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Implementation of a community-based monitoring system (CBMS) for *Crocodylus porosus* in Timor Leste

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Student Research Assistance Scheme

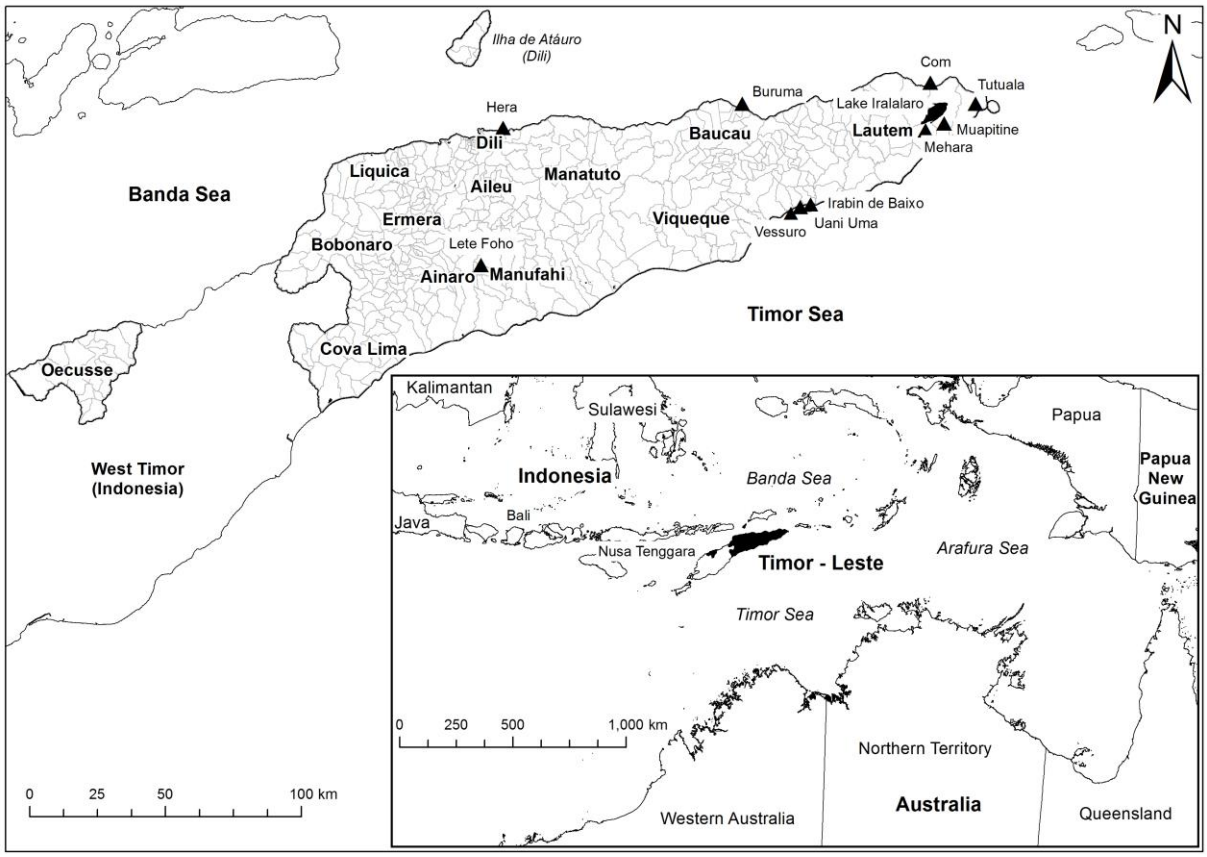
Final Report

Hamburg, 4th December 2019

1. Introduction

This report presents major results of the project „Implementation of a community-based monitoring system (CBMS) in Timor-Leste“, which was funded by a CSG Student Assistance Research Scheme and co-funded by a Rufford Foundation Small Grant. The scholar conducted community-based monitoring in the Timorese communities of Baucau (Watuboro), Com, Los Palos (Lake Iralalaro), Irabin de Baixo, Uani Uma and Hera. The research resulted in three peer-reviewed scientific journal articles and a number of associated media articles. The following chapters introduce into the area of study and present the abstracts of each published article. The full length articles can be requested from the author via email (sebastian.brackhane@felis.uni-freiburg.de).

