



Impact of Crocodile Conservation on Livelihoods in North, Madhya Pradesh, India

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Abstract— Human impacts on the conservation of biological diversity are a matter of concern. Many rivers and water bodies in India have come under tremendous human pressure in the recent years due to several factors. A study was carried out in North, M.P. from 2015-2016 and 2016-17 to collect data on crocodile population at the study site, socio-economic status of the adjoining villages and human-crocodile conflict. Data has been collected to assess the impact of Crocodile conservation on rural livelihoods, determine the status and distribution of muggers in M.P., to understand local people's attitudes towards mugger and their conservation. Methods have been suggested to promote public awareness and education for the conservation of muggers.

Keywords— Crocodile, Wetlands, Conservation, Livelihoods, Socio economic etc.

I. INTRODUCTION

Human impacts on the conservation of biological diversity are a matter of concern. Many rivers and water bodies in India have come under tremendous human pressure in the recent years due to several factors. The most important factors are over exploitation of available water, diversion of water due to multi-purpose projects, pollution etc. [1] reported the impact of human activities on wildlife in the National Chambal Sanctuary. Population reduction of various important aquatic animals from natural habitat may be the result of over exploitation of natural resources. Many of the local people depend on the rivers for their basic needs including frequent visits to the river for various purposes. Major ecological studies on *Crocodylus palustris*, crocodiles and freshwater turtles have been conducted in the Chambal River from 1983 onwards [2-8]. Crocodile (*Crocodylus palustris*) is considered as a threat to man because the wild populations are increasing in North M.P. and cases of mugger attacking human and their livestock are reported regularly. Human and Crocodiles conflicts are also highlighted by the media [9]. Only six of the 23 crocodylian species are considered dangerous to human and our livestock. Crocodiles use the Riverine ecosystem for their life propagation and also use the sand bank and marshlands for basking, egg laying and hiding place. In North, Madhya Pradesh two species of Crocodiles *Gavialis gangeticus* (Gharial) and *Crocodylus palustris* (mugger) are present.

Many workers studied the biology of Mugger crocodile in the recent past [10-13] and [14] studied the Mugger crocodiles of India extensively. Mugger was considered as a rare species in many earlier works like [15]. The status of Indian crocodiles was described by [14]. Human-crocodile conflicts have been reported from different parts of the country [16-18] [9] [19]. [20] Studied on Status, distribution and conservation of Mugger crocodiles in Charotar region, Gujarat, India. Anthropogenic pressure was reported in Chambal River [21-22].

II. MATERIAL AND METHODS

Study area

The present study was conducted Impact of Crocodile Conservation on Livelihoods in North Madhya Pradesh, The district lies between the latitude of 25°18'53"N- 26°39'42"N and longitude 77°46'10"E- 78°54'19"E in the Plateau of Central India and it is an area of about 34,235sq. km and is surrounded by six districts namely, Gwalior, Morena, Bhind, Datia, Shivpuri and Sheopur. Northern Madhya Pradesh is having various small and large water bodies. Some important water bodies selected for study on the basis of presence of mugger are, Chambal river, Tighra Reservoir, Tekanpur Lake, Atal Sagar Dam, Shakaya Sagar Lake and Madhav Sagar Lake. These water bodies are the life line of this region. They serve as source of irrigation, drinking water and also habitats for a diversity of aquatic species. The field surveys were carried out during 2015-16 and 2016-17. For the collection of primary data regular site visits were made.

A. National Chambal Sanctuary

The National Chambal Sanctuary was established in 1979. Geographically, the National Chambal Sanctuary lies between latitude 25°51'N - 26°32'N and longitude 76°34'E - 79°5'E. Chambal Sanctuary is a division of one large region jointly managed by the governments of Madhya Pradesh, Rajasthan and Uttar Pradesh. The National Chambal Sanctuary is at the borders of three districts, Sheopur, Morena and Bhind (Chambal Division) in the state of Madhya Pradesh in North India. In the National Chambal Sanctuary two species of crocodiles *Gavialis gangeticus*

(gharial) and *Crocodylus palustris* (mugger) are present. The National Chambal Sanctuary in M.P. is about 400km long stretch of famous River Chambal. The National Chambal Sanctuary is the main area for the species reintroduction programme of the crocodylian species *Gavialis gangeticus* (Gharial). Chambal supports the largest population of Gharials in the wild and other aquatic species in the river (Fig. 1).

