

## Human-Crocodile Conflict in South Asia and Iran

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### Abstract

Culture, poverty and a growing human population present unique challenges to conservation and wildlife management within the South Asian region. The three crocodilian species here are the saltwater crocodile, the Mugger, and the Gharial. Although each species is recovering across parts of its range, the loss of habitat combined with human expansion into previously wild areas is causing increased reports of conflict. This sharing of an essential, but a limited resource, has resulted in an increase of Human-Crocodile Conflict (HCC). Cultural and social reliance on natural and man-made water resources has always been a source of HCC. Here, we look at the extent of HCC, the consequences of conflict, and how it is currently dealt with across the region. We also make recommendations for mitigating HCC within the South Asia and Iran region as part of some much-needed management plans.

### Introduction

With growing crocodile populations and expanding human populations and activities, it was inevitable that conflict would arise - largely as competition for a shrinking crocodile habitat. Almost as a consequence of successful conservation programs since the late 1960s-early 1970s, the management of crocodile populations around the world now has to address the growing number of conflict incidents, and to come up with solutions to mitigate against these incidents. Human-crocodile conflict (HCC) is a significant driver to establishing sustainable management programs for crocodilians.

### The region

The region we are addressing comprises the following nations, all largely based around the Indian subcontinent: Bangladesh, India, Iran, Pakistan, Nepal, Sri Lanka and Bhutan. This region is bounded by the Bay of Bengal, the Arabian Sea, and the Indian Ocean to the south (Fig. 1).

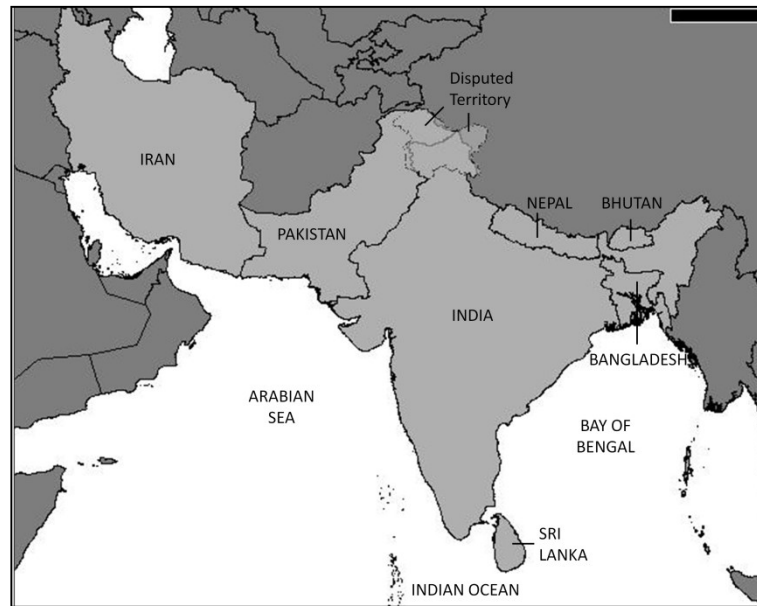


Figure 6. South Asia and Iran region (light shading)

Within this region, three crocodylian species are now extant: the saltwater crocodile, *Crocodylus porosus*; the mugger, *Crocodylus palustris*; the gharial, *Gavialis gangeticus*. Of these species, only the Mugger and the saltwater crocodile are responsible for attacks on people and livestock. Although the Gharial attains large sizes (5 m+ for males), their long and narrow jaws are much more effective at securing fish via sideways thrusts of the head than they are at attacking large mammals (Stevenson and Whitaker 2010).

Within the South Asia and Iran region, the populations of all three crocodylian species are increasing (although some of these populations continue to be supplemented from head-start programs, so figures will be inflated by animals released prior to the survey). A questionnaire was provided to CSG vice-chairs and members within each country in the region to determine how HCC was being addressed overall, what attitudes of local people were toward HCC, and what mitigation projects had been tried, in order to get some idea of effectiveness of these ideas. Data from these forms was then set alongside data from the CrocBITE online database (<http://www.crocodile-attack.info>) in order to determine the extent of HCC in this region. An important point of the exercise was to also illuminate the response protocol to conflict.

### The problem

At a very broad level, the problem can be viewed in the following scenario: crocodile populations were critically reduced through unregulated hunting in the late 19th and early to mid-20th centuries mainly for the leather industry; human populations subsequently expanded into areas previously occupied by crocodiles; legally-protected crocodile populations began to stabilise, then grow; as crocodile numbers increased, local people began seeing crocodiles more frequently; and, crocodile populations and sizes of crocodiles continued to increase and naturally expand into areas now occupied by people. The problem is perhaps that a generation or two of people are no longer accustomed to living with crocodylians (Manolis and Webb, 2013). Humans are unforgiving creatures: once we are habituated to an area and lifestyle, any threat to that is not tolerated. This is

the situation that many crocodile populations now face around the world. Addressing this conflict is a critical part of developing our management plans for crocodiles.

