Understanding and mitigating saltwater crocodile (*Crocodylus porosus*) attacks on humans in Indonesia

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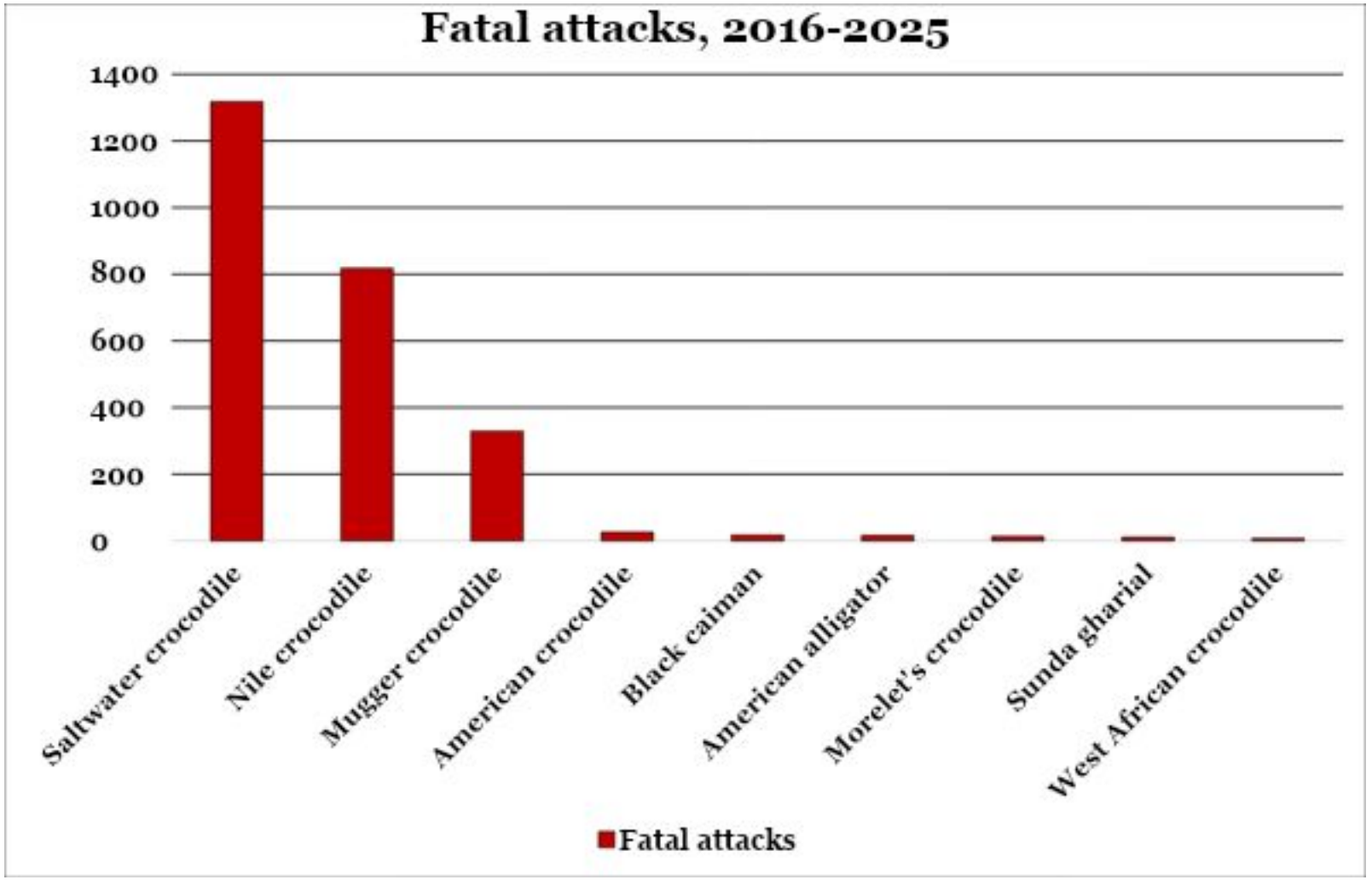
01 · Introduction

Crocodilian attacks

- Saltwater crocodile (*Crocodylus porosus*): 1,318 deaths
- Nile crocodile (*C. niloticus*): 818 deaths
- Mugger crocodile (*C. palustris*): 329 deaths

