第４回リモートセンシング技術を用いた災害軽減に関する研究委員会

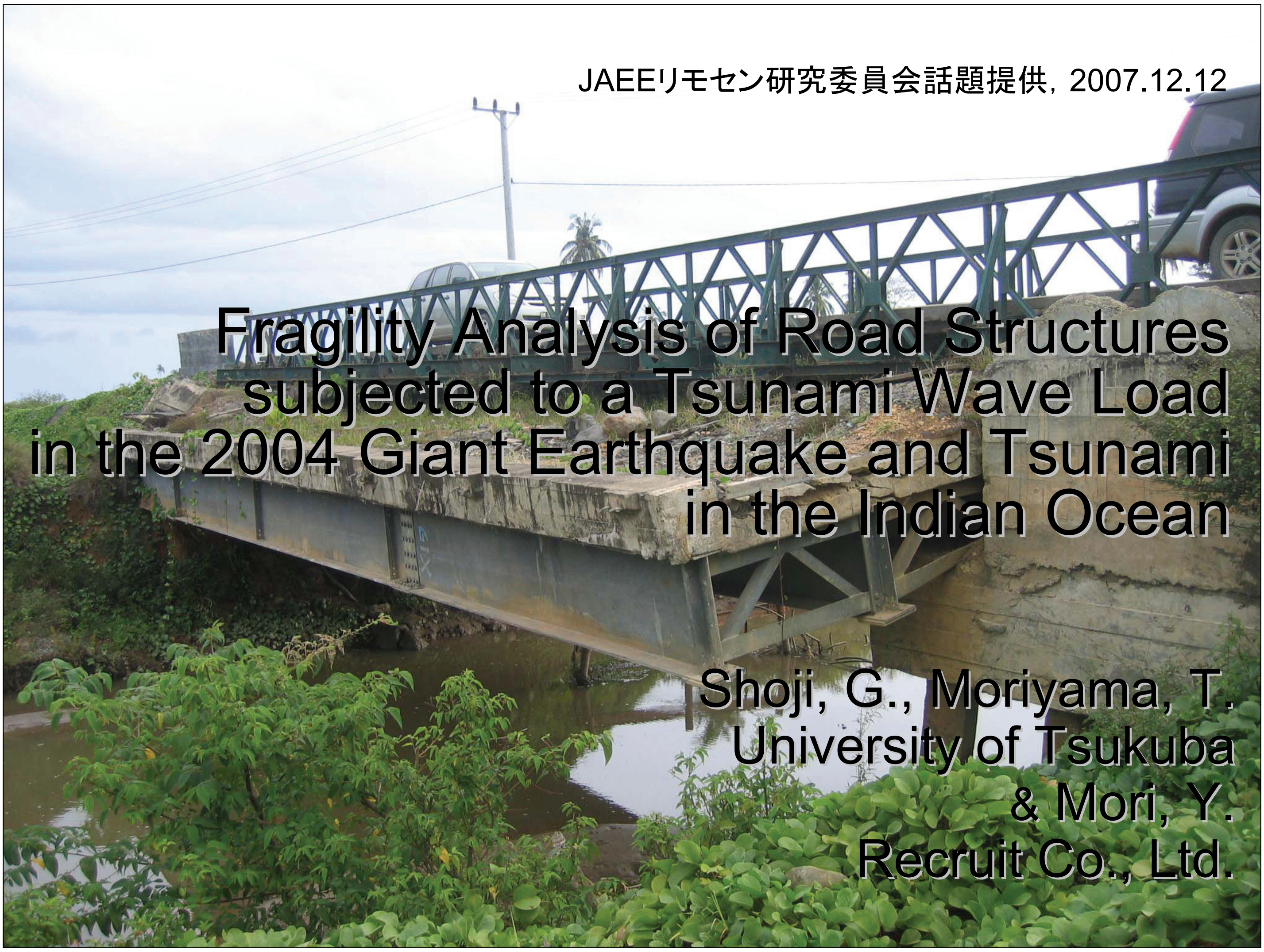
話題提供資料

2004 年インド洋大津波による橋梁構造物の被災（庄司学）

DMSP を用いたハリケーンカトリーナ被災地の復興状況のモニタリング
（高島正典）

PALSAR および ASTER データによる 2007 年ペルー沖地震の被害地域抽出
（松岡昌志）

JAEEリモセン研究委員会話題提供，2007.12.12

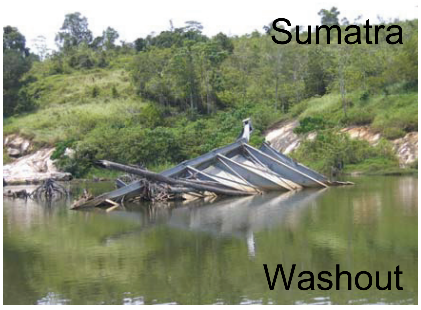


Fragility Analysis of Road Structures subjected to a Tsunami Wave Load in the 2004 Giant Earthquake and Tsunami in the Indian Ocean

Shoji, G., Moriyama, T.
University of Tsukuba
& Mori, Y.
Recruit Co., Ltd.

Damage of road structures due to the tsunami

- 2004 Giant Earthquake and Tsunami in the Indian Ocean
  - Local time of the event: UTC 00:58:49, Dec.26, 2004
  - Hypocenter: Off the shore in the northwest of the Sumatra island, Indonesia, 3.316N 95.854E
  - Focal depth: 30.0km
  - Mw =8.8 (USGS, 2007)