There has long been a strong media response to attacks on people by wild animals (Davis and McLeod 2003), and the reporting can be somewhat misleading. Even so, response to attacks can generate significant negative publicity that is detrimental to conservation programs. This is a key factor in developing comprehensive management plans for crocodiles.

Because of the dramatic and spectacular nature of attacks on people by large predators, HCC is too often seen as crocodiles attacking people. However, when management plans truly address conflict between people and animals, they must consider the damage done to the animals by people - for example, mortality associated with often illegal fishing practices throughout this region. Indeed, the present threats to wildlife species are all anthropogenic in origin. In general, such considerations are addressed as part of the traditional conservation solution based around wildlife laws and protected areas.

However, it is important to remember that human-wildlife conflict is a two-way street. Whenever conflict occurring in either direction becomes excessive (itself an often nebulous value) there is a management problem that must be accorded some priority. Conflict between humans and wildlife can also be a result of human-human conflict (Dickman 2010), and conservation programs are now recognising that there is clearly a socio-political/economic role in addressing 'wildlife conservation' problems (Webb 2013; Stevenson 2013; Hoban and Vernesi 2012).

When investigating how HCC was addressed within the region, we wanted to first of all understand how HCC is understood in the region - how do the people define HCC? Although livestock and pets are taken, the general attitude within the region is that this is expected as a natural consequence of living next to large predators. Indeed, some areas experience loss of livestock to leopards, tigers, as well as crops to elephants (Chowdhury 2008; Pokhrel and Shah 2008). So to a large extent loss of livestock to crocodiles was not the main definition of conflict. It is noted that this attitude varies across the region, and in future, crocodiles may not enjoy such tolerance.

**Overwhelmingly, in the South Asia and Iran region, conflict in this context is defined by a crocodile attacking a human being.**

Given that attacks on human beings are the definition of conflict within the region, we need to understand the species distributions within the area.

#### *Saltwater crocodile*

This large and widely distributed species occurs in Sri Lanka, India and Bangladesh. Within India, there are three main populations: Orissa, the Sundarbans and the Andaman & Nicobar Islands. Within these areas, attacks are known. In fact, a chart of saltwater crocodile attacks in this region accurately depicts the current distribution of the species (Fig. 2):

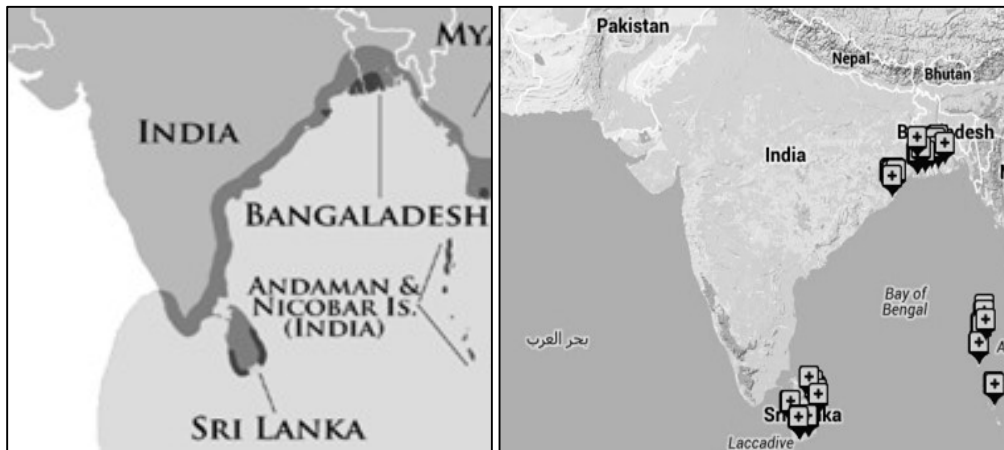


Figure 2. Distribution (black) of the saltwater crocodile within the region on left, dark grey shading is historic range within region; the distribution of saltwater crocodile attacks on the right. (images courtesy of *crocodilian.com*, and *crocodile-attack.info*.)

According to the CrocBITE database, there were 131 saltwater crocodile attacks in the area. These refer to those attacks recorded in the database thus far. The frequency of attacks varies across years (Fig. 3), and shows no increasing trend, although the figure for 2014 is only up until time of report (May 2014):



Figure 3. Frequency of saltwater crocodile attacks since 2009 in the region.

Of the 131 attacks listed in the database, 79 were fatal and 52 were non-fatal (Fig. 4).