2. Area of Study



The South-East Asian nation of Timor-Leste comprises 14.919 km^2, subdivided into northern and southern components by an east-west mountain range. The climate is tropical, but the north has 1,000 mm of rainfall annually, in a 4–6-month wet season, and the south has 2,000 mm of rain in a 7–9-month wet season. For administrative purposes, Timor-Leste is subdivided into 13 municipalities, formerly districts , 2 of which are mountainous without any coastline or larger waterbodies, and 11 of which contain potential habitat for crocodiles. Wetlands with permanent water, preferred by crocodiles, are mainly in the south and south-east, particularly in Lautem, Viqueque, Manufahi, and Cova Lima Municipalities. Timor-Leste has a human population of 1.2 million people, which has been increasing at 1.8%/year

(2010–2015). In 2011, 37.4% of civilians lived below the international poverty line of $1.25/day ($U.S., purchasing power parity), and 40% were considered malnourished. Timorese livelihoods are predominantly rural, depending on agriculture (71%) and fisheries. In 2015, 5% of Timorese households were engaged in small-scale fisheries, and today fish accounts for 31% of animal-source protein intake in the Timorese diet. The Timor Sea separates the south coast of Timor-Leste from the much larger northern coast of Australia. There are oil reserves in the Timor Sea, some of which are subject to joint ownership by Timor-Leste and Australia. Timor-Leste has approximately 766 km of coastline and 130 km^2 mangroves (*Avicennia marina, Sonneratia alba, Rhizophora stylosa, Ceriops tagal, Lumnitzeraracemosa*). The coastal and inland wetlands provide habitat for typical crocodile prey such as fish (e.g., barramundi [*Lates calcarifer*], Sagor catfish [*Hexanematichthys sagor*], bluespotmullet [*Crenimugil seheli*]), mud crabs (e.g., giant mud crab [*Scylla serrata*]), waterbirds (e.g., wandering whistling duck [*Dendrocygna arcuata*]), snakes (e.g., Macklot's python [*Liasis mackloti mackloti*]) and freshwater turtles (e.g., Timorsnake-necked turtle [*Chelodina mccordi timorensis*].

Timor Island has a highethnocultural diversity that is based on three waves of immigration by Austronesian,Melanesian, and Proto-Malays starting around 40,000 BC, although the oldest humanoccupation of Timor island can be traced back to 42,600 BC. Before colonization by the Portuguese and Dutch, Timor Island was fragmented into severalsmall dominions ruled by executive rulers, the so-called Liurais. In 1515, Portuguese colonialists landed in Timor; in 1640 the island was separated into a westerly Dutch part and an easterly Portuguese part. Timor-Leste declared independence from Portugal in 1975, but was subsequently occupied by Indonesia, which initiateda 24-year period of occupation resisted by a guerrilla army led by the President (2002–2007) and Prime Minister (2007–2015) Xanana Gusmao. In 2002, independence was achieved after a three-year UN-led transition period. Today, Timor-Leste is considered a resilient democracy despite various post-colonial and economic challenges. Many rural communities are difficult to access and most subsist by farming and fishing. Although about 98% of the population are Catholic, traditional beliefs are ingrained within Timorese culture. Traditional spiritual matters are managed by the Dato Lulik or Lia Nain, the traditional elder, and are subject to a traditional legal system titled tara bandu. Tara bandu is a complex system that evolved historically to negotiate access to natural resources. The Xefe Suku is a secular leader responsible for the country´s smallest administrative unit, the Suku. The 442 Sukus of Timor-Leste are highly diverse and home to 16 constitutionally recognized ethnolinguistic groups.

3. Saltwater crocodile abundance during Portuguese occupation

During the period of Portuguese occupation, crocodiles numbers were reported to be relatively low, as a report by René E. Honegger suggests:

„Although crocodiles (*Crocodylus porosus*) (called `Jacara` or ´Crocodilo´ locally) do not seem to have ever been abundant in Portuguese Timor, it would appear from all indications that they are much less common than formerly.

