WHO Conference on Health Aspects of Tsunami Disaster in Asia

Phuket, Thailand
4–6 May 2005

World Health Organization

Who Was Affected?
The Demography of Tsunami-Affected Population

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Assessing Needs and Measuring Impacts

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Overview

- Population
  - exposure
  - composition
  - measurement
- Crude death rates
- Socioeconomic profiles of the exposed areas
- Where are people now?
- A hazardous world: a multi-hazard approach

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Population exposure

- What do we know about the spatial distribution of human population?
  - People do not live uniformly with respect to:
    - National borders
    - Coastlines
    - Other geographic features, including hazard-prone regions
      - Some hazard prone regions may “attract” population, e.g., volcanic soils
      - Coastal zones support fishing, and access to markets (historically)
  - People move
    - Daily movement—commuting to work, markets, schools
    - Seasonal movements—tourist, labor-migration
    - Longer term movements—life-cycle (childbearing, retirement), permanent migration, forced migration

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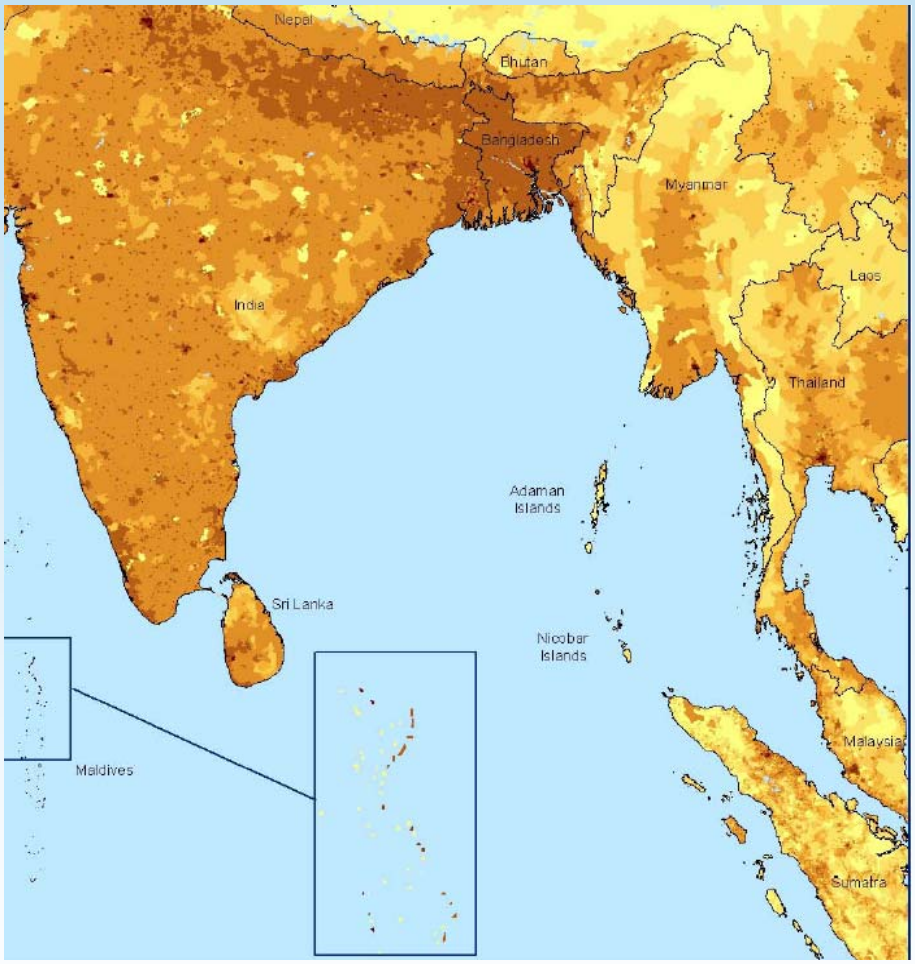
Population density



Source: CIESIN, GRUMP v1 (alpha)

http://beta.sedac.ciesin.columbia.edu/gpw

- Asia—particularly south and southeast Asia—are the most densely populated place on earth
- Coastal zones have disproportionately high population densities
  - 450 persons/km^2, Asia
  - vs. 175, globally
- Coastal areas are more urban

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Demographic Composition

- Age distribution: Asia is young.
  - Proportion of population < 15 yrs ranges between 25-35% as compared with 20% or lower in North America and Europe
- Household size and composition.
  - Larger, extended, with traditions of fosterage
- Gender
  - Displacement affects women and men differently

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Population estimation

- Who was exposed?
- Who was at risk?
- Who was affected?
  - Lost lives
  - Lost livelihoods
  - Displacement

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Who was exposed to the tsunami?

- Wave heights were reported to be between 30-40 feet at their maximum
  - Persons below roughly 40 feet, or 10 meters, in elevation
- At close distance to the coastline
  - In most places, the waves were reported to go no more than 1-2 km inland from the coast
    - Except in parts of Sumatra were there were reported as far inland as 4-5 kilometers
- Additional damage from the earthquake
  - And perhaps interactions with flooding

- *How to quantify the number of persons exposed?*

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Calculation

- Estimate the population residing
  - Within 1 and 2 km buffers of the coastline
  - And, at an elevation of 10 meters or less

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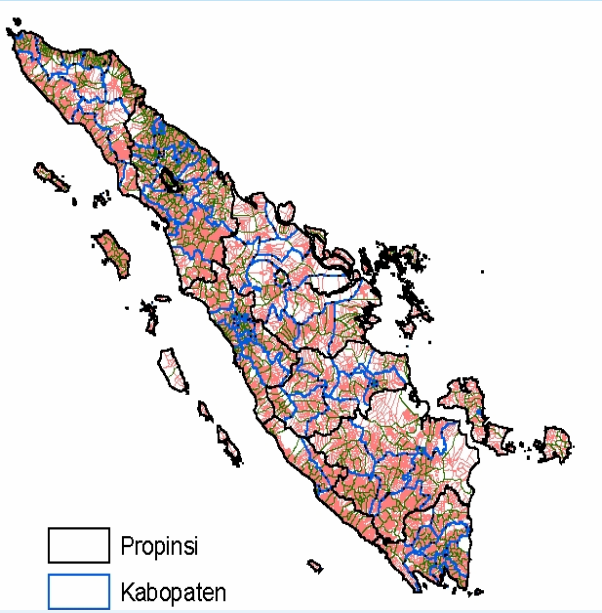
Why is population estimation tricky?