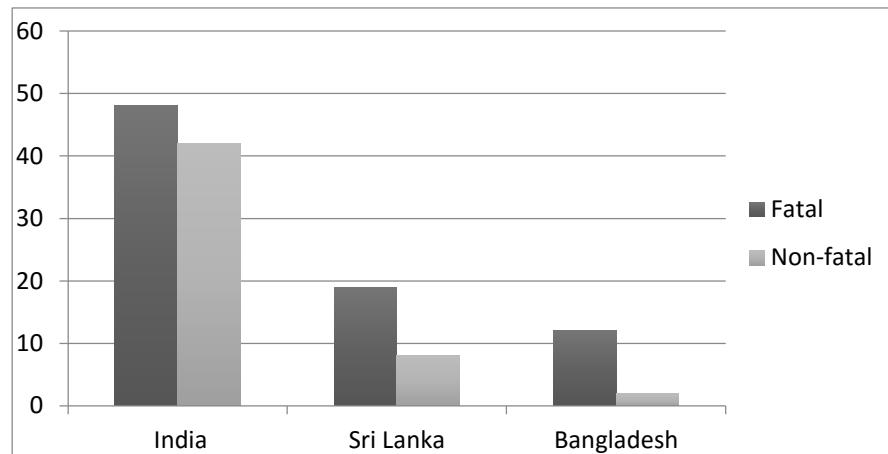


Figure 4. Outcome of saltwater crocodile attacks in the region.

The main population of saltwater crocodiles in the region is within Bhitarkanika Wildlife Sanctuary in Orissa, on the northeastern coast of India. Perhaps the most significant recovery of crocodiles in the region has occurred here. From encounter rates of 0.87 per km in the early 1970s, the figure is now over 5.0 crocodiles per km (Gobi and Pandav 2009). Estimated numbers increased from 96 in 1976 (Gobi and Pandav 2009) to 1640 in 2012 (Pandav 2012). The increase here is largely due to the rear-and-release program established under the Indian Crocodile Conservation project.

Within the Andaman and Nicobar Islands, saltwater crocodile populations have increased from an estimate of only 31 animals in the 1970s (Andrews 1999). Surveys by Madras Crocodile Bank Trust have been planned for the islands to quantify the current crocodile population.

Saltwater crocodile populations are stable or increasing slightly in Sri Lanka and Bangladesh. Although specific data on current numbers is lacking in these areas, in Sri Lanka the *C. porosus* population was assumed at 'no greater than 300' in 2001 (de Silva 2013). The Nilwala River *C. porosus* population in Sri Lanka has increased during the past 40 or so years, and the Nilwala River is the hotspot for saltwater crocodile attacks in the country (de Silva 2008, 2009, 2013).

#### *Mugger crocodile*

Muggers have a wide distribution across the region, from Sri Lanka through to Iran. Their main stronghold is India, where the species occurs across much of the country. It is a species that adjusts to disturbed or modified habitats particularly well, and is found in close proximity to human settlements. Within the state of Gujarat, this species is found in water bodies within a major city. Recent estimates for the IUCN Red List assessment put the current Mugger population at up to 8700 animals across its range (Choudhury and de Silva 2013).

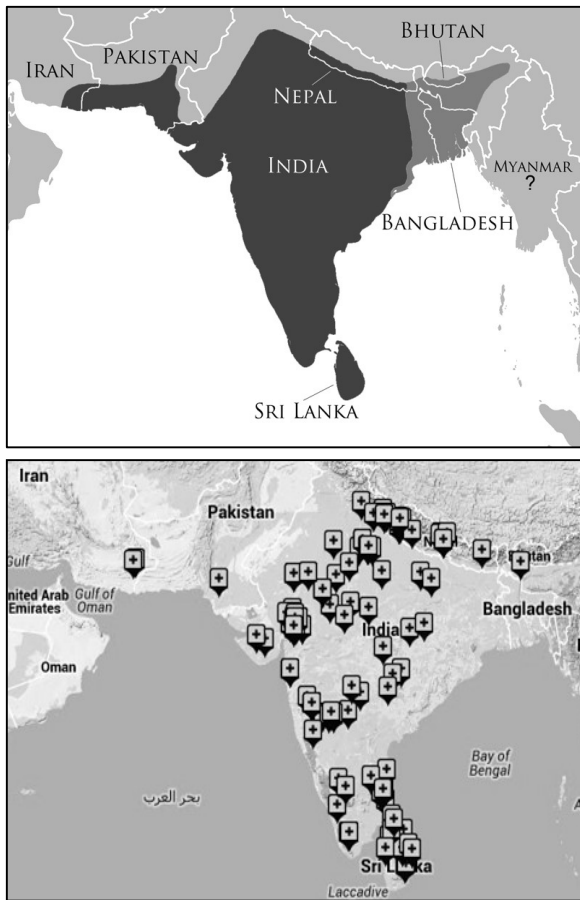


Figure 5. Distribution of the mugger across the region in dark shading (left); distribution of mugger attacks. (Images courtesy of crocodilian.com and [www.crocodile-attack.info](http://www.crocodile-attack.info).)