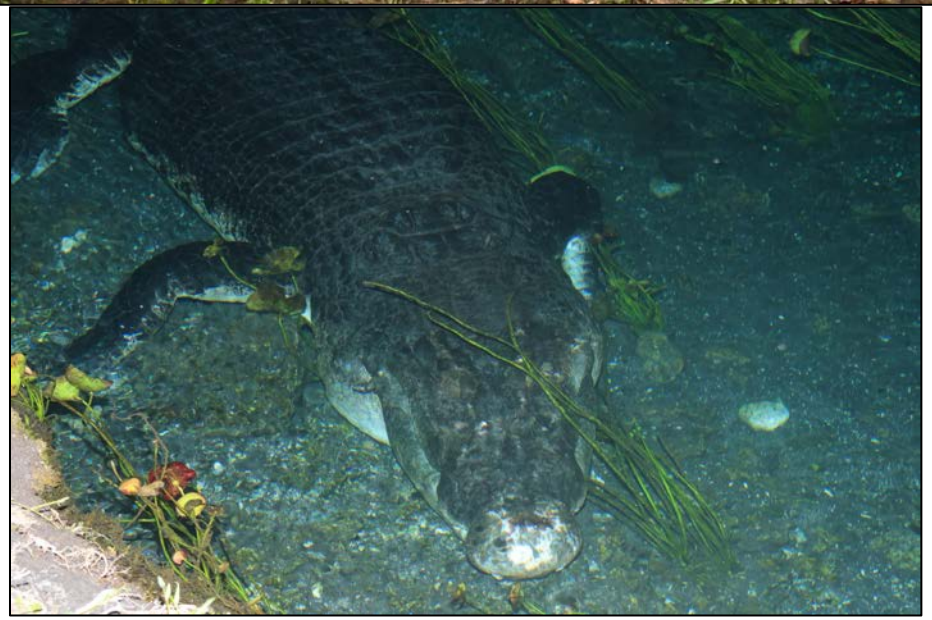
96.5%
Three species



02 · Introduction

Saltwater crocodile

- Largest extant crocodilian species.
- Capable of exceeding 6 metres in length in exceptional cases.
- Common name misleading.
- Seafaring capabilities.
- Widest-ranging crocodilian species.

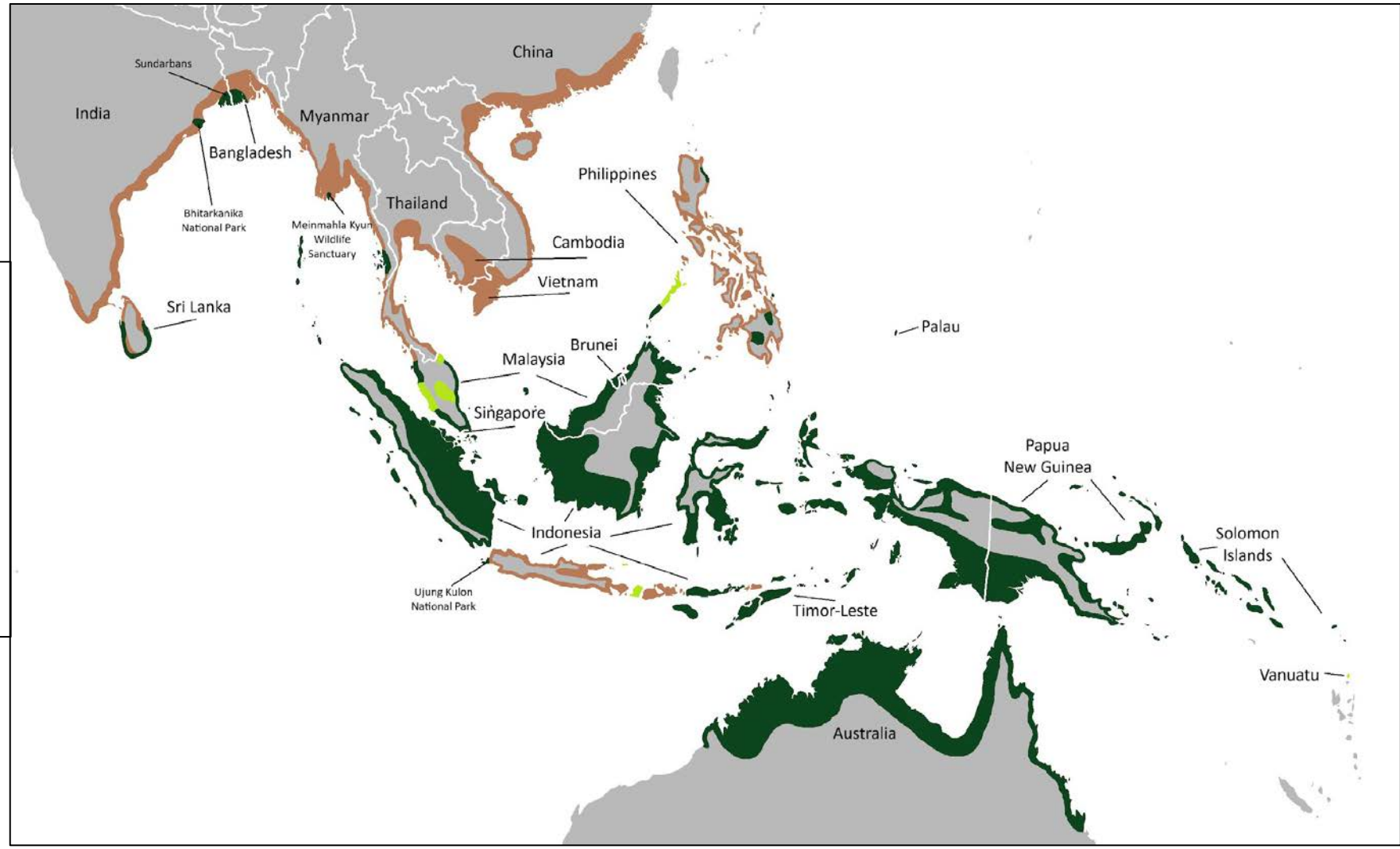


Historical distribution

- Much wider historical range.
- Extinctions in China and Seychelles pre-20th century.
- Post-World War II hide-hunting.
- Protective measures in late 20th century.

