FLOOD AND EROSION HAZARDS IN THE KAZIRANGA NATIONAL PARK OF ASSAM, INDIA

Desastres Associados A Cheias E Erosões No Parque Nacional Kaziranga Em Assam, Índia.

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ABSTRACT: *The Kaziranga National Park of Assam, India is the world famous habitat of the great Indian one-horned rhinoceros and other rare and endangered wildlife species. The river channels, swamps, wetlands and various types of vegetation in the park altogether form a unique ecological and habitat base for a wide variety of fauna and flora. The park representing distinct physiography is an integral part of the floodplain of the Brahmaputra river. But in recent years, especially after the great earthquake of 1950, the park has been experiencing devastating floods causing havocs and untold damages to its animals, vegetations and infrastructures. Besides, the alluvial channel of the Brahmaputra marked by intense braiding has caused severe erosion along the northern boundary of the park. The alarmingly increasing flood and erosion problems have thus posed serious threats to the precious bio-resources and physical existence of the park. This paper attempts to evolve a scheme of flood and erosion control measures needed for environmentally sound planning and development of the park.*

Keywords: Habitat base, devastating floods, intense braiding, bioresources, environmentally sound planning.

RESUMO: *O Parque Nacional de Kaziranga em Assam, Índia é um habitat mundialmente famoso do grande rinoceronte de um chifre e de outras raras e perigosas espécies selvagens. Os canais fluviais, pântanos, áreas úmidas e vários outros tipos de vegetação do parque conformam um nicho ecológico único e um habitat base para um grande variedade de fauna e flora. O parque apresenta distintos aspectos fisiográficos integrando parte da planície de inundação do rio Brahmaputra. Em anos recentes, especialmente após o grande terremoto de 1950, o parque tem experimentado cheias devastadoras que assolam e causam danos incontáveis a seus animais, flora e infraestrutura. Além disto, o canal aluvial do Brahmaputra marcado por intensa movimentação lateral e divagação tem causado forte erosão na porção limítrofe norte do parque. O aumento alarmante das inundações e das erosões tem causado uma intensa pressão sobre os preciosos recursos biológicos e físicos existentes no parque. Este trabalho apresenta um esquema das medidas de controle das cheias e erosões necessárias para um planejamento ambiental e desenvolvimento sustentável do parque.*

Palavras-chave: habitat, inundações devastadoras, canais divagantes, recursos biológicos, planejamento ambiental

Introduction

The floodplain of the mighty river Brahmaputra stretching for a length of 720km within the state of Assam (India) is an ecologically important physiographic zone of the Brahmaputra valley. The zone characterized by new and fresh alluvial formations and variety of land features is a part of one of the noted hotspots of global biodiversity.

Being situated amidst the riverine environment of the Brahmaputra valley, the Kaziranga National Park (KNP) has also assumed the importance as an integral part of the noted biodiversity hotspot. In the way the Brahmaputra valley is adorned with interesting physiographic mosaics of varying geo-ecological landscapes, the KNP also inherits similar geo-ecological make-up. The river channels, swamps, wetlands, grasslands and various types of vegetations in the park altogether form the most ideal habitat for a great variety of fauna and flora. The worldwide fame of the park as an important wildlife reserve rests on its unique ecological and habitat base for the world famous one-horned rhinoceros and a great number of rare and endangered birds, animals and plant species. But in recent years, this world famous park has been experiencing serious threats of floods and erosion caused by the Brahmaputra along its northern boundary. The problem of flood in the Brahmaputra valley has caused severe hazards to the people. The flood situation in the valley during rainy season takes menacing turn causing devastating damages to human life, property, standing crops and cattles. Moreover, the Brahmaputra floods also cause serious damage to the animal habitats and reserved forests and sanctuaries located in and around the riverine tract of the river. The flood water from the Brahmaputra flows into the low lying areas or depressed pockets and stays there for a long time thereby turning them into waterlogged areas. In view of their devastating nature, the Brahmaputra floods can be recognized as the conspicuous geomorphic hazard causing landscape modification, environmental degradation and habitat damage to the sanctuaries and parks located in the floodplain.

Along with floods riverbank erosion has also assumed serious dimension in the Brahmaputra valley. The bank erosion of the river Brahmaputra has been vitally responsible for the loss of large tracts of land on both the banks. As regards bank erosion and channel migration, the river is found extremely unstable at some vulnerable locations including the reach along the northern boundary of the KNP. Thus, the world famous park falls prey to severe flooding and erosion problems of the mighty Brahmaputra, thereby posing serious threats to its existence. The ever-dwindling animal habitat of the park has been a major concern in view of its eco-degradation and habitat loss caused due to flood and erosion hazards. It is in this context, the present study is aimed at examining the flood and erosion hazards in the KNP of Assam.

