of sanitation. Starting from the geo-medical point of view, this situation directs the urban poor closer to the vicious circle of poverty, aggravated by aspects of a low educational background, weak physical conditions, low financial capacity and, particularly, the ignoring of the cause and effect principle, thereby putting their whole future in jeopardy.

The risk of a hazard and the damage caused by a disaster has to be covered by the individual, since none of the property is insured by commercial assurance companies. The people affected unfortunately often react with fatalistic equanimity and consider it a stroke of fate, a judgement, which is enforced by the cultural background and their lack of education.

5.2 Countermeasures and projection

Erosion control constructions undertaken on a public and individual basis do not show much of a success, but are causing even more damage when flushed away. Successful erosion control with effective countermeasures starts with an ecologically orientated planning, coordination and organisation.

Educational and instructional work with the persons affected and the decision makers has to start first. The town planners, supported by the legislative and executive powers, should direct the urban development and, if necessary, intervene in the urbanisation process towards an ecological sustainability.

A drainage system for sewage and surface run-off in all of the wards is absolutely necessary. Along the Akko slope of the Gombe catchment area a cascade system, consisting of an arrangement of retention basins and integrated small terraces bound by fast growing hedges, could effectively reduce the surface run-off and the causal flush erosion during a strong rainfall event. This countermeasure can be done inexpensively and quickly, but has to be accompanied by a grazing control programme against damage by cattle and goats. Further, to diminish the draining of the roof rain water within the densely build-up area, water tanks (cisterns) could catch the water and store it within the compounds, thus serving as a supplementary source of water.

One has to conclude that the imbalance of nature and urban community is growing dramatically and threatens the urban ecological system. The irreversible damages have to be dammed soon by appropriate countermeasures. The towns affected are not able to

⁸⁾ UNDP claims 60 litres of water per person and day for Palestinian camps as a minimum.

fend for themselves. They are highly dependent on technical and financial assistance from outside.

Only the interruption of the vicious circle of poverty and vulnerability can reduce the risk and danger of those hazards. Unfortunately, a shift of the behavioural pattern of the urban community, including the decision

makers, is not to be expected. Temporarily there is not much chance of a solution grounded on the societal and political structure of Nigeria, an administration whose rather limited finances are totally based on one source: the unique exploitation of oil.



Photo 2: A flash flood damaged this house in the old town adjacent to a sewage gully (Photo: BALZEREK 2000)

Ein über dem Abwasser-Gully hinaus geschwemmter Hochwasserschwall hat in der Altstadt ein Haus beschädigt. Es wird noch weiter bewohnt



Photo 3: Close to an undercutting slope of a seasonal river a new building is under construction

(Photo: MOLDENHAUER 2002)

Über dem aktiven Prallhang des saisonalen Flusses wird ein neues Haus errichtet

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