Preliminary field survey of the earthquake and tsunami of 26 December, 2004

Harry Yeh

National Science Foundation
Earthquake Engineering Research Institute
a GLOBAL tsunami!

Modeling by Vasily Titov and Diego Arcas, NOAA
Long-Wave Propagation: Numeric-Analytic Hybrid Approach

$L = 10$

$L = 20$

$L = 40$

Initial Displacement
The profile of the maximum $\eta$: $L = 20$
Hirata (2005): JAMSTEC
EERI Tsunami Survey: India

Chennai (N13°01.105, E80°16.693)
Pre-Survey Numerical Prediction

by Philip Liu
We surveyed about 350km long coastline, from Pulicat (13°23’N) to Vedaranniyam (10°23’N)
EERI Tsunami Survey: India
January 7 - 11, 2005

• **Itinerary**
  – January 7: Chennai
  – January 8: Chennai -- Pondicherry
  – January 9: Pondicherry -- Karaikal
  – January 10: Karaikal -- Vedaranniyam
  – January 11: Chennai -- Punicat

• **Members**
  – **R.K. Chadha**, National Geophysical Research Institute, Hyderabad, India (Seismologist)
  – **Toshitaka Katada**, Gunma University, Japan (Social Engineer)
  – **G. Latha**, National Institute of Ocean Technology, Chennai, India (Ocean Scientist)
  – **Curt Peterson**, Portland State University, USA (Sedimentologist)
  – **Harry Yeh** (the team leader), Oregon State University, USA
Nagappattinam
(N10°45.785’ E79°50.928’)

7.2 m -- splash up

5.2 m
Scratch by a floating object

Mud line inside

Perangipettinam (N11°30.965, E79°45.947)
Periakalapet (N12°01.544, E79°51.888)
Devanaanpattinam (N11°44.529, E79°46.925)

More than 850 m inundation
<table>
<thead>
<tr>
<th>Location</th>
<th>Latitude/Longitude</th>
<th>Runup Elevation* (m)</th>
<th>Death Toll</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulicat</td>
<td>13 23.040° N</td>
<td>3.2</td>
<td>3</td>
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<tr>
<td></td>
<td>89 19.984° E</td>
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<tr>
<td>Pattinaoakkam</td>
<td>13 01.263° N</td>
<td>2.7</td>
<td>120</td>
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<tr>
<td>(Chennai)</td>
<td>80 16.722° E</td>
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<tr>
<td>Kovalam</td>
<td>12 47.455° N</td>
<td>4.3</td>
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<tr>
<td></td>
<td>80 15.003° E</td>
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<tr>
<td>Kalapakkom</td>
<td>12 30.378° N</td>
<td>3.2</td>
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</tr>
<tr>
<td></td>
<td>80 09.688° E</td>
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<tr>
<td>Periakalapet</td>
<td>12 01.544° N</td>
<td>3.9</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>79 51.888° E</td>
<td></td>
<td></td>
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<tr>
<td>Puttupattnam</td>
<td>11 51.618° N</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>79 48.926° E</td>
<td></td>
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<tr>
<td>Devanaanpattnam</td>
<td>11 44.576° N</td>
<td>2.5</td>
<td>200</td>
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<td></td>
<td>79 47.230° E</td>
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<td>Perangipettinam</td>
<td>11 30.965° N</td>
<td>2.8</td>
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<td>79 45.947° E</td>
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<td>Tarangambadi</td>
<td>11 01.620° N</td>
<td>4.4</td>
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<td>79 51.350° E</td>
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<td>Nagapattinum</td>
<td>10 45.785° N</td>
<td>5.2</td>
<td>6000</td>
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<td>79 50.928° E</td>
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<tr>
<td>Vedaranniyan</td>
<td>10 23.597° N</td>
<td>3.6</td>
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<tr>
<td></td>
<td>79 52.014° E</td>
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</tbody>
</table>
Tsunami Runup Height Distribution

- 3.2 m
- 2.7 m
- 4.3 m
- 3.2 m
- 3.9 m
- 2.6 m
- 2.5 m
- 2.8 m
- 4.4 m
- 5.2 m
- 3.6 m
Devanaanpattinam: N11°44.612′ E79°47.214
More than 200 people perished.
Bathymetry
Tsunami with the wavelength of \(~ 500\) km
This is “NOT” a typical tsunami

Source: “Earthquake” by: Bruce A. Bolt
Estimated Breadth of the Continental Shelf

Offshore Distance (km); runup height (decimeter)

100-m contour

200-m contour

Tsunami runup height
Discolored vegetation due to sea water at Kovalam (N12°47.253’ E80°15.269)
Devanaanpattinam (N11º44.589, E79º47.289)
Refugee camp at Nemmelikuppm (N12°43.162’ E80°15.206)
Nagappattinam (N10°45.785, E79°50.928)
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Nagappattinam (N10°45.785, E79°50.928)
Periakalapet (N12°01.614, E79°51.982)
Undermined sidewalk in Chennai

(N13°02.061’ E80°16.792)
(N12°30.387’ E80°09.675’)
Kalapakkom
School house at Kalapakkom (N12°30.378’ E80°09.688’)

Ocean

Ocean
Enlarged channel made by tsunami drawdown
Devanaanpattinam (N11°44.576’ E79°47.230)
Sri Lanka, Kalutara Beach
Blackened beach: sediment sorting by tsunami actions.
Multiple lamination of magnetite (?)
El Transito,
the 1992 Nicaragua Tsunami
The 1992 Flores Island Tsunami: Leworahang

The 1993 Okushiri Tsunami: Monai
Additional Survey Needed

• We could not cover the area north of N 13.5 degrees,
• We could not go in the ports of Chennai (there are three of them),
• We could not go to the southern tip of India, N 8.1 degrees.
Periakalapet (N12°01.614, E79°51.982)
Field Survey vs. Numerical simulation along east coast of India

by Philip Liu
• Storm waves pound the shore.

• Tsunamis sweep the coastal zone.