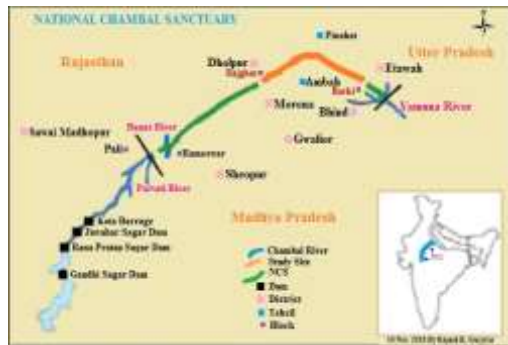


Fig. 1 National Chambal Sanctuary

B. Tighra Reservoir

Tighra is situated approximately 23 km west of Gwalior city at an altitude of 218.58 m from mean sea level. The Tighra reservoir was formed due to the construction of dam on Sank River during 1910-17 by the then late Maharaja Madhav Rao Scindia. The reservoir is spread in an area of about 7.5 sq miles Tighra reservoir lies on 78°01'30" E to 77°57'54" E longitude and 26°11'42" N to 26°14'08" N latitude. The dam was constructed in stone masonry in lime mortar and foundations were resting on the massive sandstone. It has breached in the very first filling and therefore the dam was again reconstructed in 1929. The height and length of the dam is about 7.339 meter and 1524 meter respectively. The maximum and minimum water level of the dam is 738.70 ft and 705.4 ft respectively. The full tank level is 740 ft and the low silt level and top bund level is 665ft and 744ft respectively. The dead storage capacity of the reservoir is 232 M.cft and the live storage capacity is 4390 M.cft. The catchment area of the reservoir is approximately 414.24sq km. The average rainfall in the catchment area is about 635 mm. The reservoir was mainly constructed for irrigation, pisciculture and for supplying drinking water to the Gwalior city. The reservoir irrigate cultivable crop area of about 22000 acre (8903 ha) and crop area of about 5000 acres (2223 ha) till 2000. However, due to increase in population, the demand of water increases and as a result the reservoir is now used only for supplying drinking water to the Gwalior city. This dam has been constructed in the vicinity of eleven villages. The villagers depend on this dam for their irrigation, drinking and domestic purpose. Moreover, the dam also provides the water required for the drinking purpose to Gwalior City. After the construction of the dam the area became a suitable habitat for several birds and this area was later declared as a Bird Sanctuary. However this also led to the relocation of the

people that was residing in the surrounding area of the dam. Despite of the positive attributes like control of stream regime, prevention of flood, water for irrigation. Dams present negative impacts on the environment. Some of the negative impacts that can be mentioned are water logging, land loss, relocation of people and silt formation (Fig. 2).



Fig. 2 Tighra Reservoir

C. Tekanpur Lake

The Tekanpur Lake is located between a latitude of 26°07'44"N and a longitude of 78°38'00"E at about 32 km south-east of Gwalior city in North Madhya Pradesh, India. The Tekanpur Lake was formed due to the construction of dam on Chhachhundar River in 1895, a tributary of Sind River also by the then late Maharaja Madhav Rao Scindia to alleviate the suffering of the common men deprived of irrigation facilities. The dam was 975 meters long and 17.07meter high having a catchment area of about 64.75 sq km. The dam was completed in 1910 and is also known as Band Tal. The maximum water level and top bund level of the dam is 229.4 meter and 231.23 meter respectively. The full tank level is 228.49 meter and the lowest silk level is about 221.17 meter. The live and dead storage capacity of the dam is 262.86 Mcft and 30.0 Mcft with a water spread area of about 3344 Th. Sq m. the mean monsoon run-off in the catchment area is about 368.50 Mcft respectively. The lake is completely under the protection of BSF academy. The lake serves as source of drinking water and other activities for the BSF. The lake also serves as a good habitat for varieties of aquatic species like birds and reptiles (Fig. 3).



