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By
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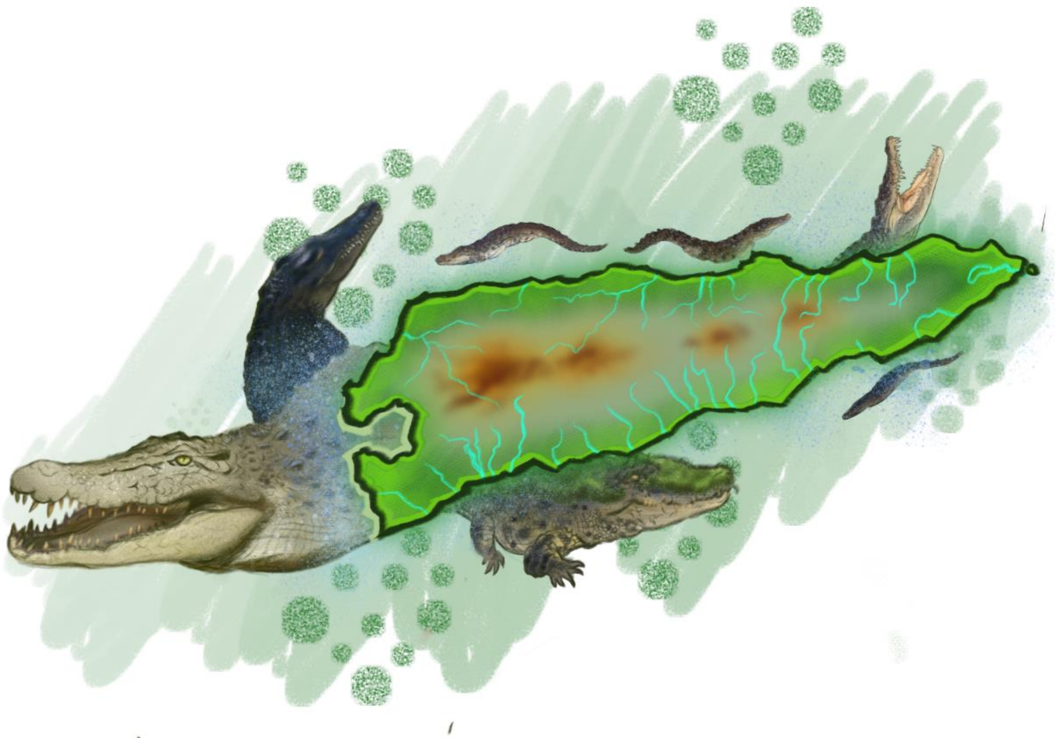

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HUMAN-CROCODILE CONFLICT IN TIMOR-LESTE: ATTACK CHARACTERISTICS AND MANAGEMENT IMPLICATIONS

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ABSTRACT

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Keywords: Cultural Values, *Crocodylus porosus*, Dispersal, Economic, Education, Habitat, HCC, Homing, Human-crocodile conflict, Saltwater crocodile, Tara Bandu, Timor-Leste, Traditional knowledge, Translocation.

Timor-Leste is a relatively new developing nation, having gained its independence from Indonesia in 2002. The people of this country have a traditional belief system in which the saltwater crocodile, *Crocodylus porosus,* forms the basis of their creation myth and thus holds great cultural value. As the populations of both humans and crocodiles on the island grow, there have been increasing occurrences of human-crocodile conflict (HCC) throughout the country. Due to the unique situation in Timor-Leste, normal management practices for HCC are not directly applicable. As a result, this country requires specific considerations for dealing with this problem while remaining sensitive to cultural values. This paper aims to discuss characteristics of human-crocodile conflict in Timor-Leste and recommend strategies for management. Conflict records from 2007-2021 were collected from the online database, CrocBITE, and attack characteristics and locations were analysed. Areas of concern due to high conflict rates are Tutuala and Lake Ira Lalaro of Lautem municipality, Suai of Cova Lima municipality, and Viqueque of Viqueque municipality. Attack hotspots followed core crocodile habitat distribution. Analysis of conflict characteristics determined that males (84%), subsistence fishers (73%) and youth below the age of 20 (43%) were the people most at risk of attack, with most conflicts (70%) resulting in a fatality. Age, activity, and water body had many cases in which these characteristics were unknown, with 32, 23, and 16 respectively. Most incidents occurred at ocean or beaches (32%), although incidents in rivers (23%) and lakes or ponds (23%) were common. Incidents peaked in the months of October to April, the warmer and wetter months, in accordance with crocodile activity levels. Crocodile size information was unavailable for most cases. Using information analysed here and existing literature, recommendations to help solve this problem were made, such as the use of traditional knowledge and education, establishment of economic incentives, genetic and migration pattern studies, and the integration of the traditional management system, Tara Bandu.

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FIGURES

ACKNOWLEDGEMENTS

The work of various other people contributed a great deal of information that was instrumental to the completion of this thesis. There were also numerous others who helped guide me in the writing process. I would like to thank Dr. William Wilson for his help and guidance through this project, and for his passion he showed for the work I have been doing. I would also like to thank Prof. Grahame Webb for our personal communication in which he provided some valuable resources and information, as well as his continued work with saltwater crocodiles in and around Timor-Leste. Prof. Ryan Wilkie has also been helpful in ensuring the requirements of this thesis have been met. Lastly, although a variety of studies were valuable sources of information, I would like to thank Brandon Sideleau and Adam Britton for their work compiling the reports on the CrocBITE database, which provided the data required for my work in this project.

INTRODUCTION AND OBJECTIVE

The saltwater crocodile, Crocodylus *porosus*, is the largest extant crocodilian and reptile on earth, and possesses the largest range of any crocodilian species. This species is known to reach lengths of up to 6-7 meters (up to 23 feet) in the largest of males, with a reputation for its aggression and tendency to prey upon humans (Ross 1998). Their massive range can be attributed to their ability to tolerate salinity, so in addition to living in freshwater habitats, they can occupy brackish and fully saline waters, and are known to traverse long stretches of open ocean (Webb et al. 2010). Thus, their natural range stretches from southern India, across the Philippines, to northern Australia, seen in figure 1.1 below.

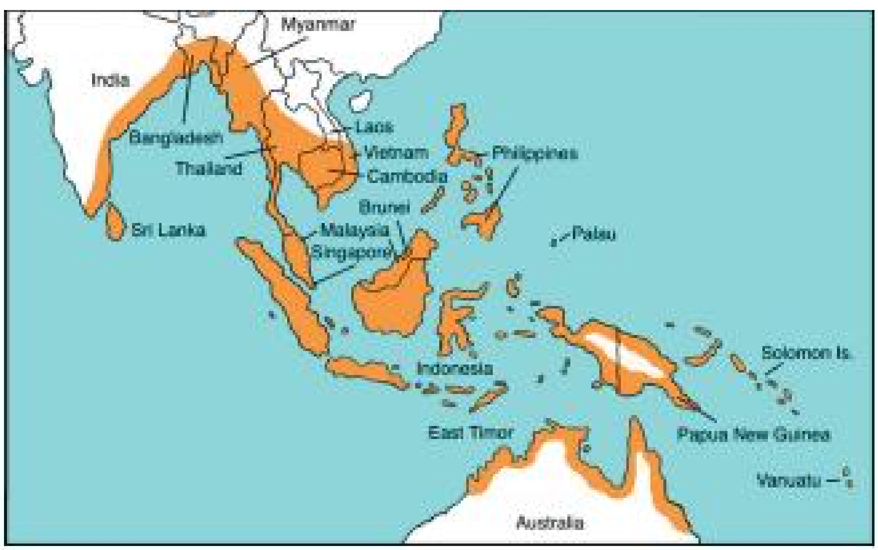

Figure 1.1. The natural range of the saltwater crocodile, C. *porosus* (Webb et al 2010).

Despite its common name, this species is usually found in freshwater, and is well known to inhabit and thrive far inland in freshwater swamps, rivers, lakes, and marshlands; in fact, they do much of their breeding in heavily vegetated freshwater swamps and rivers (Webb et al. 2010). In addition to their large range, this species has a wide selection of prey items and will consume almost anything they are able to capture. Their diet ranges from crustaceans and insects when they are hatchlings, to a variety of fish, crabs, turtles, sharks, birds, and mammals including humans when they grow large enough (Saalfield et al. 2016). Large adults are also capable of taking larger mammals such as livestock like cattle and horses (Saalfield et al. 2016). Even subadult C. *porosus* of only around 2 meters in length can take prey close to their own size, allowing them to target large prey items from a relatively young age (Corlett 2011).

C. *porosus* is relatively lightly armoured, and thus has the most commercially valuable hide of any crocodilian (Ross 1998). As a result, this species suffered intense exploitation from the late 1940s to the early 1970s, such that its numbers were severely reduced throughout much of its range (Walker 2016). Its numbers were also reduced by habitat loss due to coastal development (Ross 1998). Now, we face the opposite problem. With successful conservation efforts, their global population is stable, comprising around 500,000 individuals, although local and national populations range from being fundamentally extinct to fully recovered and at carrying capacity. The global population fits the IUCN Red List criteria for "Least Concern" (Webb et al. 2021). Conservation and management efforts are highly diverse, depending on local status, and include various combinations of regular monitoring, protection, sustainable use, strict protection, captive breeding, management of human-crocodile conflict, and enforcement. Existing threats are mainly habitat loss, incidental catch in fishing operations and hunting linked to intolerance by local peoples, all of which are difficult to control in many parts of its range (Ross 1998). Where successful recovery has occurred, due to conservation action to rebuild populations of a large predator, problems have emerged regarding their coexistence with humans.

In East Timor, also known as Timor-Leste, a small country occupying the eastern side of the island of Timor, 500 km north of Australia, crocodile attacks on people are increasing in frequency. As the wild population of C. *porosus* has increased, crocodile attack rates on humans have increased from a rate of 0.55 attacks/year in 1996-2006, to 13 attacks/ year in 2001-2014, with most victims being subsistence fishermen (Brackhane et al. 2018). Breeding is fairly limited in Timor-Leste and the relatively small resident crocodile population may not explain the rapid rate at which crocodile attacks have been increasing (Brackhane et al. 2018).

The island of Timor is split between the Indonesian province of West Nusa Tenggara on the western half, and the independent nation of Timor-Leste on the Eastern half, whose capital city is Dili (Government of Timor-Leste 2022). Before the arrival of the Portuguese in 1515, this island was ruled by two kingdoms, Sorbian and Belos, and the primary religion was animism (Government of Timor-Leste 2022). In 1651, the Dutch invaded Kupang, the capital of Western Timor, taking control of this half of the island (Government of Timor-Leste 2022). In 1859, the Dutch made an agreement with Portugal which drew the border between Portuguese Timor, which would become present-day Timor-Leste, and Dutch Timor, which would become an Indonesian province after Indonesia gained its independence in 1945 (Government of Timor-Leste 2022). However, Timor-Leste was still considered a territory under Portuguese administration until Portuguese decolonization in 1975, with widespread rejection of integration into Indonesia due to cultural differences (Government of Timor-Leste

2022). Timor-Leste declared itself an independent nation but was soon after invaded by Indonesia under the pretext of protecting its citizens, which then declared the island of Timor as one of its provinces (Government of Timor-Leste 2022). This sparked resistance across the country, which led to a violent reaction from pro-Indonesian militias, who terrorised the country until the intervention of the Blue Berets, an international military force consisting of Australia, France, Britain, Italy, Malaysia, and many others (Government of Timor-Leste 2022). This force took control by disarming the militias and beginning the reconstruction of houses, schools, and other infrastructure, before Timor-Leste was officially declared an independent country on May 20th, 2002 (Government of Timor-Leste 2022). Until the liberation of Timor-Leste, crocodile population control via culling was standard under Indonesian and Portuguese rule (Paunovic 2018).

Timor-Leste is separated into 13 political divisions called municipalities, formerly called districts, with the Municipality of Dili containing the capital city of the same name (Government of Timor-Leste 2022). A map of municipalities can be seen in figure 1.2 below. Each municipality is further divided into administrative posts, formerly subdistricts, which are in turn divided into smaller villages or sukus made up of hamlets or aldeias (Government of Timor-Leste 2022).