  - No. of deaths (at Dec, 2006): 110,229 at Indonesia, 30,922 at Sri Lanka
- Damage of road structures
  - 29 bridges among 58 bridges located along the the south and southwest coastline of Sri Lanka, were collapsed or severely affected.
    Shoji and Mori, 2006
  - 22 bridges among 27 bridges along the northwest coastline of the Sumatra island, were collapsed or severely affected.
    Kosa et al., 2006



Objectives

- Structural fragility analysis

- Structural fragility of a road structure due to a tsunami wave load is evaluated.

  by analyzing the damage data of bridge structures due to the 2004 tsunami in Sri Lanka and in Indonesia

- A fragility curve of a bridge structure due to a tsunami wave load is revealed.

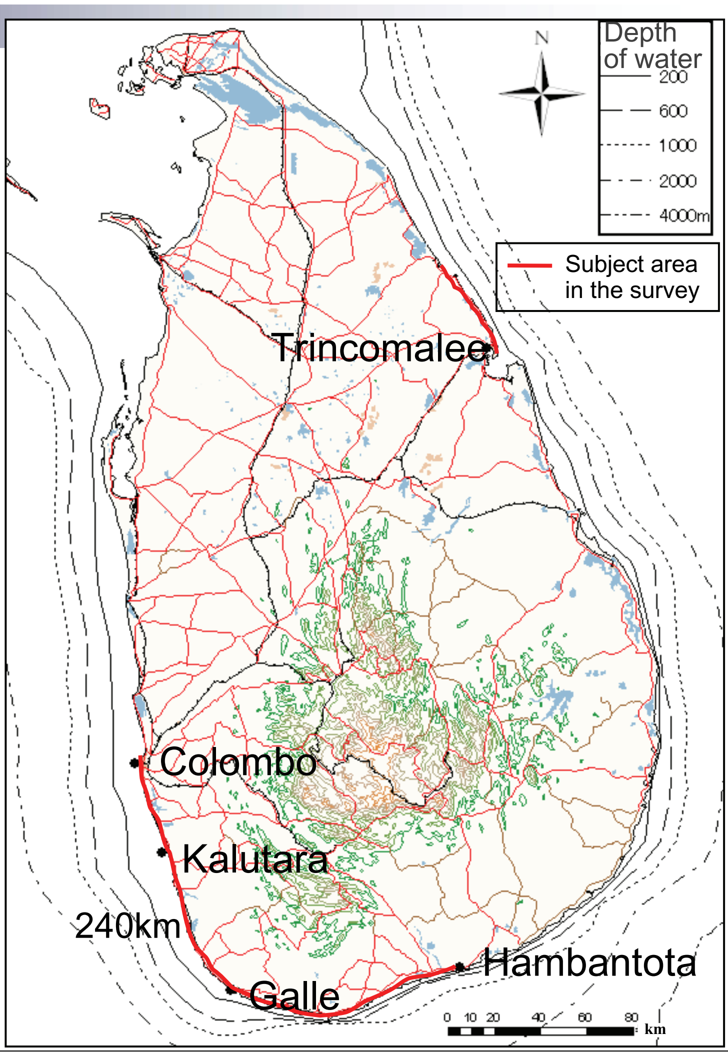
  tsunami damage classification of a bridge structure