- Data formats are not easily comparable
  - Population data come from censuses:
    - **Irregular-shaped units**
    - **“Who slept here” or usual residence;**

- Elevation data come from earth observing satellites (SRTM):
  - Uniform gridded dataset

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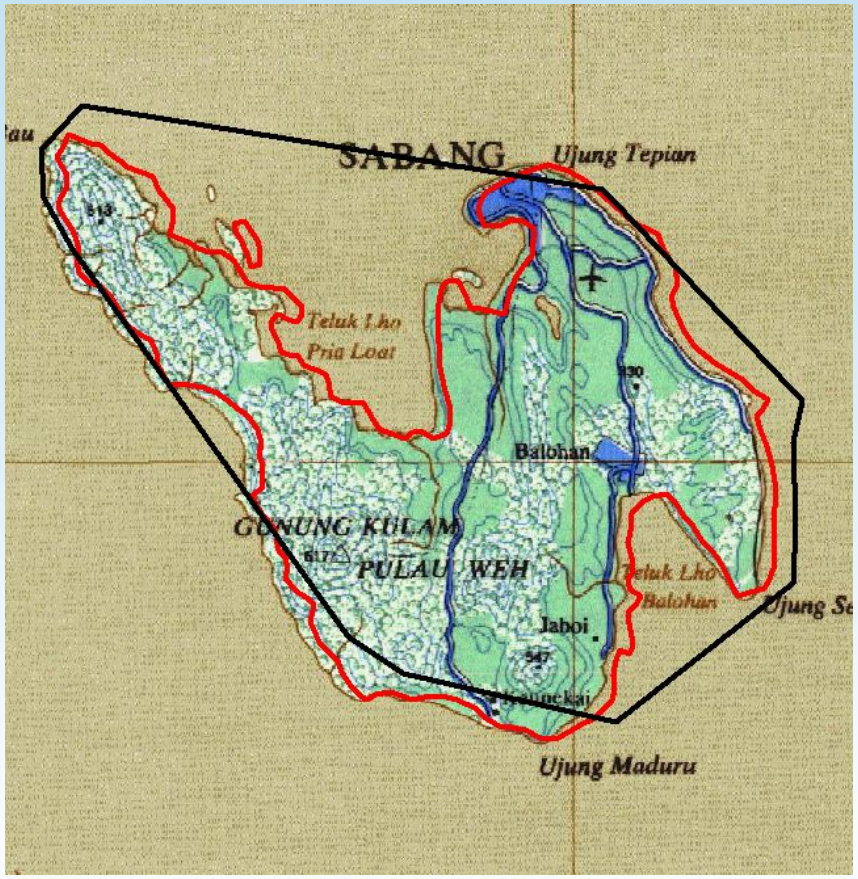
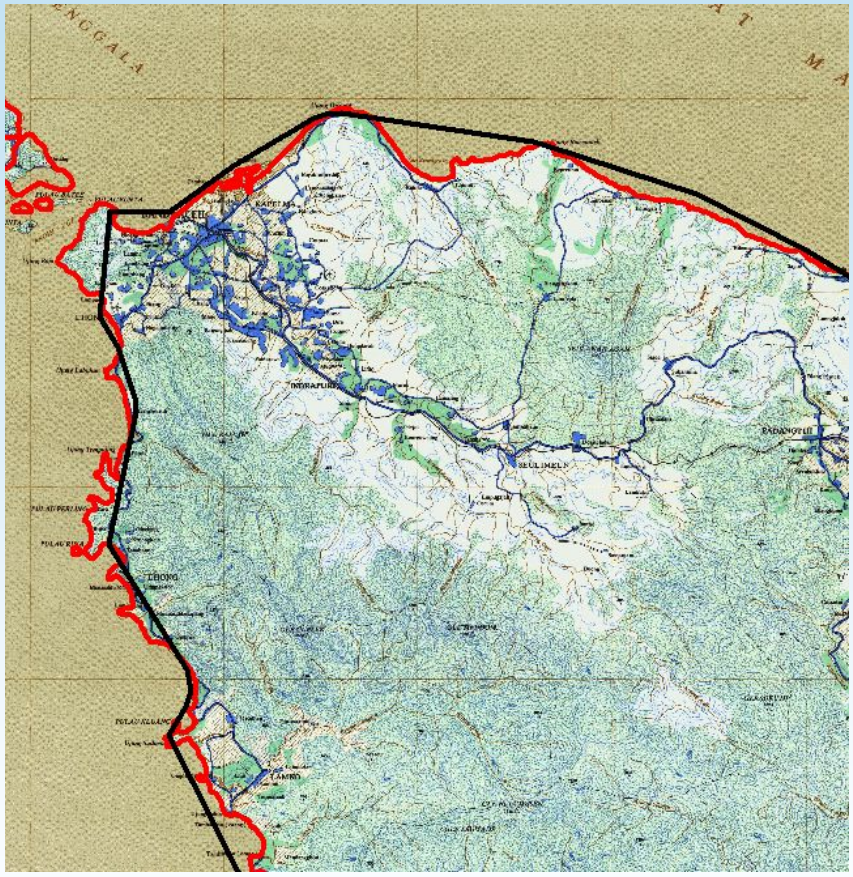
Coastlines must match, but often don't





Shorelines of data sources do not match:

Blue: shoreline: ESRI

Red: sh

Th

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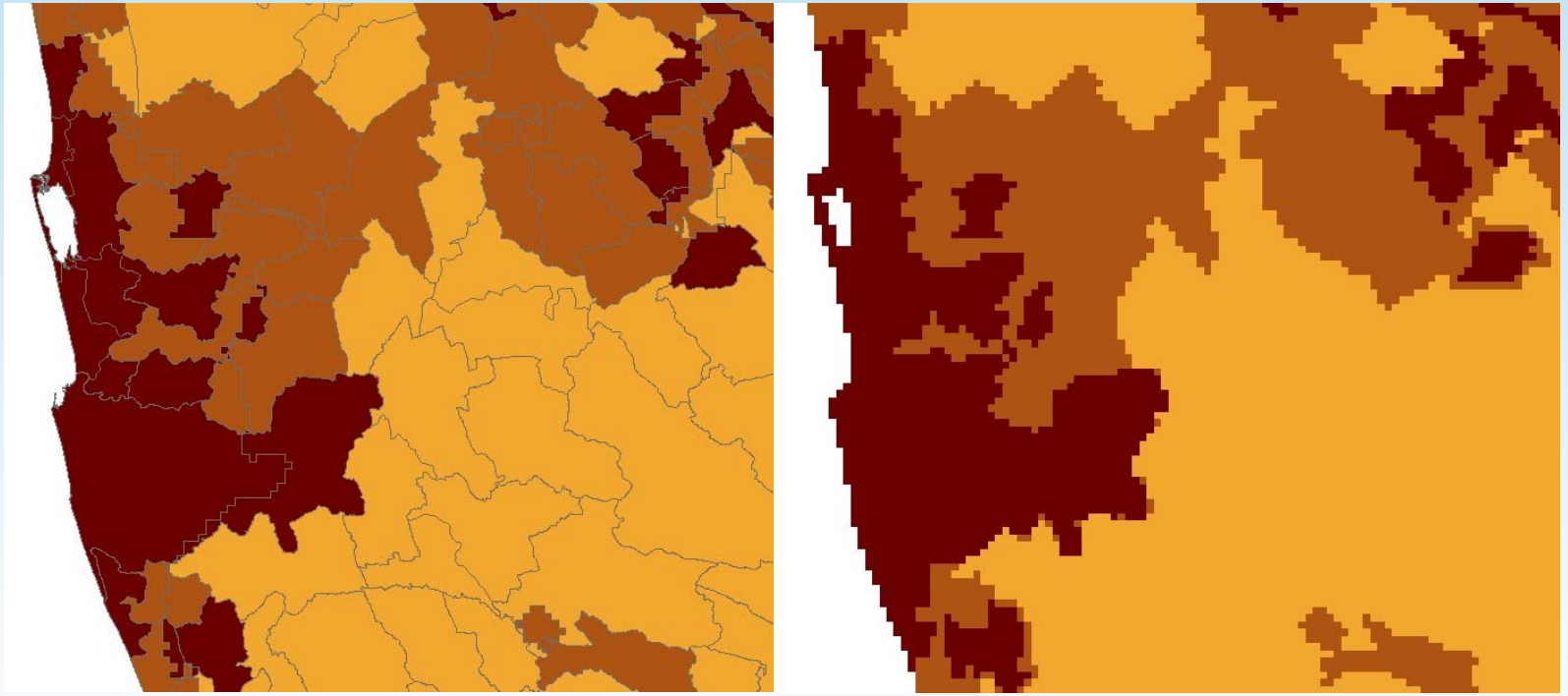
Data transformation: administrative units to grids