Study Area

The Kaziranga National Park is situated in the state of Assam (India) between latitudes 26°30'N and 26°45'N and longitudes 93°05'E to 93°40'E (Figure 1). It is roughly oval shaped with a length and width of about 40 km and 13 km

respectively. The park is bounded by the mighty river Brahmaputra in the north and the foothills of Karbi Anglong district in the south. In the east the park extends from Bokakhat to Burapahar in the west. The original notified area of the park was 430 sq.km, but it has been undergoing frequent land dynamics due to recurring floods and bank erosion along its northern boundary and consequent accretion of new land masses.

Lying along the river Brahmaputra the park is an integral part of the Brahmaputra floodplain and it falls partly under Golaghat District and partly under Nagaon District of Assam. The soils of new alluvial and old alluvial types are formed by the alluvial deposition of the Brahmaputra river. The area enjoys sub-tropical monsoon climate characterized by heavy rainfall during summer. The park contains variety of topographic features like wetlands, swamps, channel cut-offs, abandoned channels etc.

Methodology and Database

The study is based on both primary and secondary data and information. The base map and the maps landmass dynamics are prepared from the concerned topographical sheets, aerial photographs and satellite imagery. In the case of space data T.M. data of Landsat - 5 are used. Intensive field-works during pre-flood and post-flood seasons have been carried out to collect relevant data relating to flood and erosion hazards in the park. The necessary secondary data and information have been collected from the Directorate of KNP, Bokakhat, Flood Control Department, Govt. of Assam, Central Water Commission, Govt. of India, Brahmaputra Board, Govt. of India, and Assam Remote Sensing Application Centre (ARSAC), Govt. of Assam.

Discussion and Analysis

The Kaziranga National Park representing distinct physiography is an integral part of the Brahmaputra floodplain. The landmass of the park is generally a flat terrain with a gentle slope from east to west. The area remains swampy and waterlogged for a major period of the year. A large number of small and large water bodies locally called *beels* which account for about 6.7 per cent of the park area are found spreading all over the area (Baruah and Goswami, 1996). The park is also cross-crossed by river channels of which the notable ones are the Mora Dipholu and Jia Dipholu .The Mora Dipholu flows along the southern boundary while the Jia Dipholu flows east-west across the park. Besides, there are other important perennial streams like Diring, Kohora, Dehing, Bhalukjuri and Deopani originating from the southern Karbi Plateau. Vegetation of the park consists of extensive alluvial grasslands with tall and short grasses interspersed by tropical moist deciduous to semi evergreen forests. The river channels, wetlands (*beels*) and various types of vegetations altogether form the most important habitat for birds and wild animals. Because of the unique ecological and habitat base for a variety of fauna and flora, the park had assumed the status of an important wildlife reserve not only in India but also in whole of Asia.

But in recent years, this famous park has been experiencing serious threats of flood and erosion caused by the Brahmaputra river flowing along its northern boundary. The floods of the Brahmaputra can be attributed to a host of interrelated natural and anthropogenic factors. Natural factors include heavy monsoonal rains and devastating landslides coupled with easy erodibility of rocks of the northern mountains, steeps slopes and high seismicity, while the anthropogenic factors include large scale deforestation in the hilly

catchment, practice of shifting cultivation, human interventions in the river system including encroachment into the floodplains, destruction of natural wetlands and poorly managed embankment system (Bhattacharya and Bora, 1997). The earthquake of 1897 disturbing the topography of the lower Brahmaputra valley and that of 1950 disturbing especially the topography of the upper Brahmaputra valley caused extensive landslides, subsidence and fissuring of the ground in the valley. The floods of the Brahmaputra made a quantum leap, especially after the great 1950 earthquake when the bed of the Brahmaputra near Dibrugarh was significantly raised causing an abnormal rise of water level up to 3 meters. Such a phenomenon was also highly responsible for severe floods occurring in the Kaziranga National Park. In recent years, flood has become a common feature in the park that occurs at different orders of 3-4 waves in a year. As there are no flood control measures adopted so far the park is now subject to extensive inundation causing havoc and untold damage to the animals, vegetations and the infrastructure of the park (Bora and Chetia Dey, 1999). During floods some animals like elephants, rhinos and buffalos migrate to the southern Karbi Hills by crossing the N.H. 37 for shelter while the animals, especially the deer species are the worst sufferers. The latest flood of the river Brahmaputra in 1998 has inundated more than 90 percent of the park area thereby causing tremendous devastation by its 3 waves during the month of June, August and September. The animal mortality during the flood goes up to 629, number of rhinos being 39 and the worst affected hog deers being 506 (Table 1). Besides, the roads, bridges, camps and other infrastructures of the park got extensively damaged requiring crores of rupees for repairing and maintenance.