Current distribution

- Substantial recoveries in some areas.
- Modest or unknown recoveries in others.
- Extinct in Cambodia, Thailand, and Vietnam.
- Situation dire in mainland Asia.



05 · Introduction

Saltwater crocodile attacks

- Reports of attacks have increased dramatically in 21st century.
- India, Malaysia, Solomon Islands, and Timor-Leste.
- Indonesia has reported the highest number of attacks.

06 · Methods

Study area

- Fourth most populous nation.
- More than half in Java.
- 8.6% below the poverty line, higher in rural areas.
- Rural population lacks Water Sanitation and Hygiene (W.A.S.H.) infrastructure.
- Depend on natural waterways.

07 · Methods

Data collection

- All data sourced from CrocAttack (crocattack.org).
- Compiled from a variety of sources.
- Mandatory information.
- Preferred information.

08 · Methods

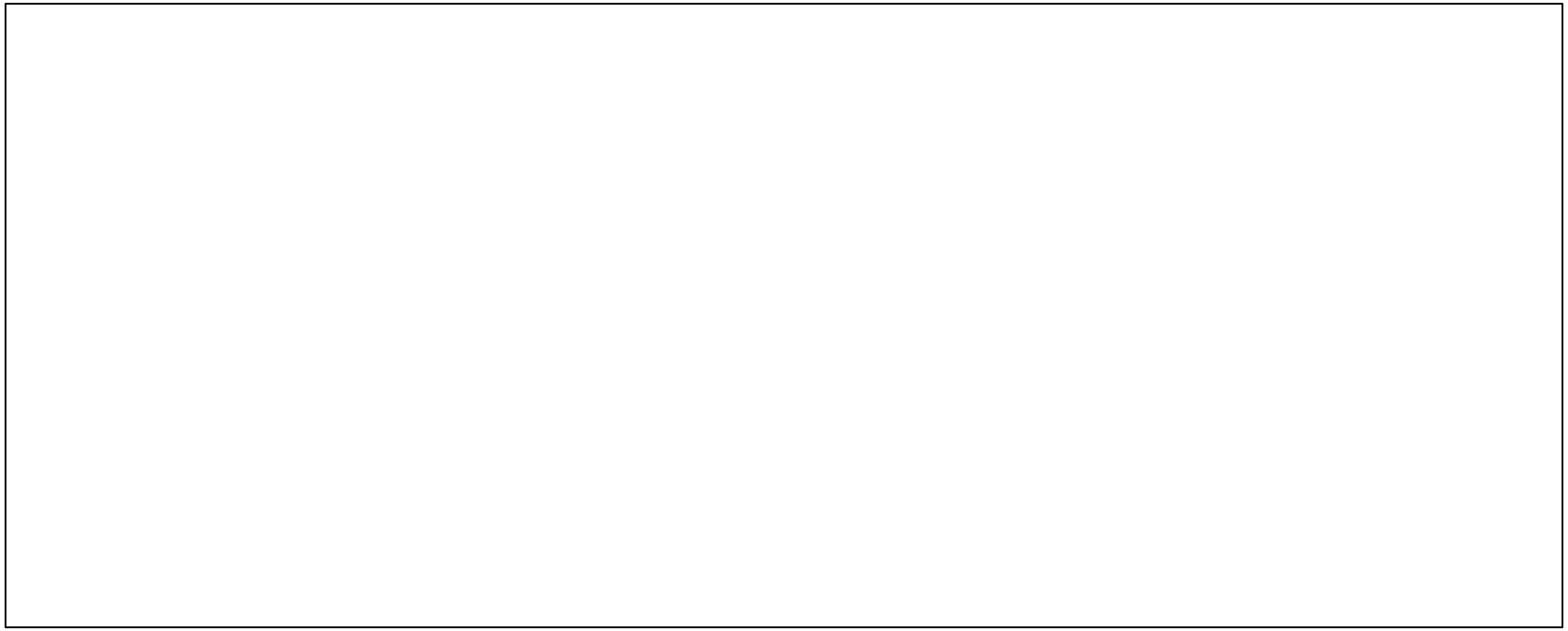
Species identification

- In many areas saltwater crocodile only possible culprit.
- Sunda gharial (*Tomistoma schlegelii*) in 10 provinces.
- New Guinea freshwater crocodile (*C. novaeguineae*) in 2 provinces.
- Siamese crocodile (*C. siamensis*) not believed to overlap.

09 · Methods

Spatial classification

- 34 provinces split up into seven geographic regions:
  - Sumatra (10 provinces)
  - Kalimantan (5 provinces)
  - Sulawesi (6 provinces)
  - Maluku Islands (2 provinces)
  - Lesser Sunda Islands (2 provinces)
  - Papua (2 provinces)*
  - Java (2 provinces)*



- Papua provinces based on pre-2022 divisions.
- Attacks were reported from only 2 Javan provinces.

10 · Methods

Victim activity classes

Victim activities at the time of attack were grouped into four broad classes — supporting consistent comparison across regions and contexts.

Fishing-related

Domestic & subsistence water use

Non-fish resource harvesting
(e.g., sago, oil palm, tin, sand, etc.)

Other
(e.g., leisure and traversal)

11 · Methods

Victim age groups

Victim age was grouped into five classes following the Indonesian Ministry of Health classification.