Figure 1.2. Map of Timor-Leste depicting political divisions by municipality (Government of Timor-Leste 2022).

The traditional Timorese creation myth, Lafaek Diak, or The Story of the Good Crocodile, describes a giant benevolent crocodile that sacrificed itself to form the island of Timor (Brackhane et al 2019). Furthermore, crocodiles are often called Avo Lafaek, or Grandfather Crocodile, under the belief that these creatures are the ancestors of the people, and as such, are incorporated into the widespread Timorese belief system, lulik, denoting them as sacred or forbidden (Brackhane et al 2019). Such a high cultural value placed on these animals produces difficulties for management in a country where human-crocodile conflict is increasing. The objective of this thesis is to analyse the available information on human-crocodile conflict and to suggest management approaches and protocols that may be effective in reducing rates of attack. Fundamental to these approaches is that traditional knowledge and established crocodile management practices elsewhere, can be used to help solve a difficult problem in a small nation with limited resources that attribute high social and cultural value to a potentially dangerous predator.

LITERATURE REVIEW

CULTURAL ATTITUDES AND TRADITIONAL KNOWLEDGE

As discussed above, cultural attitudes towards *C. porosus* complicate management strategies that aim to reduce HCC. Management of human-crocodile conflict in Timor-Leste faces cultural barriers, as crocodiles are a component of the traditional culture in Timor in multiple ways and killing them is a cultural taboo (Brackhane et al. 2018). Here, *C. porosus* forms the basis of the Timorese creation myth, “Lafaek Diak, the story of the good crocodile”, where a crocodile created the island of Timor (Brackhane et al. 2019). As a result, there is a cultural reverence of the “ancestor” or “grandfather” crocodile (Brackhane et al. 2019). These crocodiles form a part of the lulik belief system, which translates to forbidden, holy, or sacred (Brackhane et al. 2019). This belief system refers to the spiritual cosmos, which contains the spirits of the ancestors, the root of all life, and the creator, and contains sacred rules that control the relationship between people and nature (Brackhane et al. 2019). This is also the basis for Tara Bandu, which is explored below (Brackhane et al. 2019). Brackhane et al. in 2018 suggest that to effectively deal with this problem, management plans must integrate traditional knowledge. They further stress that plans need to be integrated into the traditional legal system, Tara Bandu. The research provided in this paper, particularly in locations and activities of high risk of attack, will help create a management plan more well-suited to the complicated situation in Timor-Leste (Brackhane et al. 2018). Cultural beliefs may produce incentives for conservation but are also important to consider when determining what management strategies are acceptable for local indigenous stakeholders (Brackhane et al. 2019). Saltwater crocodiles hold such respect that they are often mascots to police and military forces and taken into homes as pets (Brackhane et al. 2019). As they hold such importance, the typical western concepts of management are not directly applicable in Timor-Leste, requiring more culturally sensitive strategies (Brackhane et al. 2019). Brackhane et al.'s 2019 paper used interviews to derive information from local stakeholders to determine an appropriate response to HCC, and found useful information to help guide management decisions. They found that traditional ecological knowledge will be useful in determining how to manage crocodiles given their cultural importance, with five local authorities from the study emphasizing that it is necessary to integrate local traditional strategies into a nation-wide crocodile management system. Particularly important is an elder, called Dato Lulik or Lia Nain, within coastal communities that is responsible for issues related to crocodiles in those communities, and need to be consulted when crocodile attacks occur. These individuals represent major sources of information for guiding the future management of HCC in Timor-Leste. However, Manolis and Webb in 2019 warns that although traditional knowledge is important, it should be considered that relatively few indigenous peoples today have lived through periods of high crocodile abundance. While Manolis and Webb's study focuses on HCC in Australia's Northern Territory, Timor-Leste faces similar conditions, as crocodile populations in Timor-Leste have been historically suppressed and are increasing in recent times due to the widespread recovery of *C. porosus.* Lastly, Brackhane et al. concluded that extending research to other communities, including in West Timor where rates of HCC and attitudes towards *C. porosus* are similar, could help ensure that management is participatory and effective.

ATTACK CHARACTERISTICS

Attack characteristics are a well-studied aspect of HCC management that will be included in this thesis. Brackhane et al in 2018 found that most attacks are predatory in nature. Through analysis of available data, they found that conflicts occur in a range of locations such as the open ocean, beaches, reefs, tidal and non-tidal wetlands, and a range of salinity and turbidity (Brackhane et al. 2018). It is unknown if the crocodiles responsible for the attacks are residents or immigrants from other regions, particularly from the fully recovered population in the Northern Territory (Brackhane et al. 2018). Brackhane et al.'s 2019 study on HCC in Australia found that rural communities are most affected by human-wildlife conflict, especially in the case of crocodilians. Similarly, Manolis and Webb in 2019 analysed attack records sourced from newspaper reports and journal publications, excluding 5 attacks for which details could not be determined. Reasons for attack ranged from nest defence to mistaken identity and self-defence, to food and territoriality which was the most common (Manolis and Webb 2019). Additionally, about one third of attacks were fatal and a disproportionate number of victims were aboriginal people, explained by a traditional lifestyle that puts them at greater risk of attack (Manolis and Webb 2019). Additionally, Sideleau et al. in 2021 studied public attack records on humans from 2009 to 2018 in the Indonesian province of East Nusa Tenggara. Researchers used an online database of incidents known as CrocBITE, then worked with government representatives to visit HCC areas and gather records of unreported attacks and information on the local perception of the animals. Out of 100 attacks that were gathered, 60 were fatal, with males making up most victims at 84, mostly occurring during fishing, with 75 cases (Sideleau et al. 2021). This region includes West Timor, which has a similar context to Timor-Leste, and made up 70% of attacks (Sideleau et al. 2021). Sideleau et al.'s 2016 paper, An Analysis of Recent Saltwater Crocodile (Crocodylus Porosus) Attacks in Timor-Leste and Consequences for Management and Conservation also provides attack statistics and methodology important for this thesis. This study used a very similar methodology to the one undertaken in this thesis, although this thesis uses more up to date information. They analysed 45 reported conflicts from Timor-Leste from 2007-2014, using the CrocBITE database. The data available on CrocBITE was largely collected through publicly available media sources that was gathered by Sideleau and Britton over several years, including information on victim age, sex, activity at time of attack, witnesses, and geographic information such as waterbody and political unit when available. However, information is very limited before 2010 and non-existent before 2007 due to political difficulties before 2009 and a lack of online presence until recently (Sideleau et al. 2016). Thus, trends over time were not analysed because their results would be misleading, guiding the analysis of data in this thesis. Of the analysed attacks, 82.2% were fatal, with 46.7% of attacks occurring along the southern coast, particularly in the municipalities of Cova Lima, Manufahi, and Viqueque (Sideleau et al. 2016). The fatality rate here is much higher than in other countries, suspected to be due to reporting bias against non-fatal attacks (Sideleau et al. 2016). Papua New Guinea had similar rates of HCC fatalities, but Australia had far less (Sideleau et al. 2016). Australia differed from Timor-Leste in the fact that residents have more access to fresh water and do not need to rely on subsistence fishing, as most victims were swimming when attacked (Sideleau et al 2016). They also found that times of day of concern in this study were stated to be early morning or afternoon, unlike the information found in this thesis and other sources that suggest they occur more commonly at night.

HABITAT

Studies regarding habitat for *C. porosus* in Timor-Leste have been sparse. Sideleau et al. in 2021 strongly recommend further habitat surveys in areas of high conflict rates and risk of attack that will guide future management direction. Further, Brackhane et al.'s 2018 paper, Habitat Mapping of The Saltwater Crocodile (*Crocodylus Porosus*) In Timor-Leste provides an assessment and mapping of the suitable habitat distribution for *C. porosus* in Timor-Leste using geographic and climate data. This study exemplifies the first steps to habitat mapping for *C. porosus* in Timor-Leste and can provide valuable information to help developing countries with limited resources manage HCC. This approach may also be easily applied to various islands with simple habitat distribution, but larger countries with more complex water body systems may require more systematic approaches to habitat assessment (Brackhane et al. 2018). They found that the northern coast is relatively dry, with a rainy season from December to March with 50–350 mm precipitation/month, a transition period in November, April, and May with 50-150mm/month, and a distinctive dry season from June to October with 0–50 mm precipitation/month (Brackhane et al. 2018). The southern coast has a rainy season from December to June with 100–400 mm/month, a transition period in July and November with 50-150mm/month, and a dry season from August to October with 0-50mm/month (Brackhane et al. 2018). They mapped core, seasonal, and coastal habitat, aided by knowledge from the local Crocodile Task Force, who had information about crocodile sightings and traditional ecological knowledge of stakeholders from 8 communities affected by HCC, producing figure 2.1 below.

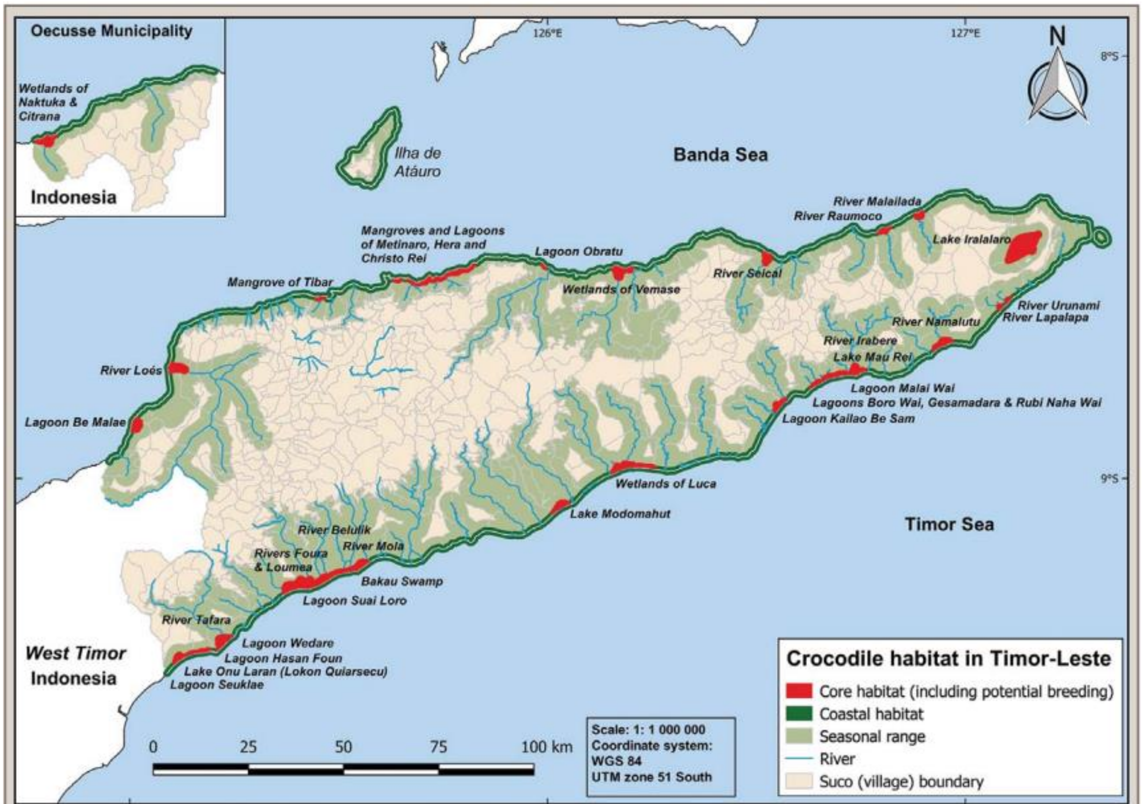

FIG. 1. Potential core, coastal, and seasonal habitats of Saltwater Crocodiles in Timor-Leste.

Figure 2.1. Mapped habitat distribution of *C. porosus* provided by Brackhane et al. 2018.