Table 1 - Animal Mortality during 1998 flood in the Kaziranga National Park

Sl. No.	Animal	Death due to Drowning	Death due to knock down by vehicle on N.H.	Total	Animals rescued during flood
1.	Rhino	39	-	39	1 (Calf)
2.	Elephant	5	1	6	1
3.	Buffalo	20	-	20	-
4.	Hog deer	478	28	506	41
5.	Swamp deer	8	-	8	2
6.	Sambar	10	-	10	-
7.	Wild Boar	14	3	17	2
8.	Hog Badger	5	2	7	-
9.	Bear	1	-	1	-
10.	Porcupine	9	-	9	-
11.	Fishing Cat	-	1	1	-
12.	Cobra	-	2	2	-
13.	Python	-	1	1	-
14.	Civet	0	2	2	-
	Total	**589**	**40**	**629**	**47**

Source: Bora and Chetia Day (1999) and field study carried out by the author.

During monsoon season when the Brahmaputra flows above the flood level, the run off originating in the southern Karbi Anglong hills immediately gets drained out into the Brahmaputra river thereby causing no floods in the park. But, when the river flows above the flood level during monsoon, the excess water flows back into the park through the active and abandoned channels running across it. As revealed from the field works the flood waters initially enter the park from the western side through two inlets — (i) the outfall of the Dipholu river and (ii) the outfall of the Mora Dipholu river (Figure 2). Being the low lying area, the southern part then gets flooded as a result of overtopping of the banks of the Mora Dipholu river. This leads to submergence of the area covering the Baguri block of the park. Since the banks of the Dipholu river are comparatively higher, overtopping of the banks occurs only during high stage of the Brahmaputra. Thus, the relatively high central part of the park gets submerged when flood height attains its maximum. On the other hand, the northern part of the park receives the fury of floods due to overflowing of the river Brahmaputra itself.

The effects of recurring floods on wild animals and their habitats are of prime concern of the matter of conservation and management of the park ecology (IIRS, 1997). In general, with the onset of monsoon the animals start moving towards higher grounds for shelter as the low lying areas start reeling under water. When the entire area gets submerged under flood water the animals especially of the low-lying southern part migrate towards Karbi Anglong hills while the animals of the central and northern parts seek shelter in the forest highlands of the park. As the grasslands are submerged and forest highlands are devoid of any grass growth, the grazing animals like deer species severely suffer from shortage of fodder. The rhinoceros and wild buffalos can, however, eat the submerged grasses. Due to prolonged submergence under water the grasses die or rot resulting in severe shortage of food and thereby the general health of the animals. Besides, a large number of animals are washed away by the turbulent currents of flood water. Killing of animals during flood thus become a common incidence as the shelter — seeking animals easily fall prey to fast moving traffic on the National Highway, the poachers as well as the surrounding inhabitants.

As regards to erosion havocs, the park is also facing serious threats to its existence in recent years. Along its northern side the park is under constant forces of erosion from the river Brahmaputra. The Brahmaputra being the second largest river of the world in terms of the amount of sediment transported per unit of drainage area and the fourth largest river of the world in terms of average water discharge is a unique river (Goswami, 1985). With such gigantic water and sediment discharge magnitude the river represents a most dynamic fluvial regime. Its large alluvial channel having a width of 6 to 10 km is thus marked by intense braiding, rapid bed aggradation and sedimentation, drastic bankline changes and severe bank erosion. Heavy bank erosion actually takes place during the falling stage of flood level, where relatively less erosion occurs during the rising of flood level and low flow period. During floods, because of geomorphological changes in river configuration, the channel starts shifting at some vulnerable sites thereby inducing bank erosion (Bora, 2001). Moreover, the impinging flood waters raise the pore pressure of the bank wall, which results in a reverse flow of sand and silt into the river during falling stages leading eventually to a subaqueous bank failure. Under these situation, the left bank of the Brahmaputra bordering the northern boundary of the KNP experiences severe bank erosion during floods. As revealed through multidated satellite data the park area is significantly shrinking at alarming rates. In 1967 the area of the

park stood at 428.7 sq.km. But in 1990 the area was reduced to 400.2 sq.km and, similarly in 1997 the park area was found to be 407.9 sq.km resulting in total loss of area in the order of 20.8 sq.km during 1967-97 accounting for a shrinking rate of 0.7 sq.km per year (Table 2).