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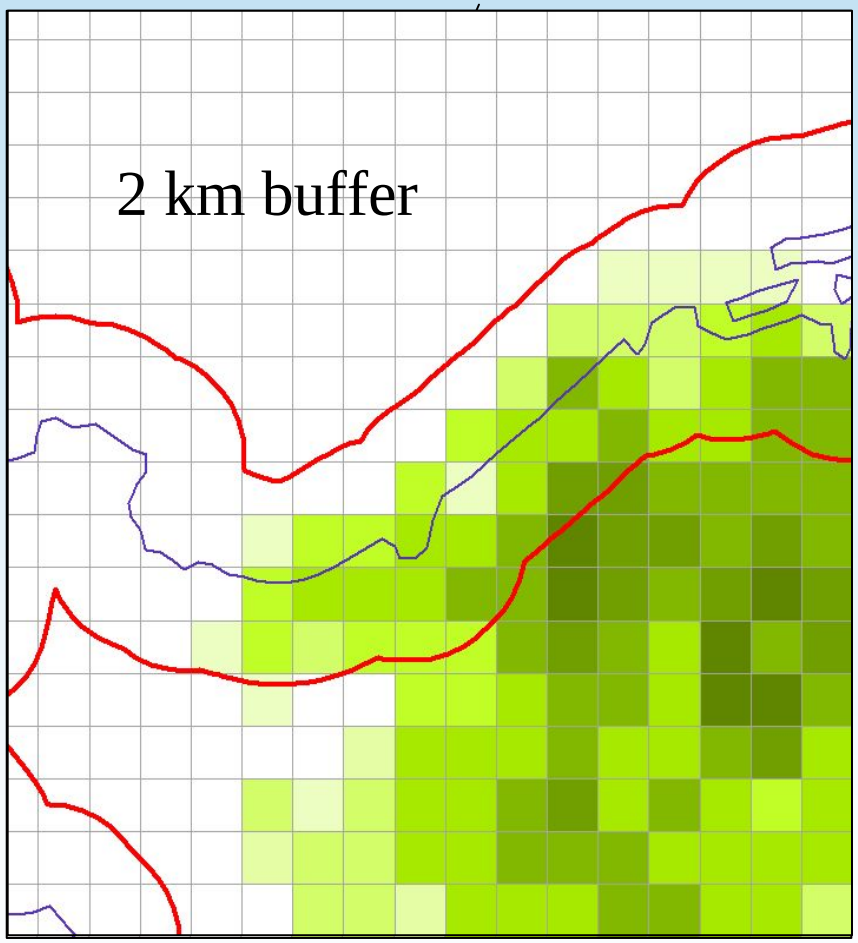
Vector and raster data combination



Population data are now Gridded (i.e., rasterized)

Shoreline is vector (convert to raster)

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Results

County	Region	Area of Region (km^2)	Population exposed, 2005			
			Within 1 km of coast		Within 2 km of coast	
			Count	% of regional population	Count	% of regional population
India			*1,642,855*		*3,398,071*	
India	Andaman and Nicobar Islands	7,248	10,496	6.8	13,467	8.8
India	Andhra Pradesh	276,086	295,676	0.3	641,895	0.7
India	Pondicherry	560	84,923	9.2	116,908	12.6
India	Tamil Nadu	130,644	565,132	1.1	1,165,692	2.2
Indonesia			*571,169*		*1,149,231*	
Indonesia	Aceh*	57,301	120,453	4.8	249,219	10.0
Indonesia	Bengkulu	20,720	21,271	1.3	42,388	2.6
Indonesia	Sumatera Barat	43,026	108,666	2.2	216,973	4.5
Indonesia	Sumatera Utara	71,276	136,490	1.1	284,075	2.2
Sri Lanka			*550,208*		*889,676*	
Sri Lanka	Eastern	69,427	109,366	7.6	169,606	11.9
Sri Lanka	North Western	41,391	56,340	2.5	107,665	4.7
Sri Lanka	Northern	8,077	209,762	21.6	331,269	34.1
Sri Lanka	Southern	5,662	57,789	2.4	89,620	3.8
Sri Lanka	Western	8,024	116,951	2.3	191,516	3.7
Thailand			*89,888*		*133,715*	
Thailand	Krabi	4,326	11,401	3.6	17,359	5.5
Thailand	Phuket	558	30,649	13.7	37,695	16.8
Subregion at highest exposure to Tsunami			**1,935,365**		**3,675,347**	

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Bangladesh			*5,827,219*		*10,331,836*	
Bangladesh	Barisal	8,808	1,520,136	17.4	2,804,123	32.1
Bangladesh	Chittagong	42,149	1,870,569	4.9	3,510,491	9.2
Bangladesh	Dhaka	31,129	2,389,612	5.0	3,909,754	8.2
Bangladesh	Khulna	21,919	46,902	0.3	107,467	0.6
India	Kerala	38,725	9,167	0.0	14,747	0.1
India	Orissa	149,402	197,383	0.5	394,517	1.0
India	West Bengal	85,479	480,078	0.7	1,050,845	1.5
Indonesia	Lampung	34,514	3,803	0.1	4,888	0.1
Maldives			*319,452*	100.0	*319,452*	100.0
Malaysia			*297,579*		*599,790*	
Malaysia	Kedah	3,516	24,307	1.4	49,176	2.9
Malaysia	Perak	8,035	20,935	0.8	43,938	1.6
Malaysia	Perlis	471	5,806	2.5	10,489	4.6
Malaysia	Pulau Pinang	374	133,946	9.7	271,506	19.6
Malaysia	Selangor	3,016	112,585	2.9	224,681	5.8
Myanmar			*1,268,726*		*2,408,847*	
Myanmar	Arakan State	35,227	228,029	8.1	428,409	15.3
Myanmar	Irrawaddy	33,573	207,667	2.9	444,709	6.2
Myanmar	Karen State	30,476	1,291	0.1	3,533	0.4
Myanmar	Mon State	10,813	203,272	8.1	368,528	14.8
Myanmar	Pegu	38,484	27,852	0.5	54,358	1.0
Myanmar	Rangoon	9,563	552,206	9.4	1,003,537	17.0
Myanmar	Tenasserim	39,688	48,408	3.8	105,773	8.3
Thailand	Phangnga	4,045	10,331	4.3	16,013	6.7
Thailand	Ranong	3,356	9,574	5.3	14,146	7.9
Thailand	Satun	996	16,954	7.3	29,808	12.9
Thailand	Trang	4,860	10,980	1.8	18,693	3.0
Total Asian region at any exposure to Tsunami			10,387,208		18,879,773	

