



***On the Job Training on  
Tsunami Inundation Modelling and Mapping and Development of Tsunami Hazards Maps for  
Implementation of UNESCO-IOC Tsunami Ready Pilot Sites in Madagascar, Maldives, Seychelles and Sri Lanka  
Hyderabad – India, 16–21 March 2026***

# ***Tsunami Sources considerations for the ComMIT***

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# Important Questions

Which of your coastal communities face a threat from tsunamis significant enough to call for inundation modelling, and which tsunami scenarios would you choose for such modelling?

- Where is the tsunami hazard along your coast significant?
- What are the important source zones in the Indian Ocean?
  - Sumatra & Makran
  - Near Source: India (A&N), Indonesia, Oman, Malaysia
  - Far Source: India (Mainland), Maldives, Seychelles
- DTHA or PTHA
  - Source Locations & Magnitudes ?
  - Was the 2004 IOT the “worst case”, or does the potential for even higher impacts exist?
  - Can the results of IO PTHA guide your decision on a credible scenario
- Understanding uncertainty?

# Sources used for 2009 PTHA

Subduction Zone	Segment	Maximum Magnitude (Mw)		
		Historical	Low Hazard	High Hazard
Andaman-Sunda Arc	A	unknown (1762 <sup>1</sup> )	0.0	9.5
	B	9.2 (1881 <sup>2</sup> , 2004 <sup>3</sup> )	9.2	
	C	8.7 (1861,2005 <sup>4</sup> )	8.7	
	D	9.1 (1797,1833,2007 <sup>5</sup> )	9.1	
	E	7.6 (2000 <sup>5</sup> )	7.6	
	F	7.8 (1994 <sup>7</sup> ,2006 <sup>8</sup> )	7.8	
	G	none	0.0	
Makran	H	unknown (1483 <sup>8</sup> )	0.0	9.1
	I	8.1 (1945 <sup>9</sup> )	8.2	
South Sandwich	none		0.0	9.0

Table 2: Summary of megathrust earthquake tsunami source zones used in the low-hazard and high-hazard maps. The three subduction zones considered are shown, along with the segmentation that was used for the low-hazard maps (see Fig. 5a). The maximum magnitude of the historical earthquakes listed in brackets is listed in the third column. The maximum magnitudes used to generate the low-hazard and high-hazard assessments are shown in columns four and five. Where the maximum magnitude for historical earthquakes is listed as 'unknown' that indicates that a large (possibly megathrust) earthquake occurred, but its magnitude is unknown. By contrast 'none' indicates that there is no known historical occurrence of a megathrust earthquake large enough to generate a destructive tsunami. The years of historical earthquakes are indicated in parentheses with superscripts to indicate the following references: <sup>1</sup> Cummins (2007), <sup>2</sup> Ortiz and Bilham (2003), <sup>3</sup> Stein and Okal (2005), <sup>4</sup> Briggs *et al* (2005), <sup>5</sup>Natawidjaja *et al* (2006), <sup>6</sup>Abercrombie *et al* (2003), <sup>7</sup> Abercrombie *et al* (2001), <sup>8</sup>Ammon *et al* (2007), <sup>8</sup>Abraseys and Melville (1982), <sup>9</sup>Byrne *et al* (1992). These studies were used to infer the width of the megathrust seismogenic zone used in the low-hazard map, indicated as (full) or (half).

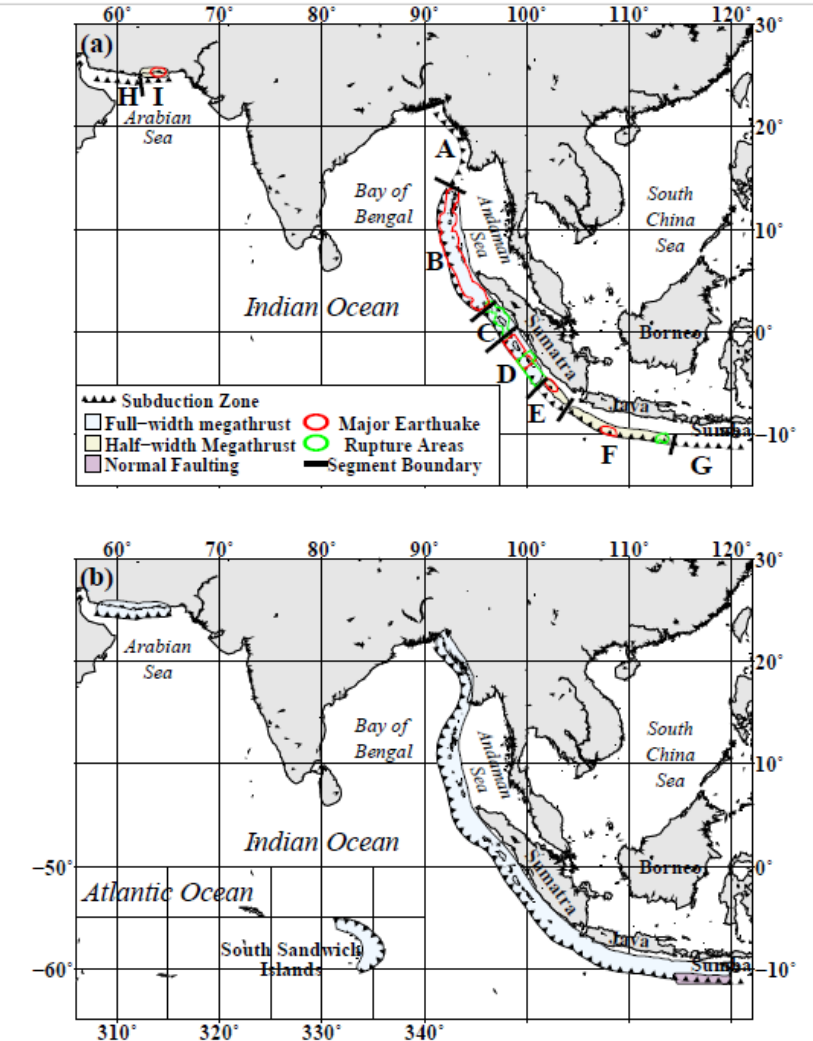
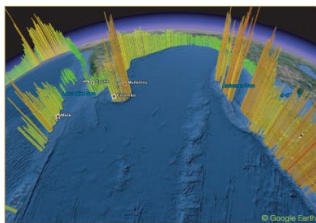


