11 Kainji Dam and Lake

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Abstract

The area covered by the Kainji dam, Kainji Lake and Kainji National Park constitutes a distinct landscape within the Nigerian scenery. The dam and lake were created along the River Niger approximately 105 km upstream from Jebba between 1964 and 1968. Though the primary focus of the dam and associated impoundment is hydroelectricity generation, other ancillary purposes are flood control, navigation enhancement, irrigation and fishery development. The lake's annual hydrograph shows there are two peak inflows: the 'White' and 'Black' floods, occurring in September and February, respectively. Draw-down occurs from February to June. A National Park was created from two existing game reserves that were contiguous to the impoundment area. Notable geomorphological features, namely corestones, tors, ruwares, and littoral caves and crevices abound in the area. Corestones, tors and ruwares were etched out from crystalline rocks, while the caves and crevices were created by the impact of waves and seiches on headlands and promontories in the lake's draw-down zone.

Keywords

Kainji Dam • Kainji Lake • Kainji Lake National Park • Ruwares • Tors • Corestones • Terraces • Lake shoreline caves • Hydroelectricity • Resettlement

11.1 Introduction

The massive growth in the demand for electricity in Nigeria by the middle of the twentieth century led to a consideration of hydroelectricity as a supply source option by the government. Consequently, studies of the hydropower potentials of the River Niger and its tributaries were commissioned (e.g. Balfour Beatty & Co. Ltd. and NEDECO 1958; 1961; 1965). Consultancy reports suggested some sites for hydropower development, namely Kainji, Jebba, Lokoja and Onitsha on the River Niger, Shiroro and Zungeru on the River Kaduna, a tributary of the Niger, Makurdi and Yola on the River Benue, Katsina-Ala on River Katsina-Ala, a tributary of the Benue, Beli on the River Taraba, another tributary of the Benue, and Mambilla Plateau on the River Donga, also a tributary of the Benue. Kainji Hydroelectric Power project was the first option pursued, and after its completion, a National Park was created from two existing game reserves that were contiguous to the impoundment area. The whole Kainji area has since become a national heritage comprising the dam, the lake and National Park. Notable geomorphological features including those created by etch-planation on crystalline rocks, and the impact of waves and seiches[1] in the lake's draw-down zone, abound in the area.

11.2 Kainji Dam and Lake

11.2.1 Kainji Dam

Kainji Dam (9°51′45″ N 4°36′48″ E) is a multipurpose dam constructed between 1964 and 1968 across the River Niger,

[1] A seiche is a standing wave oscillating in a body of water and is typically caused when strong winds push water from one end of a body of water to the other. When the wind stops, the water rebounds to the other side of the enclosed area. The water then continues to oscillate back and forth for hours or even days.

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approximately 105 km upstream from Jebba. Though the primary focus of the dam and associated impoundment is to produce hydroelectricity, other ancillary purposes are flood control, navigation enhancement, irrigation and fishery development. The dam, anchored on a rocky island, the Kainji Island, is aligned approximately WSW–ENE across the river. It has a central concrete gravity structure, which houses the penstocks (steel-lined ducts that convey water from the reservoir to the turbines), the hydroelectric power plant and the associated tailrace structure located at its downstream foot. The spillway and its associated tailrace structure are at the eastern extremity of the concrete structure. Kainji Island also hosts the hydroelectric power plant's Switch Yard (Figs. 11.1, 11.2 and 11.3).

Abutting this central area are the western and eastern rock-filled sections, with compacted clay cores (Fig. 11.3). The eastern section is traversed by a 2.4 km long navigation canal with two locks, each capable of lifting four barges over a total elevation of 41.2 m from the river water surface level to the lake water surface level. It takes 15 min for each lock to fill and two hours for each barge train to pass through the navigation canal across the dam to the reservoir (Figs. 11.4 and 11.5). Beyond the eastern rock-filled dam is a saddle dam built across a tributary that would have bypassed the dam (Fig. 11.3). Other features of the Kainji Dam are presented in Table 11.1. It is one of the longest dams in the world, and it took about 20,000 men of nine different nationalities to construct (Olagunju 1972). The dam was designed to generate 960 MW, but this had to be reduced to 760 MW due to a 30-year drought (1968–1998) that occurred mainly in the Sudan and Sahel ecological zones of West Africa, the preponderant parts of the River Niger drainage basin upstream of the dam. The original design of the Kainji Project was based on rainfall and runoff data between 1914 and 1959, a pluvial period in West Africa. Events that occurred immediately after the commissioning of the dam in 1968 indicated that longer-term climatic conditions in the upstream River Niger drainage basin include much drier epochs during which available water will not meet Kainji's initial hydroelectric power production target (cf. Sagua 1979).