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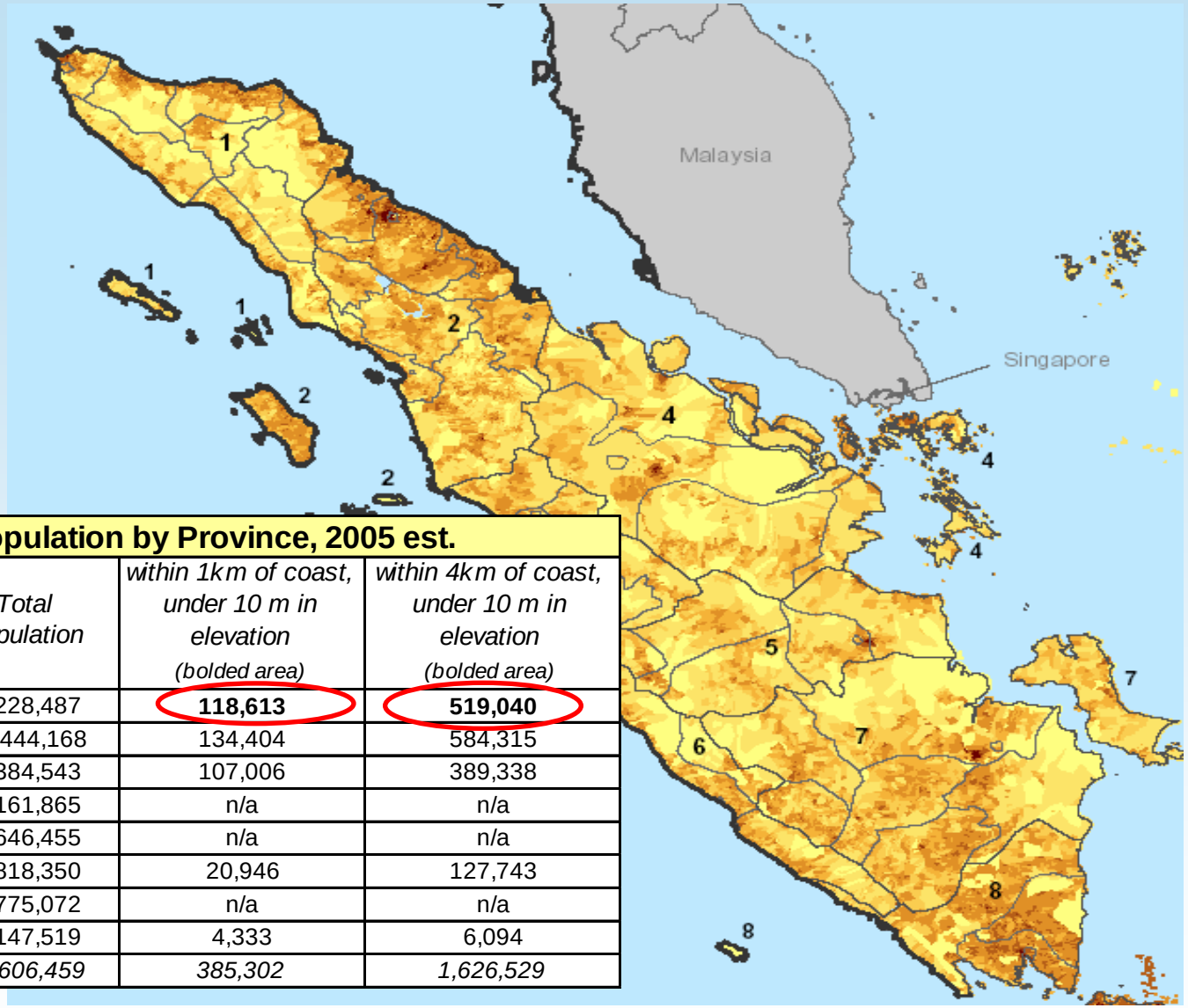

Sumatra Population by Province, 2005 est.				
#	*Province*	*Total Population*	*within 1km of coast, under 10 m in elevation (bolded area)*	*within 4km of coast, under 10 m in elevation (bolded area)*
1	Aceh	4,228,487	**118,613**	**519,040**
2	Sumatera Utara	12,444,168	134,404	584,315
3	Sumatera Barat	4,384,543	107,006	389,338
4	Riau	6,161,865	n/a	n/a
5	Jambi	2,646,455	n/a	n/a
6	Bengkulu	1,818,350	20,946	127,743
7	Sumatera Selatan	7,775,072	n/a	n/a
8	Lampung	7,147,519	4,333	6,094
Sumatra Total		*46,606,459*	*385,302*	*1,626,529*

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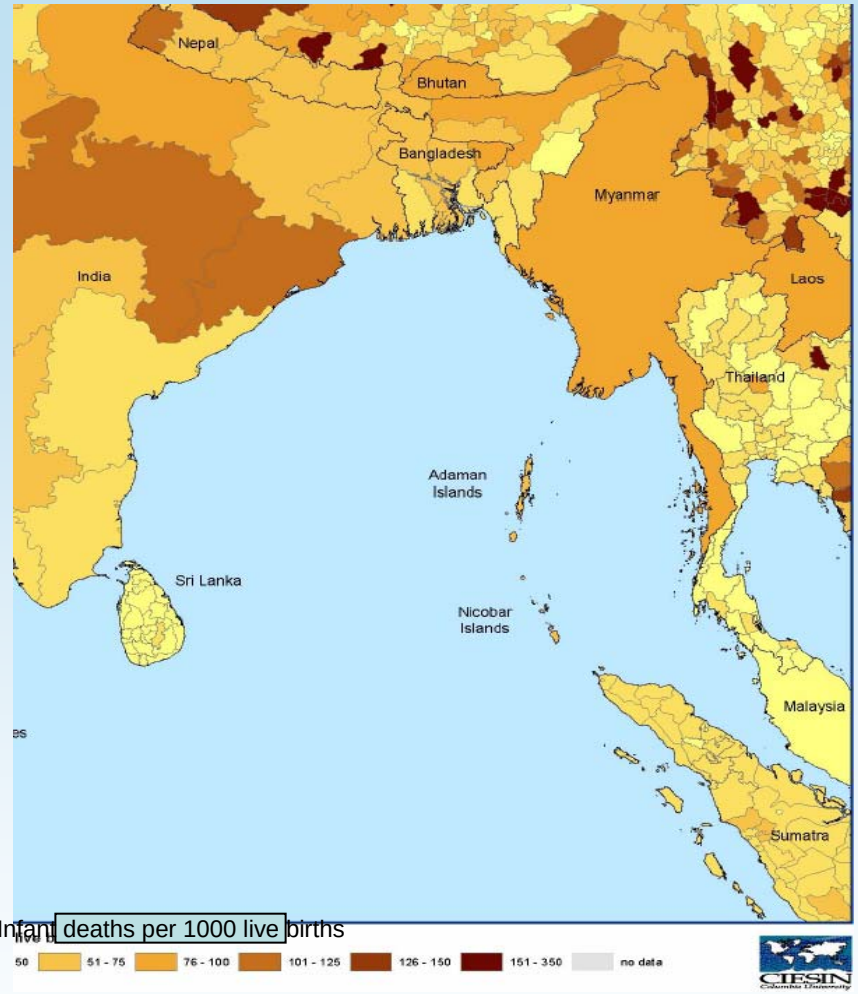
Socio-economic conditions of the affected region

The relative well-off areas hit hardest



Poverty estimate	In all exposed regions	In highly exposed regions
Low poverty (IMR under 30)	9%	29%
Moderate poverty (IMR between 30 and 60)	22%	71%
High poverty (IMR above 60)	69%	0%

Source: CIESIN, DHS, MICS.