Figure 5: Map of megathrust earthquake sources of tsunami in the Indian Ocean, illustrating the source characterisation used for the low-hazard and the high-hazard maps. (a) The megathrust segmentation for the low hazard map. Also shown are the megathrust seismogenic zones characterized as "full-width" and "half-width". (b) The segmentation for the high-hazard assessment. This figure also includes the South Sandwich Arc, which is a source of tsunami for the high-hazard map but not for the low-hazard one. The Puysegur subduction zone south of New Zealand was included, but made no significant contribution to the hazard along the coastlines considered here. Plate boundaries from Bird (2002).



# Results of Indian Ocean PTHA

Indian Ocean nation	1/2000yr tsunami amplitude (m)		Most Important Subduction Zone Segments
	low	high	
Bangladesh	0.5	0.6	Andaman
British Ocean Territory	1.1	1.7	Andaman, Sumatra
Burma	1.1	1.5	Andaman, Sumatra
Comoros	0.3	0.5	Makran, Andaman, Sumatra
Djibouti	0.2	0.4	Makran
India	1.9	3.1	Makran, Andaman, Sumatra
Indonesia	5.6	7.1	Andaman, Sumatra, Java and Sumba
Iran	0.3	2.7	Makran
Kenya	0.5	0.8	Andaman, Sumatra
Madagascar	1.0	2.2	Andaman, Sumatra, Java, Sth Sandwich
Maldives	2.2	3.0	Andaman, Sumatra, Makran
Mauritius	1.2	1.7	Andaman, Sumatra, Makran
Mayotte	0.3	0.4	Andaman, Sumatra, Makran
Mozambique	0.5	1.4	Andaman, Sumatra, Sth Sandwich
Oman	0.6	3.8	Andaman, Sumatra, Makran
Pakistan	0.9	2.8	Makran
Reunion	0.7	1.4	Andaman, Sumatra, Sth Sandwich
Seychelles	0.8	1.2	Andaman, Sumatra, Makran
Somalia	0.7	1.1	Andaman, Sumatra, Makran
South Africa	0.6	1.6	Andaman, Sumatra, S Sandwich
Sri Lanka	2.9	3.7	Andaman, Sumatra
Tanzania	0.5	0.9	Andaman, Sumatra, Makran
Thailand	1.9	2.6	Andaman, Sumatra
United Arab Emirates	0.1	0.8	Makran
Yemen	0.8	1.3	Makran, Andaman, Sumatra

Table 1: Summary of results for all the nations considered in the study for one particular measure of the offshore tsunami hazard, the name of country is listed in the first column. The second and third columns show the maximum tsunami amplitude with a 1 in 2000 year chance of being exceeded for any point off the Indian Ocean nation shown in the first column for the low hazard and high hazard assessments, respectively. The nations shown in red have the highest (greater than 2m maximum tsunami amplitude in the high hazard map) hazard at this return period. The nations shown in green have the lowest (tsunami amplitude is less than 1m in the high hazard map) at the 2000 year return period. The fourth column lists the subduction zones which make the greatest contribution to the 1 in 2000 year hazard for that particular nation.

- A 2000 year return period is typically the upper limit used for emergency planning because it is normally associated with a large, but still reasonably probable, event.
- Tsunami height at 100m water depth
  - Less than 25 cm is likely insignificant
  - 25 to 75 cm could cause significant localized run-up
  - Greater than 75 cm, a significant threat
- You may need to modify these as you learn more from inundation modelling
- Greens Law

# Guidance for Selection of Scenarios

Selection of appropriate scenarios and magnitude may be based on the results of PTHA which provides a range of maximum tsunami amplitude with a 1 in 2000-year chance of being exceeded for each country for a low and high hazard source. The table also provides information on the subduction zone segments that contribute to tsunami hazard for each country.