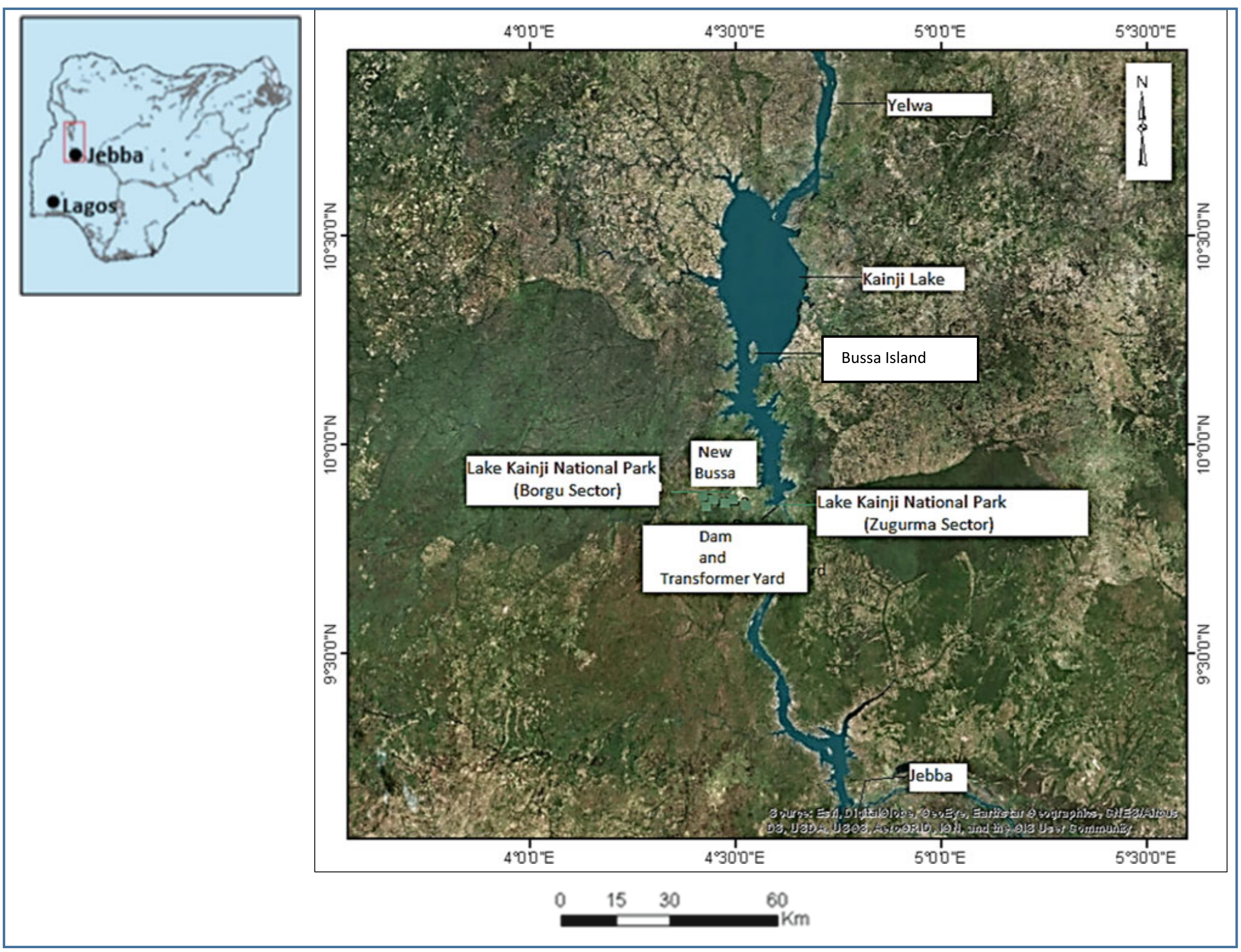

Fig. 11.1 Kainji Dam, Kainji Lake and Kainji National Park (after Google Earth), and map of Nigeria showing their situation

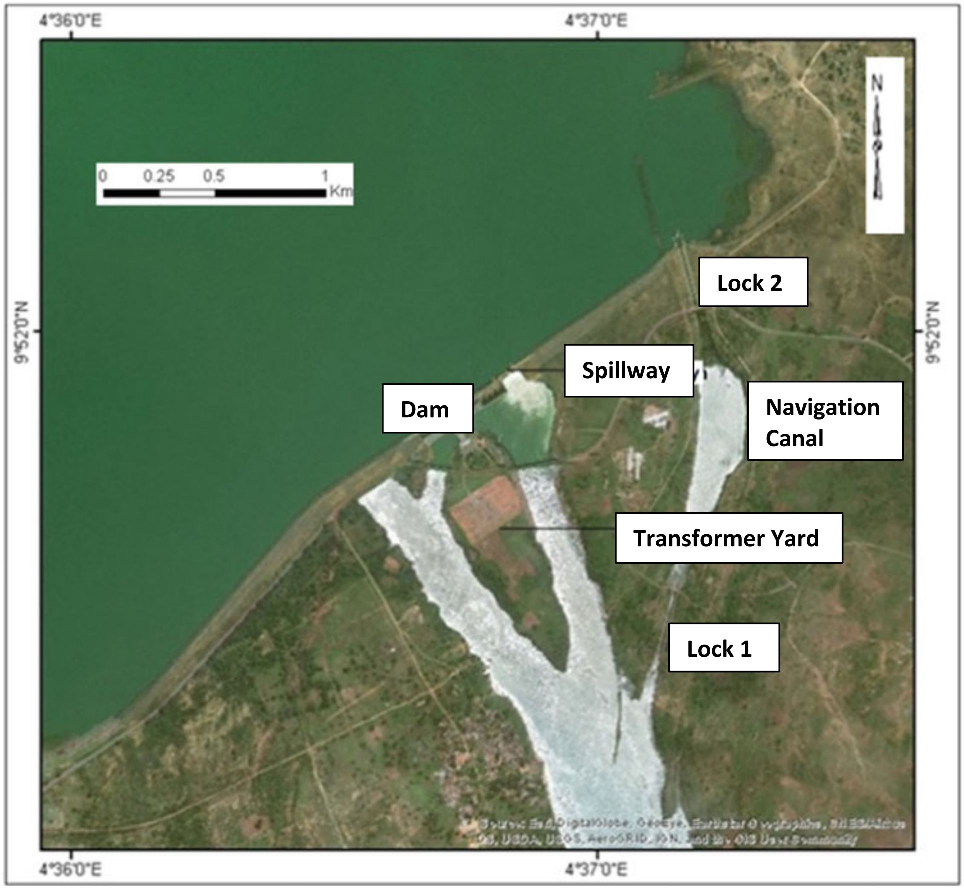

Fig. 11.2 Kainji Dam and the remnant Kainji Island (strip of land between the two Tailraces) now used as Switch Yard (after Google Earth)