Fig. 3 Tekanpur Lake

D. Madikheda Dam (Atal Sagar)

Madikheda Dam is a multipurpose dam situated in Shivpuri district in Madhya Pradesh, India. The Madikheda dam is constructed on the Sindh River near Madikheda village, about 35 km away from Shivpuri town (district headquarter) of Madhya Pradesh state in India. The extension of dam lies at latitude $25^{\circ} 33' 20''$ N and longitude $77^{\circ} 51' 10''$ E. The Sindh River is one of the sub-systems of Ganges, which confluences with Yamuna River near Etawa (Uttar Pradesh). It has 5540 sq. km watershed area. Mean monsoon rainfall is about 763.42 mm while mean annual rainfall is 923.29 mm. Maximum height of dam is 59 m. Gross storage capacity is 970.50 m cum and production capacity is 60 MW. The total submerged area of the dam is 5679.91 ha, which includes 3050 ha of forestland. There are thirteen villages in the submerged area with 7.9 per cent of total agricultural land, while its command area has a large proportion of rain-fed agricultural land. The irrigation facilities in the command areas of reservoir are just negligible. The beneficiary districts of MDP are Shivpuri, Datia, Bhind, and Gwalior in general and whole Madhya Pradesh State in particular (Fig.4).

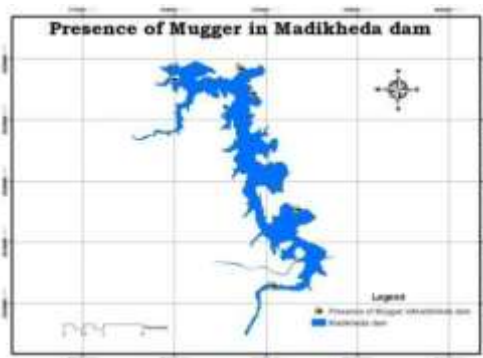


Fig. 4 Atal Sagar Dam

E. Sakhya Sagar (Chandpatha) Lake

The Sakhya Sagar Lake is located on the border of forests of the Madhav National Park. It was created on the Manier River in the year 1918. The Sakhya Sagar Lake is locally called Chandpatha also, because of its semi circular moon shape. The lake looks stunningly beautiful at dusk when it reflects the changing colors of the sky. This lake is interconnected with two other water bodies, one within the Madhav national Park and one outside the park. Sakhya Sagar and Madhav Sagar are inside the park and Jadhav Sagar is towards the city. All the lakes are ideal for crocodile habitat. It lies between latitude $25^{\circ} 26'$ to $25^{\circ} 38'$ N and longitude $77^{\circ} 43'$ to $77^{\circ} 57'$ E. It spreads about 309.01 hectares and it is located 4 km. from Shivpuri town. This is man-made lake situated in the central zone of the Madhav National Park. It provides a permanent source of water to the wildlife and drinking water for the peoples of Shivpuri town. The lake is bounded with a huge masonry wall situated along its eastern shore. The length of dam is 2164 m. and maximum height of dam is 13.81m.

The catchment area of lake is 72.52 sq. km., submergence area is 217.06 ha. and gross storage capacity is 7.78m.cum. A nala namely Karbala from the Shivpuri town joins the lake in the Southern bank of the lake. From winter onwards the nala which feeds the lake get dried up and only the used water of Shivpuri town flows into the lake. It carries sewage and waste water of the town. A large number of reptiles like marsh crocodiles, and two species of turtles and one species of water snake is present in Sakhya Sagar Lake.

F. Madhav Sagar Lake

It is second lake inside Madhav National Park and is connected by a channel with Chandpatha. It was also constructed by Maharaja Madhav Rao Scindia on Manier River for the purpose to store water for different purposes. It is smaller than Chandpatha and in summer it looks like a marshy land. The lake is used by the wild animals which are present inside park. It is locally known as Ghansari. It lies between latitude of $25^{\circ} 25' 40''$ North and a longitude of $77^{\circ} 43' 2''$ East. The smaller patch of land inside this lake serves as a basking site of muggers and for laying eggs. The lake has large vegetation of lotus and other aquatic plants. It is also a protected site as it is located inside the park. Chital, Nilgai and other mammals are occasionally seen around the lake at dusk. The lake is not as deep as Chandpatha (Fig. 5).