Investigation revealed that nowadays they are only occasional visitors to the whole North coast of the Portuguese section oft he island, including the island of Atauro. In any case, they could never have been common on the North coast because there are few areas suitable to their needs. This is particularly true of virtually the whole coastline between Baucau and Liquica. I was not able to visit the Northern coastal areas east of Baucau, but I heard from several sources that crocodiles are still sometimes seen along the coast at a place about 40 miles east of Baucau, in the vicinity of Laivai.

The situation seems somewhat brighter on the South coast. The habitat here is more favourable to the Saurians as the climate is wetter, thus giving rise to more permanent watercourses and allowing, according to the dictates of the terrain, the formation of permanent swamps or small lakes on the coastal plain.

As noted previously, crocodiles have been seen in the coastal sections of both the Tilomar and Lore Reserves, but it is doubtful if they breed there with any frequency.

However, they do still breed on the south-east coast between the Lore Reserve and Jaco Island (sometimes going considerable distances up river) and also on the central south coast at a place called Fatu Berliu, south of Betano. The two areas seem to be the last strongholds of estuarine crocodiles in Portuguese Timor and steps should be taken to ensure that they survive in the province.“

Source: Honegger, R.E. (1973). Regional Situation Report: Asia – Portuguese Timor. *In* Crocodiles – Proceedings of the Second Working Meeting of Crocodile Specialists, Ndmu and Lake St. Lucia, Zululand: pp. 52-53.

4. Paper 1: When conservation becomes dangerous: Human-crocodile conflict in Timor-Leste

Article: Brackhane, S., Webb, G., Xavier, F. M., Gusmao, M., & Pechacek, P. (2018). When conservation becomes dangerous: Human-crocodile conflict in Timor-Leste. *The Journal of Wildlife Management*, 82(7), 1332-1344.

Abstract: In northern Australia and nearby Timor-Leste, saltwater crocodile (*Crocodylus porosus*) populations were seriously depleted historically but recovered rapidly after protection: 1969–1974 in northern Australia, and 2000–2005 in Timor-Leste. In both places,

recovery caused increased rates of human-crocodile conflict (HCC). Within northern Australia, the crocodile recovery and HCC have been documented over time. In contrast, this has not been the situation in Timor-Leste, where we investigated HCC based on 130 attack records (1996–2014; 52% fatal). In 1996–2006, 0.55 attacks/year were reported in Timor-Leste. By 2007–2014, 9 years later, a 23-fold increase had occurred (13 attacks/year). Traditional subsistence fishing (82.5% of all attack records) is the highest risk activity, followed by bathing (7.5%) and water collecting (4.2%). Although the human population was correlated with crocodile attacks in Timor-Leste, it likely does not explain the dramatic increase in crocodile attacks. Alternatively, crocodile numbers may have increased, either in the remnant resident crocodile population, or via migrants from elsewhere. Permanent crocodile habitat is limited, and limited breeding does not explain the high number of large crocodiles, and consequent increase in attacks in such a short time. A plausible explanation, consistent with traditional knowledge in Timor-Leste, is that the influx of large crocodiles attacking people are migrants from Australia. We examined this possibility from available sources. Within Australia crocodiles have recovered since protection and they regularly invade adjacent habitats, such as Darwin harbor, where they are removed to prevent attacks on people. Saltwater crocodiles have been sighted at oil rigs, in the open ocean, moving between northern Australia and the south coast of Timor-Leste. The likelihood of crocodiles migrating from Australia to Timor-Leste raises obvious conservation, moral, and ethical dilemmas when conserving a large dangerous predator in one country to increase abundance results in dispersal to another country, where the predator attacks and kills people.

5. Paper 2: Habitat mapping of the saltwater crocodile (*Crocodylus porosus*) in Timor-Leste

Article: Brackhane, S., Xavier, F. M., Gusmao, M., & Fukuda, Y. (2018). Habitat mapping of the saltwater crocodile (*Crocodylus porosus*) in Timor-Leste. *Herpetological Review*, 49(3), 439-441.