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	low	high	
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### 5.17 Madagascar (low hazard)

The hazard offshore Madagascar in the low hazard assessment is much higher offshore eastern and south-eastern coasts than the western and north-western coasts (Figure 32(c)). The south-eastern coast has hazard noticeably larger than the rest of the east coast. Hazard values at the 2000 year return period range from 0.1m (west coast) to 1m (southeast coast) (Figure 32(a)) and comes from both the Sumatran and Andaman zones (Figure 32(b))

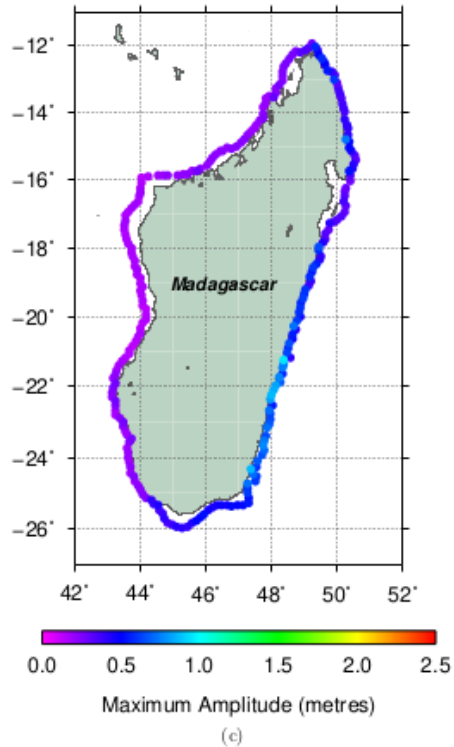
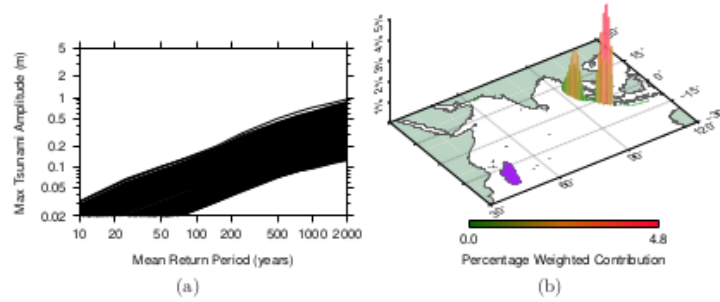


Figure 32: Madagascar:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.18 Madagascar (high hazard)

In the high hazard assessment the hazard is again much higher off the west to southwest coasts of Madagascar (Figure 33(c)). The hazard off the south and northeast coast is intermediate and that off the western coast is much smaller. At the 2000 year return period the hazard ranges from 0.2m to 2.2m (Figure 33(a)). The hazard mostly comes from the Sunda Arc zones, but there is also a significant contribution from the South Sandwich zone (Figure 33(b)).

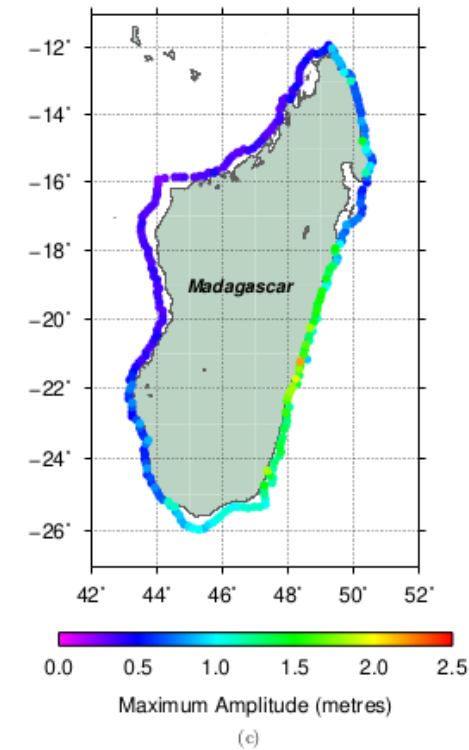
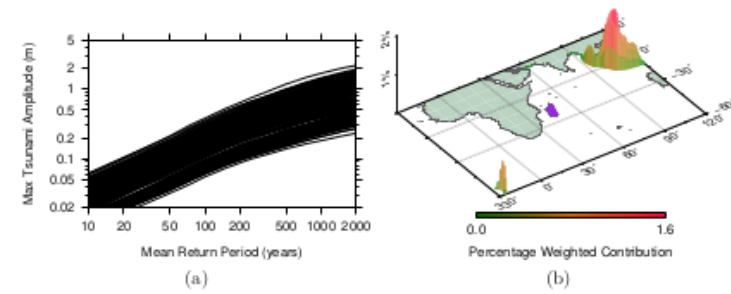


Figure 33: Madagascar:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.19 Maldives (low hazard)

The hazard offshore the Maldives in the low hazard assessment is much higher offshore the eastern coasts than the west and higher in south than the north (Figure 34(c)). The hazard at this return period comes entirely from the Andaman zone (Figure 34(b)) and ranges from 0.3m to 2.2m depending on location (Figure 34(a)).