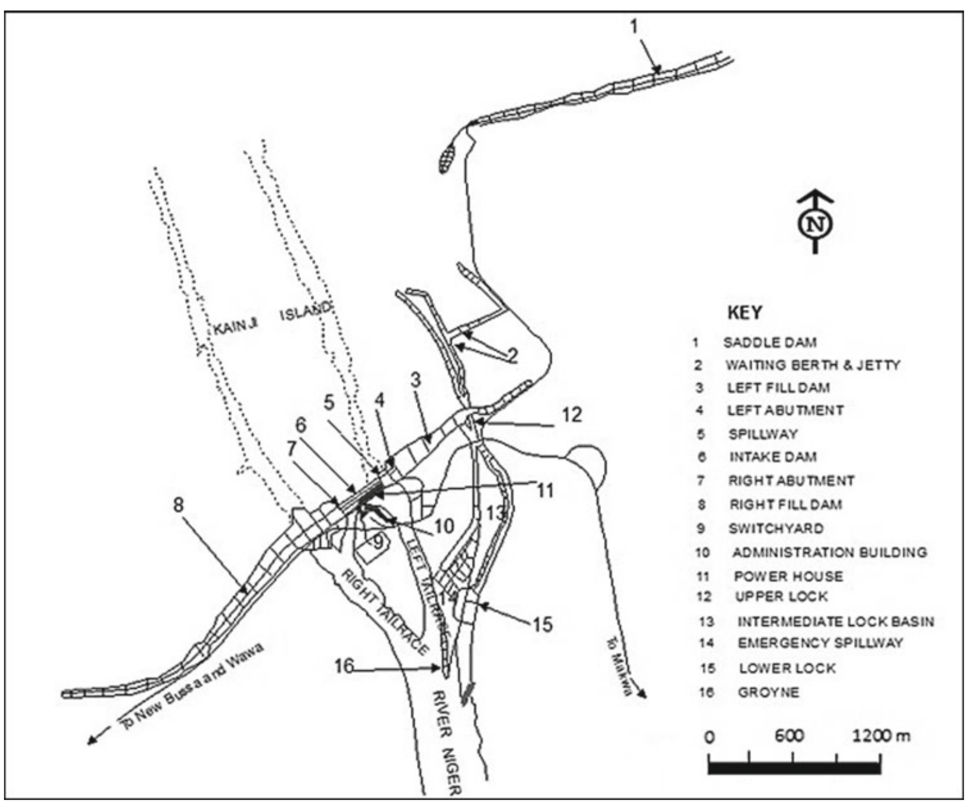

Fig. 11.3 The layout of the Kainji Dam (modified after Olagunju 1972)

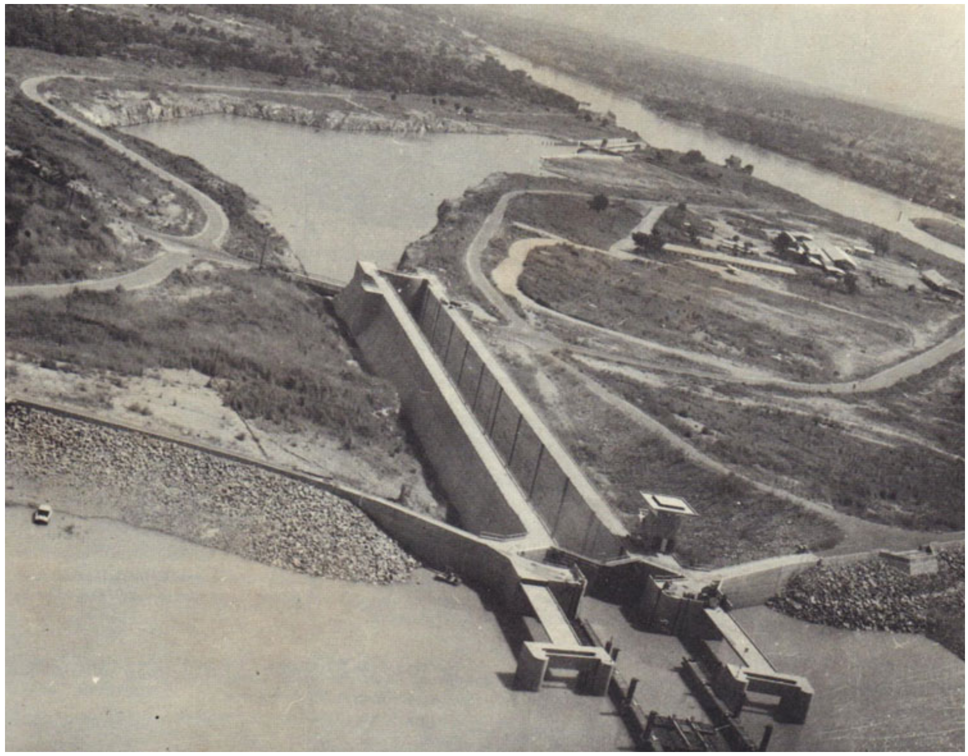

Fig. 11.4 Upper lock (foreground), waiting basin and lower lock of the Kainji Navigation Canal with River Niger in the background (after Olagunju 1972)

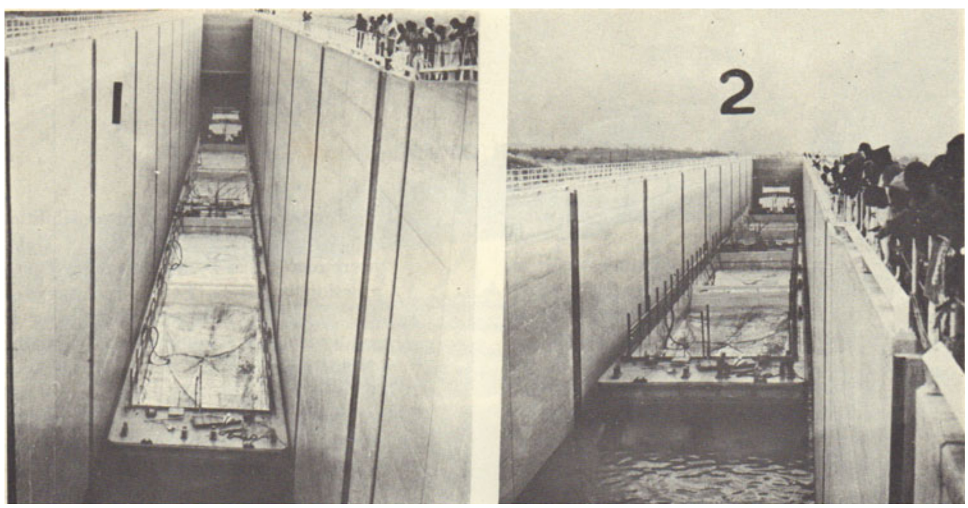

Fig. 11.5 (1) Barges and Tug-pusher in the lock, and (2) the lock filling up to enable passage to the higher level (after Olagunju 1972)