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Who was affected?

- Relief agencies are on the forefront of this
- A difficult undertaking
  - Capacity is critical
    - Disaster Management Center in Sri Lanka has
      - GIS capacity
      - Shares data openly
      - Works in coordination with other agencies
  - Coordination is critical
    - Much more in Sri Lanka than in Sumatra, for example
- Satellite data can help

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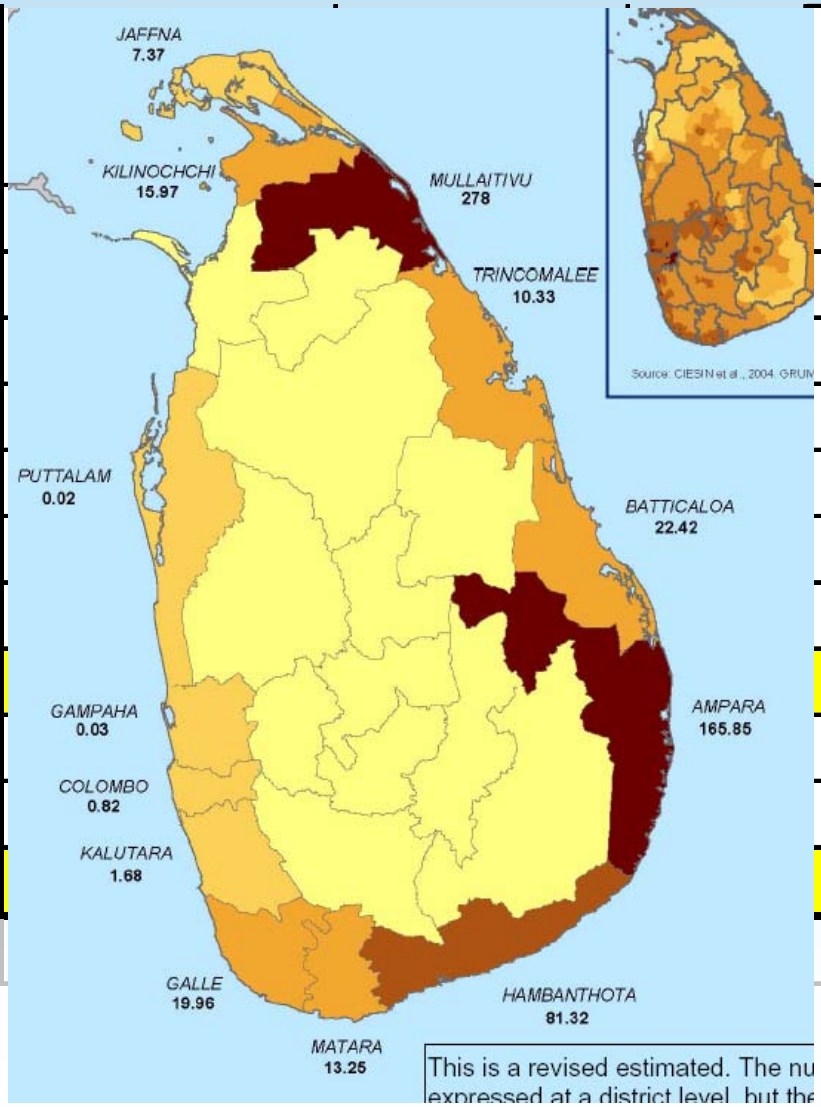
Rates depend on spatial distribution

District	Total pop.	Coastal pop.
Colombo	0.30	8.24
Kalutara	1.90	16.78
Kilinochchi	38.61	159.75
Trincomalee	25.11	103.30
Matara	14.80	132.52
Batticaloa	43.97	224.19
Jaffna	63.38	73.74
Mullaitivu	205.55	2779.96
Galle	38.29	199.61
Hambanthota	78.64	813.16
Ampara	149.96	1658.52



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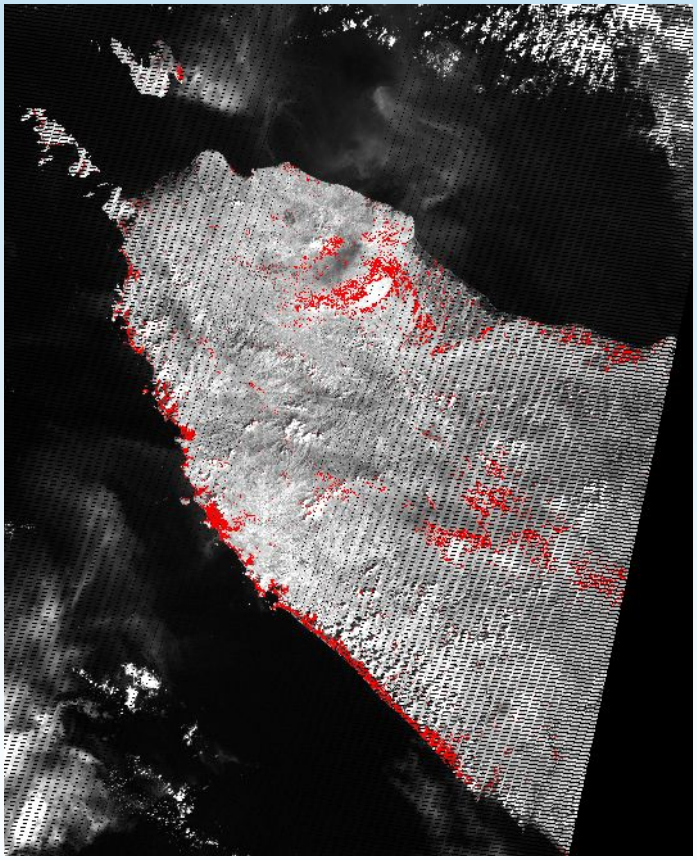
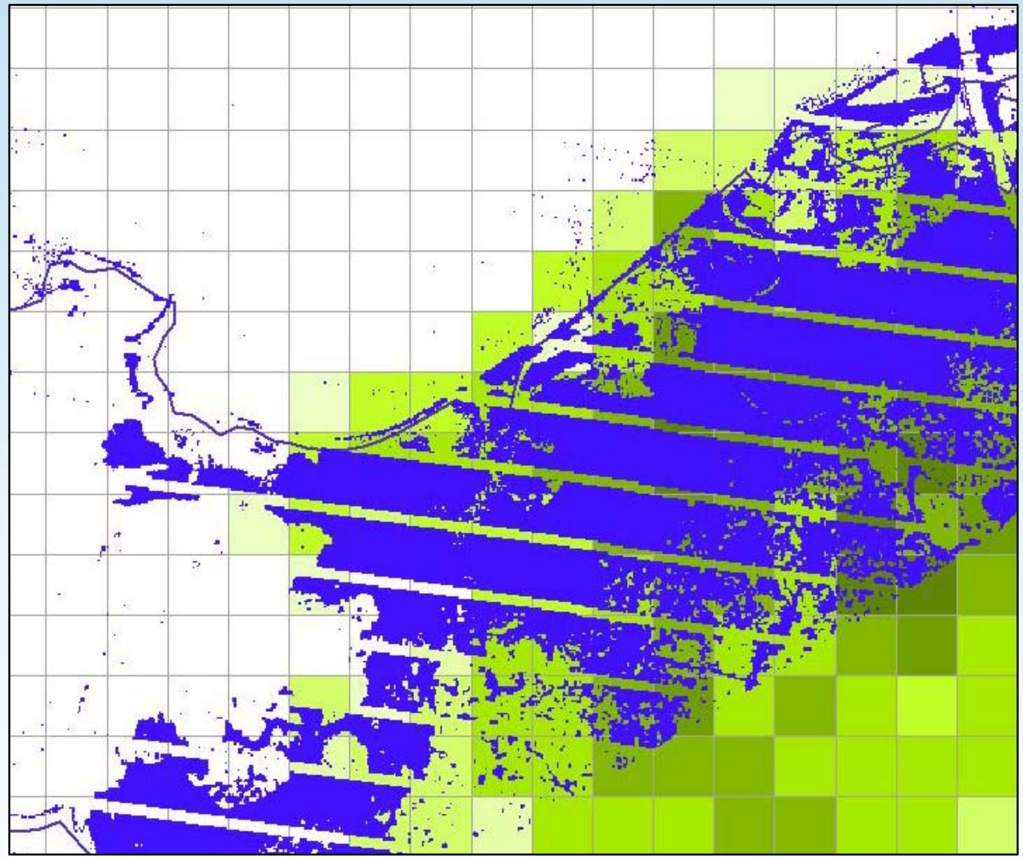
Detected changed areas from the Landsat images