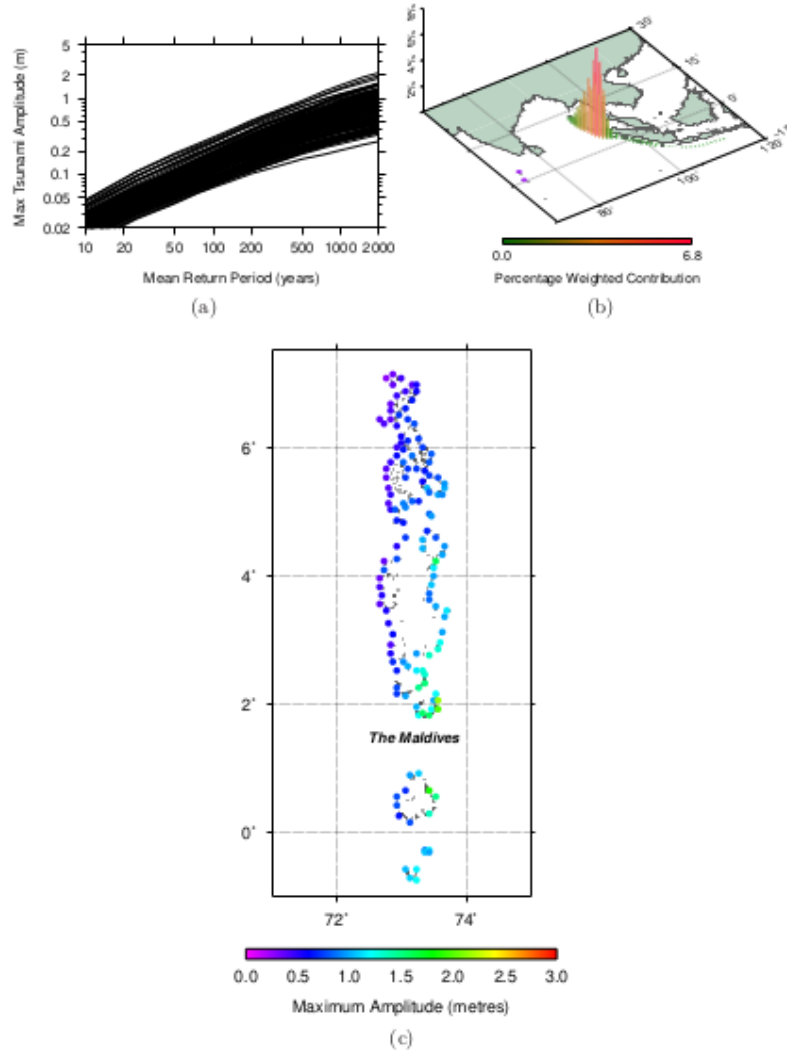


Figure 34: Maldives:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.20 Maldives (high hazard)

The distribution of hazard in the high hazard assessment of the Maldives is similar to the low hazard one (Figure 35(c)). The 2000 year hazard values range from 0.6m to 3.0m depending on which side of the chain the points are located (Figure 35(a)). Hazard again mostly originates from the Andaman zone, with a small contribution from Sumatra as well (Figure 35(b))

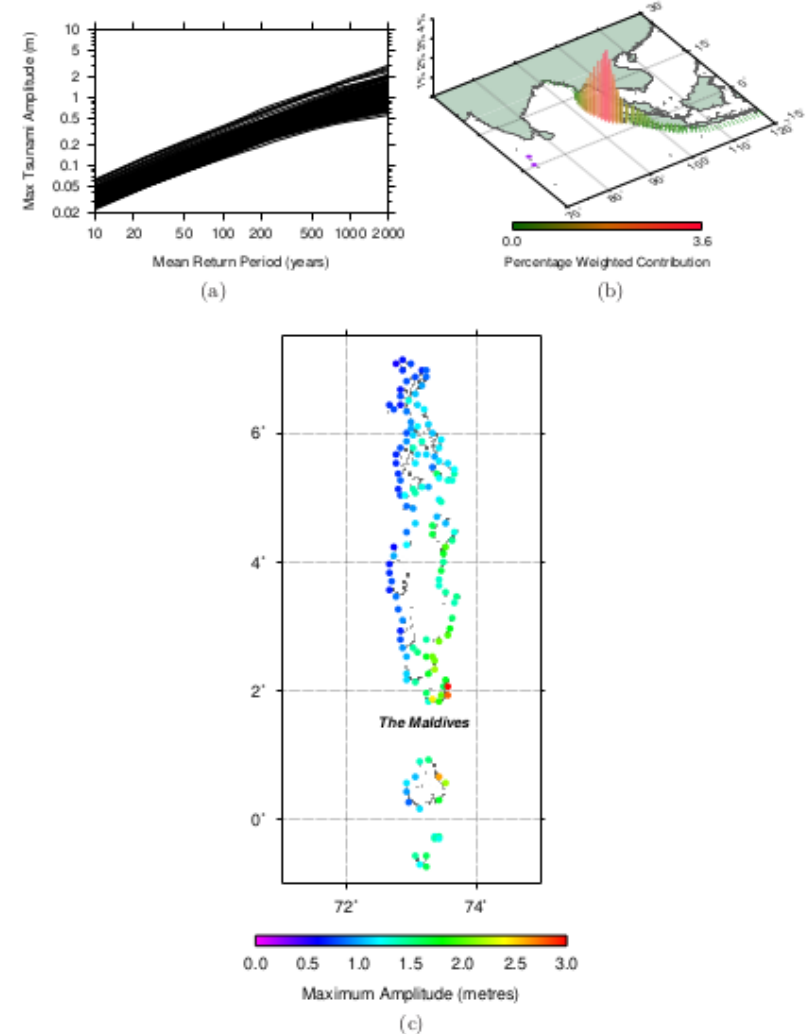


Figure 35: Maldives:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.33 Seychelles (low hazard)

Hazard in the Seychelles at the 2000 year return period is at a maximum for the islands in the northeast part of the archipelago (Figure 48(c)). Values range from about 0.1m to 0.8m depending on location (Figure 48(a)). The most important subduction zone for the Seychelles from this assessment is the Andaman section of the Sunda Arc, with a smaller contribution from Sumatra (Figure 48(b))