Fig. 5 Sakhya Sagar Lake and Madhav Sagar Lake

The field survey was classified into two sections, river survey and questionnaire survey. Questionnaire surveys were carried out in North Madhya Pradesh in the study area within the Sanctuary. At such study site, a total of 300 persons in each village were interviewed for data like socio-economic information, family income, livelihood, livestock, sex and age of conflict victim, circumstances of attack and compensation amounts.

Details of study sites, including major landmarks, sites of crocodile capture (for translocation), release sites, crocodile nesting sites, basking sites, sand mining, irrigation and other important features and location of villages were recorded using GPS. The detailed conflict information that would be collected was related to human injury/fatality, and

injury/fatalities of livestock. Study sites were visited along with State Forest Department personnel to easily identify regions of conflict.

Secondary Data collection

Secondary data on human-crocodile conflict were collected from records available in the Forest Department. It have also been collected through literature survey i.e., by consulting different journals, newspapers, and unpublished thesis/dissertations and other study material from the libraries.

Statistical Analysis

Statistical analyses like mean, frequency, cumulative frequency, percentile of available data have been done with the help of Microsoft excel.

III. RESULTS AND DISCUSSION

A total number of 593 muggers in 2016 following and 712 muggers in 2017 were seen in the study area. This indicates an increase of 119 individuals from the 2015-16 survey. North M.P. has an area of about 34,235 sq. km and is surrounded by six districts namely, Gwalior, Morena, Bhind, Datia, Shivpuri and Sheopur. North Madhya Pradesh is having many water bodies and river; there are many important basking and nesting areas of crocodiles. There are direct conflicts like injury and death of human and indirect conflicts like crocodile destroying the fishing nets, damage to fish population, predator domestic livestock. People use the river for various purposes including drinking water collection, cloth washing etc. Observations of the study indicate that major habitats of crocodiles are under pressure due to increase in human activities. These reservoirs and river, the life line of the northern city, was primarily constructed to fulfill the water supply of the city (Table 1 and Fig. 6).

TABLE. 1 THE MUGGER NUMBERS HAVE INCREASED, IN COMPARISON WITH THE 2015-16 SURVEY, ESPECIALLY THE NUMBER OF ADULTS. DISTRIBUTION OF MUGGERS OBSERVED DURING SURVEY 2015-16 AND 2016-17.

S. No	Water Resources	No. of Crocodiles (2015-16)	No. of Crocodiles (2016-17)
1	Chambal River	454	562
2	Atal sagar Dam	15	17
3	Sakhya Sagar Lake	60	62
4	Madhav Sagar Lake	10	11
5	Tekanpur Lake	40	43
6	Tighra Reservoir	14	17
Total		593	712



Fig. 6 Showing Different types of Activities of Human and Livestock.

Climate

The temperature and Humidity was recorded 2016 and 2017 in the study area. The minimum temperature was 14.50C in the month of January 2017 in National Chambal sanctuary, however, the maximum temperature was 36.10C in the month of June 2016 in Atal Sagar Dam and The minimum Humidity was 27.6 % in the month of April 2017 in Tekenpur Lake, however, the maximum Humidity was 84.9 % in the month of August 2016 in Madhav Sagar Lake.

Incidents of crocodile attacks

It was found that most of the people who are the residents of the sampled villages were farmers followed by fishermen and labour. Buffalos, goats, dogs and cows are the prime victim of the crocodile in the study area. 87.60% dies and 12.40% injured of the 113 incidents were direct and incidental has been taken by crocodiles. There were 12 confirmed human fatalities caused by crocodile attacks; in addition, 6 peoples who “disappeared” are believed to have been taken by crocodiles and 6 peoples were have been injured during attacks. Crocodiles have killed or Injured livestock’s (e.g. cows, goats, buffalos) and pets or guard dogs. Mostly attacks took place in the early morning and late evening (Fig. 7).