Summary: Human-Crocodile Conflict (HCC) is increasing, but limited financial and technical resources in many developing countries impede scientifically sound management to mitigate such conflicts. Analysis of crocodilian habitats is an important step for effective HCC management and crocodilian conservation. Using Timor-Leste as a case study, here we demonstrate how potential habitats of Saltwater Crocodiles (*Crocodylus porosus*) can be mapped using cost-free tools and data from the World Wide Web, and local knowledge. One of the least developed countries in the World, Timor-Leste struggles to manage HCC with *C. porosus*, the largest and one of the most aggressive crocodilian species, the population of which has increased significantly in Timor-Leste since its independence from Indonesian occupation in 2002. Since 1996 at least 130 people have been attacked by crocodiles in Timor-Leste, yet the information available is insufficient to identify priority areas for a

conservation scheme on a national scale. Thus, we suggest that crocodile habitat mapping is an important first step towards the development of the first crocodile management plan for the country.

We performed habitat analysis based on Geographic Information Systems (GIS) to identify: 1) core habitats (including perennial waterbodies such as lakes, swamps, billabongs and rivers providing possible breeding sites for *C. porosus*); 2) coastal marine habitats, inter alia, *C. porosus* perennial range for hunting; and, 3) seasonal range, namely potential habitat for *C. porosus* during the wet season. Core crocodile habitats were identified based on knowledge of members of the Crocodile Task Force (CTF) who were familiar with the areas through regular sightings of crocodiles, and traditional ecological knowledge of local stakeholders from eight communities (Vessuro, Mehara, Uani Uma, Malahara, Com, Baucau, Hera, Irabin de Baixo) affected by HCC. Usually, local knowledge holders, Xefe Suku (Village headmen), Dato Lulik/ Lia Na`in (Traditional elders) or local fishermen were contacted during surveys (2007–2017) and asked to identify areas where saltwater crocodiles reside throughout the year. The identified areas were then inspected by the CTF to determine numbers of crocodiles and to measure GPS coordinates of control points of the relevant waterbodies using (Garmin) hand devices. The measured control points were transferred to a GIS where the extent of crocodile core habitat could be identified and measured based on Google satellite imagery (https://www.google.de/maps). As a sea-going species, with the potential for long-distance movement, *C. porosus* may be found along the entire coastline of Timor-Leste throughout the year. We applied a 1-km buffer to coastlines and core (buffer only inwards) habitats digitized by GIS to account for seasonal variations in the habitat extent as well as adjacent coastal habitats. These areas, accounting for 341.6 km² of core habitat (126.3 km² excluding the 1-km buffer) and approximately 766 km of coastline, represent the habitat where *C. porosus* can be found during the whole year. We followed Brackhane et al. (2018) in defining the areas of potential crocodile range as temporary waterbodies with a 3-km buffer to include seasonally possible, but unusual habitat for saltwater crocodiles. These include rice paddies and the canals of the associated irrigation systems. As there were no reported sightings of *C. porosus* at altitudes above 500 m, we excluded all areas above this altitude from the identified core habitats and seasonal range using 3-arc second Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM). The highest observed record of a Saltwater Crocodile in Timor-Leste is at 422 m elev., in Lete Foho, Manufahí district (9.14331°S, 125.58883°E; S. Brackhane, pers. obs.). All spatial analysis was performed using the free QGIS 2.18 software including the relevant extensions such as OpenLayers Plugin for spatial analysis of Google satellite imagery and QuickMapServices 18.4 Plugin for basemaps. SRTM DEM was downloaded from SRTM 90m Digital Elevation Database v4.1 (http://www.cgiar-csi.org/data/ srtm-90m-digital-elevation-database-v4-1, accessed on 6 March 2017). Additional information such as administrative boundaries and waterbodies were downloaded at no cost from Geographic information Group (GIG) Timor-Leste (https://sites.google.com/site/gigtimorleste/data/administrative-boundaries, accessed on 6 March 2017) and Diva-GIS (www.diva-gis.orghttp://www.divagis.org/, accessed on 6 March 2017).