11.2.2 Lake Kainji

Lake Kainji, the impoundment behind the Kainji Dam, is located in the western extremity of central Nigeria (Ogunjo et al. 2022a, b). It extends over a distance of 136.8 km, well beyond Yelwa (10°50′0″ N 4°44′44″ E), covers an area of 1243 km^2 (Fig. 11.1) and has a maximum depth, and maximum width of 55 m and 24 km, respectively. The lake has a high-water perimeter of approximately 720 km and a shore development factor of 5.65. The latter is the ratio of the actual shoreline to the shoreline of a perfectly circular lake of the same area. High values indicate considerable shoreline extension produced by bays and other indentations of the lake margin and the significance of the lake's shallow littoral zone to the open deep-water zone. Most natural lakes approach the idealized circular form much more closely than Kainji and have shore development factor values around 2.0. Values for most African reservoirs are much higher than 2.0 (Henderson 1973). The indentations, particularly along the long, narrow northern and southern ends of Lake Kainji, account for its poor non-circularity (Fig. 11.6).

Table 11.1 Characteristics of the Kainji Dam

Description	Parameters
Type of dam	Concrete gravity and rock-fill
Total length of dam	8.64 km
Maximum height of dam	65.5 m
Maximum dam crest width	14.6 m
Maximum dam base width	91.4 m
Dam crest elevation	158.3 m a.s.l
Reservoir catchment area	Tributary catchments in Nigeria have an area of approximately 100,000 km^2
Reservoir length	136.8 km
Maximum water level	155 m a.s.l
Lowest water level	128.9 m
Maximum fluctuation in water depth	26 m
Maximum water depth	55 m
Freeboard	3.3 m
Maximum reservoir capacity	15,000 MCM
Dead storage	3500 MCM
Reservoir area	1243 km^2
Annual evaporation	2500 MCM
Spillway discharge	4 radial gates; 7900 m^3/s
Penstock	12; 8.53 m diameter
Installed HEP capacity	760 MW
Lock	2 locks (each 198 m long and 12 m wide), each capable of lifting four barges (each 40 m long and 9.1 m wide plus the pusher-tug)
Lock lift	41.2 m from river to reservoir

The lake's inflow hydrograph shows that discharges increase during the rainy season, from June onward, reaching a peak in October. This inflow, contributed virtually solely by upstream catchments in Nigeria, mainly rivers Sokoto, Dan Zaki, Malendo and Menai, is termed the 'White Flood' on account of the high kaolinitic sediment load it carries. The water is consequently highly turbid (Secchi disc transparency approximately 0.3 m) and greyish (Henderson 1973; Ogunjo et al. 2022a, b). The annual draw-down commences with the onset of the dry season in November, but a secondary water level peak is attained between December and February (the 'Black Flood'—because its waters are desilted and clearer). This flood is caused by rains of the same rainy season at the headwaters of the Niger in the Republics of Guinea and Sierra Leone, but arrives late in Nigeria due to flow retardation in River Niger's inland delta in the region southwest of Timbuktu, Republic of Mali. The water level falls from February to its lowest levels in June (Sagua 1979). The magnitude of the secondary flood only marginally affects the rapid recession from the White Flood peak discharges. The Black Flood may however soon become a historical phenomenon given the current and potential growth in the exploitation of water resources of the upstream River Niger. The developments include the Selingue dam (2350 MCM) in Mali and the Fomi dam (5300 MCM) in Guinea built to meet irrigation and hydropower needs. But a most critical one is the Kandadji Dam (1596 MCM), a large multipurpose dam on the River Niger near the small town of Kandadji, 180 km northwest and upstream of Niamey, Republic of Niger. A few hundred kilometres from Nigeria's border with the Republic of Niger, the project, formally known as the *Kandadji Programme for Ecosystem Regeneration and Niger River Development* is being constructed to guarantee Niamey's water supply, generate electricity and provide water for irrigation (Liersch et al. 2019; https://www.iied.org/niger-tough-questions-posed-kandadji-dam-development). Though designed to release a regulated discharge of 120 m^3/s, since this amount could be entirely accounted for by channel evaporation, seepage and downstream informal irrigation in the Republic