Landsat sce

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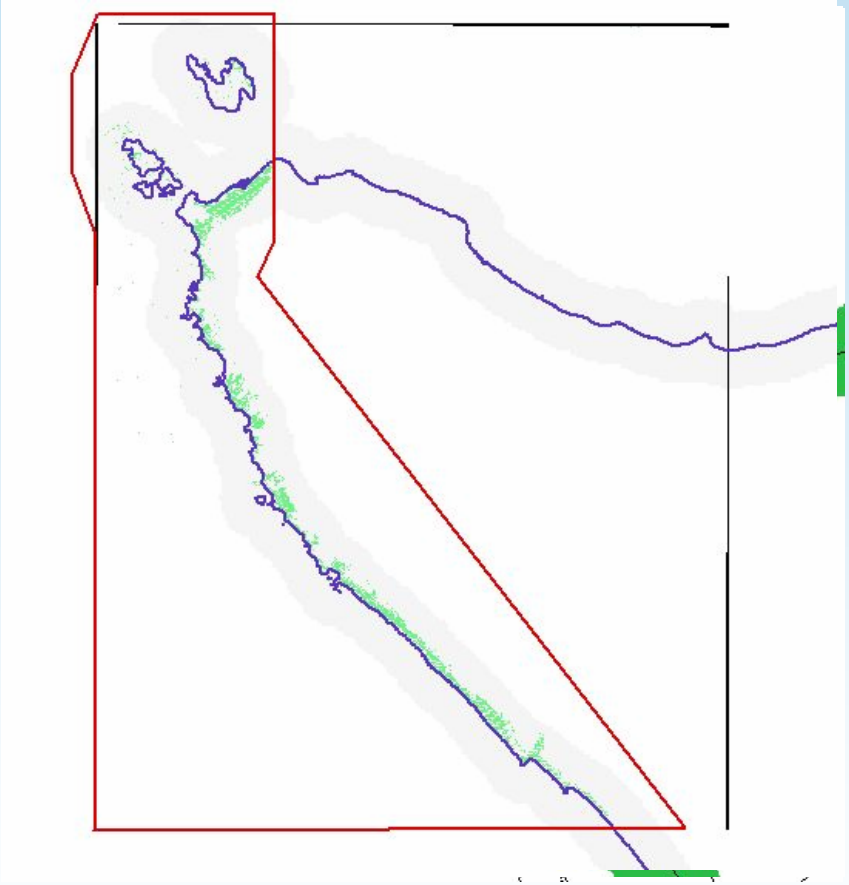
Estimation population in changed areas

- Areas of detectable change (light green)
- Area of analysis = Northern Aceh Province
  - 10 km coastal buffer (grey)
  - 4 km coastal buffer (not shown)
  - 4 km coast buffer on western and northern coasts only (red outline)



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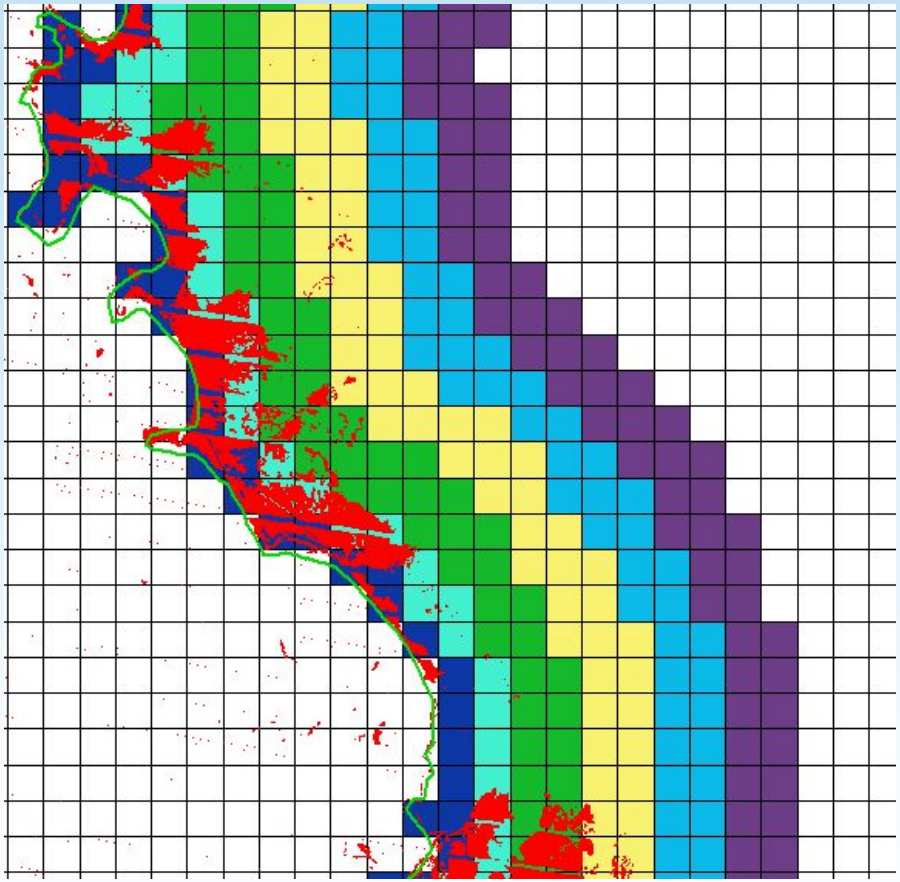
Damaged areas and various buffer distances (Sumatra coast)