The map generated may be used by the CTF to identify priority areas for HCC management, i.e., to link management activities to areas where human and crocodile habitat frequently overlaps, especially by overlaying it with a current risk map showing hotspots of crocodile attacks or human density maps. Also, if made available through a website (e.g., www.commonenvironment.org or peskador.org), the map would help wildlife managers to raise public awareness and to inform local residents and tourists about areas of potential crocodile risk. The map will be improved as more crocodile-sighting and environmental data become available through field surveys or community-based monitoring approaches as described by Brackhane and Pechacek (2015). In particular, inclusion of crocodile sightings made by citizen scientists would be a cost-effective option to improve data availability. *Crocodylus porosus* habitat mapping will significantly improve when integrated with comprehensive vegetation data. In this context, the continuous assessment of available habitat suitable for nesting will be a crucial variable to estimate the capacity for a viable population of *C. porosus* in Timor-Leste, and to inform wildlife managers on crocodile conservation needs. Our case study here could hopefully serve as an example of the first step to habitat mapping for many developing countries, particularly those with limited resources, and facing HCC challenges like Timor-Leste. Whereas the methodology may be relatively easily applicable on islands with a rather simple habitat distribution such as Palau, Vanuatu, Solomon Islands and several islands of volcanic origin in Papua New Guinea and Indonesia, its application to larger countries with extensive freshwater lakes and swamps, floodplains and large river systems may require more systematic assessment of habitat quality. Particularly in these areas with high geographical complexity, the integration of local knowledge may constitute a valuable data source increasing the accuracy of habitat mapping. We caution that the presented methodology is designed for *C. porosus* and may be misleading for other crocodilian species.

6. Paper 3: Crocodile management in Timor-Leste: Drawing upon traditional ecological knowledge and cultural beliefs

Article: Brackhane, S., Webb, G., Xavier, F. M., Trindade, J., Gusmao, M., & Pechacek, P. (2019). Crocodile management in Timor-Leste: Drawing upon traditional ecological knowledge and cultural beliefs. *Human Dimensions of Wildlife*, 1-18.

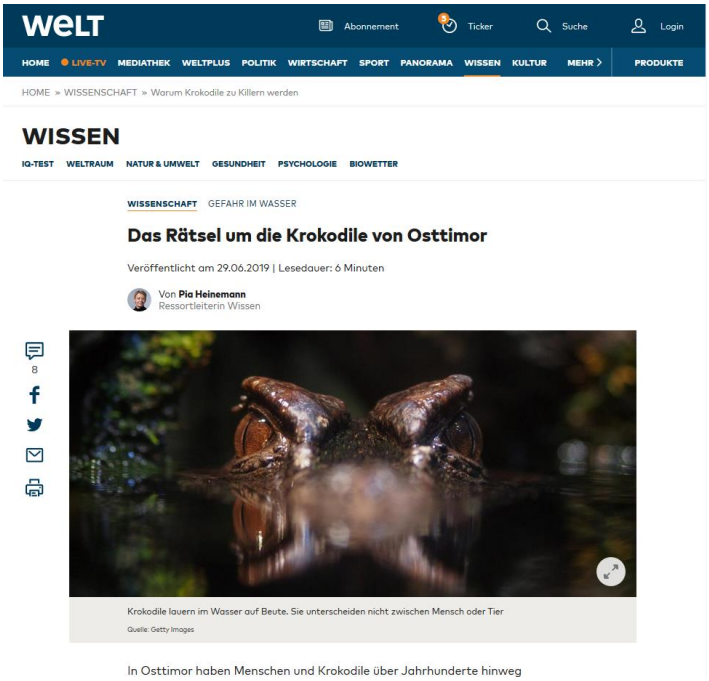
Cultural beliefs based on Timor-Leste´s creation myth “Lafaek Diak – The Good Crocodile” are anchored in the East Timorese traditional belief system lulik and involve worship of the widely distributed, but dangerous, saltwater crocodile (Crocodylus porosus). The wild saltwater crocodile population and rate of fatal attacks on people are both increasing due to conservation action. More innovative management is needed to reduce the frequency of attacks, but reverence for crocodiles constrains the management options available. We used semi-structured interviews with Timorese stakeholders (25 local authorities, 10 national experts, 15 citizens) to understand the cultural beliefs and traditional ecological knowledge underlying human-crocodile interactions, and conflict (HCC) in Timor-Leste. Interviewees knew this species was a risk (respect, fear) and its population was expanding, and had

culturally determined beliefs (ceremonies, rituals) that included differentiating between local “ancestor” crocodiles and invasive “troublemakers.” Cost-effective management could integrate stakeholder groups, especially traditional elders and local knowledge holders.