Recorded in the CrocBITE database are 161 Mugging attacks as of May 2014 (Fig. 5). Of these, 82 were fatal, and 79 were non-fatal (Fig. 6). The frequency of Mugging attacks is clearly increasing (Fig. 7), particularly in areas such as Gujarat, where 5 fatal attacks occurred in April 2014.

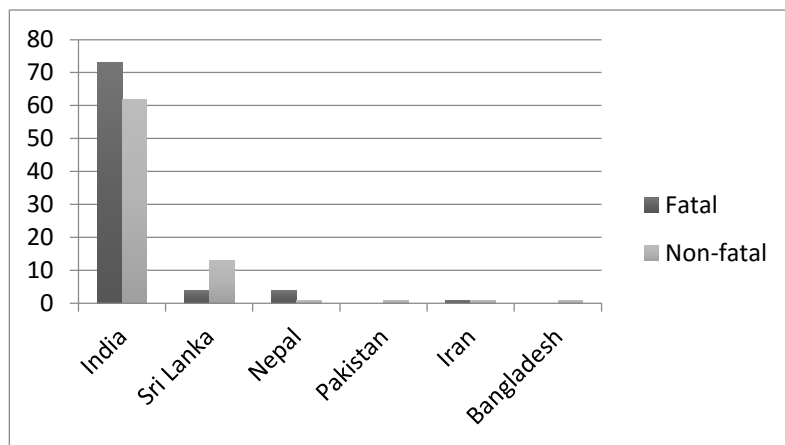


Figure 6. Outcome of attacks by Muggers in the region.

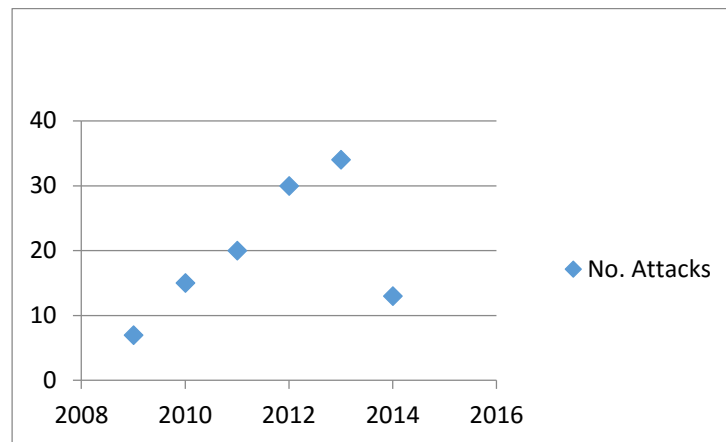


Figure 7. Mugging attack frequency since 2009 in the region (2014 figures are up to May).

### Culture of Conflict

The population of South Asia is largely rural, and poverty and associated socio-economic problems is widespread. Public infrastructure is poorly developed and civic amenities are mostly absent. Hence, there is a high dependence on natural and man-made water-bodies in the locality. The adaptable Mugger is often present in these water-bodies and regularly interacts with people and their livestock. While mutual avoidance is the norm, the potential for HCC is significant because of the fore mentioned problems combined with the lack of awareness, a blatant disregard for basic precautions and religious fatalism. In many areas, conflict with wildlife can go unreported.

### India

In 1976, the Indian Government initiated the FAO/UNDP-supported Project Crocodile. This program was aimed largely at breeding and releasing head-started crocodiles of all three species back into newly-created protected areas. Without question, this project was responsible for not only reversing the decline of crocodiles within the country, but also establishing sanctuaries and developing expertise within the country (ENVIS 1999). Despite the mixed success of this project, there is no current management program for the country.

Within India, there is little concerted effort at mitigating conflict between humans and crocodiles. An attack may result in retaliatory killings, or conversely, no response at all. Varying by area, different agencies may be deemed responsible for investigating attacks: normally it is the Forest Department, but may also be the police. In some areas, there may be efforts to capture and relocate the crocodile responsible. Over the years, many cases attributed to crocodile attack were very likely death by other causes - drowning, murder and suicide. Validity of attacks reported is often poorly investigated. When investigating crocodile attacks there is usually no effort to identify whether the attack was provoked or unprovoked, or to identify the perpetrating crocodile.

Victims of animal attack (or their family) are granted compensation, however even this varies from zero to INR200000 /\$US3200 (Times of India, 26 September 2012). Often, this compensation can amount to little more than \$US160. Corruption clearly plays a part in the compensation mechanism. The point is, there is no established protocol for compensating victims of HCC.