  versus

  a tsunami wave load such as inundation depth and inundation height

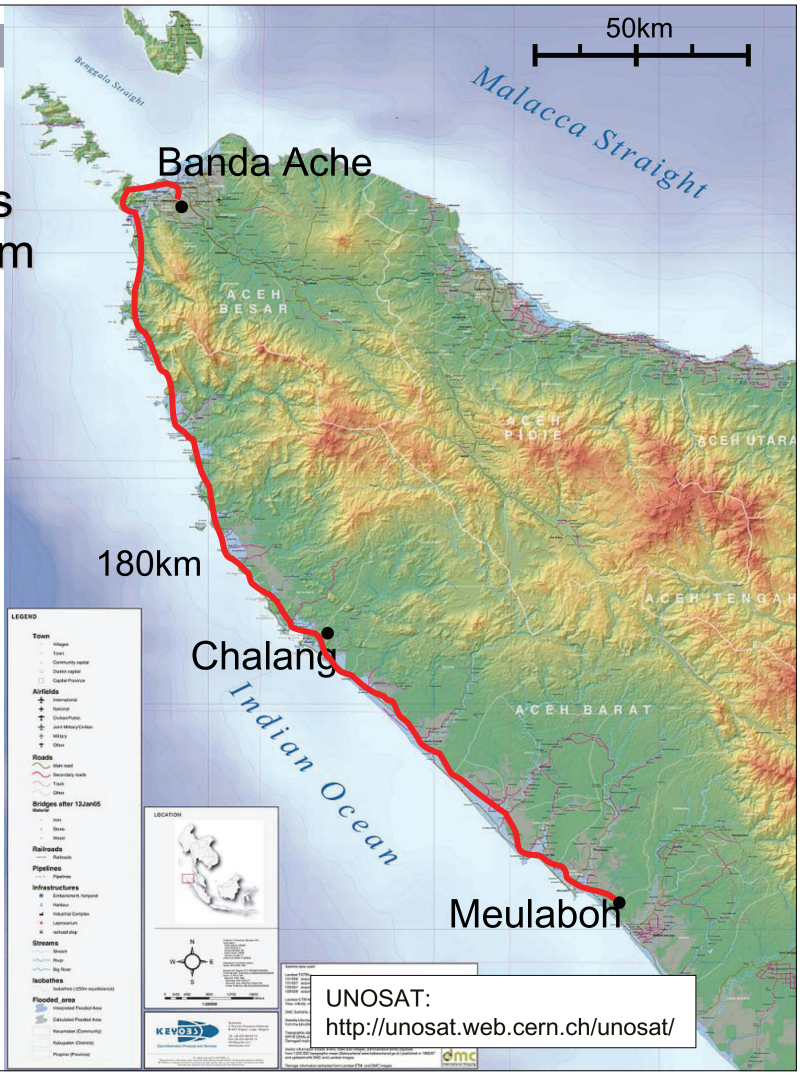
Subject area: Sri Lanka

- 58 data of bridge structures collected by Shoji and Mori, 2006
  - Along the northeast coast in the northern part of Trincomalee
  - Along the southwest and south coast between Colombo and Hambantota