Table 2 -: Area shrinking due to erosion in the Kaziranga National Park, Assam

Year	Park area (sq.km.)	Rate of park area shrinkage (sq.km/year)	Wetland area (sq.km.)	P.C. of wetland area to park area
1967	428.7	1.24	36.6	8.5
1990	400.2		23.5	5.9
1997	407.9		27.4	6.4
1967-97	-	0.70	-	-

N.B. Increase of park area during 1990-97 is due to inclusion of new area.

Source: Baruah and Goswami (1996) and (2) Bora and Chetia Day (1999)

In general, the Brahmaputra river has a tendency of shift southward by eroding the left bank which makes the northern boundary of the park. It has been observed that the bank materials of the reach of the Brahmaputra along the park consist of silty loam up to depth of 11.3m except for some sediments at a depth of 2.1m where it is sandy. The D50 size varies from 0.027mm at the top to 0.17 mm at the depth of 2.1m and to 0.013 mm at a depth of 11.3m. The bank materials are thus poorly graded thereby easily susceptible to erosion even at low velocities. Moreover, the entire reach of the Brahmaputra channel along the park is quite unstable barring two relatively stable segments. These two segments include the banklines near Debeswari Chapori and Bhaori Chapari. However, the most severe bank erosion takes place along the eastern boundary little downstream of Dhansiri confluence and on the reach near Arimora.

The channel configuration of the Brahmaputra has a significant bearing on its bank erosion (Goswami, 1985). Earlier by the end of 19th century, Dhansiri, a south-bank tributary used to flow parallel to the Brahmaputra for about 24 km in its tail reach before meeting the Brahmaputra. But, the river Brahmaputra has now claimed the tail reach of Dhansiri and one spill channel of the Brahmaputra is seen flowing along the old course of Dhansiri (Figure 2). This channel is presently responsible for bank erosion on the eastern boundary of the park. The other spill channel of the Brahmaputra separating Debeswari Chapori from the mainland of the park has an outlet to Bhengrai Jan (stream) that in turn joins the Dipholu river. During monsoon this spill channel becomes more active and threatens to erode away a large tract of the park. Similarly, the spill channel of the Brahmaputra joining Dipholu near Dipholumukh is also posing a constant threat to the stability of Bhaori Chapori that is a part of the park.

In view of growing dimensionality of the flood and erosional problems and non-execution of any measures so far to check these problems, the following suggestions have been made for proper management of the ever-expanding problems:

(a) A proper scheme of flood fighting measures including pre-flood, during-flood and post-flood measures needs to be launched.

(b) Some more artificial elevated platforms should be created at appropriate locations for providing shelter to animals during floods.
(c) To thwart of any possible attack of the Brahmaputra river through the spill channels, silt inducing structures need to be constructed at suitable locations.
(d) The porcupines should be laid on the bank projecting into the river in three or four rows and tied together to form a permeable spur for arresting bank erosion.
(e) Other structural measures like cribs permeable spur, RCC porcupine prism should be created at the erosion-prone sites so as to induce siltation and divert the thalweg.
(f) Proper river training works need to be undertaken upstream of the park in order to check erosion and habitat loss.
(g) Above all, an interdisciplinary approach towards control of flood and erosion hazards in the park should be urgently made for environmentally sound planning and management of the park.

Conclusion

Being endowed with favourable terrain characteristics and ecological conditions the Kaziranga National Park continues to be the suitable habitat for a wide spectrum of flora and fauna. As an integral part of the riverine environment of the Brahmaputra valley of Assam the park supports a rich variety of plants and animals in general, and the world famous one-horned rhinoceros and other rare and endangered wildlife species in particular. Along with the increasing fury of floods in the Brahmaputra especially after the earthquake of 1950, the park has also fallen prey to the problems of floods and erosion which have been causing their proportional damages to the park environment. The park area is significantly shrinking at an alarming rate in the order of 0.70 km^2 /year during 1967-97. Besides infrastructural damages, the increasing flood and erosion hazards have posed a threat to the existing rich biodiversity of the park. It really needs urgent concerns and proper scientific study to make realistic assessment of the ever expanding flood and erosion problems and to evolve a scheme of flood and erosion control measures needed for environmentally sound planning and development of the park. Moreover, this study provides necessary scientific data and baseline information towards preparing a master plan to resolve the vital issue pertaining to conservation of biodiversity and restoration of dwindling ecology of the park.