The higher levels of precipitation in the southern portion of the island produces wetter conditions, which in turn provides more available habitat for crocodiles (Brackhane et al. 2018). No crocodiles were sighted above 500m in elevation, so these areas were excluded (Brackhane et al 2018). Almost all creeks and rivers in the country originate in the central mountain ridge and many of them dry up during the dry season (Brackhane et al 2018). The integration of more traditional knowledge can provide information that can improve the effectiveness of habitat mapping, especially in areas of high geographical complexity (Brackhane et al. 2018). The information in this paper provides valuable information regarding high-risk areas in Timor-Leste and will help guide management decisions that aim to reduce HCC.

OCEAN CURRENTS AND DISPERSAL

Although the natural recovery of crocodiles following the end of exploitation has produced increased numbers, local stakeholders assume that the “troublemakers” are migrants that mostly roam the coastline (Brackhane et al. 2019). Another potential contributor to the problem is the ongoing extraction of resources that damage crocodile habitats and nesting sites, which one local authority reports is causing crocodiles to disperse (Brackhane et al. 2019). Further, Fukuda et al., 2014, found that most problem crocodiles were relatively young migrating males; thus, effective management should focus on examining their movements and focussing capture efforts in areas where they enter and exit management zones. Fukuda et al. in 2019 also studied genetic structure and homing ability of *C. porosus* near the Cobourg Peninsula of Australia’s Northern coast. Management interventions meant to reduce HCC are complicated by the homing ability of *C. porosus,* which often return to the capture site. Every year, 250-300 crocodiles are removed from Darwin Harbour in Australia’s Northern Territory (Brackhane et al. 2019). With limited local breeding, the number of individuals removed every year indicates significant immigration through coastal movement (Brackhane et al. 2019). High mobility would promote random mixing, which would lead to a genetically homogenous population, but these assumptions about crocodile movement or genetic homogeny have not been tested (Brackhane et al. 2019). Therefore, this study aimed to understand these concepts for application to HCC management. They used satellite tracking and DNA analysis to test two null hypotheses: movements around the

NT coast are not limited by natural barriers, and there are no genetically distinct subpopulations across the coast separated by natural barriers. Both null hypotheses were rejected. They used satellite tracking devices to track the movements of 5 large male *C. porosus* that were captured and translocated 100-320km from their capture site, with 3 additional individuals released at the site of capture as controls and found that translocated crocodiles became more mobile than the controls and began to move by sea towards their original capture site (Brackhane et al. 2019). However, the Cobourg Peninsula presented a major geographic barrier to their movement, as they were either unable or unwilling to navigate around it, which prevented homing in all five cases (Brackhane et al. 2019). In comparison, the Cape York Peninsula was not an effective barrier, as an individual caught on the western side and translocated to the East was able to return, possibly by exploiting surface currents (Brackhane et al. 2019). It is unknown why the Cobourg Peninsula interferes with the movements of *C. porosus,* and the coastal oceanography around this area is complex and not well understood, but ocean currents likely contribute (Brackhane et al. 2019). The researchers also collected tissue samples from nests across the coast of the Northern Territory, and with genetic testing, they found significant genetic structure across populations on the coast, with the Cobourg Peninsula contributing to genetic differentiation among populations (Brackhane et al. 2019). Although *C. porosus* can navigate long distances, this study provides evidence that their homing and travel abilities can be inhibited by geographic structure, which provides valuable information that should be considered for management (Brackhane et al. 2019). Also, the fact that genetically distinct subpopulations exist means that the source of individual problem animals can be identified (Brackhane et al. 2019). These findings can thus guide management efforts with new information about movement barriers and source populations.

Furthermore, the long-distance migratory capabilities of *C. porosus* has been poorly understood, but Campbell et al. in 2010 has studied the idea that they make use of ocean currents to facilitate their movements. Mountain ranges, icefields, deserts, and oceans often represent major obstructions in the long-distance movements of animals, but individuals that can utilise wind and water currents to reduce the burden on their own energy stores increase their chances of success (Campbell et al. 2010). Accordingly, the flight paths of many migrating birds follow wind patterns and travelling marine animals will also tend to follow currents (Campbell et al. 2010). All crocodilians have limited aerobic capacity, so this level of sustained swimming is difficult to explain and suggests that these animals are making use of ocean currents like other long-distance migrants (Campbell et al. 2010). Furthermore, crocodilians have evolved from terrestrial archosaurian ancestors, and have morphology evolved for semi-aquatic life rather than fully aquatic life, which inhibits their efficiency when travelling long distances in water (Campbell et al. 2010). There are many accounts of crocodiles sighted in the open ocean, but there have been few studies tracking individuals making journeys like this (Campbell et al 2010). In this study, crocodiles were implanted with acoustic transmitters to track their long-distance movements in rivers, and satellite transmitters to track them in the ocean. They found that crocodiles altered their behaviour to account for changes in current flow in both river and ocean journeys, often coming ashore or diving to rest on the substrate when flow was unfavorable (Campbell et al. 2010). For three crocodiles that were making long-distance travels at sea, there was significant correlation between the bearing of the travelling crocodile and the residual surface current velocity (Campbell et al. 2010). This study provides evidence that adult *C. porosus* make use of surface currents to overcome physiological limitations to facilitate their long-distance oceanic voyages. This finding has considerable management implications for this species and provides insight into how these animals may be moving between regions and countries throughout their range (Campbell et al. 2010).

REMOVAL AND TRANSLOCATION

When applied to saltwater crocodile management, the strategy of removing crocodiles through translocation or culling has long had mixed results. Brackhane et al.'s 2019 paper, researchers analysed the situation in Timor-Leste, where there has been a dramatic increase in saltwater crocodile attacks following the successful recovery of the species. In this paper, removal as a management strategy is criticized, as it is complicated by the reptile's ability to travel long distances between environments and neighboring countries, such that removed crocodiles can be quickly replaced by immigrants (Brackhane et al. 2018). Therefore, removal as a management strategy must be maintained constantly, such as in Australia's Darwin Harbour, where around 300 crocodiles must be removed every year to ensure human safety (Fukuda et al. 2014). Specific problem crocodiles may also be removed on requests by landowners (Fukuda et al. 2014). Fukuda et al. in 2019 also found that the practice of translocating problem crocodiles as a management strategy for reducing HCC needs to be re-evaluated, as they are likely to return unless moved across a sufficient geographic barrier. According to Brackhane et al.'s, Crocodile Management in Timor-Leste, Drawing Upon Traditional

Knowledge, Timor-Leste established a crocodile task force in 2012 in response to increased HCC, but this task force lacks the resources to create and implement effective management measures. Although there is a general aversion to killing crocodiles in Timor-Leste, the increased attack rates have resulted in some calls for culling (Sideleau et al. 2016). This method should still be avoided based on protecting cultural values (Brackhane et al. 2019). Amarasinghe et al.'s 2015 study of HCC in Sri-Lanka further criticized the prospect of removal, stating that due to their strong homing instinct, *C. porosus* will often return capture sites. Additionally, translocated crocodiles in Australia appear to become more mobile after translocation, and two of them were involved in attacks on humans afterwards (Amarasinge et al. 2015). Thus, translocation to the wild is generally not an effective strategy, potentially even making HCC worse (Amarasinghe et al. 2015). Only problem crocodiles that threaten humans or livestock should be captured and relocated to captive facilities (Amarasinghe et al. 2015). Crocodile exclusion enclosures have been used effectively in Sri-Lanka and have helped reduce HCC, but they are costly to construct and maintain (Amarasinghe et al. 2015). Local communities may be able to facilitate and contribute to their construction and maintenance, which would help implement them sustainably (Amarasinghe et al. 2015).

EDUCATION

Education has been widely identified as an effective tool in mitigating HCC and is supported by several studies. A common lack of concern for safety regarding large and potentially dangerous predators due to traditional beliefs by the Timorese people increases risk of attack (Sideleau et al. 2016). Australia provides evidence that education and awareness campaigns aimed at more vulnerable younger demographics can effectively mitigate attack risk (Sideleau et al. 2016). They also suggest that improved signage and safety barriers can help further reduce conflicts (Sideleau et al. 2016). Similarly, Fukuda et al. in 2014 found that education through various forms of media to inform the public as well as programs to inform both indigenous and non-indigenous peoples are important to reduce conflict in Australia. Also, it is important to note that crocodilians are moving back into areas where the residents have no institutional knowledge of crocodiles and thus assume their absence when performing water activities that put them at risk of attack, further increasing the need for education and awareness campaigns (Fukuda et al. 2014). Through Manolis and Webb's 2019 analysis of attacks since 1971, they also supported that public education is a critical element of management, and such a high proportion of attacks on indigenous peoples indicates that there needs to be more attention on this sector in a culturally appropriate manner. Sideleau et al's 2021 study in East Nusa Tenggara also recommends resources and training to help improve local knowledge and the implementation of community-based education. In Amarasinghe et al., Sri Lanka also faces rising levels of HCC due to an increasing number of crocodiles and high human population around protected areas. Although, the attitude towards crocodiles in Sri-Lanka differs from that of Timor-Leste (Amarasinghe et al. 2015). In Sri Lanka, perception is generally negative as they are seen as monsters and killers, while in Timor-Leste they are revered (Amarasinghe et al. 2015). Therefore, Sri-Lanka faces more violent responses to crocodile conflict from humans, which threatens conservation efforts (Amarasinghe et al. 2015). This study also stresses the importance of awareness and educational campaigns, which will involve a diverse range of stakeholders such as the government, non-governmental agencies, business and tourism sectors, the media, and both the urban and rural public (Amarasinghe et al. 2015). Due to volatile societal perceptions towards crocodiles in Sri-Lanka, education must inform people on the dangers of living with crocodiles, but also convey why they need to be conserved (Amarasinghe et al. 2015). The media should also use neutral language and present a balanced view on the animals to avoid negative perception (Amarasinghe et al. 2015).

TARA BANDU

Tara Bandu, the customary legal system mentioned previously, is a traditional method of natural resource management that was outlawed during Indonesia's occupation of Timor-Leste (Bhattacharya 2018). To help stop the exploitation of its forests and oceans, Timor-Leste has been reviving the tradition since its independence in 2002 (Bhattacharya 2018). Tara Bandu literally means hanging law, in reference to the traditional hanging of culturally significant items placed on a wooden or bamboo shaft to place a ban on certain activities in an area (Piludu 2017). This can include access to certain spaces, fishing in certain locations, catching or cutting down certain species, or damaging anything declared sacred, or *lulik* (Bhattacharya 2018). The practice involves fines for violating restrictions that are determined on a community level, and it is particularly effective since it has strong cultural implications, namely that violating Tara Bandu is considered sacrilege by the Maubere, the various indigenous ethnic groups in Timor (Bhattacharya 2018). Tara Bandu is flexible and localized, able to include a range of restrictions that vary at a community level, so that local preferences and beliefs can be incorporated, especially in rural locations where a central government is less effective (Bhattacharya 2018). However, Tara Bandu laws do not govern crocodiles themselves at present, only specific rivers and lagoons and the resources within (Brackhane et al. 2019). Thus, this indigenous method of natural resources management may be particularly important for managing the increased attacks brought on by increased numbers of saltwater crocodiles.

ECONOMIC INCENTIVES

A major tool for managing HCC can be the development of economic incentives for the people that live alongside crocodiles. Sustainable methods such as farming and ranching crocodiles for their skins and harvesting their eggs are employed in Australia and are recommended by the 2018 Brackhane et al. paper. Although, they identify that Timor-Leste lacks the infrastructure and capability to employ these methods at present (Brackhane et al. 2018). Thus, once more information on migratory populations and infrastructure is developed more, sustainable methods of population control could create new income opportunities that reduce the need for high-risk activities (Brackhane et al. 2018). Fukuda et al.'s 2014 stresses that sustainable economic incentives also create an incentive for communities to tolerate and conserve wild populations. For example, the ranching program landowners with income from crocodile eggs, creating commercial incentives to tolerate crocodiles (Fukuda et al. 2014). As a result, the current management plans aim to maintain high and abundant crocodile populations in the wild, despite the threat they pose (Fukuda et al. 2014). Tourism may also represent a significant economic benefit in Timor-Leste. Sideleau et al. in 2016 identified that a high number of attacks on beaches represents a potential barrier to the growth of the tourism industry in Timor-Leste, which would negatively affect crocodile conservation if there were fatalities of tourists. They also suggest that the development of the ecotourism sectors in Timor-Leste would bring further benefit to both humans and crocodiles (Sideleau et al. 2016).