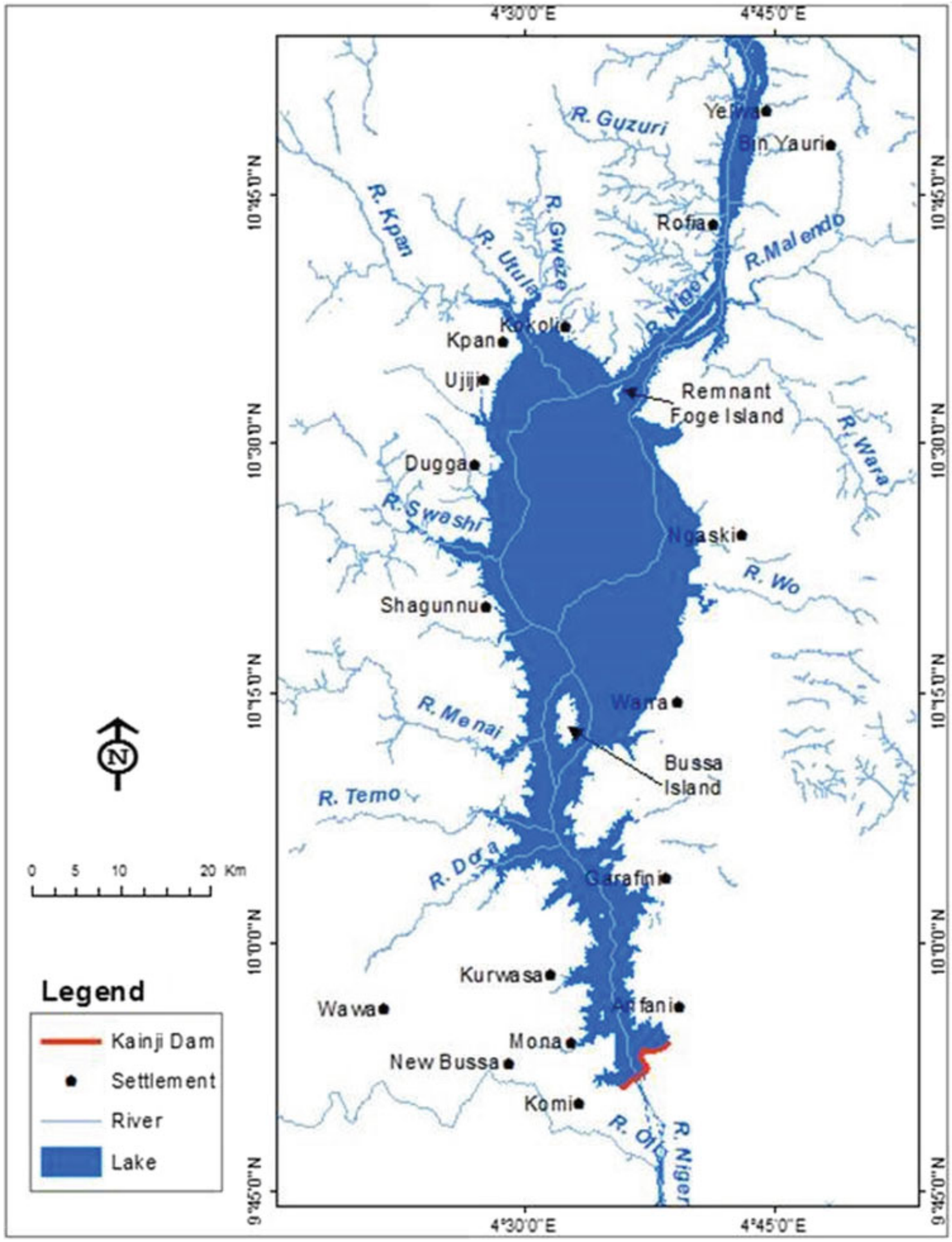

Fig. 11.6 Kainji Lake showing lake indentation, tributaries and islands

of Niger, the project's completion may result in upstream River Niger waters never again reaching Nigeria.

The inflow regime imbues a rhythmic fluctuation of the lake level during the year, which determines the extent of inundation of the islands within the lake, the draw-down and the area of the lake floor that is annually exposed, and subjected to wave erosion. Superimposed on this annual rhythm is that caused by variations in the outflow of turbinated water due to power generation needs, daily rhythms of evaporation and the seiches, common in the lake.

Seventy (70) percent of the impoundment zone was cleared of all vegetation. An essence was to reduce the effects of vegetation decay on water quality and weed growth. Another one was to promote fishing, a purpose for the creation of the lake, by removing obstructions to fish gear, particularly gill nets, which will be impossible to use except the lake bed was reasonably free of obstructions that could entangle the nets. Experience of the effects of clearing vegetation at the Kainji has led to the global recommendation that complete clearance should not be undertaken at any new impoundment but rather strip clearance to provide for fish shelter and feeding grounds (Olagunju 1972). A consequence of weed clearance was that most game in the impoundment zone voluntarily moved off the cleared zone. Another was that there was a minimum amount of rotting vegetation that could elevate biochemical oxygen demand leading to deoxygenation of the waters; hence, there was no aquatic weed problem as at Kariba Dam, Zambia, nor mass fish mortality as at Volta Dam, Ghana (Imevbore 1970).

11.2.3 Lake Islands

There are three groups of islands in Lake Kainji. One comprises the non-permanently inundated parts of the old Foge Island (04°33'E, 10°13,N), which created the bifurcation of River Niger in the area that now constitutes the main body of the lake. Another is the old Bussa Hill formerly located on the right bank of the river, just downstream of where the two branches around the Foge Island re-join. It is a partly submerged inselberg formed from Basement Complex rocks and now located at the beginning of the narrow southern extension of the lake (Fig. 11.6). The final group comprises isolated bodies of headlands along the coast that have been cut-off by wave erosion (Fig. 11.7). The Foge Island trended N-S and was about 35 km long with a maximum width of 16 km. It was a floodplain island composed of sand and silty alluvium deposited during the last 15,000 years (Halstead 1975). Currently, the western section of the old island is permanently submerged, but two much smaller masses remain in the northern and eastern parts (Fig. 11.6). More parts of the island emerge at low water levels. The current size of the island, therefore, varies depending on the water level of the lake, which varies between the rainy and dry seasons, and reflects the extent of draw-down through power generation and evaporation. The low-lying island topography ensures that erosion is minimal except at the shores where waves and the action of seiches create wave-cut platforms. The permanently exposed sections lie within Kebbi State, are dotted with numerous termite mounds and have a large population of resident and migratory species of birds. They are important breeding grounds for waterbirds, including the White-faced whistling duck (*Dendrocygna viduata*), Blue-cheeked Bee-eater (*Merops persicus*), Collared Pratincole (*Glareola pratincola*) and Spur-winged Lapwing (*Vanellus spinosus*). Other birds sighted in the area include the Glossy Ibis (*Plegadis falcinellus*), Spur-winged goose (*Plectropterus gambensis*), Pintain (*Anas acuta*) and African Darter (*Anhinga rufa*). Some people inhabit the remnant island and fish the pools and the lake, and also engage in traditional irrigation agriculture and harvesting of other wild resources, including the birds. The Foge Island forms part of a regional biodiversity hotspot due to its species richness and supports the element of biodiversity that is characteristic of such wetlands in the Guinea Savanna woodland of Nigeria. In 2008, it was declared a RAMSAR Wetland of International Importance by the International Union for the Conservation of Nature (IUCN; https://www.ramsar.org/news/nigerias-new-wetlands-of-international-importance). It is part of the Kainji National Park, though across the waters from the Borgu Sector (western sector) of the park. The Kainji National Park and the Nigerian Institute for Freshwater and Fisheries Research at New Bussa have criteria and stipulations for managing the ecology of the island. The island is now virtually treeless due to vegetation clearance before impoundment. The Kainji Lake has a diverse fish fauna comprising 82 known species belonging to 18 families (Ogunkoya and Dami 2008; https://www.ramsar.org/news/nigerias-new-wetlands-of-international-importance).