The rigid caste system in India - especially in the north - contributes to the problem in that lower castes are often not granted access to public infrastructure such as water pumps and crocodile exclusion enclosures. This exposes these members of society to unprotected sites.

Disposal of dead bodies (human and animal) in rivers is common in parts of India. Crocodiles often feed on these remains. There is speculation that this could encourage crocodiles to associate people with food, thereby encouraging HCC.

Within the Andaman and Nicobar Islands, the most recent surveys indicated a small number of saltwater crocodiles. In recent years, numbers appear to be increasing, as are attacks, with at least 5 fatal and 3 non-fatal attacks in a 12-month period during 2011-2012 (Saxena 2012). Compensation paid to victims on these islands ranged from INR3000 for injury to INR1,00,000 for death; the victim's family must claim for compensation (Saxena 2012). Some attacks are blamed on illegal dumping of chicken waste and other animal products into waters, thus attracting crocodiles close to areas used by humans (Andaman Chronicle 2012). The Andaman and Nicobar Islands also have a large immigrant population from mainland India, many of whom have never lived in close proximity with *C. porosus* and therefore do not exercise the necessary level of caution near water bodies when in the Islands.

Recent efforts on the Andaman and Nicobar Islands to raise awareness of saltwater crocodiles includes a new and impressive display at Port Blair, and Madras Crocodile Bank Trust has carried out training of Forest Department staff in crocodile capture, as well as developing awareness and education materials. Continued training of staff is carried out by Zoological Survey of India. Some of the warning signs on the islands use wording that many feel contribute to the hostility toward crocodiles (Chandi 2012). Such wording includes 'this river infested with crocodiles', although this wording may well be a translational issue, as the signs are in English (rather than in the local languages - itself, a bit of a problem to campaign effectiveness).

Although attacks occur on the Nicobars, the Nicobar islanders themselves remain relatively isolated, and retain traditional knowledge, with more tolerance of crocodiles. Certain districts also hunt crocodiles (Chandi 2012).

Within Orissa, the Bhitarkanika Wildlife Sanctuary holds the largest saltwater crocodile population within the region, estimated at over 1600 crocodiles (Pandav 2012). Attack on both humans and livestock occur mainly during the monsoon period. Compensation for victims' families has increased from INR100,000 to INR200,000 in recent years, however, compensation claims are not always processed in a timely manner (ToI 2012). In response to a dramatic increase in HCC reports, authorities for the Sanctuary employed local fishermen to use traditional methods to remove problem crocodiles - essentially chasing the animals away from human settlements (CSG 2008).

## **Pakistan**

Within Pakistan, Muggers occur in the southern regions of the country (see Appendix I). The Gharial is considered extinct in Pakistan. The estimated Mugger population in the country is around 600 individuals: approximately 430-450 in Sindh Province; 120-150 in Balochistan Province. Wild populations are extirpated from the Punjab area.

Crocodile breeding facilities exist in the country, but as of 2014, commercial use had not commenced.

HCC in Pakistan is low, but fear of attack on humans and livestock is entwined with tribal customs and traditions. Attacks on humans are rare, but conflict arises from loss - or *perceived* loss - of livestock and fish and the economic impact of such losses.



In recent years, dead crocodiles have been found, clearly killed by people, but suspicions that they were killed for their skins is unfounded as the carcasses were found intact. These are retaliatory killings, or intentional killing in response to the fear of the threat crocodiles pose.

One custom involves killing the crocodile responsible for attack on a human. Not doing so would be considered '*Zan Talaq*' - a derogatory term that infers poor social status ('divorced') on the widow/widower. This tradition is changing as awareness grows.

Crocodiles are now found in areas that do not come under jurisdiction of wildlife departments, hence many attacks are unreported. Lack of funds and resources in wildlife departments also reduces monitoring of crocodile incidents.

The main form of mitigation in Pakistan was the World Wildlife Fund (WWF) program of public awareness campaigns and community-empowerment projects in the River Dasht region. The WWF program in this area has now stopped, but clearly there was a positive impact on the local communities with regard to reducing conflict and improving awareness of crocodiles. The WWF program is now being implemented in the Sindh region, again with positive impacts. There is no use of crocodile exclusion enclosures in Pakistan.

With the new breeding centres being established in the country, there are now reports of the illegal capture of young crocodiles for sale to the private sector breeding centres.

## **Iran**

Iran holds the western-most population of mugger crocodiles, where they are found in Sistan and Baluchistan Province. The area is designated as a Protected Area (Gandou Protected Area), with Muggers found in a range of natural and artificial water bodies that are in close proximity to human settlements.

Fortunately, local people in crocodile areas hold cultural beliefs that do not permit killing of crocodiles, and the animals are afforded high respect.