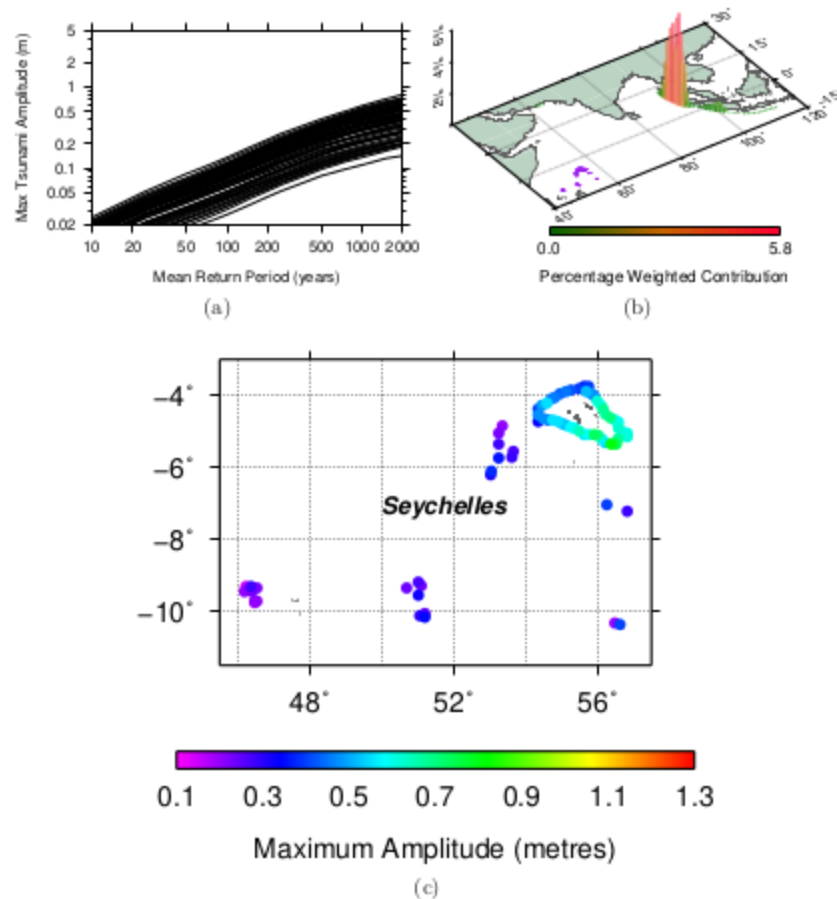


Figure 48: Seychelles:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.34 Seychelles (high hazard)

As with the low hazard assessment, the hazard offshore islands in the northeast of the Seychelles is much higher than it is for the rest of islands (Figure 49(c)). Values range from 0.2m to 1.2m at the 2000 year return period (Figure 49(a)). Most of this hazard again comes from Andaman, but there is also a strong contribution from Sumatra (Figure 49(c)).

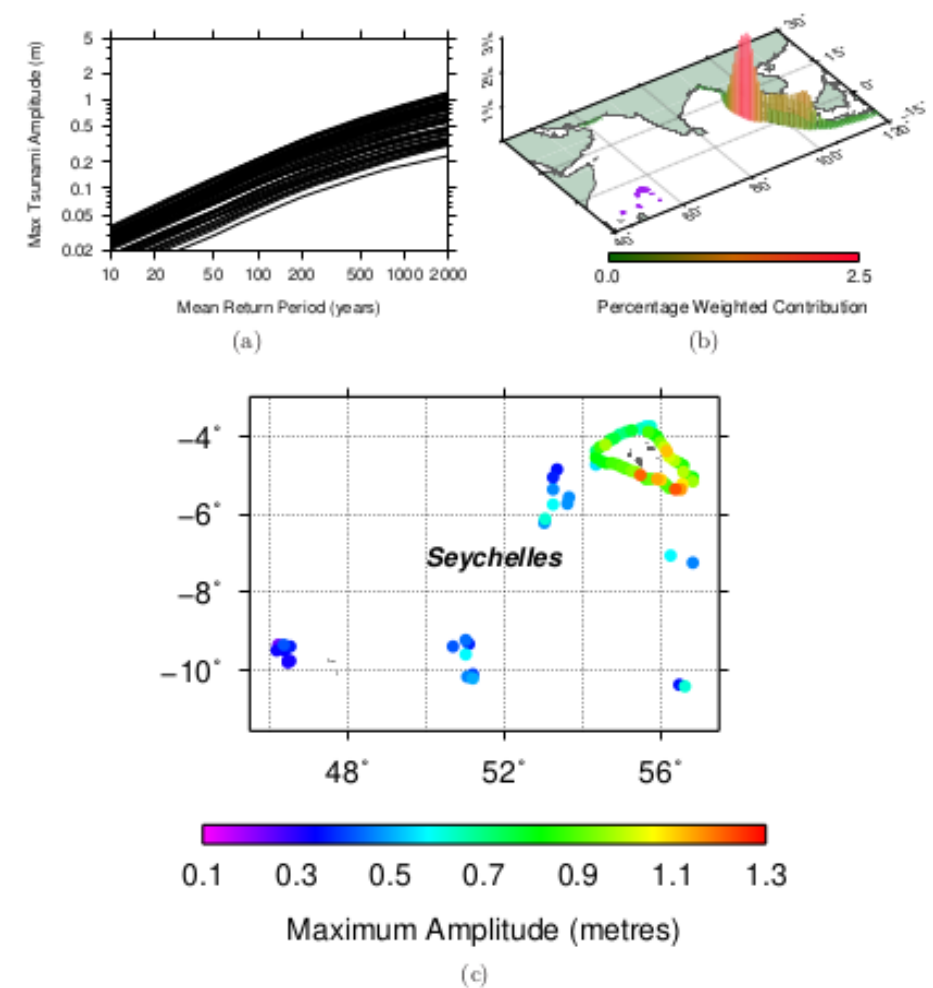


Figure 49: Seychelles:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.39 Sri Lanka (low hazard)

The hazard offshore the eastern coasts of Sri Lanka at a 2000 year return period is much higher than offshore the western coasts of Sri Lanka which face India (Figure 54(c)). Values range from 0.4m to 3m, depending on the choice of coast (Figure 54(a)). The hazard here is naturally dominated by the Andaman zone Figure 54(b)).