Subject area: Sumatra

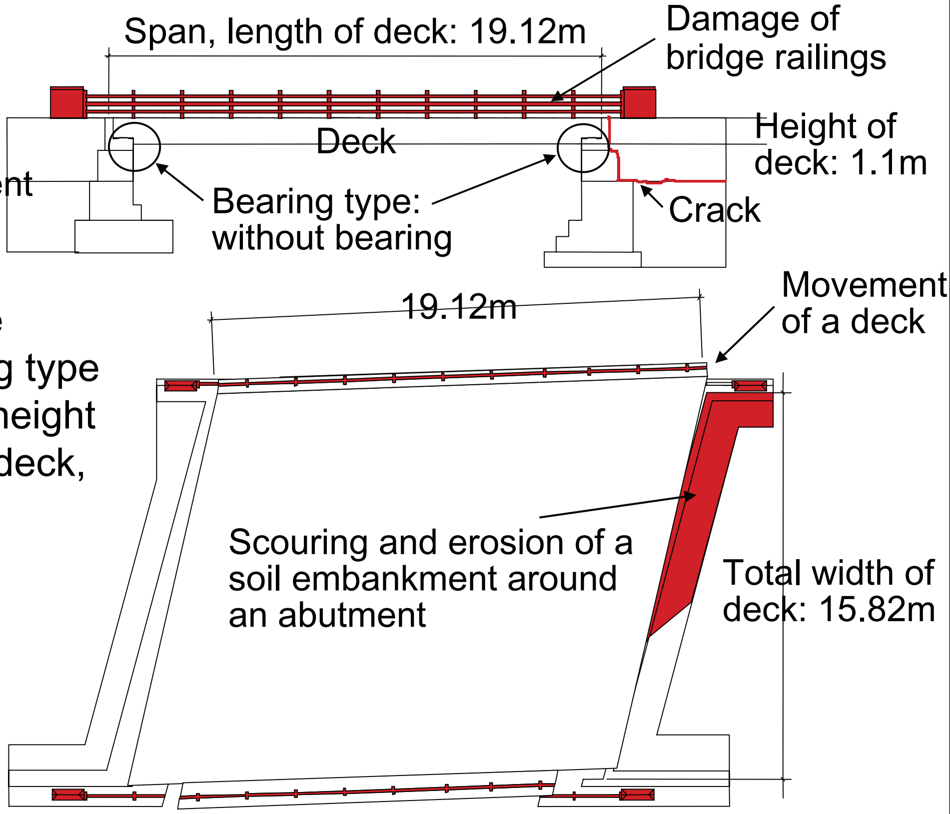
- 17 data of bridge structures collected by the survey team organized jointly by JSCE and JAEE, 2006
  - Along northwest coast between Banda Ache and Meulaboh



Analyzed data of subject bridges

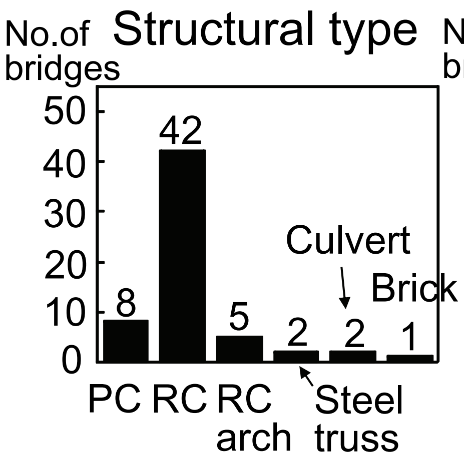
- e.g. Magalle bridge at Galle, Sri Lanka

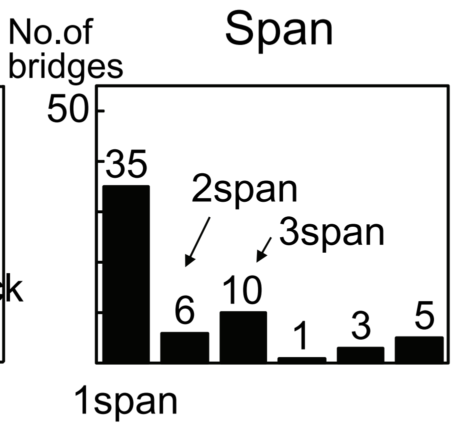
Structural type:
1span reinforced concrete (RC) structure