0-11 years Anak - children	**12-25 years** Remaja - adolescents	**26-45 years** Dewasa - adults
46-59 years Pra-lansia - Pre-elderly	**60+ years** Lansia - Elderly	

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Time of day

Attacks with known timing were classified into four 6-hour periods.

00:00 – 05:59	**06:00 – 11:59**
12:00 – 17:59	**18:00 – 23:59**

Data analyses

- We modelled total, fatal, and non-fatal attacks using Poisson GLMs.
- We tested monthly and time of day using χ^2 goodness-of-fit tests.
- We tested sex by activity class and region using χ^2 tests of association.
- National tests involved all regions.
- Regional tests omitted Java and Papua.

Total attacks

1,217
Total attacks

588
Deaths

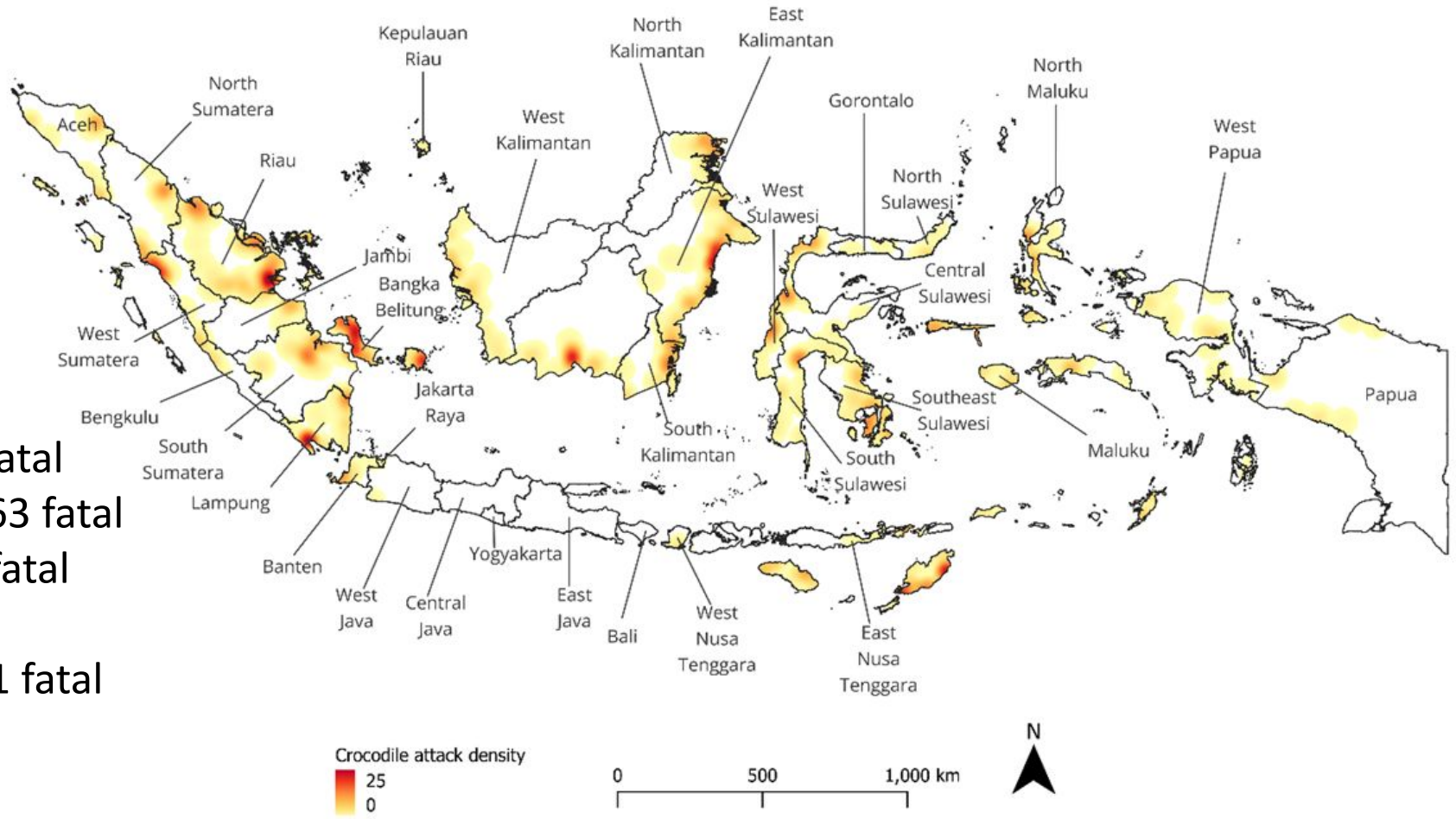
Attacks were recorded in 29 of 34 provinces. No incidents were recorded in Bali, Central Java, East Java, Jakarta, or Yogyakarta.