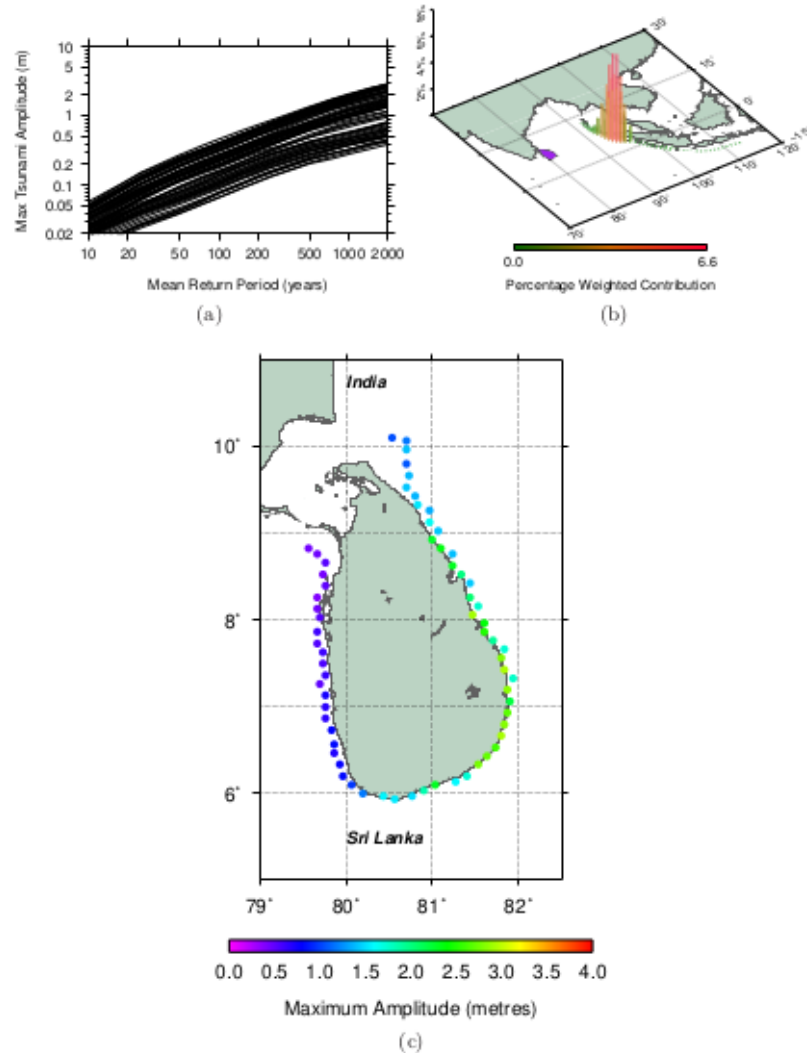


Figure 54: Sri Lanka:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.40 Sri Lanka (high hazard)

The hazard offshore Sri Lanka is again much higher off the eastern, particularly the south-east coasts, at the 2000 year return than offshore the western and northern coasts (Figure 55(c)). Values range from 0.6m to nearly 3.7m Figure 55(a)). Again, the main source of this hazard is the Andaman zone Figure 55(b)).