MATERIALS AND METHODS

Following Sideleau et al. 2021 and Brackhane et al., the online crocodile attack database, CrocBITE was used to gather information about saltwater crocodile attacks in Timor-Leste, including the size of the crocodile responsible for the attack; fatality, date, water body and location of the attack; and the victim's gender, age, and activity. The available data begins in the year 2007 and the most recent record available is from the year 2020, with a total of 60 incidents. These incidents were entered into Microsoft Excel for basic analysis of various attack characteristics and the preparation of figures. When possible, these incidents were identified to the municipality and administrative post level and markers representing these incidents were plotted on a satellite map of the country using the online mapping software, Maptive. Plotted points on the map allowed the identification of HCC hotspots in Timor-Leste for comment. Locations referred to on CrocBITE, when possible, were located using the sites Mapcarta and Mindat. Additional information about municipality and administrative post for each attack was gathered from the Government of Timor-Leste's document: Timor-Leste in Figures. When the water body the conflict occurred was identified in the source, it was placed in the corresponding water body on the map. When it was not stated, the marker was placed within the general vicinity of the location referred to in the source, such as a nearby body of water or the identified town. Although there were 60 incidents, the location of 8 of them could not be determined to a reasonable degree with the available information, resulting in a total of 52 marked incident locations. Location data was also graphed by both municipality and administrative post. Additionally, conflict characteristics such as activity when attacked, fatality, age and gender of victim, and size of the crocodile involved were visualized. Similarly, years of attack were graphed. Mean climate data such as precipitation and temperature for Timor-Leste was gathered from the Climate Change Knowledge Portal, then graphed with comparison to conflicts for each month. Using this information, along with the available literature, the results and their management implications are discussed.

RESULTS

Using the available data, various conflict aspects were illustrated in figures 4.1 to 4.12. As evident in figure 4.1, conflict incidents were spread across the country, but following normal *C. porosus* behaviour, they were limited to coastal areas with none occurring very far inland. The furthest inland incident was a non-fatal conflict that occurred in the Saisal River near Uatu-ua, in the administrative post, Baucau, Baucau Municipality, which is only about 10km from the ocean. There was an incident potentially further inland in a river near the city of Lospalos, although the precise location or water body was not provided in the record. Figure 4.2 is a heatmap of recorded incidents to show conflict density. A full table of all data combined can be found in Appendix I.

Figure 4.1. Satellite map of Timor-Leste with all known conflict locations plotted using markers. Red markers indicate fatal incidents and purple markers indicate non-fatal incidents.

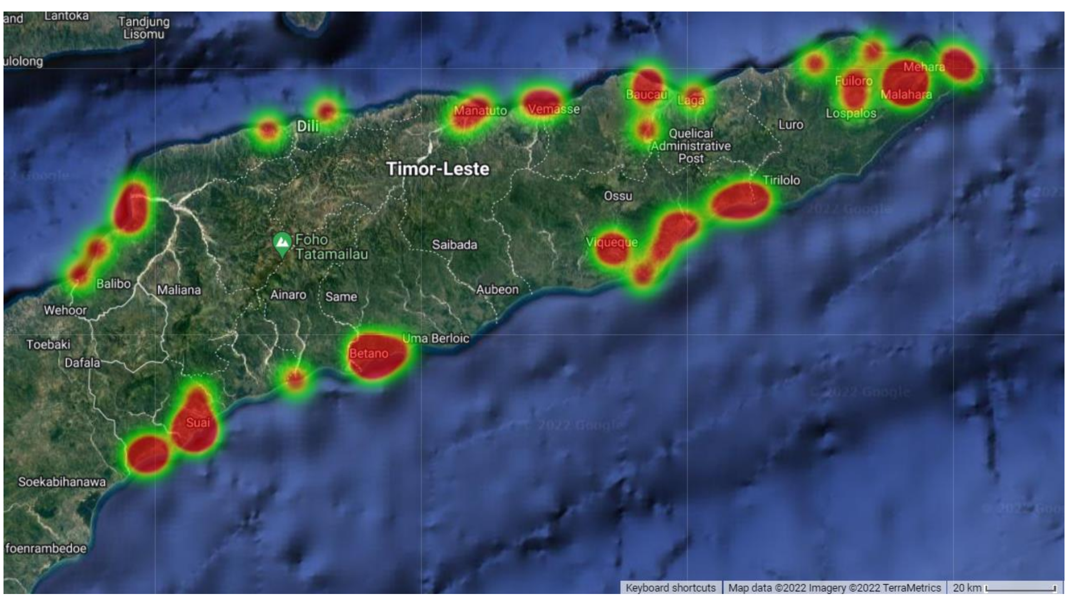

Figure 4.2. Heat map of conflict incidents, illustrating hotspots.

Numbers of conflicts can be seen graphed by municipality in figure 4.3. C. *porosus* conflict with humans was the highest in the municipality of Lautem, with 13 incidents, and second highest in the municipalities of Cova Lima and Viqueque, with 9 each.

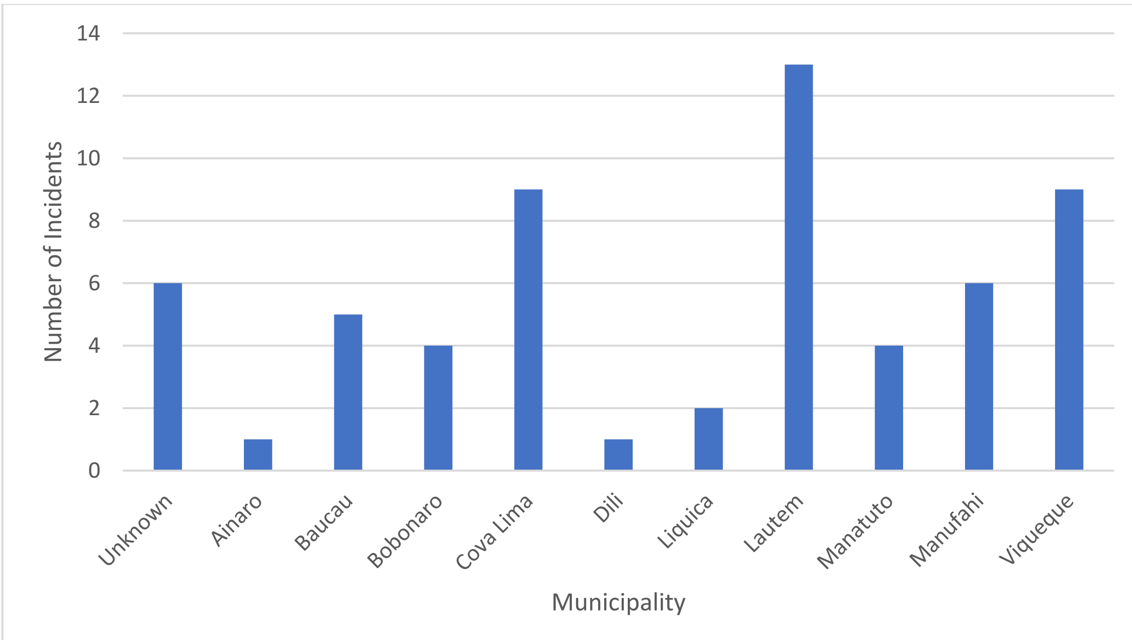

Figure 4.3. Number of conflicts graphed by municipality.

Incidents are graphed by administrative post and their respective municipality in figure 4.4. In this figure, the administrative post within Lautem with the most conflicts was Tutuala, with 7 incidents, 5 of which occurred in Lake Ira Lalaro. The incidents of Lautem can be seen mapped in figure 4.5. The administrative post in Cova Lima with the most conflicts was Suai with 6 records, and in Viqueque records were equal between Uatu Carbau, Uatulari, and Viqueque, with 3 conflicts each. Incidents from these municipalities were plotted on the map in figure 4.6.

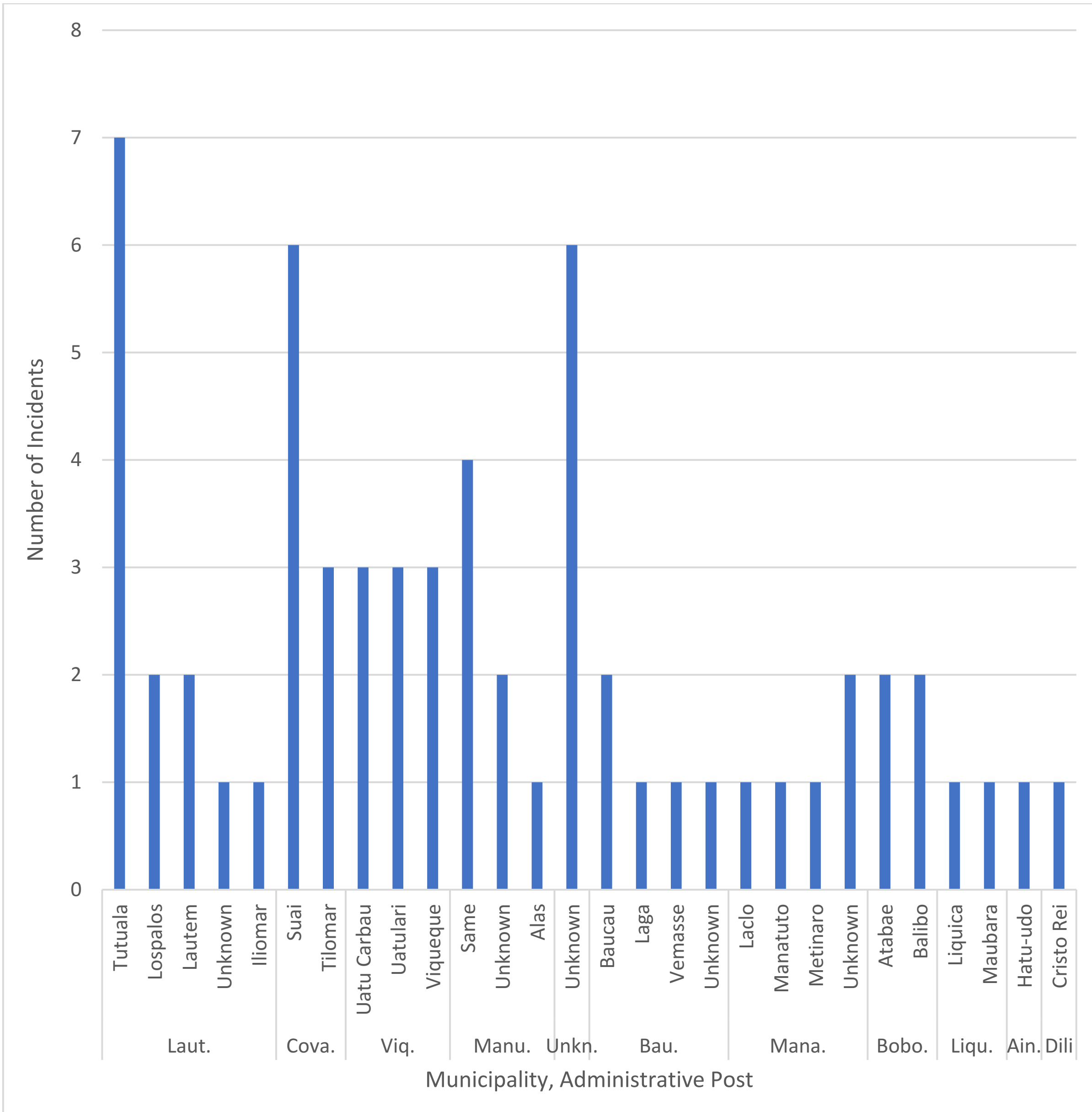

Figure 4.4. Number of conflicts graphed by municipality and administrative posts.