Spatial temporal trends

50%

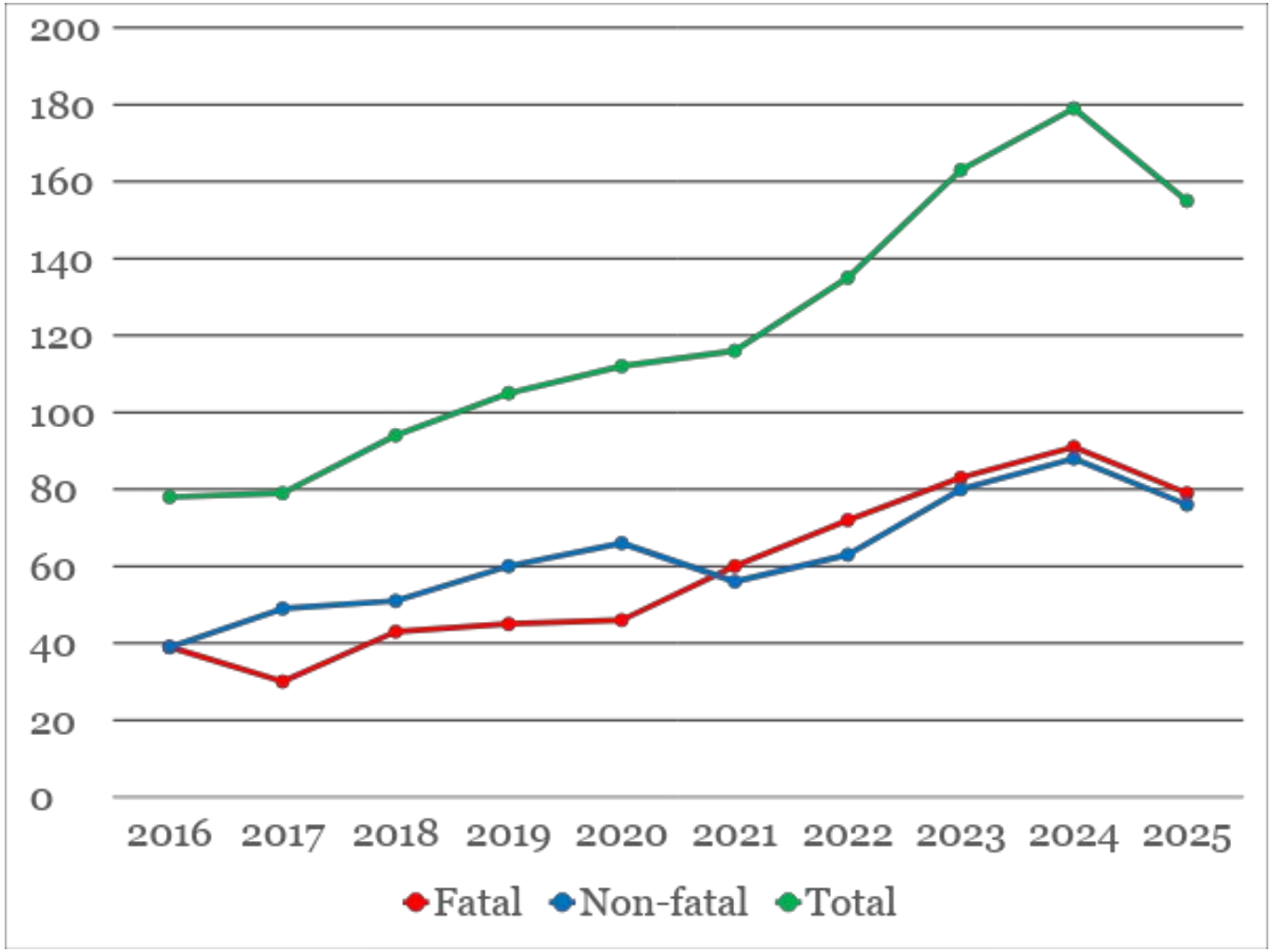
of all attacks in six provinces.

- **Riau**: 124 attacks, 56 fatal
- **East Kalimantan**: 118 attacks, 63 fatal
- **East Nusa Tenggara**: 114 attacks, 63 fatal
- **Bangka-Belitung**: 112 attacks, 55 fatal
- **North Maluku**: 76 attacks, 35 fatal
- **Southeast Sulawesi**: 64 attacks, 31 fatal