Fig. 11.7 The island that was part of a headland but is now cut off by wave erosion

Table 11.2 Rainfall in the Kainji lake area

Town	Location	Altitude (m)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Ilorin	8°29'N 4°35'E	307	10	18	64	102	170	193	142	132	251	165	28	13	1288
Mokwa	9°18'N 5°04'E	152	3	8	25	84	147	196	201	119	269	107	10	5	1174
Kainji Dam	10°10'N 4°38'E	144	0	0	8	53	132	137	163	228	190	59	0	0	970

11.3 Lake Kainji Area

11.3.1 Climate

The climate in the Kainji Lake area is the Köppen's $\mathbf{A_{w1}}$ (i.e. humid tropical wet and dry climate), with an almost equal length of the rainy season and dry season. The dry season extends from November to April, while the rainy season covers the remainder of the year (May–October). The mean total annual rainfall is approximately 1000 mm, with the peak of the rainy season between July and August (Table 11.2). Mean maximum and minimum temperatures during the rainy season are 35 °C and 24 °C, respectively, while those of the dry season are 38 °C (in late March and April) and 16 °C in December/January, respectively. The dry season is dominated by cool and dusty north-easterly Harmattan winds.

11.3.2 Geology and Geomorphology

The Precambrian Basement Complex and sedimentary rocks underlie or are exposed in specific zones of the area in the proximity of and beneath the lake. The northern, northeastern and southern parts of the area are underlain by argillaceous and arenaceous meta-sediments, granites, gneisses, muscovite schists and quartzites of the Basement Complex. The Upper Cretaceous Nupe Formation, comprising conglomerates, grits and sandstones, occurs continuously along the northern half of the western coast of the main body of the lake, and also southeastwards of the lake. It is of both marine and continental origin and is the main source of sediment delivered into the lake. The Late Quaternary Alluvium believed to be derived mainly from the Nupe Formation occurs along the central-eastern coast, and as the bed of the lake (Fig. 11.8). It comprises mainly sand, but is in parts of the draw-down zone characterized by depressions and covered by mud (Adegoke and Kogbe 1975; Halstead 1975).

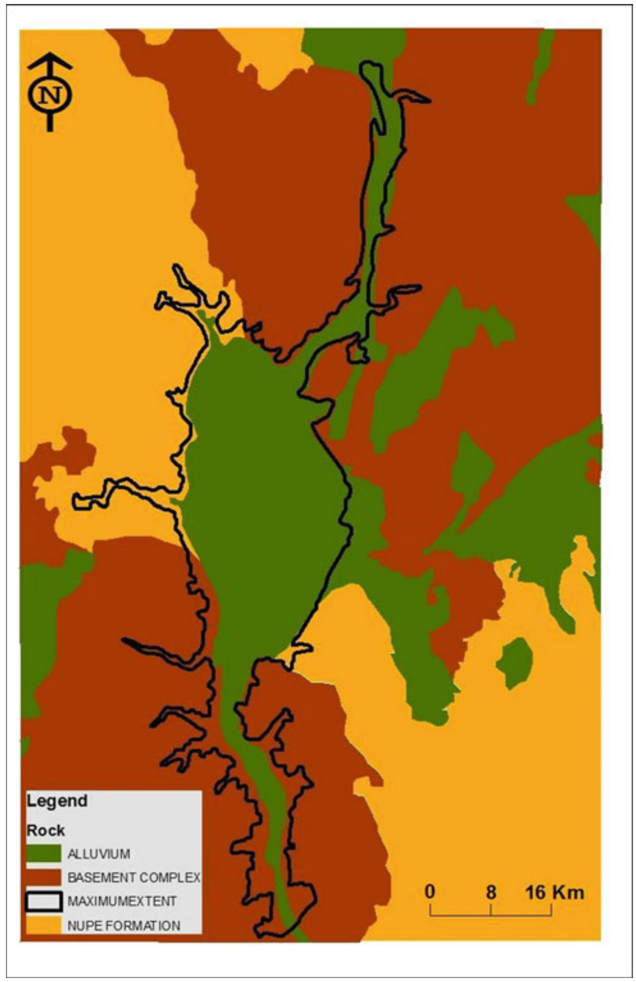

Fig. 11.8 Geology of the Lake Kainji area (after Halstead 1975)

The area has low relief topography, with elevations ranging between 150 and 400 m a.s.l. In general, the underlying geology of the area determines the surface topography. For example, the N-S trend of the valley of the Niger between Yelwa and Jebba, and more so, the gorge-like nature of the area occupied by the southern narrow and deep extension of the lake, since it is confined by a hard rock on both banks, suggest that the valley follows and occupies a line of faults (cf. NEDECO 1961). This zone was marked by rapids and cataracts, but these features have been blasted off and the area is now submerged. The zone extends beyond the Kainji Dam to Jebba, an area now also inundated and occupied by the Jebba Lake created by the dam at Jebba. Further, areas with low and medium relief are generally restricted to zones underlain by alluvium and argillaceous meta-sediments. Bays and inlets have been formed in these zones, indicating drowned former tributaries of the River Niger (Fig. 11.6). Areas with high relief are on the other hand restricted to zones where the Basement Complex and the Nupe Formation are exposed. In the latter case, the landforms are mainly low-lying buttes (small, flat-topped hills, capped by resistant rock platform), rocky coasts, promontories and headlands.