However, when Muggers move between habitats during dry seasons, they are struck by vehicles as they cross roads. Periods of drought and flooding are the major threats to the crocodiles of the area.

The last survey in May 2012 indicated a direct count of 326 crocodiles.

Although there is a cultural taboo against harming crocodiles, loss of livestock and the fear of crocodiles which stray into villages does exist. Livestock loss appears to be tolerated by the local Baluchi tribes, and compensation for losses due to crocodiles is given. However, despite use of water bodies for washing, bathing and swimming, serious conflict is not reported.

The main form of mitigation is the use of warning signs at water bodies used by local people. Due to the low incidences of HCC, there is little impetus to introduce further measures.

## **Sri Lanka**

Both saltwater crocodiles and Muggers inhabit Sri Lanka: saltwater crocodiles are mainly confined to the southwest and northeast of the islands; Muggers are found in the south east and many parts of the north, north-central and northeast of the country. Both species are responsible for attacks on people and livestock. Sri Lanka has identified the main areas of conflict, and the patterns of crocodile attack in the country (de Silva 2013; Grametz 2008). When crocodiles do attack, there are often retaliatory killings of several crocodiles in the area. Five cases of poisoning of crocodiles

are recorded in the Matara Nilwala. The response by authorities is varied and does not follow any standard protocol.

There is a long tradition of mitigation measures used in Sri Lanka. These include:

- Crocodile repellents, consisting of plant toxins (often accompanied by rituals) placed in the water
- Charms and talismans, whereby granite blocks are inscribed with a talisman and are believed to offer protection against crocodile attack within the water body (see plate 6)
- Charms and mantras that are prescribed for use prior to entering the water
- Crocodile Exclusion Enclosures, which are placed at the edge of the water to allow safe washing and bathing (see plates 1, 2 and 3)
- Crocodile Fences (metal fences between the river and domestic animal pens) are sometimes used to protect domestic pets from crocodiles at night (see plate 4)
- Warning Signs have been under-utilised even in areas with high conflict.
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#### *Crocodile Exclusion Enclosures (CEEs)*

These traditional enclosures are made of thick palm or hard wood poles driven deep into the river bed, with each end of the enclosure meeting the river bank. More recent enclosures are constructed of metal and wire mesh. These enclosures are known in Sri Lanka as '*kimbula kotuwa*', which simply means 'crocodile enclosure'. Along the Nilwala Ganga, these are common, and consist of both private and public enclosures. Private ones are smaller, and are used by the owners of property on the river. Larger public enclosures are communal property.

Interestingly, although many of the enclosures examined by de Silva (de Silva 2013) were not secure and were enclosed on only 3 sides, crocodile attacks that occurred during the survey period all took place outside of enclosures, or in areas that had no enclosures. Recently, a young boy was killed when he bathed just a few metres from a CEE in Matara, and a young girl was killed as several poles of a personal CEE were missing, allowing the crocodile to enter (de Silva, pers. comm.). It appears that these facilities offer a very real benefit to avoiding crocodile attack in Sri Lanka.

The way forward for Sri Lanka includes expanding the CEE program, increasing the use of Crocodile Fences and warning signs in crocodile areas, and introducing an education and awareness campaign.

## **Nepal**

Two species of crocodylian are found in Nepal: the Gharial and the Mugger. There is a strong Gharial project in Nepal, based on head-starting, chiefly in the Royal Chitwan National Park. The Mugger population is small in the country, numbering perhaps 200 animals, but is considered to be growing (Choudhury and de Silva 2013).

Muggers occur in the southern terai region of marshy grasslands and savannas (Bhatt *et al.* 2012), and there are at least 5 attacks by Muggers on people recorded for the last 10 years - of which 4 were fatal. Most of the victims were reported to be fishing at the time of the attacks.

Between 1981 and 2008, 164 Muggers were released from rearing stations, but they were not monitored at all (Goit and Basnet 2011).

Most of the work on crocodylians in Nepal has focused on the Gharial, and given the small populations of both species in the country, little work on HCC mitigation has been carried out.

Recent studies indicate that Muggers exist in isolated populations within protected areas. Human-wildlife conflict within Nepal is concerned more with elephants and tigers (Shrestha 2007), although sloth bears and leopards also attack people (Pokhrel and Shah 2008) - in this report crocodiles were not mentioned as a species causing conflict with humans.

However, Pokhrel and Shah (2008) report that 9.5% of injuries caused by wild animals on people within the Bardia National Park were by crocodiles, and that these occurred as people fished or bathed in the Rapti River. Again, though, little information is given about mitigation measures or response protocols for HCC.

The Mugger population in Nepal is still too low to have a significant number of HCC incidents. Most studies call for protection measures, including awareness programs, and involvement by the local people in aspects of protection such as nest monitoring (Goit and Basnet 2011; Wagle 2010; Siwakoti and Karki 2009).