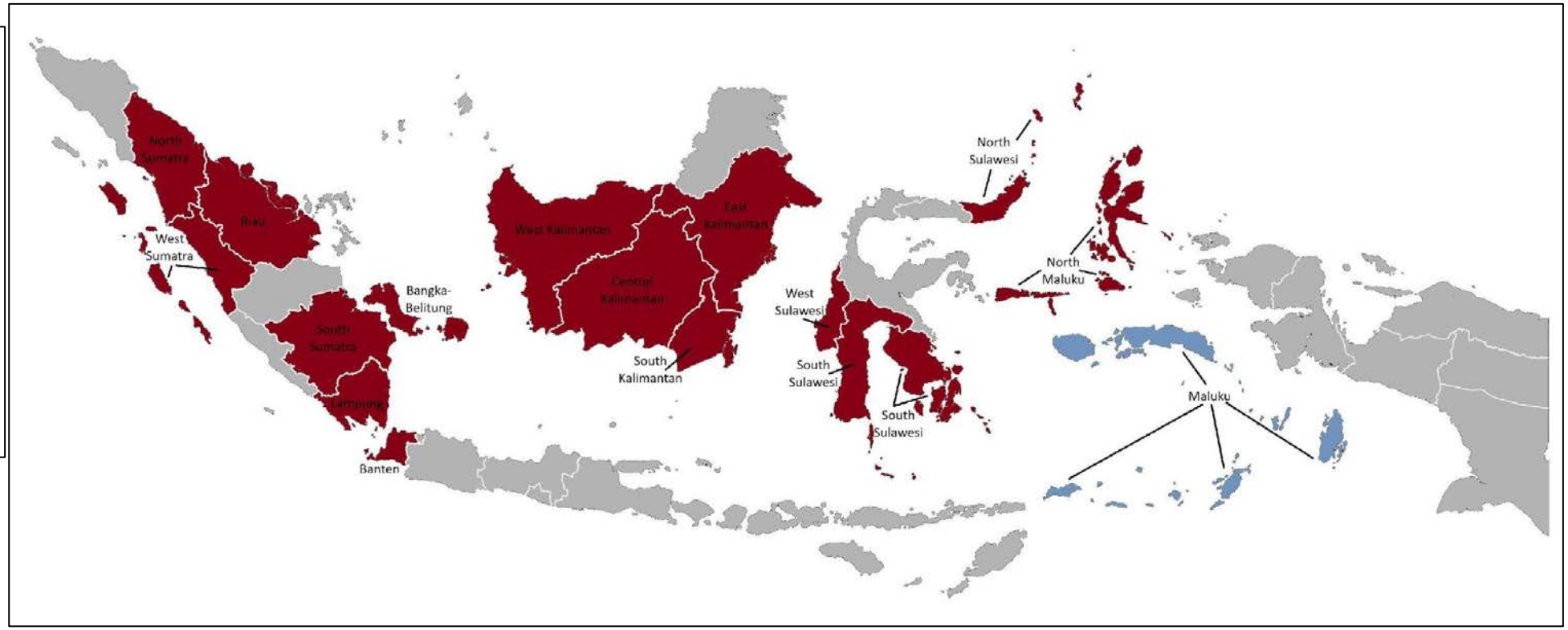
Temporal trends (national)

- 9.7% mean annual increase in total attacks.
- 12.1% mean annual increase in fatal attacks.
- 7.6% mean annual increase in non-fatal attacks.



Temporal trends (provincial)

- Significant increase in 16 provinces.
- Significant decrease in one province (Maluku).
- No significant change in 12 provinces.



Time of day

- 12:00 – 17:59 and 18:00 – 23:59 periods overrepresented nationally.
- 12:00 – 17:59 overrepresented in Kalimantan, Sumatra, and Sulawesi.
- 18:00 – 23:59 overrepresented in Lesser Sunda and Maluku Islands.
- Reflects regional activity patterns.

Victim Demographics

86.7%
Male

26-45
years old

68.2%

fatality rate in children aged 0–11 — consistent with smaller body size

Victim Activities

National patterns

1. Fishing-related
2. Domestic & subsistence water use
3. Non-fish resource harvesting

Regional deviations

Kalimantan: domestic water use exceeds fishing.

Sumatra: non-fish resource harvesting much more common.

Lesser Sundas & Maluku: fishing-related activities dominate.

FEMALE VICTIMS

Significantly overrepresented in domestic water use activities in Kalimantan and Sumatra — and disproportionately attacked while washing clothes and dishes. The pattern likely reflects traditional gender roles shaping activity distributions in areas with extensive freshwater habitat.

Overall attack trends

- 22 times total attacks compared to Australia.*
- 54 times fatal attacks compared to Australia.*
- 196 times fatal attacks compared to Top End.
- Fatality rate higher than Australia and Solomon Islands.
- Fatality rate lower than in India, PNG, and Timor-Leste.

- *Does not include known attacks on Indonesian trepangers not reported in the Australian press.

Crocodile population recovery?

Population recovery is the most-cited explanation in other range states.

Surveys at some hotspots show LOW densities

Non-hatchling densities very low at attack hotspots in East Nusa Tenggara — and similarly low in parts of Bangka-Belitung and Sumatra.

High attack rates ≠ high crocodile numbers

Attack frequency can be high despite low density, suggesting drivers other than population size in at least some regions.

However, saltwater crocodile population status remains unknown throughout most of Indonesia.

Increased internet access

Increased internet and social-media access — particularly in remote areas — likely contributes to the rise in reported incidents over the past decade.

INDONESIA · INTERNET ACCESS

2016	2024
25% →	73%

Industrial & Land-Use Drivers

Human encroachment and specific industries are implicated as indirect drivers of increased attack frequency.

BANGKA-BELITUNG

Tin mining

Excavation craters flood into ‘kulongs’ that connect to waterways at high water — letting crocodiles enter areas beyond their usual range.

MULTIPLE PROVINCES

Oil palm plantations

Extensive canal networks expand crocodile access into previously uninhabited areas — structurally analogous to the kulong mechanism.

CENTRAL & SOUTHEAST SULAWESI

Nickel mining pollution

Local communities report depleted fish stocks, believed to drive crocodiles toward human prey.

EAST KALIMANTAN

Nusantara development

Habitat loss, pollution, and prey depletion linked to industrial activity and the new capital are implicated in crocodile displacement.

Waterway Dependency

78%

of incidents involved fishing or domestic water use — direct waterway dependence is the primary driver.

Domestic-water attacks reflect absence of piped or pumped water — natural waterways used for bathing, cleaning, and sanitation.