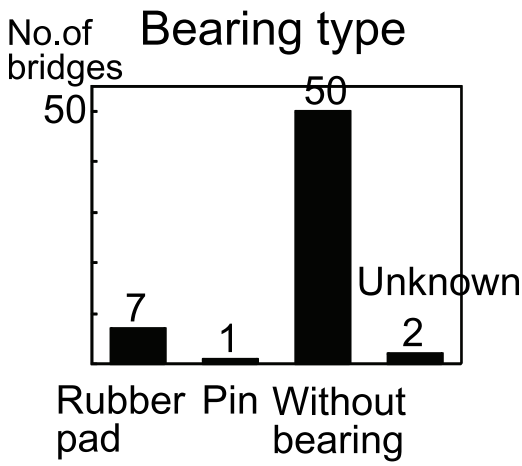


- Structural failure mode
- Structural type, bearing type
- Span, length of deck, height of deck, total width of deck, thickness of deck

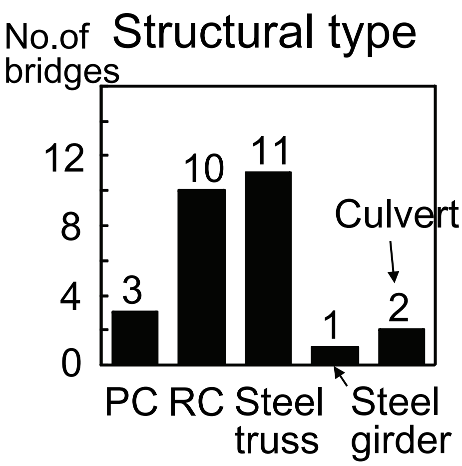
Structural characteristics of subject bridges on Sri Lanka

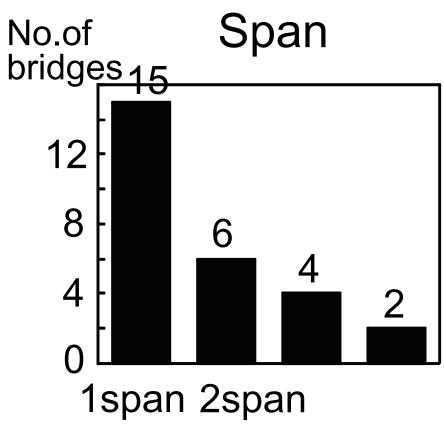






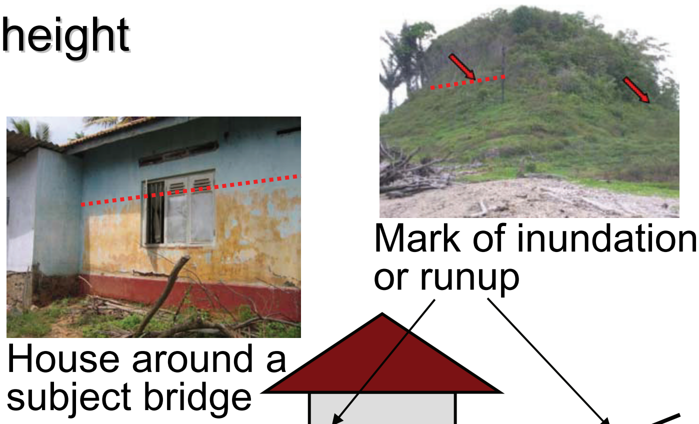
Structural characteristics of subject bridges on Sumatra