Red color – areas of changed landcover as detected from LANDSAT imagery

Other colors – distance from coast, each pixel = 1 km

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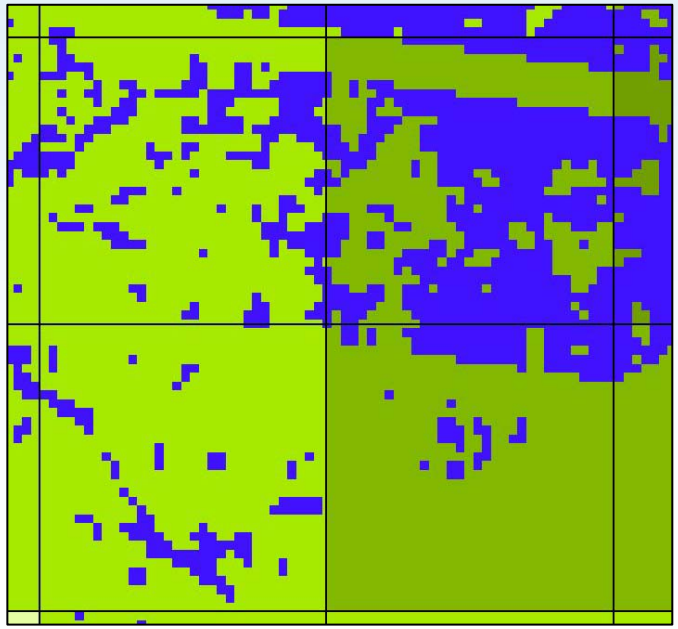
Estimation population in changed areas

Total population where damaged pixeled		% of Total population within		
		10 km	4 km	4 km, western
> 50%	87,430	10%	24%	35%
> 25%	138,376	17%	37%	55%
> 1%	266,659	32%	72%	106%
Total population within buffer		833,452	372,040	252,399



One population pixel (1 x 1 km) contains 1231 pixels

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Data Availability and Sharing

GIST - Data Repository of the Geographic Information Support Team

The Geographic Information Support Team (GIST) is an inter-agency initiative that promotes the use of geographic data standards and geographical information systems (GIS) in support of humanitarian relief operations.

https://gist.itos.uga.edu/index.asp

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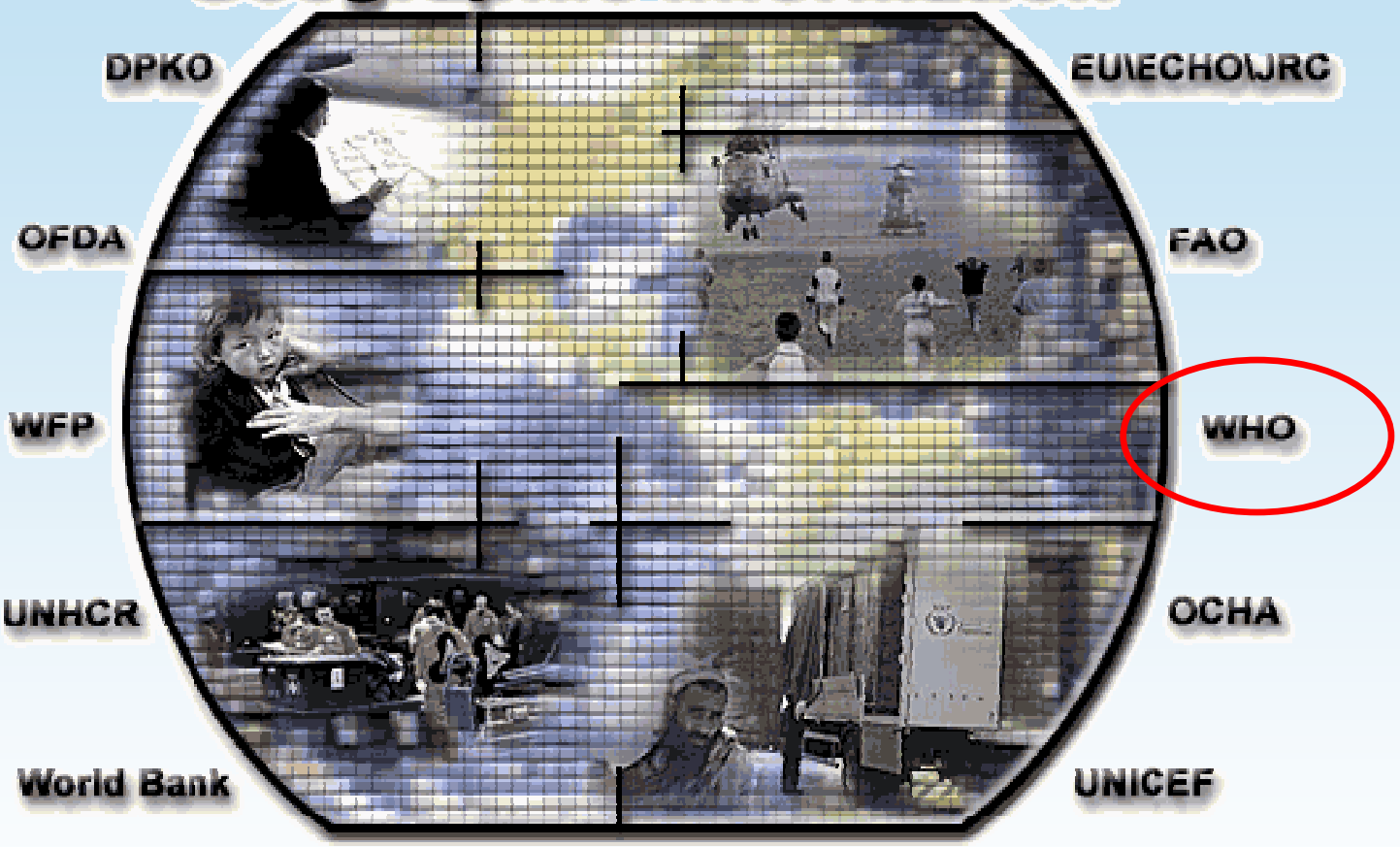
Data Availabilty and Sharing

- Mandate:
  - Works to improve humanitarian response through the improved information flow and presentation
  - Provides a forum for geographic and geo-referenced information and data exchange amongst humanitarian response agencies and donors
  - Develops and promotes the use of techniques and standards to enhance data and information co-ordination and exchange.
- Functioning:
  - Active, but not full participation
  - Not all data can be shared (e.g., Indonesian desa-level boundaries and population data)
    - Some clever solutions (e.g., RS commercial sector)
  - Some data are too coarse to be useful
  - Most data are not uploaded with metadata. Always a problem for use.