7. Conclusion and outlook

Community-based monitoring is a cost-effective, integrative tool to assess human-crocodile conflict (attack assessment), crocodile habitat, traditional ecological knowledge, human attitudes and cultural beliefs toward crocociles in remote countries and areas where only little scientific knowledge is available. In Timor-Leste, we could identify patterns of human-crocodile conflict, including a major increase in crocodile attacks. We were also able to develop a preliminary habitat map for saltwater crocodile in Timor-Leste. Finally, we were able to explore the cultural relevance that saltwater crocodiles possess for many coastal communities in Timor-Leste. However, our research is only the first step into crocodile research and management in Timor-Leste. The need for future research is profound. Genetic analysis is needed to resolve the question whether saltwater crocodiles from neighboring countries (e.g., Australia) migrate to Timor-Leste where they contribute to the increasing rates of crocodile attacks. Professional monitoring schemes will be needed to generate better numbers on the saltwater crocodile population and crocodile habitats in Timor-Leste. Last but not least, sophisticated crocodile management will be needed, balancing cultural values against human safety.

8. Media coverage



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Veröffentlicht am 29.06.2019 | Lesedauer: 6 Minuten

Von **Pia Heinemann**
Ressortleiterin Wissen

8

Krokodile lauern im Wasser auf Beute. Sie unterscheiden nicht zwischen Mensch oder Tier

Quelle: Getty Images

In Osttimor haben Menschen und Krokodile über Jahrhunderte hinweg



Mon, Nov 11, 2019 **Newsweek**

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HEALTH

KILLER CROCODILE: WHY ONE REPTILE SPECIES HAS FATALLY ATTACKED MORE THAN 130 PEOPLE IN SOUTHEAST ASIA

BY SCOTTIE ANDREW ON 6/28/18 AT 9:45 AM EDT

A saltwater crocodile haunts the Adelaide river in September 2008 in Australia. The formerly endangered predator now launches record-high attacks against residents of an island in southeast Asia.
(PHOTO BY GREG WOOD/AFP/GETTY IMAGES)

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HEALTH

Once endangered, the saltwater crocodile now menaces residents of an island in southeast Asia.



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Fears monster Australian crocodiles could be SWIMMING to East Timor - where attacks have surged 20-fold and a human is bitten every month

- Crocodiles are suspected of migrating from Northern Australia to East Timor
- Conservation efforts to restore crocodile numbers in Australia could be to blame
- East Timor now averages 13 attacks a year with over half of them fatal

By TOM PLACE FOR DAILY MAIL AUSTRALIA



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Crocodiles swimming across from the Northern Territory may be to blame for huge spike in Timor-Leste croc attacks

By Emily Smith

Posted 24 Nov 2018, 11:38pm



PHOTO: Soldier Eder Almeida poses with a large crocodile in Timor-Leste. (Supplied: Sebastian Brackhane)

Crocodile attack rates have surged more than 20-fold in Timor-Leste in less than a decade — and experts think crocs from the Northern Territory (NT) could be to blame.

Researchers Sebastian Brackhane and Grahame Webb published a research paper earlier this year, outlining why they think Territory crocs are swimming more than 600 kilometres and attacking one person a month in the tiny island nation.

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Crocodile Attacks On The Rise In East Timor

East Timor's growing population of saltwater crocodiles have increasingly been encountering—and attacking—humans.

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AsianScientist (Jul. 13, 2018) – Scientists have found that crocodile attacks on humans are increasing in frequency in East Timor. They published their findings in the *Journal of Wildlife Management*.

A native of Southeast Asia and the north of Australia, saltwater crocodiles are the largest of all crocodile species, growing to lengths of six meters and weighing more than a ton. Unlike other species of crocodile, they can survive in both fresh and salt water, which enables them to cover lengthy distances by sea.

XaLuan.com

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JWM: Is Australia's croc success killing humans across sea?

By David Frey

Posted on August 7, 2018



Crocodiles are revered in Timor-Leste, but they're also responsible for a growing number of attacks against fishermen. ©Grahame Webb

Saltwater crocodiles (*Crocodylus porosus*) have rebounded in northern Australia, but the swelling populations may be creating problems across the Timor Sea to the north, where the young nation of Timor-Leste is seeing a dramatic increase in crocodile attacks on humans.

Killer crocodiles: Why are more humans being attacked in Timor-Leste?



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Timor-Leste

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Scientists looking into whether reptile migration is behind big rise in number of attacks



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