Figure 4.5. Mapped incidents for the administrative district with the most conflict records, Lautem.

Figure 4.6. Mapped incidents for the administrative districts with the second most incidents: Cova Lima (top) and Viqueque (bottom).

Using average climate data for Timor-Leste, conflicts were graphed with climate in figure 4.7. Temperature for the country differs by about 3 degrees throughout the year. The highest average minimum temperatures were in the months of December and March at a temperature of 21.02°, and the lowest was 18.25° in the month of August. Precipitation followed a similar pattern, with the lowest month for precipitation also being August, with only 19mm. January was the month with the highest precipitation at 224mm. Highest mean temperature remains mostly consistent throughout the year, dipping slightly in May-September. Numbers of human-crocodile conflict incidents followed precipitation and temperature patterns, with only one in June and August, and 8 in January, February, and October. During the months of October to April, conflicts were highest, with 8 incidents each in January, February, and October. A table containing climate and attack data can be found in Appendix II.

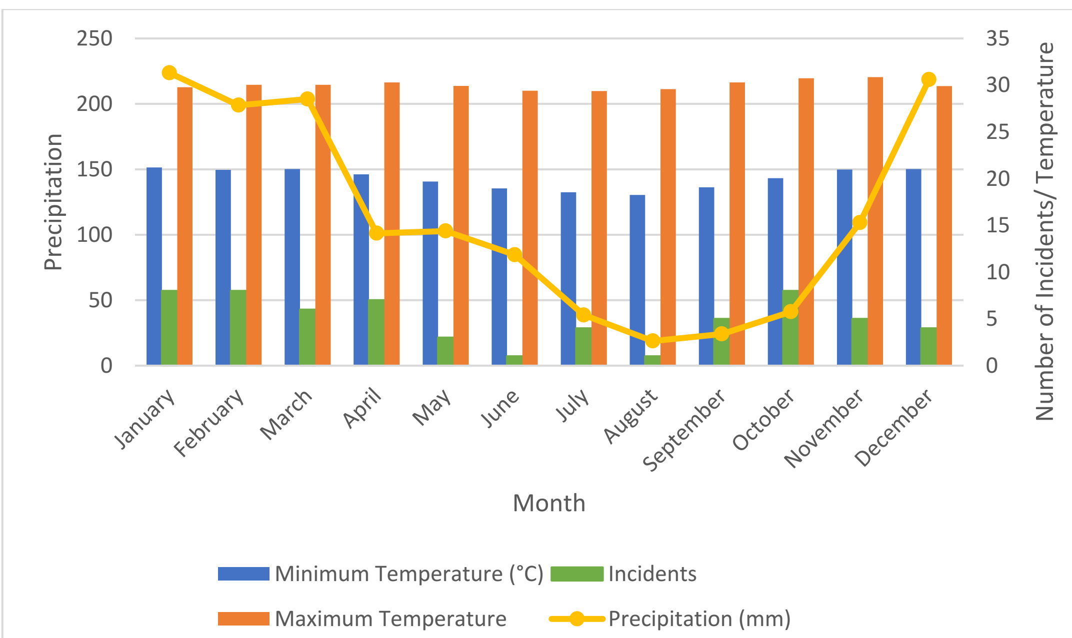

Figure 4.7. Average precipitation and temperature of Timor-Leste graphed with human-crocodile conflict by month.

The water bodies that conflicts occurred in are graphed in figure 4.8 below. In most cases, the type of water body was unknown, but in the ocean or on a beach was the highest category of the known incidents, making up 32%. This category is followed closely by lakes and ponds with 23%.

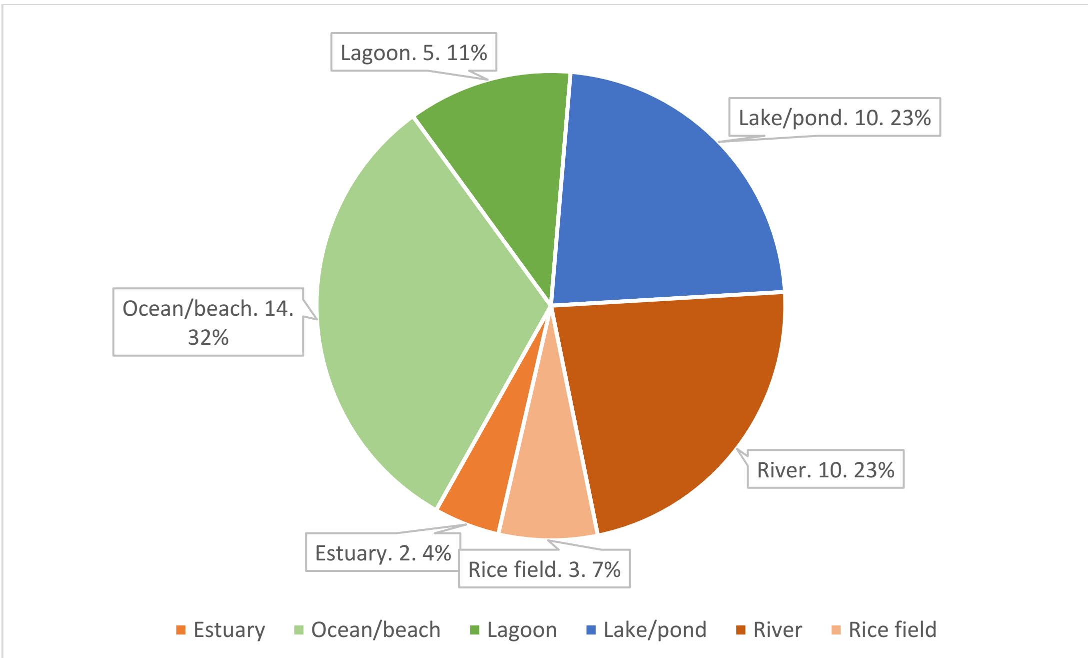

Figure 4.8. Instances of human-crocodile conflict illustrated by the water bodies they occurred in. There were 16 attacks in which water body was unknown, which have been excluded.

Number of incidents were illustrated by the activity being performed by the victim at the time of the conflict in figure 4.9. Fishing was by far the most common activity of the records. Figure 4.10 graphs victim age grouped by 20-year intervals and shows that of the known cases, most victims were youth between 0 and 19 (43%).

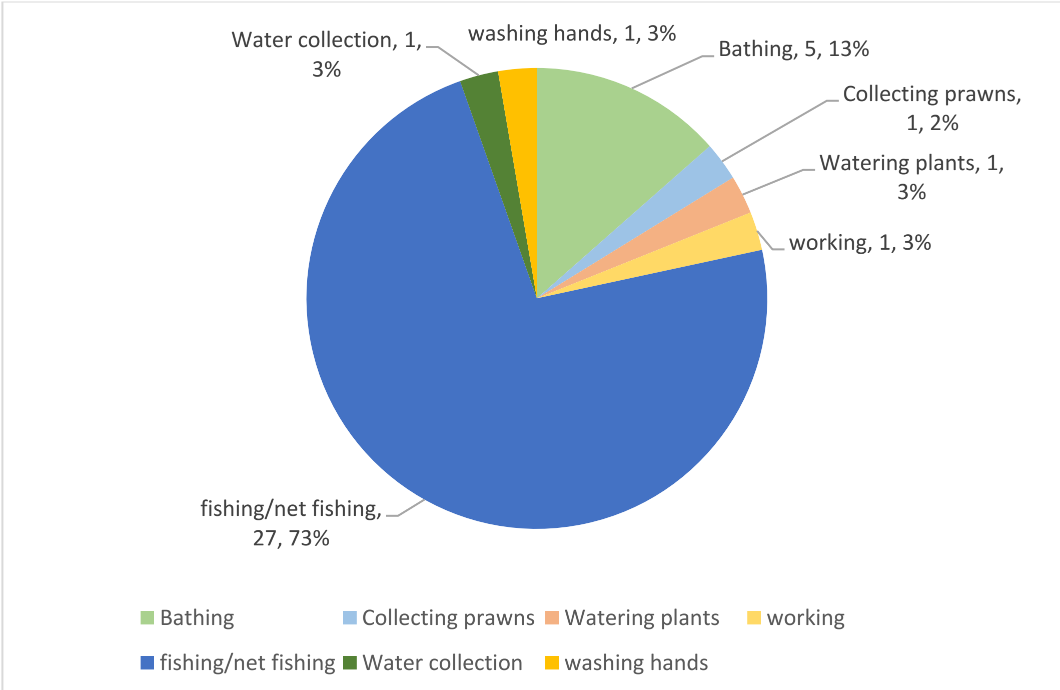

Figure 4.9. Conflicts illustrated by the activity being performed when the attack occurred. 23 incidents were unknown.

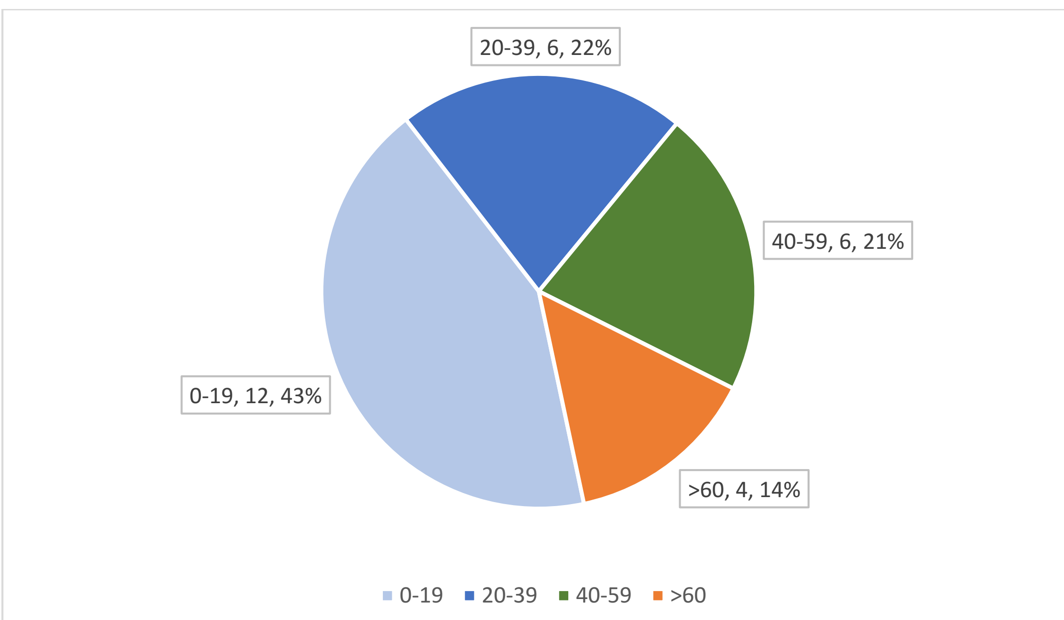

Figure 4.10. Conflicts depicted by victim age, grouped in 20-year intervals. 32 incidents were unknown.

Figure 4.11 graphs cases by whether the conflict resulted in a human fatality, with 70% resulting in a death. In figure 4.12, which graphs cases by the victim's gender, a majority of the victims are male. This data only includes reported attacks, not the numerous unreported attacks caused by cultural bias.

