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CROCODILES OF RIVER KRISHNA: IMPACT ON AGRICULTURE, ECONOMY, AND THE SOCIOLOGY OF HUMAN POPULATION IN SANGLI, MAHARASHTRA, INDIA

Rajaram Hindurao Atigre

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CROCODILES OF RIVER KRISHNA: IMPACT ON AGRICULTURE, ECONOMY, AND THE SOCIOLOGY OF HUMAN POPULATION IN SANGLI, MAHARASHTRA, INDIA

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Abstract: Krishna is one of the main rivers of the Deccan Plateau. It begins its course in the Western Ghats. A large human population relies on the river Krishna for agricultural irrigation, watering livestock (cattle), fishing and other activities. The presence of and attacks by the Mugger Crocodile *Crocodylus palustris* on humans and livestock are reported in the Krishna resulted in the formulation of the present research. Data collection comprised on-site observations and field interviews using a structured questionnaire. Attacks were found to occur mostly during winter and summer seasons. During winter, crocodiles bask in the sunlight on river banks and attack in self-defense. The summer season corresponds with their breeding period and attacks occur as the crocodiles protect their nests.

Keywords: *Crocodylus palustris*, human-animal interaction, human-crocodile conflict, impact, Mugger Crocodile.

The Mugger Crocodile *Crocodylus palustris* has inhabited the Krishna River in Sangli District of Maharashtra for a long period (Whitaker & Andrews 2003). Its population size has not been determined as no population survey has been carried out. In general, *C. palustris* is shy, but can become aggressive if disturbed in its natural habitat. The crocodile is a long-lived animal, late maturing with complex social hierarchy, easily unapproachable, and studies needs to be carried out over a long period of time and with considerable effort

(Chihona 2014). The preferred habitat is typically difficult to access. Human beings or livestock are not natural preys of crocodile but they are misidentified as they go down to the water and may appear to the crocodile as a natural prey item. The crocodiles may attack them as defense when human beings or livestock present a threat to the crocodile or its nest.

Extensive water extraction for consumption, irrigation and industrial use, coupled with a decrease in fish stocks in the wild has contributed to habitat loss for crocodiles throughout the world (Botha et al. 2011). Similarly, extensive fishing by fishermen has also affected the crocodiles' feeding habit with the result that the risk of competition for food (livestock and humans) has increased. The crocodiles of Krishna River are also affected by similar factors. Most crocodilians which occur near human population are potential predators of humans and livestock. The recovery of the wild population of crocodiles (Stuart Chihona, 2014) often increases at a large extent, as it increases the human, livestock-crocodile competition. Fishermen and livestock farmers are the most likely victims and hence they are likely to want to reduce crocodile numbers and kill crocodiles (Barnes 1996) or

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ज्ञान - विज्ञानं विमुक्तये

damage their nests and/or eggs in an attempt to reduce their numbers (Shacks 2006). Crocodile attacks can also be correlated with the number of crocodiles and condition or state of the habitat. Those rivers with slow flowing water and a flat substrate show presence of a large number of crocodiles (Atigre et al. 2015) where the livestock get into the water and the crocodile attack can result. Competition for resources has been a matter of concern for most carnivores, with humans as well as crocodiles, as it affects distribution and behaviour of wildlife (Ehrlich 2009; Vanak & Gompper 2009; Combrink et al. 2011), due to either disturbance or shortage of resources. The shortage of resources coupled with the overpopulation of crocodiles has resulted in the migration of crocodiles from river Krishna to its tributaries, Warana and Kadavi (Patil et al. 2012).

All the above-mentioned potential threats to the crocodile population in the Krishna led to crocodile attacks on human in the last 12 to 15 years. According to the records of the sub-divisional forest office in Sangli, Maharashtra the first known crocodile attack on human occurred in April 2003. Many such attacks on humans and livestock are reported from the selected study area. The present research was initiated to study the impact of crocodiles on agriculture, economy and the sociology of local people in Sangli, Maharashtra.

The main focus of the research was to identify the levels of human-crocodile interactions, i.e., property damage (like crop fields), predation of livestock and attacks on humans. As the study area is densely populated with a heavy agricultural load of sugarcane plantations, the farming community frequently visits the river belt for

agricultural purposes. Similarly, there is a large number of cattle domestication in the region. Thus, it is interesting to know how farmers manage the agriculture system and livestock management methods with crocodiles in close vicinity.

MATERIALS AND METHODS

To identify the impact of crocodiles on agriculture, economy and sociology of human population from Sangli, Maharashtra, the study area was frequently visited from January to May of both years in 2016 and 2017. During these visits, farmers from various villages on the banks were interviewed to collect the research information regarding problem.