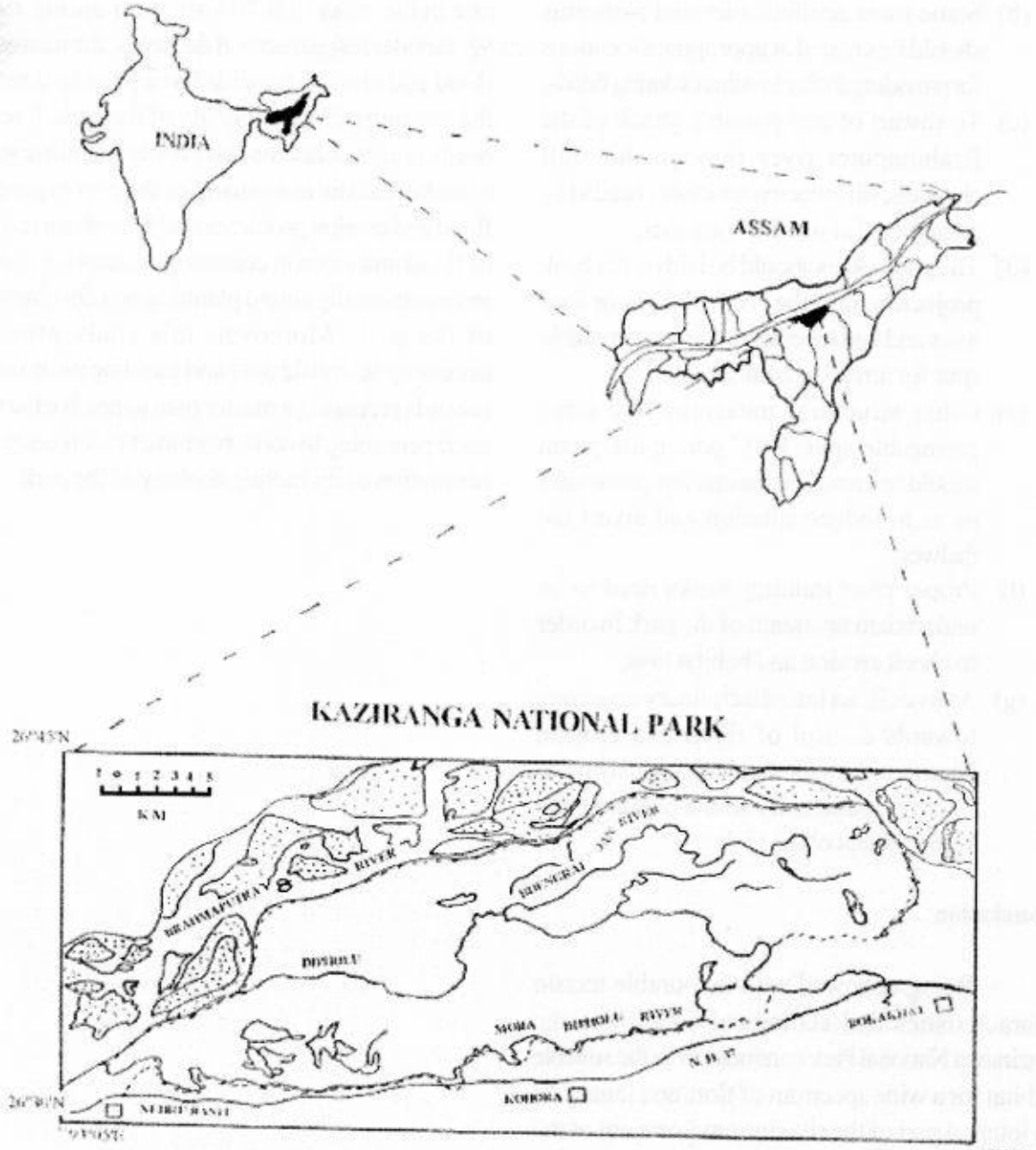

FIGURE 1: LOCATION OF STUDY AREA

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