The Basement Complex of the Kainji Lake area is part of the northernmost outliers of a large hilly range, the Yoruba Hills and Ranges and their extension, the Kukuruku Hills, that trend NW–SE extending from Nigeria's border with the Republic of Benin to the main trunk of the River Niger. The rocks are associated with denudation landforms, mainly inselbergs (isolated rocky hills rising sharply above the general surrounding level). The inselbergs in the Kainji area, however, have smaller dimensions compared to those in the southern parts of the Hills and Ranges. Bedrock outcrops occurring in the Kainji area include corestones, tors and ruwares (Figs. 11.9, 11.10 and 11.11). Ruwares are low-lying, gently sloping rock pavements with smooth convex surfaces, which barely rise above the general ground surface. They are believed (e.g. Thomas 1965; 1974; 1994) to be inselbergs in the early stage of development through exhumation. Tors are piles of exposed, rounded boulders perched atop a solid rock platform, and rising abruptly from the surrounding ground surface. Corestones are piles of rounded or sub-rounded rock boulders lying on a buried underlying rock platform. They and tors are formed from well-jointed rock masses. It is believed (e.g. Thomas 1989; 1994) that these landforms have developed through the process of etch-planation, i.e. deep weathering, multicyclic erosion and exhumation. The areas underlain by Quaternary Alluvium are gently undulating, comprising low slopes, irregular small depressions and numerous termite mounds. The depressions are now filled with mud, which on exposure after draw-down are scarred by desiccation cracks.

The indentations along the narrow southern extension of the Kainji lake (Fig. 11.6) mark the now-drowned valleys of small tributaries of the River Niger (e.g. rivers Sadoro, Doro, Timo and Menai) that drained the area. Halstead (1975) noted that the indentations are zones where argillaceous meta-sediments occur, while the headlands and promontories are formed by gneisses and arenaceous meta-sediments.

Considerable beach erosion is caused by waves and seiches created by the predominant South Westerlies and North Easterlies sweeping across the surface of Lake Kainji in the rainy season and dry season, respectively. With a fetch greater than 24 km, waves break on the shore with some force (Fig. 11.12), creating striking erosional features. Henderson (1973) reported that waves of 50–75 cm in height are common and waves up to 1 m occur during storms. The waves have stripped off the vegetation cover and soils of the draw-down zone and in the area underlain by the Nupe Formation, exposing clean, un-weathered grits and sands (Fig. 11.13). Active undercutting of headland and cliffs by waves at various water levels during the filling up of the lake in the rainy season and its draw-down in the dry season has also created wave-cut platforms featuring terraces. These are common in the areas where the Nupe Formation is exposed along the shoreline or forms a headland

Fig. 11.9 Corestones near New Bussa

Fig. 11.10 Ruware near Bussa

Fig. 11.11 Low stature inselberg of the type common in the Kainji area

(Fig. 11.14). Terracing on headlands (Fig. 11.15) represents beaches formed during the retreat of the strand. The terraces are in many areas covered by gravel, evidence of the stripping off of the sand and smaller soil fractions (Fig. 11.16). The wave-cut platforms are submerged during high water but exposed during draw-down. The platform may be bare (Fig. 11.13) or covered by gravel or sand (Fig. 11.16). The cliffs backing the wave-cut platforms are also subject to wave attacks at high water. The base of the cliffs is the main focus of wave action involving notching by abrasion, hydraulic action and compression, leading to the creation of littoral caves (Fig. 11.17), the collapse of the cliff face,

Fig. 11.12 Waves breaking on the shore in the dry season near Shagunu

Fig. 11.13 Nupe Formation exposed in draw-down zone swept bare by waves

removal of debris by backwash and the landward extension of the wave-cut platform. Notches are enlarged into littoral caves through compression when waves crash into air pockets in notches causing cracks to spread and pieces of rock to break off (Short 1982). The seiches have, through the oscillations in water level they induce, seriously affected human safety (Abayomi 1979).

11.3.3 Resettlement of Displaced People

44,000 people from both the present-day Niger State (Borgu and Kontagora Emirates) and Kebbi State (Yauri Emirate) were displaced from the dam, navigation canal and impoundment areas. They were resettled in new housing estates built well above the maximum water level, where there was enough farmland, the possibility of obtaining a good water supply, and within the Native Authority from which they were displaced. 139 new villages and two towns (Yelwa and New Bussa; Fig. 11.1), all comprising 4320 houses, were constructed and given to re-settlers. The resettlement communities and the constituent houses and facilities (schools, markets, health centres and hospitals, mosques and churches) were designed by the renowned tropical architecture experts, 'Fry, Drew and Atkinson'.

11.4 Lake Kainji National Park

The Kainji National Park, located between latitudes 9°40'N and 10°30'N, and longitudes 3°30'E and 5°50'E, spread across two states: Niger State and Kebbi State. The Park was