STUDY AREA

River Krishna is the third longest river in India, measuring about 1400km. It originates at Mahabaleshwar (17.92°N & 73.65°E) in the extreme north of Wai Tahsil, Satara District, Maharashtra and meets the Bay of Bengal at Hamasaladeevi (15.95°N & 80.98°E) in Andhra Pradesh. The selected segment of study starts at Junekhed (17.07°N & 74.35°E) in Walwa Tahsil of Sangli District and ends at the Krishna-Warana confluence (16.83°N & 74.53°E) at Haripur near the city of Sangli. This river segment is about 50km long (Fig. 1). The villages on the left bank are Punadi, Nagrale, Shirgaon, Burli, Aamanapur, Anugadewadi, Dhangaon, Audumbar, Bhilawadi, Chopadewadi, Sukhwadi, Bramhnal, Mouje Digraj, Padmale, Sangli (Ganpati Mandir, Gaonbhag, Haripur Road) and Haripur. Villages on the right bank are Junekhed, Navekhed, Walwa, Nagthane, Suryagaon, Santgaon, Shantinagar,

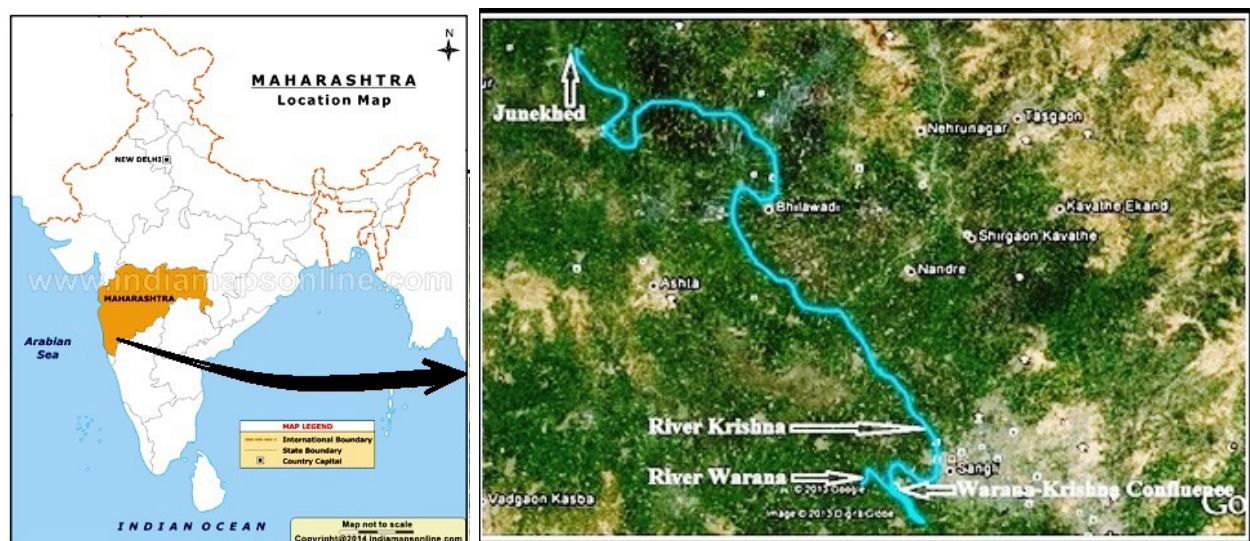


Figure 1. Study area as indicated by the arrows

Ankalkhop, Mardwadi, Karandwadi, Tung, Kasabe Digraj and Sangliwadi. According to 2011 census, the human population of Sangli District was 2,822,143 with density of 329 per km² (Directorate of Census Operations, Maharashtra, 2011). The villages Walwa and Bhilawadi are in developing stage with industrialization and there is less interactions while Sangli City is a District place with 447,774 populations and there is no interactions. The populations of all other villages of study area are dependent on agriculture or livestock and are affected by crocodiles.

Interviews and personal observations

The methodology used included interviews of the people native to the study area together with personal observations made during the visits. Moore (1953), Charnock-Wilson (1970), Abercrombie (1978), and Whitaker (1978) have used this method for crocodile survey to obtain more information or to augment more detailed studies (Parker & Watson 1970) about the problem.