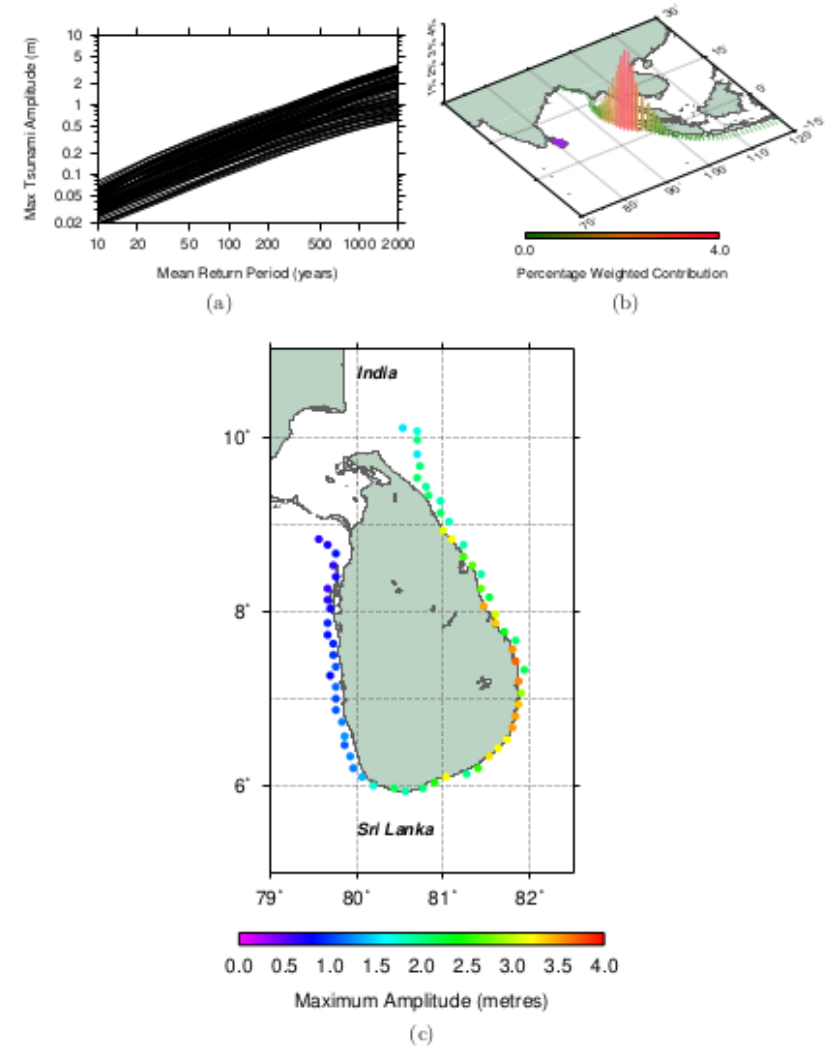


Figure 55: Sri Lanka:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

## 5.11 India

### 5.11.1 Indian Mainland (low hazard)

The large 2000 year maximum amplitude has a very large spread of values for mainland India. It is far higher on the east coast than on the west coast (Figure 18(c)). Values at the 2000 year return period range from 0.1m (west coast) to 1.9m (east coast). The hazard here is dominated by the southern and central Andaman zone (Figure 18(b))

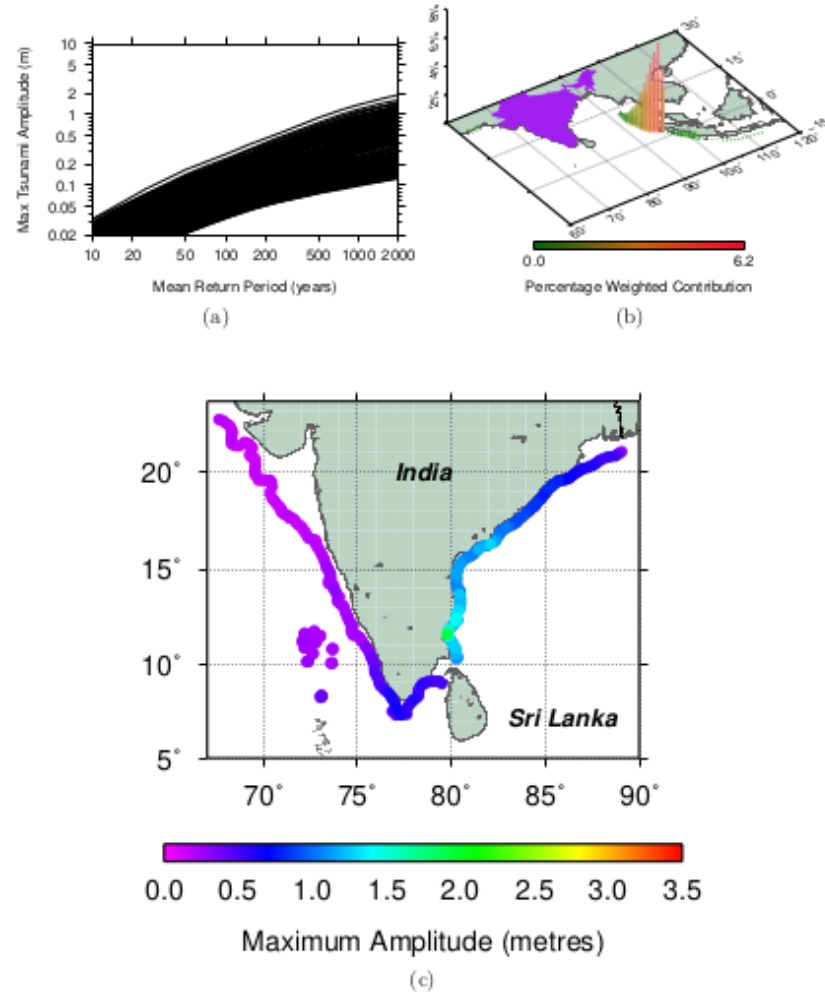


Figure 18: India:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

### 5.11.2 Indian Mainland (high hazard)

The large 2000 year maximum amplitude in the high hazard again is much higher on the east coast than the west (Figure 19(c)). The hazard ranges from over 3m (east coast) to 0.3m (west coast). The single high hazard value for the east coast in both the low and high hazard maps should be interpreted with caution as this could be due to a local bathymetric anomaly in the global bathymetry dataset used in this assessment. The deaggregated hazard map (Figure 19(b)) shows that the most important zone is the Andaman, but significant contributions also come from the Arakan (east coast) and Makran (west coast).