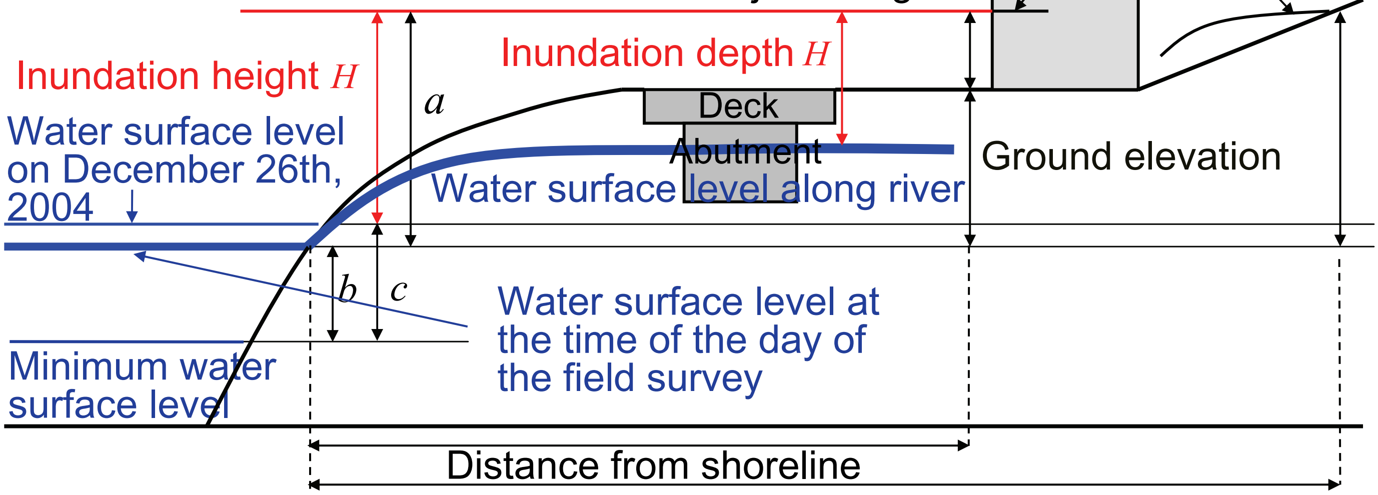




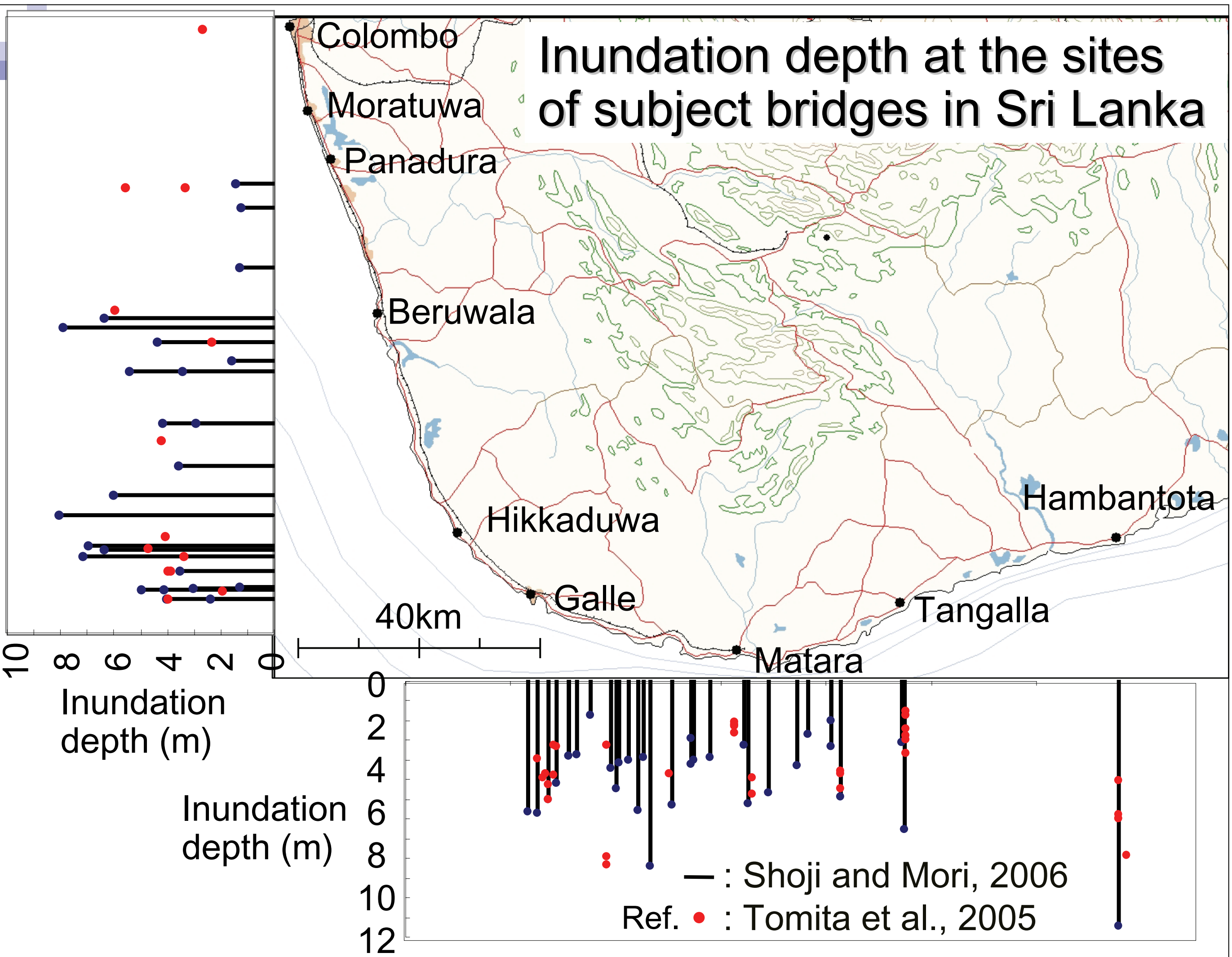
Measure of a tsunami wave load

- Inundation depth & inundation height