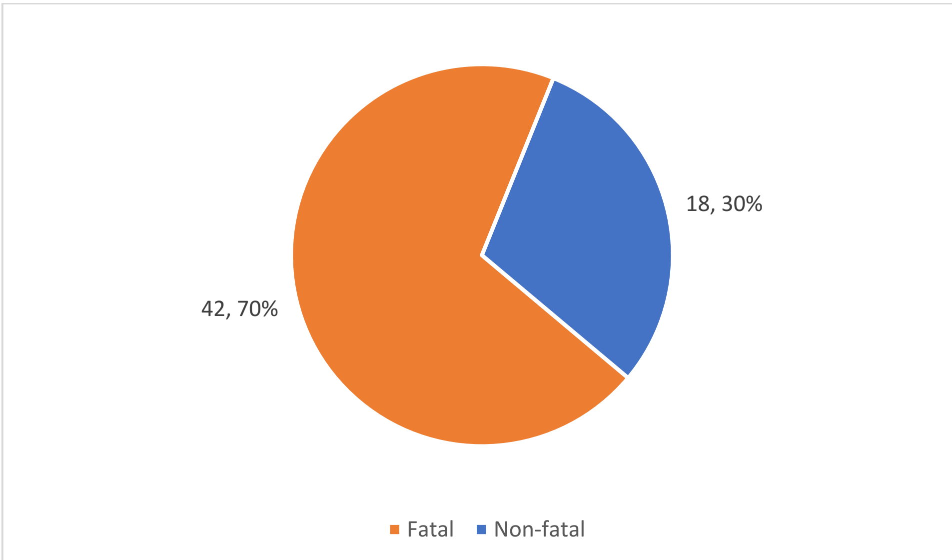

Figure 4.11. Conflicts illustrated by fatality.

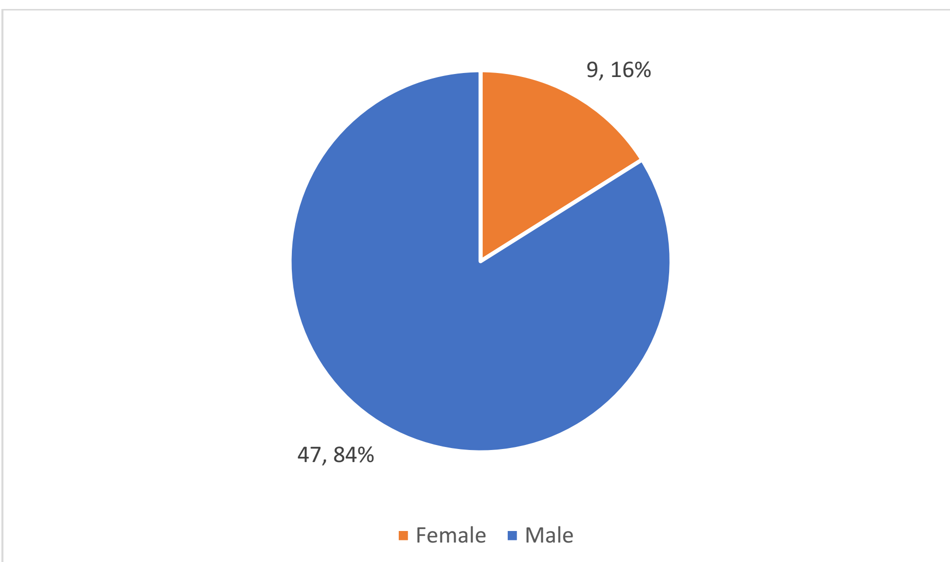

Figure 4.12. Conflicts graphed by victim gender. The gender of four victims were unknown.

DISCUSSION

GEOGRAPHIC DISTRIBUTION

The geographic distribution of *C. porosus* conflict incidents across Timor-Leste aligns strongly with the core distribution of habitat provided in Brackhane et al.'s 2018 paper and the known information on crocodile habitat in the country. Despite limited breeding habitat in Timor-Leste, conflicts are clustered around core habitat, suggesting that the crocodiles responsible for attacks are largely not migrants roaming the coast, although there were still many occurrences on beaches outside of these areas. These instances are well within dispersal range for this species, so they may also be crocodiles from Timor-Leste, and not necessarily migrants from elsewhere (Brackhane et al 2018). However, as it can be seen in figure 5.1, this may be due to the lack of people in the area, meaning that conflicts are more common near core habitat because the conditions of these sites attract both crocodiles and people, in good fishing spots for humans, and ideal habitat for crocodiles. The higher proportion of incidents in the southern part of the country may be explained by migrants from Australia, but it is more likely that this is because of the more favorable conditions in the south which provide more suitable habitat for crocodiles. The idea that crocodiles are migrating from Australia to the Southern coast of Timor-Leste comes from circumstantial evidence such as *C. porosus* sightings at oil wells between the Northern Territory and Timor-Leste, which suggest that a proportion of attacks on the south coast are caused by migrants (Webb pers. Comm. 2022). The extent of such immigration and the proportion of attacks contributed by migrants remains unknown but is currently being investigated by DNA sampling of coastal *C.*

porosus (Webb pers. Comm. 2022). Also, although the population of the country is increasing, the areas most affected by HCC are the areas with some of the lowest population densities, evident in figure 5.1, meaning the people in remote areas of Timor-Leste are at a higher risk of attack, like the findings of Manolis and Webb in 2019.

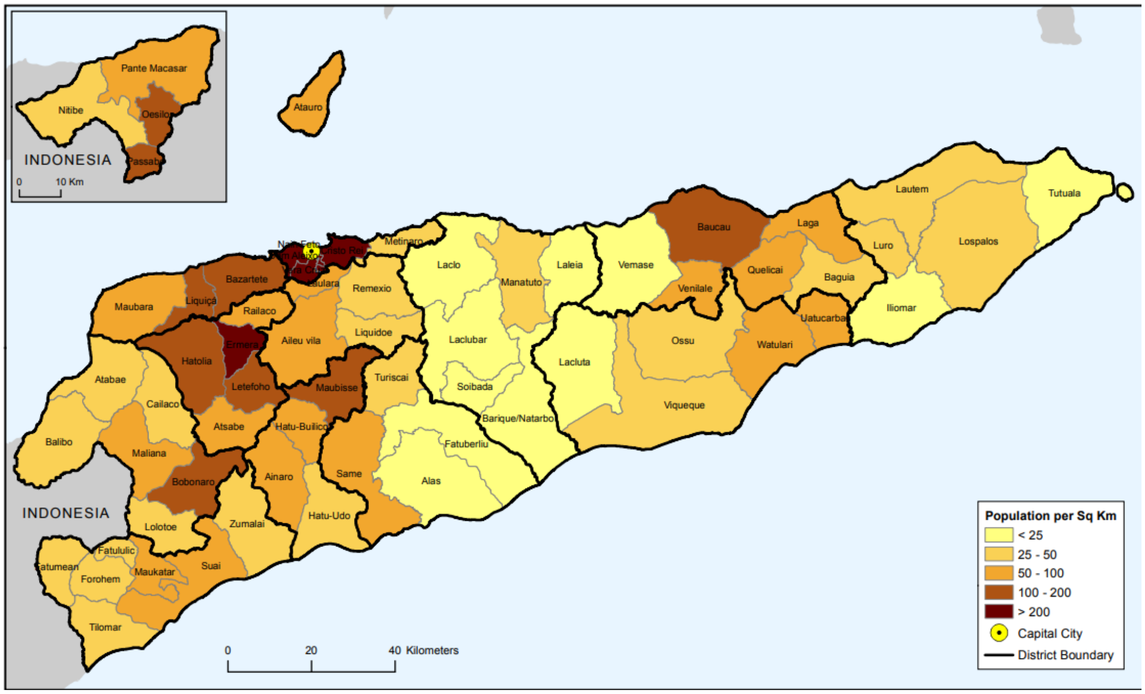

Figure 5.1. Map of population densities by municipality and administrative post in Timor-Leste (Census Atlas 2004).

The area with the most conflicts was Lautem, administrative post Tutuala, with a low population density. The next highest areas were Viqueque and Cova Lima. In Viqueque, the administrative posts Viqueque, Uatulari, and Uatu Carbau had low to moderate density. Suai in Cova Lima also had moderate human density. The administrative post, Same of Manufahi municipality also had a high number of incidents, also with a moderate population density. Lake Ira Lalaro is a reason for such a high incident rate in Lautem. This lake lies in the administrative post, Tutuala, and is the location of five of the seven incidents in this region. This lake is believed to contain the largest population of crocodiles in the country, and many people rely on it for subsistence fishing (Sideleau et al. 2016). Furthermore, the use of boats in this lake was prohibited for cultural reasons, putting the people that use this lake at even further risk of attack (Sideleau et al. 2016). Although population surveys for *C. porosus* in Timor-Lest are lacking, populations have likely been increasing since management of crocodile populations have ceased following Timor-Leste’s independence from Indonesia. This further increases risk to the people who live close to crocodile habitat and who have not lived through periods of such high crocodile abundance, as seen in cases involving aboriginal peoples in the Northern Territory of Australia (Manolis and Webb 2019).

VICTIMS AND CROCODILES

Most of the victims were men, which aligns with gender roles, where men are the individuals primarily responsible for tasks like fishing (Sideleau et al. 2015). Fishing is the activity that holds the highest risk of attack with 27 instances: 45% of all recorded cases. Fishers are more at risk due to risky fishing practices, where they stand in knee deep water and catch fish using nets, which gives crocodiles greater opportunity to easily attack them. Conflicts were also overwhelmingly fatal, at a rate of 70%. However, this highlights an issue with data. This study suffers from a lack of data and the available records of incidents were often lacking important information. Further, data is likely biased influenced by cultural perceptions of the region, where there is a belief among the people that “good” crocodiles only attack “bad” people (Webb pers. Comm. 2022). This leads to a reluctance to report attacks, meaning less severe and non-fatal incidents would not have been underreported. The total amount of unreported attacks is unknown. In other studies, much of their data was sourced from in person interviews that were not available on CrocBITE, which means the data used for this study was further limited. For comparison, only about one third of the conflicts from Australia were fatal. Regardless, the number of unreported incidents is unknown but likely substantial.

The ages of 53% of the victims are unknown, but the next highest group was youth, individuals below 20 years old, which made up 20% of the total victims. This is explained by a very high proportion of young people in the country (Sideleau et al 2015). This group of the population is projected to increase even further, putting them even more at risk in the future (Worldbank 2008). A graph depicting the age distribution of Timor-Leste and its projected increase can be seen in figure 5.2 below. Here, by 2050, the entire population will grow, and the age distribution will be spread more evenly amongst the older age groups, but those below 25 years of age will remain predominant.

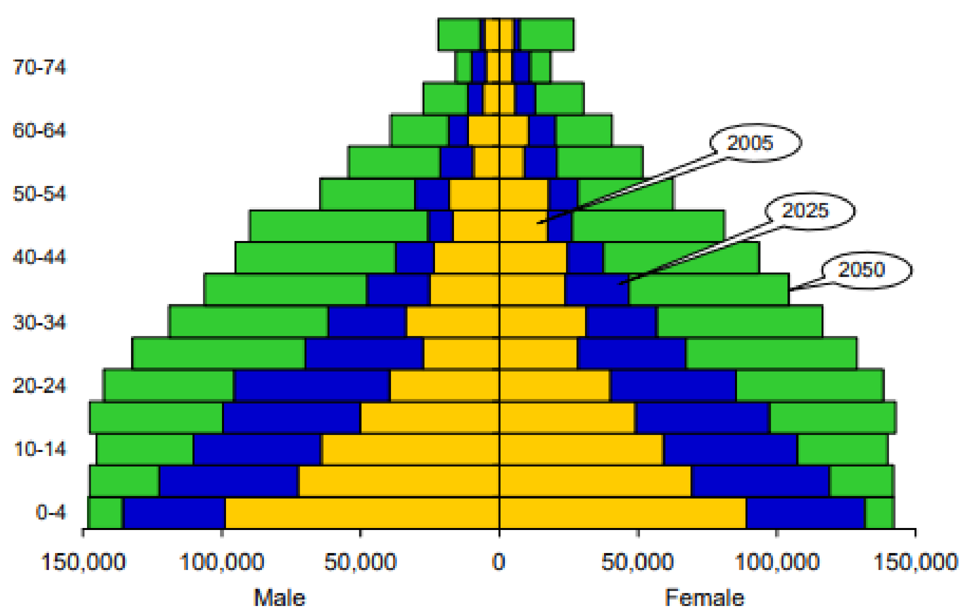

Figure 5.2. Population age and gender distribution and projection for Timor-Leste (Worldbank 2008).