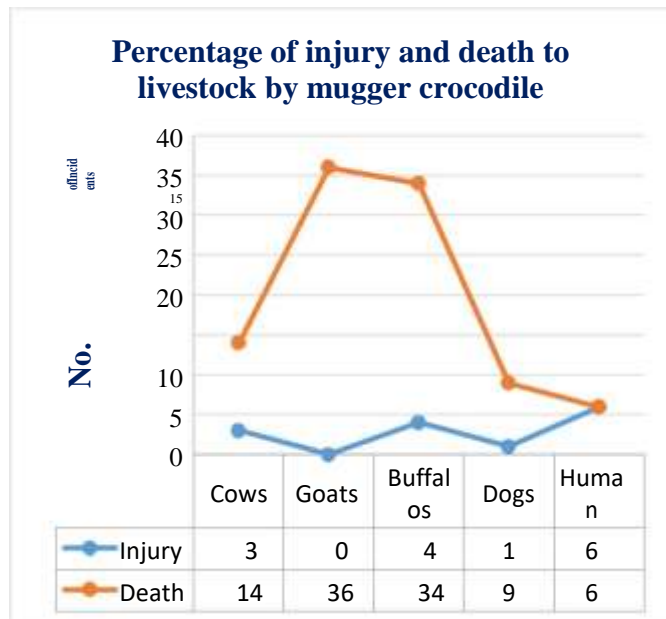


Fig. 7 Percentage of injury and death to livestock by mugger crocodile

Human Demographic profile

The 40 villages selected in the present study have a population of about 34,500 with overall male female ratio of 1.11. The literacy rate of the selected villages as per the census 2011 is 52.7. Population profile and literacy rate of the 40 villages located in the study sites in National Chambal

Sanctuary and other water body are given and location of these villages.

Present Threats

- Intensive pressure from riverside development
- Mining of sand for building materials
- High intensity of illegal net fishing causing crocodile mortality.
- Water extraction for agriculture at point (dams and canals) and non-point areas.
- Significant increase of mugger population resulting habitat competition with Gharial.
- These activities have reduced basking areas and disturbed nesting areas of mugger (Fig. 8).



Fig. 8 Showing illegal activities of Crocodiles Habitat

Human-crocodile conflict studies have been carried out extensively in many parts of the world [23][17-18][24][25-29]. Wildlife habitats were considerably altered and there are disturbances along the river by wood collectors, poachers, farmers and sand miners. Such human activities have increased instances of human-crocodile conflict. There are many reports in the sanctuary regarding killing of cattle and human by mugger crocodile in the Chambal River [9].

The multi-purpose dam and reservoir projects in worldwide have extremely improved the entire development processes of the region and most of the countries having

developed stage of their economy only after successfully completion of these reservoir projects. Gwalior regions hilly type area in Madhya Pradesh, which constructed too many dams and reservoirs [30]. The major dams and reservoirs in India have been responsible for 12 percent of the forestland losses during the period 1951 to 1985 [31]. Conservation of aquatic biodiversity in the National Chambal Sanctuary is major subject of research since 1983 [2] [32] [7]. There are direct conflicts like injury and death of human and indirect conflicts like crocodile destroying the fishing nets, damage to fish population, predate domestic livestock. The present study is mainly focused on the crocodile-human conflict at the water resources in North Madhya Pradesh. Large numbers of people residing in the water resources side villages are directly dependent on the Chambal River and other water body. They collect sand, grow agriculture along the banks and collect fish from the water bodies and river.

IV. CONCLUSIONS

The findings of this study indicate that major habitats of crocodiles are under pressure due to increase in human activities. The major threat at present is habitat lose due to human encroachment, and disruption of populations through fishing and other hunting activates. In the present study it is observed that due to crocodile human conflict relationship between local communities and wildlife authorities is not cordial. Locals consider that crocodile programmes in the Chambal river are major obstacle for poverty elevation as the depend primarily on the river for livelihood and govt. restrict use of resources for crocodile conservation. Local's people should be aware



Fig. 9 Showing Different types of Habitat for Crocodiles

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