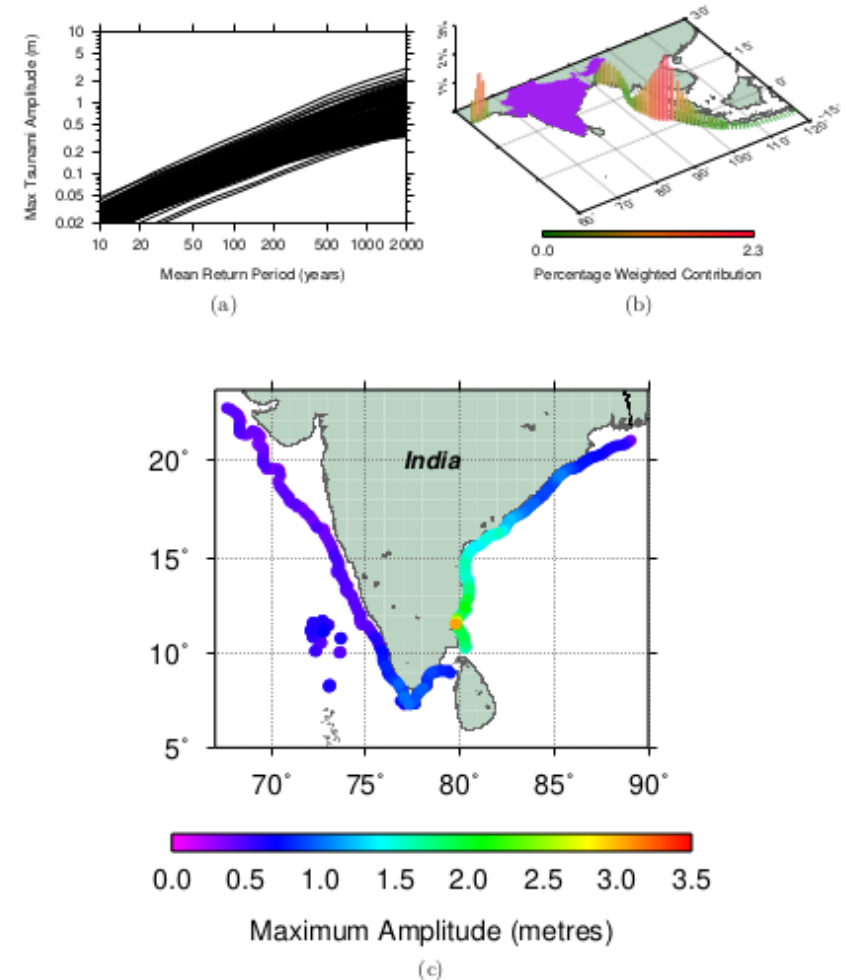


Figure 19: India:- (a) Hazard curves for all model output points. (b) National weighted deaggregated hazard. (c) Maximum amplitude at a 2000 year return period for all model output points.

# Highly vulnerable Areas

(Based on the probabilistic tsunami amplitudes in 1000y recurrence)

## Maldives



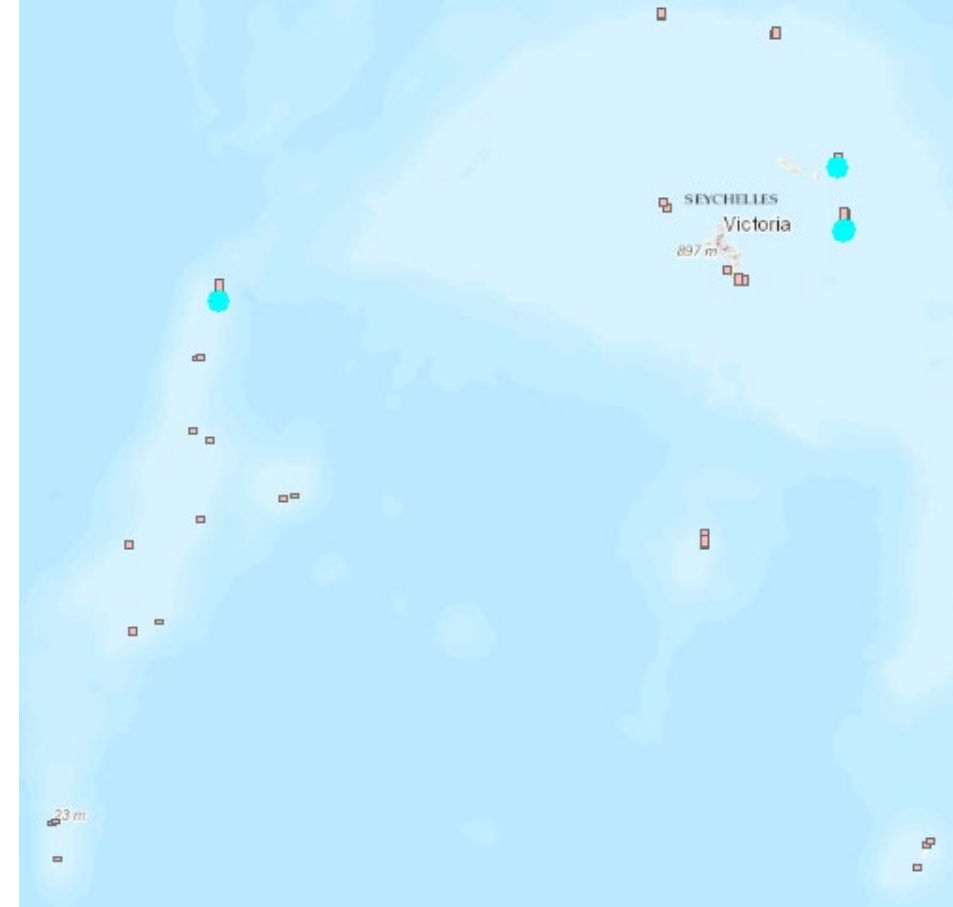
## Sri Lanka



## Madagascar



## Seychelles



# ComMIT Unit Sources for PTHA Suggested Scenarios