Frequent visits in the study area were carried out during late winter and summer seasons from January to May to identify the impact of the crocodile population on agriculture, economy and the sociology of human population. This is the breeding period of *C. palustris*. The crocodile lays eggs in the month of March in nest holes, which hatch in the last week of May. Farmers, women, cattle herders and wash girls who visit the river bank in the study area regularly were interviewed with the help of a questionnaire. Farmers' were asked about interference of crocodiles in their routine works of farming and cattle domestication. A total of 212 questionnaires from the people of the age group 15 to 70 years were collected and analyzed. Independent and random sampling methods were used for the selection of farmers from every village. The village guard (Kotwal), village revenue officer (Talathi), and the village headman (Sarpanch) were included in the surveys due to their responsibility in dealing with human-crocodile interactions in the study area.

OBSERVATIONS AND RESULTS

Crocodile sightings

During most of the surveys crocodiles were observed basking on the river banks in the study area. A population count was not done. Respondents who were daily visitors to the river reported the presence of crocodiles in Krishna and this was supported by researcher observation; photographs of basking crocodiles were taken during study visits (Images 1 & 2). Respondents reported that crocodiles could be observed about 50m from either river



Image 1. Crocodile observed in water at Bramhnal



Image 2. Two crocodiles observed on red soil at Bhilawadi

banks, more frequently observed basking on the grass, soil or few rocky surfaces. They also reported that more number of crocodiles are observed in recent 5–6 years than past and the size of crocodiles is also bigger.

Crocodile attacks on livestock and humans

Table 1 demonstrates that there were more crocodile attacks on livestock than on humans mainly in the summer months. Respondents reported that livestock (buffalo, cow, sheep and goat) are driven to the water to drink and most of the drinking sites are covered with a thick canopy. The density of the vegetation was directly proportional to the attacks on livestock, with few attacks noted in open spaces. The respondents, particularly the village guards noted that out of all these attacks on cattle very few were fatal; cattle were strong and large enough to escape from the crocodile jaws. There were more attacks on the cattle in the evening (82%), rather than during the morning (18%) (Table 3). The cattle herders needed to remain vigilant during this process, with some reporting that they held the tails of the animals to pull them away from possible attacks. Before the animals drank water, the cattle herders threw stones to chase the crocodiles away from the banks. Cattle were mostly attacked as they entered the river for drinking and therefore became an easy target for the crocodiles.

Sixteen (16) attacks on human were recorded in the study area from April 2003 to March 2017, of which six were female and 10 were male. Out of these 16 incidents,

Table 1. Summary of the Mugger Crocodile survey and observations

Crocodile Survey			Observations		
Length of river surveyed	No. of villages visited	No. of respondents	River water used for	Reported crocodile attacks (April 2003 to March 2017)	Impact of crocodile attacks
50km	16	212	. Irrigation to crop plants . Watering and washing cattle . Washing clothes . By women . Bathing	. 16 on humans . 62 on cattle	. Loss of human life . Loss of cattle life . Loss of wealth for treatment . Damage to crops . Decrease in crop yield

Table 2. List of crocodile attacks on human

	Date of interaction	Place of interaction	Name of person	Gender	Remark
1	29.iv.2003	Kadam vasti Kasbe Digraj	Mr. Aniket Rajaram Kadam	Male	Dead
2	11.ix.2003	Sakharwadi, Bhilawadi	Mr. Ramchandra Bhiku Nalawade	Male	Dead
3	19.vii.2005	Chopadewadi	Mrs. Ratnaprabha Nayku Yadav	Female	Injured
4	16.iii.2007	Ankalkhop	Mr. Sunil Pandurang Bhosale	Male	Dead
5	28.vi.2008	Bhilwadi	Mr. Tanaji Keru Kamble	Male	Injured
6	28.viii.2008	Dhangaon	Mrs. Sunita Balaso Mohite	Female	Injured
7	17.x.2008	Bhilawadi	Mr. Ramchandra Nana Kamble	Male	Severely injured
8	13.ix.2009	Dhangaon	Mr. Mahadev Keshav Yadav	Male	Injured
9	13.xi.2010	Bramhnal	Mrs. Varsha Vinod Kamble	Female	Dead
10	02.vi.2011	Walawa	Mrs. Kalpana Babaso Khandekar	Female	Severely injured
11	11.iv.2011	Ankalkhop	Mr. Tushar Balaso Magadum	Male	Dead
12	17.ix.2013	Aamanapur	Mr. Shankar Bhau Pawar	Male	Injured
13	14.iv.2014	Bramhnal	Mrs. Sakhubai Dilip Kamble	Female	Severely injured
14	12.iii.2015	Bhilawadi	Mrs. Sushama Dadu Changdeo	Female	Dead
15	25.v.2015	Kasabe Digraj	Mr. Shivaji Nana Chougale	Male	Injured
16	05.iii.2017	Haripur	Mr. Keshav Damu Patil	Male	Severely injured