## **Bangladesh**

The Mugger is no longer considered to survive in the wild in Bangladesh, and the Gharial is reported in very small numbers that indicate stray animals. No breeding population exists for Gharials in Bangladesh, despite occasional reports (Stevenson and Whitaker 2010). There is a small captive group of Muggers at the Khan Jahan Ali Shrine at Bagerhat (southwest of Dhaka). Here, people come to worship and feed the crocodiles. There was one fatal attack in 2008 at the shrine. Another incident involved a group of men beating the crocodiles - the men later being sentenced to two years in prison with hard labour (BBC News), according to Bangladesh law. The main crocodilian remaining in the country is the saltwater crocodile, found along the coastal region, particularly the Sundarban mangrove region.

Within this vast network of mangrove forests that straddles the India-Bangladesh border, saltwater crocodiles and tigers are reported to take a serious toll on local fishermen. Although the CrocBITE database records only 15 attacks over the past decade, reports often indicate that tigers and crocodiles collectively have killed around 200 people in the past decade (New Age 2012). Considering the isolation and poverty of the villages within this region, clearly most attacks would go unreported. Given the terrain, many would consist of missing persons, presumed killed by tigers, crocodiles or sharks.

The mangrove forest is a valuable resource to over 10 million people, who are either directly or indirectly dependent upon it, from fishing and agriculture to cattle rearing, settlement and as a food resource (Islam and Wahab 2005). Recently, shrimp farming and tiger prawn seed collection have been a major source of income, as well as controversy, in the region (Badola *et al.* 2011; Jalais 2010; Chowdhury *et al.* 2008). Given the proximity to and the reliance of the local people on the Sundarban mangrove forests, attacks by crocodiles remain a constant threat, although tigers appear to be more of a concern (Vyas 2012). Most of the recent crocodile attacks seem to be confined to areas where tiger prawn seed collection is carried out (Vyas 2012; Islam and Chuenpagdee 2013).

Despite significant numbers of HCC incidents in the Sundarbans, there is no protocol to deal with this in Bangladesh. Fatal attacks by tigers and crocodiles are certainly under-reported, as only deaths of officially registered forestry workers are documented (Islam and Chuenpagdee 2013). Compensation is normally around 100,000 BDT (\$US1240), but obtaining this compensation can involve bribery and long delays (Islam and Chuenpagdee 2013).

## Discussion

That crocodile numbers are increasing and available habitat is decreasing is the favoured reason for increased HCC incidents.

However, the pattern of water use in this region clearly shows the true cause of the high HCC incidents. In all areas within the region, most attacks were whilst people were bathing, washing, crossing rivers, collecting edible and non edible plants and fishing (de Silva 2013; Vyas 2013). Contrasted with a developed country such as Australia, the patterns of water use are quite different, with water bodies there used often for leisure, and attacks much less frequent. Within the developing world, rivers, lakes and ponds are essential for daily life, so local people are forced to share crocodile habitats on a daily basis.

Compounding this problem are habitat degradation, polluting of rivers, hydrological issues such as dams and water extraction/diversion, which reduces not only crocodile habitat, but also availability of prey.

Reliance on natural and man-made water bodies places people at a higher risk of crocodile attack. In many areas, these people are poorly educated, unemployed and facing extreme poverty. For them, survival means risking crocodiles and other predatory animals. Disposal of animal by-products into local waterways in some areas, such as the Andaman Islands, serves to attract crocodiles to these areas.

In Sri Lanka, there is evidence that the use of Crocodile Exclusion Enclosures is effective in reducing crocodile attacks on people, and the Crocodile Fences have a similar positive effect for pets and livestock.

Throughout the region, there is a universal call for education and awareness programs, training of Forest Department staff, and for a protocol for responding to HCC incidents, dealing with problem crocodiles (Kumar *et al.* 1999; Vyas 2013; de Silva *et al.* 2013; Rao and Gurjwar 2013; Kar and Patnaik 1999). The lack of any comprehensive crocodile management programs requires serious consideration. The Government of India/FAO/UNDP Project Crocodile successfully rebuilt crocodile populations within the country, and although discontinued, the mindset remains set that crocodile conservation equals head-starting programs. Current management plans for Protected Areas address the protection of wildlife, and do not adequately address conflict with wildlife. These plans need to be updated to recognise that wildlife populations need to be *managed*, as well as protected.