Fishing in Indonesia is overwhelmingly livelihood- or subsistence-based.

REGIONAL PATTERNS

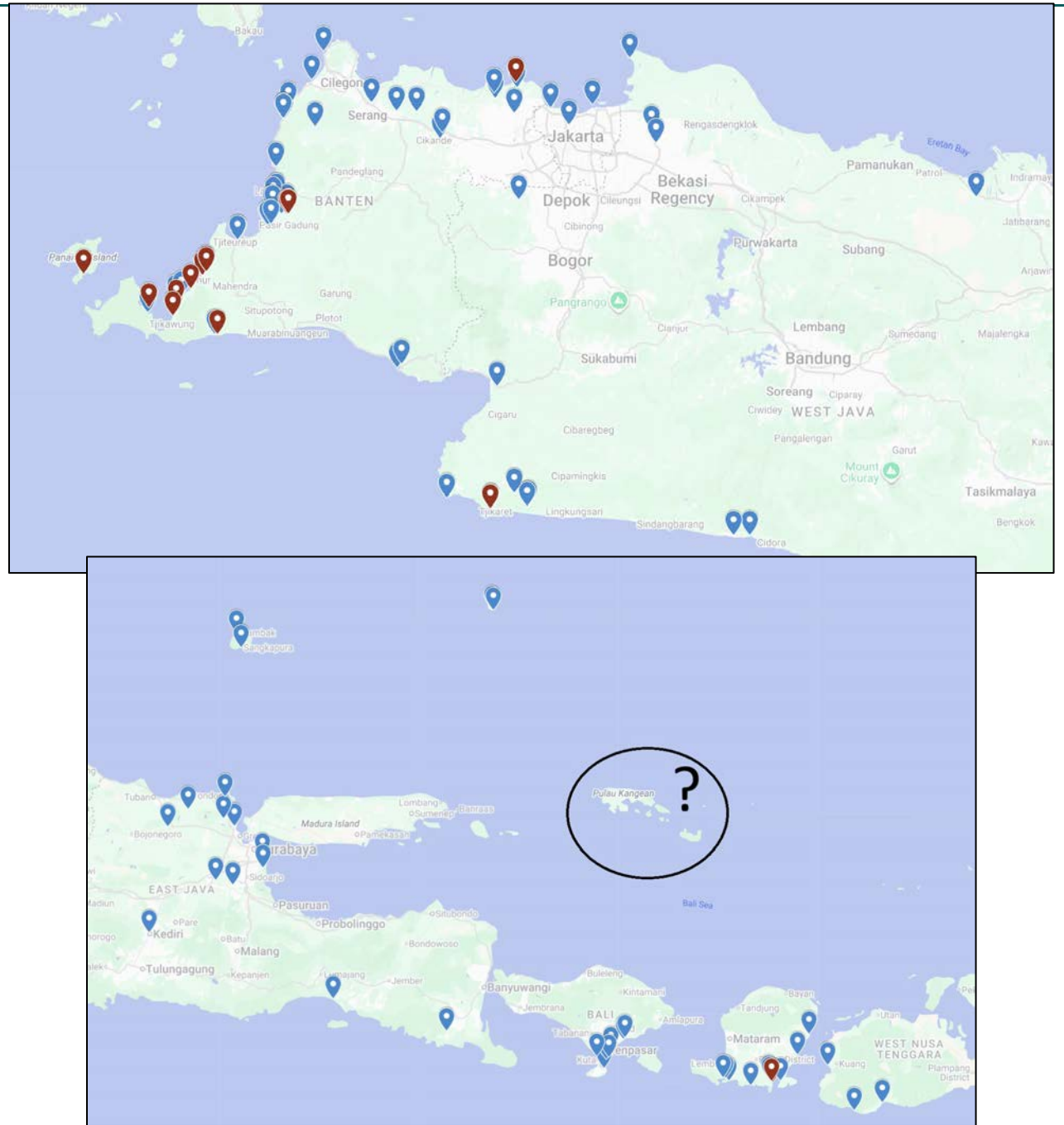
Island regions (Lesser Sunda & Maluku Islands): fishing dominates — limited freshwater habitat.

Kalimantan: domestic water use overrepresented — large tidal rivers extend hundreds of kilometres inland with extensive wetlands.

Sumatra: non-fish harvesting reflects sago (Riau) and tin-mining (Bangka-Belitung) industries.

Why no attacks in some provinces?

- Extirpation or rarity in these five provinces.
- Kangean Islands of East Java a possible exception.
- Itinerant/wandering individuals have been recorded in all five provinces.