Geographic Information



Support Team

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Better Data – Better Estimates?

Tamil Nadu Coast

Post-tsunami IKONOS, panchromatic image, 1 m resolution

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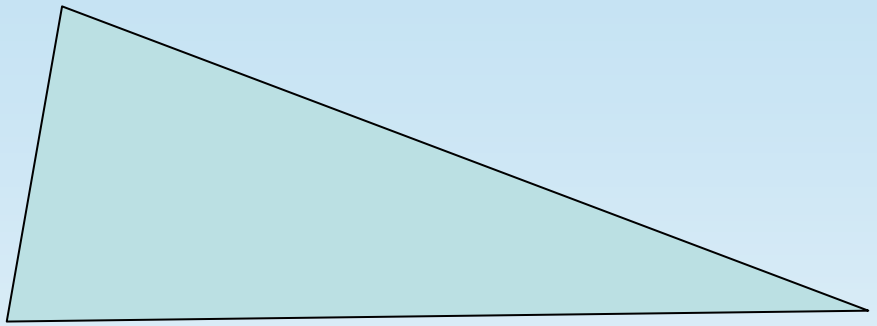
GIS Data Availability and Quality During Tsunami



- Population
- Digital Elevation Model
- Coastline
- Roads

- Relocation Camps
- Health Clinics/Hospitals
- Wells, water supply system
- Economic activity

"shelter, water, food, and sanitation"

Máire A Connolly et. al. 2004. Communicable diseases in complex emergencies: impact and Challenges. Lancet 364: 1974–83

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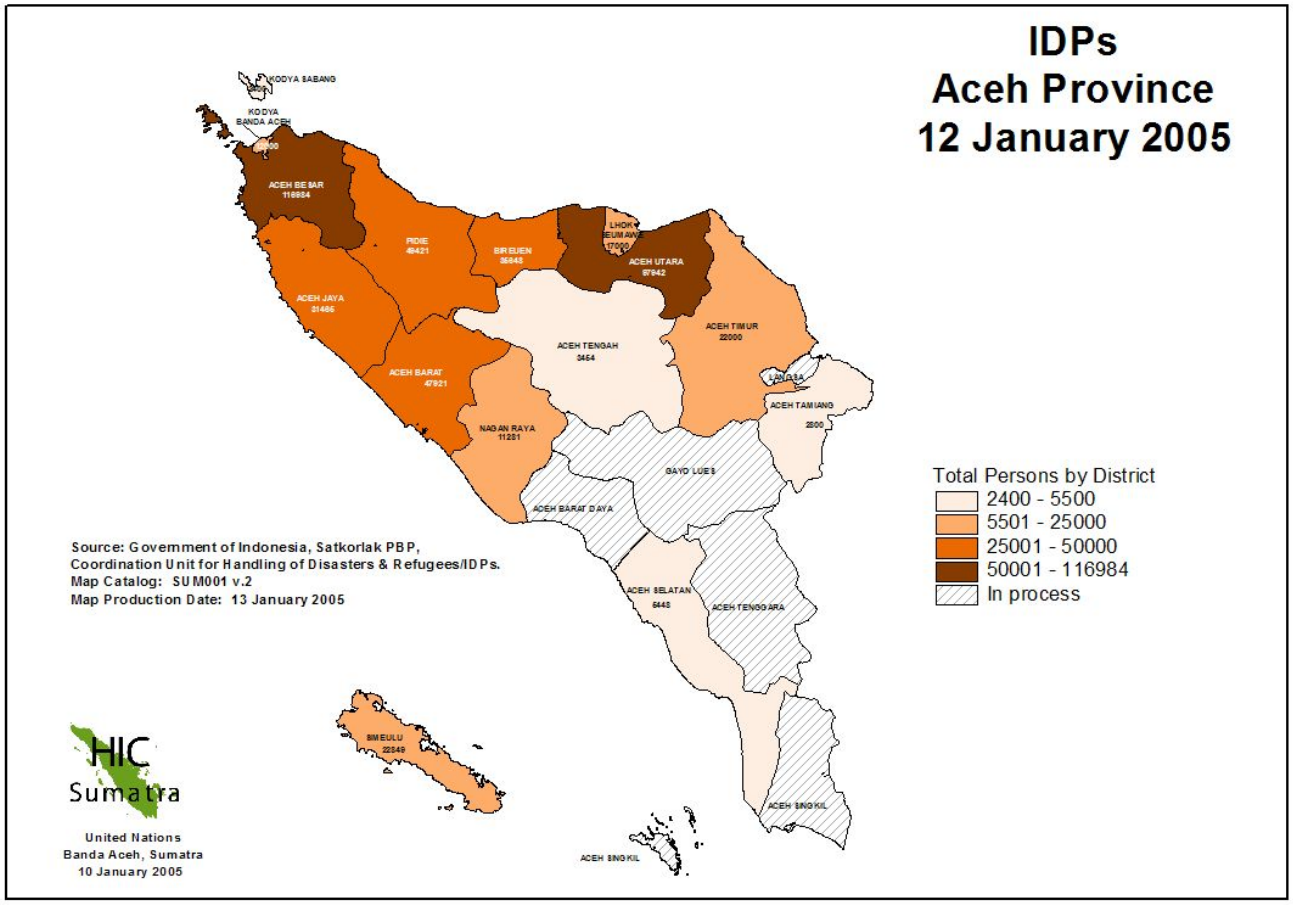
Where are people now?

- Much harder to assess
  - Displaced persons estimate
    - UNFPA estimates that 500,000 girls and women have been displaced in Sri Lanka alone



- Short-term needs are different from medium and longer-term ones
- Recovery efforts
  - Where are the displaced persons?
  - How to reach them?
  - What are their needs?
- Reconstruction
  - Rebuild with sustainability in mind
  - Learn from assessments of our vulnerabilities
  - Create Critical GIS Data in advance

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How many lives might a warning system have saved?

- Distance to epicenter
  - Effects of earthquake
  - Effects of tsunami
- Infrastructure
  - Civil alert system?
  - Use of local knowledge
- Which type of warning system?
  - Not all are alike
- Would there have been anywhere to go?
  - Up? High ground or buildings?
  - Away—Indonesians had further to go than Sri Lankans

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Answers to longer term questions

- Were geophysical and environmental properties protective in some places?
  - Have recent population dynamics and related behavioral change altered some of the underlying geophysical benefits
    - E.g., Protective ecosystems
- Scenario building. What if this—or other hazards—happened elsewhere?

- *These questions presuppose a basic understanding of the population distribution at the time of the event, and* even *in the recent past*

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Lessons learned

- For analysis:
  - Baseline information is NOT ready for use
    - Data sharing issues arise and pose legal issues
  - Data integration is skill and time intensive

- For policy:
  - Short-term recovery, and medium and long-run development pose much different but closely related questions
  - We have a better idea of the right parameters to construct early warning
  - Consider the risk of multiple and different hazards

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For more information

- http://www.ciesin.columbia.edu/tsunami2004.html
- http://www.earth.columbia.edu/tsunami/
- http://www.ldeo.columbia.edu/res/pi/chrr/

- Check back for continuing updates!

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