During a Human-Crocodile Conflict symposium in Bangalore, India, in 2012, a panel discussed the necessity for India to contemplate a limited sustainable use model to allow for removal of problem crocodiles. As discussed, crocodiles are sometimes translocated after HCC incidents, but this is haphazard and often not effective, with the crocodile either returning to the capture site, or moving into other human-occupied areas. There are few captive facilities that can cope with these crocodiles due to their capacity already having been reached, and it is difficult to retain the support of local people who see only a danger to themselves and their families from the crocodiles. Sustainable use of crocodiles, particularly within India, would have been a natural result of Project Crocodile: with many breeding farms established around the country, some felt that the opportunity to develop sustainable use as a key component of an on-going crocodile management plan was lost (see Whitaker 1999; Singh 1999).

Another option that has not been explored except within Sri Lanka (and in some Protected Areas within India) is ecotourism, with crocodiles being a focal species. In Sri Lanka, wildlife tourism is well-established, but crocodiles are an added extra. Eco-tourism based around crocodiles is a vital part of the economy in Northern Territory in Australia and Florida in the USA, as examples. The potential for such an industry in this region is strong, and the call for such is not new (ENVIS 1999).

Wildlife conservation today is as much about human welfare and support as it is about protecting wildlife populations (Webb 2014; Berkes 2007; Stevenson 2013). Progressive and successful conservation programs recognise that by developing the economy and livelihoods of local villages, a reduction in behaviours and practices detrimental to the local environment results (Mehta and Heinen 2001; van Weerd and van der Ploeg 2012; Dickman 2010). It also opens up possibilities for education and awareness programs at the local level.

One failing of crocodile conservation programs within the region is that they have not included local people in the conservation solutions - although reports on the Bhitarkanika program indicate relatively good support from locals (Kar 2013), but there are clear problems even here (Badola *et al.* 2012). There is a lack of value assigned to crocodiles by local people, and without this support, long-term conservation will be difficult, and require regular mitigation efforts (see van Weerd and van der Ploeg 2012, for more on this). Local people often see the conservation programs as a direct threat to their way of life (de Vos 1984). Such approaches will never succeed long-term.

### **Recommendations**

Given that the cases of HCC being reported are increasing within the region, governments - both local and federal - should begin taking the issue seriously. To significantly impact HCC will require long-term commitment from both government and NGOs working within areas that have crocodile populations.

The recommendations in this report are realistic actions that can be taken to help mitigate HCC. However, there are some immediate steps that could have a rapid and positive impact on HCC. These are:

1. Committed trial of Crocodile Exclusion Enclosures within HCC 'hotspots'
2. Committed trial of Crocodile Fences within areas of attacks on livestock and household animals
3. Immediate use of warning signs in areas known to hold crocodile populations, and that are used frequently by local people
4. Immediate development of education and awareness materials

There is a financial cost to implementing these, as local people could not be expected to bear the cost of installing fences or enclosures themselves. In Sri Lanka, local government, Disaster Management and NGO bodies install CEEs.

Long-term strategy requires a comprehensive crocodile management plan. Such a plan would need to cover:

1. Regular monitoring of crocodile populations
2. Protocol for dealing with problem crocodiles - removal/relocation/captive/culling.
3. Training of wildlife/Forest Department staff
4. Protocol for investigating attacks on humans - including compensation mechanism
5. Provision to link with government-run socio-economic programs that deal with basic humanitarian issues within local villages
6. Enforcement of Protected Area/Wildlife laws
7. Eco-tourism proposals that will benefit local people
8. Education and Awareness programs for schools, villages, communities

The emphasis in developing such a plan must be on building these communities, not in forcing them to change their lifestyle, making things more difficult for the people. They must see the

conservation of wildlife as a part of an overall solution to their own problems. If they can benefit by either eco-tourism or alternative livelihoods that are realistic and based on the skills they already have or those that they are willing to develop, then there can be an expectation of support from these people.

There are many programs around the world that can be used as a basis for developing these crocodile management plans (eg Leach *et al.* 2009), and there is ample expertise within the region, as well as access to IUCN specialists.

## Conclusions

HCC should not be treated as an independent issue, but dealt with in a comprehensive management plan for crocodiles. Whether such a plan is completed at a local or federal level is not as critical as the actual development of these plans. It is clear that supporting lifestyle changes and reliance on water bodies for basic activities such as bathing and washing is the key to the reduction of HCC in these areas. Use of crocodile exclusion enclosures and crocodile fences have been effective in Sri Lanka and less so in India. Properly implemented and monitored, these clearly can be a part of the solution. Long-term solutions to HCC require developing a management plan that will incorporate socio-economic realities and suit local sensibilities to gain local community support. Behaviours detrimental to the environment in these areas are often a result of limited livelihood options for local people.

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Plate 1: Insecure Crocodile Exclusion Enclosure



Plate 2: Personal Crocodile Exclusion Enclosure



Plate 3: Secure Kitul palm (*Caryota urens*) CEE



Plate 4: Crocodile Exclusion Fence, Matara



Plate 5: Mugger near houses



Plate 6: 14-15 century granite talisman for crocodiles

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