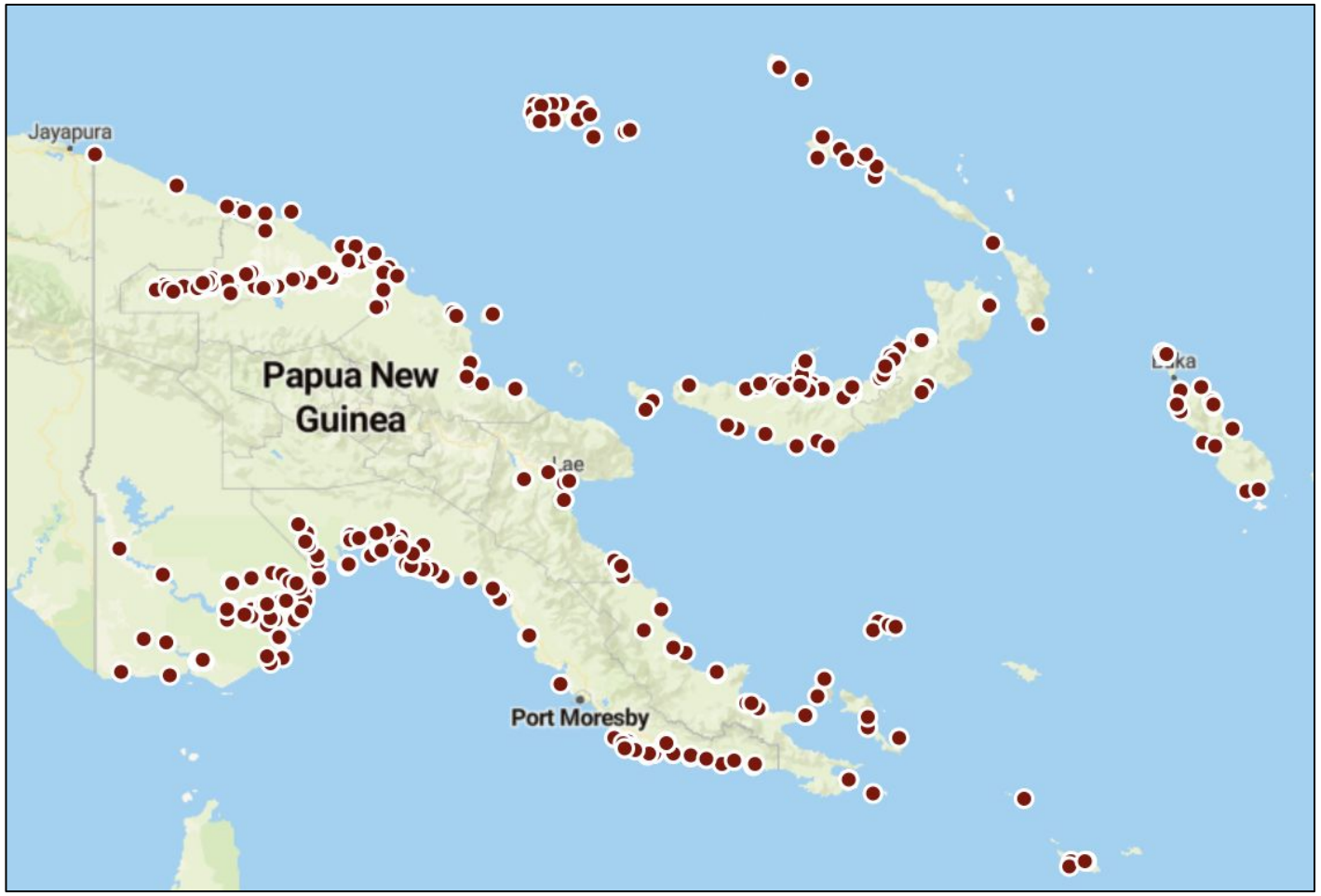


Recolonisation?

- Attacks increased in Banten (western tip of Java).
- Single non-fatal incident in West Java.
- Small resident population and three attacks along the southern coast of Lombok.
- Crocodile found at Legian Beach in Bali.

Limitations

- Indonesian Papua believed to hold largest crocodile population.
- Only 2.5% of total attacks were reported from the region.
- In neighbouring PNG, surveys revealed attacks largely unreported (only 5.8%).
- Status unclear in Kangean Islands.
- Attacks may also go unreported in Aru Islands and Wetar Island (Maluku).



Spotlight surveys

Baseline population data is mandatory to ensure effectiveness and sustainability of management plans.

- Prioritise high-conflict areas and representative high-quality habitat — countrywide assessment is impractical.
- Consistent methodology, trained personnel, non-hatchling densities reported.
- Species ID competence essential where range overlaps with Sunda gharial (Kalimantan, Sumatra) or New Guinea freshwater crocodile (Papua).

Public awareness and education programs

Similar to the CrocWise campaign here.

- Should be tailored to the predominant at-risk demographics within each region.
- Incorporate local cultural relationships and beliefs regarding crocodiles when possible.
- Signs warning of crocodile presence.

W.A.S.H. infrastructure

- Alternative water sources for at-risk communities.
- Could prevent >30% of attacks.
- Most useful in Greater Sunda Islands.
- Piped or pumped water.
- Benefits beyond crocodile attack mitigation, particularly if treated.

CEEs and other barriers

- Crocodile Exclusion Enclosures (CEEs) could prove useful.
- Must be maintained, though certain materials may increase longevity.
- Fences around villages and fishing areas.

Crocodile management

- Sustainable and population-status-dependent.
- Australian management plans unlikely to be realistic or sustainable in Indonesia.
- Targeted removal of “problem” crocodiles.
- Sustainable use in areas that can support such activities.

Industry pressure

- Pressure on multinational industries (tin, palm oil).
  - Provide safe worker access to bathing & sanitation facilities.
  - Increase environmental regulations.
  - Habitat rehabilitation.
  - Benefits beyond crocodile attack mitigation.

Thank you