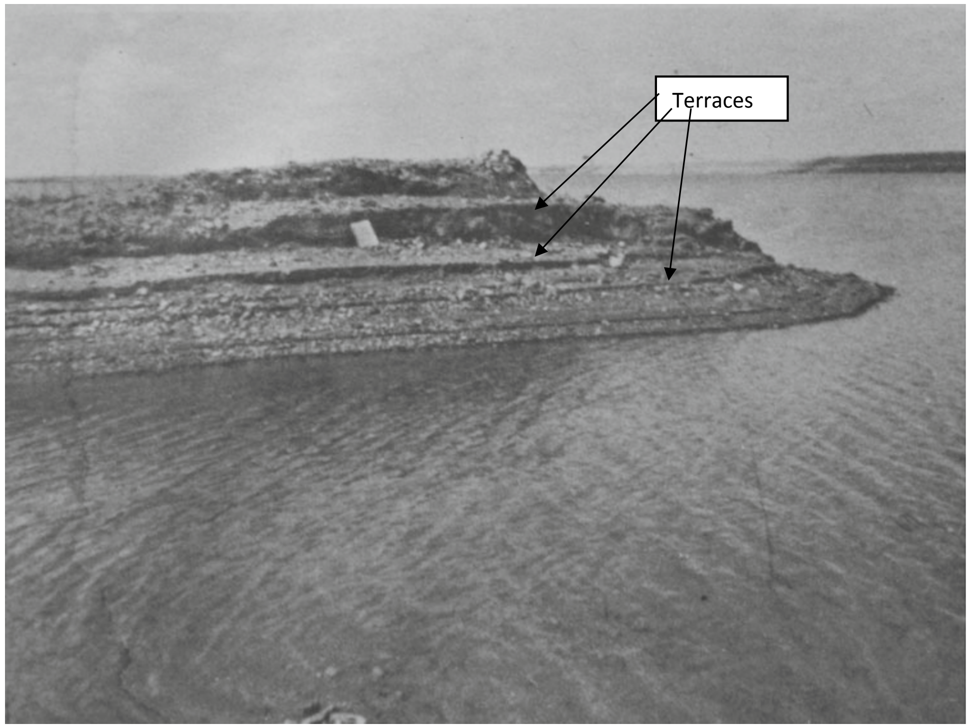

Fig. 11.14 Terracing on a Nupe Formation headland along the banks of the Lake Kainji (after Halstead 1975)

Fig. 11.15 Terrace covered by gravel in Nupe Formation area

formally established in 1979 by the amalgamation of two existing game reserves, Borgu Games Reserve in the Niger State and Zugurma Games Reserve in the Kebbi State. It has a combined area of 5341 km^2, made of three distinct sectors: Foge Island Sector; Borgu Sector (3970 km^2) to the west of the Kainji Lake and the Zugurma Sector (1371 km^2) to the southeast of the lake (Fig. 11.1). The Borgu sector is studded with various types of inselbergs. The sector extends to less than 10 km from the border with the Republic of Benin to the west and is drained mainly by the River Oli, which supports hippopotamus populations. The Zugurma sector is poorly drained, and the topography is more subdued. The park belongs to the IUCN Management Category II (National Park) and the Biogeographical Province 3.04.04 (West African Woodland/savanna) (https://www.unep-wcmc.org/sites/pa/0302p.htm Kainji Lake National Park). The park is in the Northern Guinea Savanna, but the humidity of the environment and the soil water regime create the ambience of the Southern Guinea Savanna (https://nigeriaparkservice.org/?p=148). The flora is typically Guinea Savanna woodland and shrub (*Burkea africana*, *Terminalia avicennioides*, *Afzelia* sp., *Acacia* sp., *Isoberlinia* sp., *Hyparrhenia* sp., *Andropogon*

Fig. 11.16 Sandy terraces near Shagunu

Fig. 11.17 Wave cut platform backed by cliff having littoral caves at its base

sp., *Parkia clappertoniana*, *Butyrospermum paradoxum*, *Uapaca togoensis* and *Khaya senegalensis*).

Sixty-five (65) mammal, 350 bird and 30 amphibia and reptile species, all of which are typical of the Guinea Savanna woodland, are recorded in the park. The mammals include lion *Panthera leo* (VU),[2] leopard *P. pardus* (CR), caracal *Felis caracal* (LC), elephant *Loxodonta africana* (VU), buffalo *Syncerus caffer* (LC), hartebeest *Alcelaphus buselaphus* (NT), kob *Kobus kob* (LC), roan antelope *Hippotragus equinus* (LC), red-flanked duiker *Cephalophus rufilatus* (LC), common duiker *Sylvicapra grimmia* (LC), Bohor reedbuck *Redunca redunca* (LC), waterbuck *Kobus ellipsiprymnus* (LC), oribi *Ourebia ourebi* (LC), bushbuck *Tragelaphus scriptus* (LC), warthog *Phacochoerus aethiopicus* (LC), giant pangolin *Smutsia gigantea* (VU), hippopotamus *Hippopotamus amphibious* (VU), wildcat *Felis silvestris* (LC), African Wild dog *Lycaon pictus* (EN), honey badger *Mellivora capensis* (LC), clawless otter *Aonyx capensis* (NT), olive baboon *Papio anubis* (LC), green monkey *Chlorocebus sabaeus* (LC), patas monkey *Erythrocebus patas* (LC), Senegal bush baby *Galago senegalensis* (LC), aardvark *Orycteropus afer* (LC), manatee

[2] These are abbreviations used in the IUCN Red List Categories and Criteria as components of an objective framework for the classification of the broadest range of species according to their extinction risk:CR (Critically Endangered)—species that are facing an extremely high risk of extinction in the wild.EN (Endangered)—species that are facing a very high risk of extinction in the wild.NT (Near threatened)—species that do not qualify for Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) now, but are close to qualifying for or are likely to qualify for a threatened category in the near future.VU (Vulnerable)—species that are facing a high risk of extinction in the wild.LC (Least concern)—species that are widespread and abundant.

Trichechus senegalensis (VU) and Cheetah *Acinonyx jubatus* (VU). Reptiles include Nile crocodile *Crocodylus niloticus* (LC), slender snouted crocodile *Mecistops cataphractus* (CR), rock python *Python sebae*, royal python *P. regius* (LC), spitting cobra *Naja nigricollis* (LC), black cobra *N. melanoleuca*, puff adder *Bitis arietans*, gaboon viper *B. gabonica*, monitor lizard *Varanus niloticus* and *V. exanthematicus*, and terrapin *Pelomedusa subrufa* and *Pelusiosa dansoni*. Wildlife numbers are much lower in the Zugurma sector due to poor drainage, deteriorating vegetation, heavy poaching and extensive cattle grazing. Ostrich (*Struthio camelus* (LC)) has been domesticated in the area.

11.5 Conclusion

The Kainji Dam, Kainji Lake and Kainji National Park may indeed have become a national heritage of tremendous benefit to the nation as a whole and the Kainji area in particular, but the heritage is facing significant threats. First, the national quest for food security that has been associated with formal and informal irrigation schemes appears to be impacting inflows into the lake. The impending climate change may reinforce inflow reduction, threatening the capacity of the lake to support an already reduced hydroelectric power generation scope. Climate change may also impact the vegetation of the National Park, and therefore its fauna, and further reinforce the significant threat from poachers. Serious consideration should therefore be given to factors that could promote the sustainability of the National Heritage.

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