Another factor influencing the distribution of conflicts is crocodile behaviour. As evident in figure 4.7, incidents peaked in the warm and wet summer months and were very low in the dry and cool winter months. This can be explained by the variation of crocodile behaviour throughout the year. During the cooler and dryer months between April and October, attack rates fell as crocodiles are less active during these periods (Sideleau et al. 2015). As crocodiles are ectothermic, they become more active and need to eat more when the temperature is warmer. Maximum average temperature is relatively consistent throughout the year in Timor-Leste, so minimum temperatures and precipitation drives crocodile behaviour and conflict incidents, with more attacks in the warmer and wetter months. This also coincides with the breeding season, as the animals move more during this period, which makes them more likely to pass through areas where they are not normally found (Webb pers. Comm. 2022). Thus, increased rates of attack are not the result of increased aggression during the breeding season, which has not been scientifically established (Webb pers. Comm. 2022). This period also coincides with the time of year when food insecurity for humans in Timor-Leste is the highest, leading people to perform more subsistence fishing activities, further increasing their risk of attack (Sideleau et al. 2015). Conflict rates are increased further during the wet season because crocodiles have access to seasonal habitat (Brackhane et al. 2015). The expanded range during this season allows crocodiles to enter areas that they may not be seen regularly, taking people by surprise (Brackhane et al. 2015). Although information about the time of day the victim was attacked was rare, many instances occurred at night, dawn, or dusk. Activities in the water during these parts of the day put people at greater risk of attack, since this is when crocodiles are most active (Queensland

Government 2021). In most cases, the crocodile responsible for the attack escaped without capture, with only a few cases where they were killed. Additionally, information regarding the size of the crocodile was unavailable in most cases. Although, given the known behaviour of *C. porosus,* the crocodiles could have been relatively small or very large, from 3m up to 7m long (Corlett 2011). Due to the high fatality rate of these conflicts, it is likely that the crocodiles are larger. Chances of survival decrease rapidly with increasing crocodile size in comparison with the victim, although the large number of young victims means the crocodiles responsible may have represented a wide range of sizes (Fukuda et al 2015).

SUGGESTIONS

The case in Timor-Leste is unique compared to HCC in other countries. The people of Timor have a cultural attachment to crocodiles, which introduces challenges to management as discussed above. The situation is further complicated by the country's relatively recent independence from Indonesia and a lack of infrastructure and information to handle this growing problem. With the available information, this section will provide some recommendations for management. Given the geographic distribution of conflicts and crocodile habitat, priority areas for these efforts should be in Viqueque, Cova Lima, and Lautem, especially in and around Lake Ira Lalaro. First, while most management solutions in other places involve the removal of problem crocodiles, this strategy is not as viable in Timor-Leste where there are cultural values attached to the animals that produce an aversion to killing them (Brackhane et al. 2018). Therefore, removal of problem crocodiles by killing them or culling to reduce the total population is not a desirable solution in this case. Removal of problem crocodiles via translocation, another method often used in crocodile management, should also be avoided, as efforts in other countries have shown that due to their extreme dispersal and homing abilities, *C. porosus* is often able to return to their point of capture easily (Amarasinghe et al. 2015). Translocation may also lead to increased conflict, as translocated crocodiles become highly mobile and transit through areas where resident crocodiles are reasonably rare, which creates an increased risk for people utilising such areas (Fukuda et al. 2019). Furthermore, translocated crocodiles can easily be replaced by crocodiles migrating from other regions (Brackhane et al. 2018). There is evidence that the return of translocated *C. porosus* can be inhibited by geographic barriers, but the coast of Timor-Leste lacks the geographic formations that would allow the implementation of this strategy (Fukuda et al. 2019). Crocodile exclusion enclosures to restrict crocodile presence in particular areas may be a viable solution, although these would be costly to build and maintain and is likely not the best option for the current situation in Timor-Leste (Amarasinghe et al. 2015). Alternatively, education has been identified as a crucial tool for reducing HCC (Amarasinghe et al. 2015) (Manolis and Webb 2019). This aspect of management will involve a diverse range of stakeholders such as the government, non-governmental agencies, business and tourism sectors, the media, and both the urban and rural public (Amarasinghe et al 2015). As discussed above, the population of Timor-Leste is growing, increasing the potential for more conflicts. Young people are the group most affected by HCC, and with a growing youth population, education efforts may be focused on these age groups. Aboriginal peoples and other people living in remote locations who rely on subsistence fishing are another group most at risk of conflict, so these groups of people are a priority for education.

Education and awareness should aim to inform people about how to reduce their risk of attack. Crocwise, provided by the Queensland Government, 2021, and implemented in the Northern Territory, can serve as a guideline for awareness campaigns that can be applied to people in Timor-Leste. Deaths from risky fishing practices like wading with nets into the water can be reduced by recommending and teaching other fishing practices that put people less at risk. The risks of water activities in riskiest times of the day such as dusk, night, and dawn, and risky times of year, during the wet season should also be taught. Education can help remove some of the stigma of being attacked, which will improve reporting and will help guide management efforts in the future. It is also important to teach people of the importance of conserving crocodiles so that the existing positive attitude towards these animals is not eroded, ensuring the successful conservation of this species into the future (Amarasinghe et al. 2015). Like in Australia, crocodile warnings may also be thoroughly posted near water bodies in areas of high crocodile abundance to inform people of the risks. Also, Brackhane et al. in 2018 suggest that the traditional management system Tara Bandu should be used to integrate management practices for crocodiles. This system can be used to support education efforts and to reduce risk of conflict by placing restrictions on risky activities in risky times and locations, determined at the community level. Lake Ira Lalaro should be considered separately due to its importance to people in the area and high crocodile population. Also, in Australia's Northern Territory, saltwater crocodiles are economically important as a natural resource in the through sustainable farming, ranching, tourism, and egg collection, which creates an incentive for communities to tolerate and conserve wild populations (Fukuda et al. 2014). Adopting a similar approach to crocodile management in Timor-Leste could provide income to help reduce the need for high-risk activities (Brackhane et al. 2018). These practices can be regulated using the Tara Bandu system to avoid exploiting the crocodiles by placing limits and prohibitions on these activities in areas of interest determined by specific community values.

An important next step in developing effective management strategies for this problem is more research. The situation in Timor-Leste lacks important information, which hinders efforts to manage rates of HCC in the country. One of the major barricades to this is the fact that it is unknown whether the crocodiles responsible for attacking humans are migrants from Australia's thriving populations or residents native to Timor-Leste. *C. porosus* is known to be capable of long-distance dispersal across open ocean from Australia, but there is also a growing population in Timor-Leste that is recovering after Indonesian occupation of the island (Webb et al. 2010). Currently, there are genetic studies on saltwater crocodiles being conducted to try to solve this problem. For example, Fukuda et al in 2019 determined that there is some genetic differentiation among populations separated by the Cobourg Peninsula along the Northern Territory's coast. High levels of migration would favor genetic homogeny among crocodiles of different locations, which can be looked for with genetic testing (Fukuda et al. 2019). By identifying genetic differences among Timorese crocodiles and Australian crocodiles, the amount of interchange between these two populations can be determined. Under the traditional belief system, local "ancestor" crocodiles are differentiated from the invasive "troublemakers", so determining the proportion of migrants will help guide future management direction (Brackhane et al. 2019). In other countries, management strategies focus on capturing crocodiles where they enter or exit management zones (Fukuda et al. 2014). A similar approach can be taken to determine the source of migrating crocodiles to see how many migrants contribute to the population in Timor-Leste. There is evidence supporting the idea that *C. porosus* will make use of ocean currents to facilitate their movements across ocean, so strategies can aim to monitor and capture them at potential arrival areas (Campbell et al. 2010). Lastly, if crocodiles are using ocean currents to migrate, migrants may be coming from places other than Australia. Figure 5.3 shows ocean currents around Australia and Timor below.

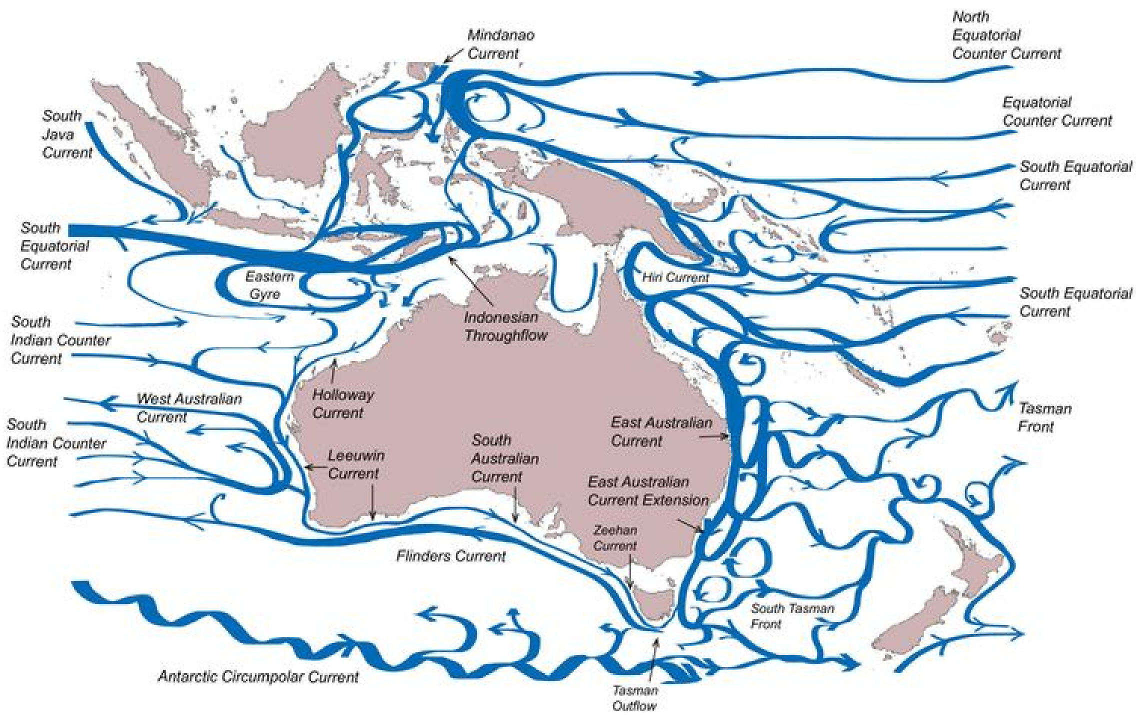

Figure 5.3. Ocean currents around Australia, Timor, and other Indonesian islands (Pattiaratchi et al. 2019).

Many of the ocean currents from across Australasia converge along the northern coast and Eastern coasts of Timor. The natural range of *C. porosus* extends across this range, meaning that crocodiles may be migrating from any of these numerous islands.

Most of these routes bring crocodiles towards the eastern side of the country, potentially contributing to the high number of incidents in Lautem. From here, migrants could make their way to other parts of the country. Thus, capture and monitoring efforts should target Lautem and the southern coast of the island. Additionally, given that information about crocodile populations on Timor-Leste is lacking, future studies should aim to assess the crocodile population, especially in the aforementioned areas of high conflict.

CONCLUSION

In conclusion, the situation in Timor-Leste is unique due to cultural beliefs regarding a very mobile and potentially aggressive large predator, whose numbers have been increasing throughout its range. Through analysis and mapping of conflict records available on CrocBITE, locations, people, times of year, and activities most at risk were identified. Cultural attitudes and a lack of information and resources complicates approaches to management, but approaches such as education, economic incentives, genetic studies, and the widespread implementation of the traditional management system, Tara Bandu are recommended as vital methods of appropriately managing HCC in Timor-Leste. However, given the lack of important areas of information, more studies are required to effectively form management strategies specific to Timor-Leste in the future.

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APPENDICES

APPENDIX I.

COMBINED INFORMATION OF RECORDED C. POROSUS ATTACKS ON HUMANS IN TIMOR-LESTE FROM 2007-2020. SOURCE: CROCBITE 2013.