Table 3. Summary of observations

	Description	Observation
1	Time of the day when the cattles are driven to the river for water	82% in the evening 18% in the morning
2	Crop plantation in the study area	70% area covered with sugarcane 30% area with seasonal crops
3	Damage to crops by crocodile movements	10% of crops were damaged
4	Crocodile attacks on humans	37.5% (6) attacks caused death 25% (4) were severe 37.5% (6) were not severe

six (37.5%) caused death while 4 (25%) were severe and the remaining six (37.5%) were not severe (Table 2). Though the humans of all age groups were attacked, the humans above 60 years of age were severely harmed. Interestingly, in all of the crocodile attacks the victims' bodies (both humans and cattle) were recovered with no missing organs or body parts. This clearly indicated that the crocodiles had not attacked the humans or the

livestock for food.

Damage to crop plants

The soil surface on both the banks of the river is covered with sugarcane plantation (70%) along with some seasonal crops (30%) such as groundnut, wheat, jowar and maize (Table 3). The basking period of *C. palustris* is during the winter when the farmers grow short-lived (three months) seasonal crops. The crocodiles come out of the water for basking and move to the nearby cropland. The majority of the respondents (87%) reported that crocodiles damaged the small or newly germinated crops (about 10% of crops in the 50m area) (Table3).

DISCUSSION AND CONCLUSIONS

There has been a remarkable increase in human-wildlife conflict worldwide (Woodroffe et al. 2007). The increase is linked to the risk factors associated with predator attacks on humans and livestock that range from fatal injuries to death (Ogada et al.2003). Positive

solutions for these negative interactions need a deep understanding of the local situation, anthropogenic factors and ecological aspects of the area. This will reduce negative attitudes towards the predators, and will serve to further maintain viable populations of predators, even creating good breeding sites for them to boost other areas (Chihona 2014). This will increase the chances for a predator such as *Crocodylus palustris* to retain its status in natural waters.

Villages close to the river are mainly affected by crocodile attacks. Livestock are mainly attacked when they enter the river for water as well as when they graze on river banks during the summer months. This can be correlated with the breeding season of the crocodiles in India. Mating occurs in late February or early March and the females lay eggs which are incubated in nest holes near the water edge for 80 to 90 days. Hatching occurs usually in late May (Patil & Atigre 2016) and the female carries her hatchlings in her mouth to the water (https://www.youtube.com/watch?v=XH3xQQ9_Zml). The most interaction have occurred in the summer months which is the breeding season of *C. palustris* and they are protecting their nests.

The data showed that more than 60% of cases of attacks on humans resulted in severe injury or death since 2003. The social impacts on victims' families vary depending on the victim's familial responsibilities. For example, the loss of a parent, a breadwinner, means that the children drop out of schools, be forced to engage in activities like cattle herding for boys and house hold chores for girls. Furthermore, girls would be forced into premature marriages as they try to alleviate poverty in their homes. In the case of severe injuries in crocodile attacks, maximum income of the family is used for treatment and reduced workforce for agricultural activities.

This study did not measure the effects of crop raiding. All seasonal plants are sowed in the winter along with new sugarcane plantation, when crocodiles are seen basking on the banks. Crocodiles move out of water on to the land in the morning causing damage to the young crops resulting in economic losses to the farmers.

Although crocodiles have become a threat to the agricultural, economic and social scenario of the region, there were no reports or observations that they are harmed or attacked.

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Appendix 1. Questionnaire

Respondents' information

Place: _____ Date: _____
 Latitude _____ Longitude: _____
 Name of person: _____
 Address: _____
 Age: _____ Education: _____ Occupation: _____

Since when, you are staying nearby the habitat of crocodile?

Questions:

1. Have you seen any crocodile/s?
2. How many times?
3. How long are you watching a crocodile/s?
4. How many crocodile/s at a time you have seen?
5. What is the length of crocodile/s?
6. Have you seen eggs of crocodile/s? How many?
7. Have you seen young ones of crocodile/s? How many?
8. Have you seen a crocodile with young ones?
9. Have you heard the sounds of crocodile/s or its young ones?
10. Have you seen nest of crocodile/s?
11. How many crocodile/s live in one nest?
12. Do you know any crocodile -human conflict or attack on any other animal?
13. When? How many times?
14. Is anybody injured or died in crocodile/s attack?
15. Does Crocodile damage the crop plants?
16. If yes, How and When?
17. Give the quantitative data.
18. Have you heard about crocodile/s protection and conservation?
19. Is there a need of crocodile/s protection and conservation?
20. How to protect and conserve crocodile/s?
21. Have you any memorable event regarding crocodile/s?
22. Will you accept a crocodile park in your area?





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