Location/Water body	District/ Municipality	Subdistrict/administrative post	**Activity**	**gender**	**Fatality**	**Age**	**Date**	**size of crocodile (m)**	**Link**
Lake Ira Lalaro	Lautem	Tutuala	Fishing	Male	Fatal	42	**2012-09-30**	Unknown	http://www.crocodile-attack.info/incident/100-3519
Beifun Lagoon, Uatulari	Viqueque	Uatulari	Unknown	Male	Fatal	Unknown	**2018-01-20**	Unknown	http://www.crocodile-attack.info/incident/100-6871
Welini of the Klere River area, Betano	Manufahi	Same	Unknown	Male	Fatal	Unknown	**2013-08-11**	Unknown	http://www.crocodile-attack.info/incident/100-3636
Wesamadara	Viqueque	Uatu Carbau	Fishing	Male	Non-fatal	13	**2008-09-04**	Unknown	http://www.crocodile-attack.info/incident/100-3399
Wesamadara	Viqueque	Uatu Carbau	Fishing	Male	Fatal	18	**2008-09-04**	Unknown	http://www.crocodile-attack.info/incident/100-3399
Coastal Manufahi	Manufahi	-	Unknown	Male	Fatal	Unknown	**2018-03-08**	Unknown	http://www.crocodile-attack.info/incident/100-7265
Non-Specific, Lake	-	-	Fishing	Male	Fatal	15	**2011-10-24**	Unknown	http://www.crocodile-attack.info/incident/100-3483
Ocean, Suai-Loro	Cova Lima	Suai	Bathing	Female	Fatal	15	**2019-01-01**	Unknown	http://www.crocodile-attack.info/incident/100-7286
Farupeli area, Maina 1 village	Lautem	Lautem	Unknown	Male	Fatal	21	**2012-10-17**	Unknown	http://www.crocodile-attack.info/incident/100-3520
Laleia Beach	Manatuto	Metinaro	Fishing	Male	Non-Fatal	40	**2011-10-31**	Unknown	http://www.crocodile-attack.info/incident/100-3484
Ocean, Suai-Loro	Cova Lima	Suai	Unknown	Male	Fatal	Unknown	**2019-01-01**	Unknown	http://www.crocodile-attack.info/incident/100-7287
Tibar Coast	Liquica	Liquica	Net-Fishing	Male	Fatal	12	**2018-03-13**	Unknown	http://www.crocodile-attack.info/incident/100-6924
Lake, Waicoa of Vemasse	Baucau	Vemasse	Bathing	Male	Non-fatal	38	**2012-11-13**	Unknown	http://www.crocodile-attack.info/incident

									/100-3523
Non-Specific, River	-	-	Bathing	Male	Non-fatal	Unknown	**2010-11-19**	Unknown	http://www.crocodile-attack.info/incident/100-3458
River, Laga	Baucau	Laga	Unknown	Male	Non-fatal	Unknown	**2020-04-15**	Unknown	http://www.crocodile-attack.info/incident/100-7889
Ocean, Dolok Oan	Dili	Cristo Rei	Fishing	Male	Fatal	Unknown	**2019-05-01**	Unknown	http://www.crocodile-attack.info/incident/100-7433
Pond, Lois River/Gulumanu	Liquica	Maubara	Fishing	Male	Fatal	13	**2012-01-28**	Unknown	http://www.crocodile-attack.info/incident/100-3490
Ocean, Watabo	Baucau	Baucau	Fishing	Male	Fatal	18	**2013-02-09**	5	http://www.crocodile-attack.info/incident/100-3535
Lagoon, Samadili	-	-	Fishing	Male	Non-fatal	21	**2009-10-23**	4	http://www.crocodile-attack.info/node/5310
River, Uma Kiik village	Viqueque	Viqueque	Bathing	Male	Non-fatal	Unknown	**2010-10-19**	Unknown	http://www.crocodile-attack.info/incident/100-3453
Estuary, near Nutur River	Manufahi	Same	Unknown	Male	Fatal	10	**2009-07-01**	Unknown	http://www.crocodile-attack.info/incident/100-3415
Matahoi, Makadiki	Viqueque	Uatulari	Unknown	Male	Non-fatal	Unknown	**2019-03-23**	Unknown	http://www.crocodile-attack.info/incident/100-7396
Lou Mea River, Beko	Cova Lima	Suai	Unknown	Unknown	Fatal	6	**2010-11-24**	Unknown	http://www.crocodile-attack.info/incident/100-3460
Aldeia Selihassan, Betano	Manufahi	Same	Fishing	Unknown	Fatal	Unknown	**2012-02-10**	Unknown	http://www.crocodile-attack.info/incident/100-3492
Tutuno/Valo Beach, Tutuala	Lautem	Tutuala	Unknown	Male	Fatal	14	**2014-02-21**	Unknown	http://www.crocodile-attack.info/node/4858
Beobe village	Viqueque	Viqueque	Bathing	Male	Fatal	65	**2009-10-05**	Unknown	http://www.crocodile-attack.info/node/5311
Beacu	Viqueque	Viqueque	Fishing	Male	Fatal	Unknown	**2010-12-14**	Unknown	http://www.crocodile-attack.info/incident/100-3464
Lake Ira Lalaro	Lautem	Tutuala	Fishing	Male	Fatal	29	**2020-05-22**	Unknown	http://www.crocodile-attack.info/incident/100-7893
Lake, Bikantidi in Ainaro	Ainaro	Hatu-Udo	Fishing	Male	Fatal	Unknown	**2020-04-05**	Unknown	http://www.crocodile-attack.info/incident/100-7874
Ocean, Manatuto	Manatuto	Manatuto	Unknown	Male	Fatal	Unknown	**2019-02-11**	Unknown	http://www.crocodile-attack.info/incident

									/100-7314
River, Lospalos	Lautem	Lospalos	Fishing	Male	Non-fatal	13	**2007-12-01**	Unknown	http://www.crocodile-attack.info/incident/100-3691
Hasan Foun, Salele	Cova Lima	Tilomar	Net-Fishing	Female	Fatal	Unknown	**2012-02-19**	5	http://www.crocodile-attack.info/incident/100-3493
Verucotcho River	Lautem	-	Fishing	Male	Non-fatal	Unknown (youth)	**2018-05-22**	Unknown	http://www.crocodile-attack.info/incident/100-7257
Lake Ira Lalaro	Lautem	Tutuala	Unknown	Female	Fatal	47	**2014-01-23**	Unknown	http://www.crocodile-attack.info/node/4802
Lake Ira Lalaro	Lautem	Tutuala	Fishing	Male	Fatal	49	**2014-02-23**	Unknown	http://www.crocodile-attack.info/node/4859
River, Baucau	Baucau	-	Fishing	Male	Fatal	Unknown	**2009-09-07**	Unknown	http://www.crocodile-attack.info/node/5312
Ocean, Atabae	Bobonaro	Atabae	Unknown	Female	Fatal	60	**2010-12-26**	Unknown	http://www.crocodile-attack.info/incident/100-3467
Lake Ira Lalaro	Lautem	Tutuala	Net-Fishing	Female	Non-fatal	Unknown	**2013-07-11**	Unknown	http://www.crocodile-attack.info/incident/100-3573
Rice field, Suai Loro	Cova Lima	Suai	Unknown	Male	Fatal	Unknown	**2012-04-04**	Unknown	http://www.crocodile-attack.info/incident/100-3494
Aldeia Liacaiua, Macadique, Uatolari	Viqueque	Uatulari	Unknown	Male	Fatal	Unknown	**2015-07-18**	Unknown, Large	http://www.crocodile-attack.info/node/5611
Hasan Foun, Suai Tilomar	Cova Lima	Tilomar	Unknown	Female	Fatal	Unknown	**2017-03-12**	Unknown	http://www.crocodile-attack.info/incident/100-7260
Verikojo, Serilau-Moru	-	-	Fishing	Male	Fatal	24	**2015-01-27**	Unknown	http://www.crocodile-attack.info/node/5426
Be Malae Lagoon, Balibo	Bobonaro	Balibo	Fishing	Unknown	Non-fatal	Unknown	**2017-10-07**	Unknown	http://www.crocodile-attack.info/node/6755
Ocean, Aldea Sulilaran	Bobonaro	Atabae	Fishing	Male	Fatal	60	**2011-01-05**	Unknown	http://www.crocodile-attack.info/incident/100-3468
Non-Specific	-	-	Collecting Prawns	Female	Fatal	70	**2012-04-18**	7	http://www.crocodile-attack.info/incident/100-3496
Alas Wedauberek Estuary	Manufahi	Alas	Washing hands	Male	Fatal	Unknown	**2015-07-15**	Unknown	http://www.crocodile-attack.info/incident/100-7292
Seisal River, Watuwa	Baucau	Baucau	Unknown	Male	Non-fatal	Unknown	**2019-01-25**	Unknown	http://www.crocodile-attack.info/incident

									/100-7340
Daes Beach, Suai	Cova Lima	Suai	Fishing	Male	Fatal	25	**2009-11-23**	Unknown	http://www.crocodile-attack.info/incident/100-3428
Cova Lima, Suai	Cova Lima	Suai	Unknown	Male	Fatal	Unknown	**2018-12-06**	Unknown	http://www.crocodile-attack.info/incident/100-7261
Wetaba Village, Beiseuk, Tilomar	Cova Lima	Tilomar	Unknown	Male	Non-Fatal	Unknown	**2019-04-08**	Unknown	http://www.crocodile-attack.info/incident/100-7401
Betano of Bemetan, Manufahi	Manufahi	Same	Unknown	Male	Fatal	Unknown	**2018-06-15**	Unknown	http://www.crocodile-attack.info/incident/100-7263
Laclo River, Rembor	Manatuto	Laclo	Unknown	Male	Non-Fatal	Unknown	**2018-10-31**	Unknown	http://www.crocodile-attack.info/incident/100-7284
Rice field, Sorloi-Wa'aka, Uatu Carbau	Viqueque	Uatu Carbau	Water collection	Female	Fatal	Unknown	**2013-11-14**	Unknown	http://www.crocodile-attack.info/node/4329
Kia Rara Sikara/Com area	Lautem	Lautem	Fishing	Male	Fatal	Unknown	**2016-02-08**	Unknown	http://www.crocodile-attack.info/node/5954
Aldeia bemoris, Suco fuiloro, Lospalos	Lautem	Lospalos	Watering plants	Female	Fatal	45	**2013-09-22**	Unknown	http://www.crocodile-attack.info/incident/100-3760
Mtta Bot Bee Dotor, Manatuto	Manatuto	-	Unknown	Male	Non-fatal	Unknown	**2019-03-18**	Unknown	http://www.crocodile-attack.info/incident/100-7414
Dana Maurei Lake, Iliomar, Lautem	Lautem	Iliomar	Unknown	Unknown	Non-fatal	Unknown	**2018-03-31**	Unknown	http://www.crocodile-attack.info/incident/100-7264
Walu Beach, Tutuala	Lautem	Tutuala	Fishing	Male	Fatal	Unknown	**2016-02-09**	Unknown	http://www.crocodile-attack.info/node/5955
Rice Field, Nariquici, Mauselok	-	-	Working	Male	Non-fatal	Unknown	**2016-04-07**	Unknown	http://www.crocodile-attack.info/node/6135
Batugade beach, Balibo	Bobonaro	Balibo	Fishing	Male	Fatal	45	**2012-04-20**	Unknown	http://www.crocodile-attack.info/incident/100-3497

APPENDIX II.

AVERAGE CLIMATE DATA FOR TIMOR FROM 1991-2020. SOURCE: CLIMATE CHANGE KNOWLEDGE PORTAL 2022.

Month	Minimum Temperature (°C)	Mean Temperature (°C)	Maximum Temperature (°C)	Precipitation (mm)
January	21.2	25.43	29.78	223.64
February	20.94	25.46	30.04	198.95
March	21.02	25.5	30.04	203.69
April	20.46	25.36	30.3	101.13
May	19.69	24.79	29.92	102.85
June	18.96	24.15	29.4	84.68
July	18.55	23.94	29.37	38.65
August	18.25	23.88	29.57	18.82
September	19.08	25.66	30.29	24.2
October	20.06	25.37	30.74	41.18
November	20.98	25.89	30.86	109.27
December	21.02	25.43	29.9	218.5