  - Inundation depth for Sri Lanka data
  - Inundation height for Sumatra data

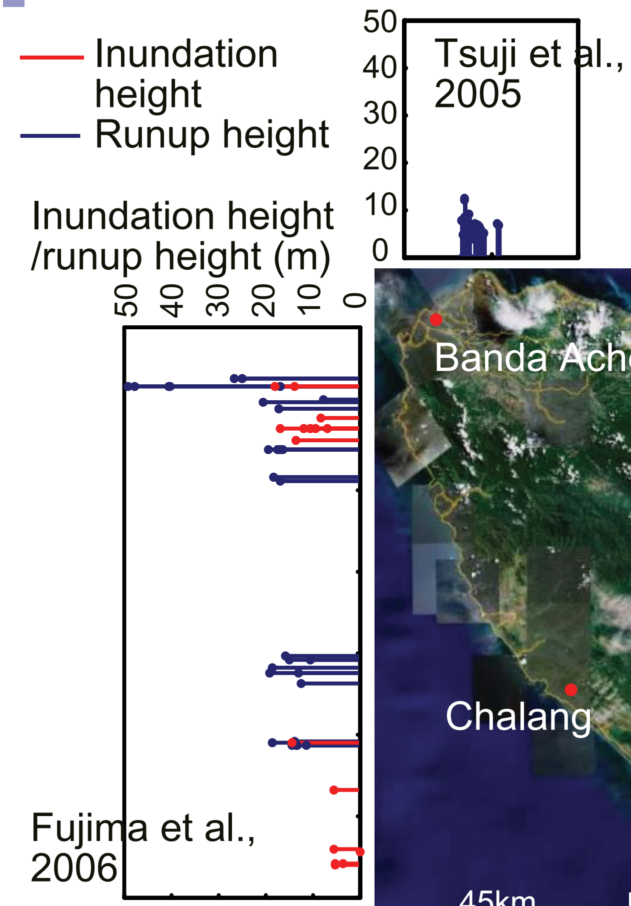


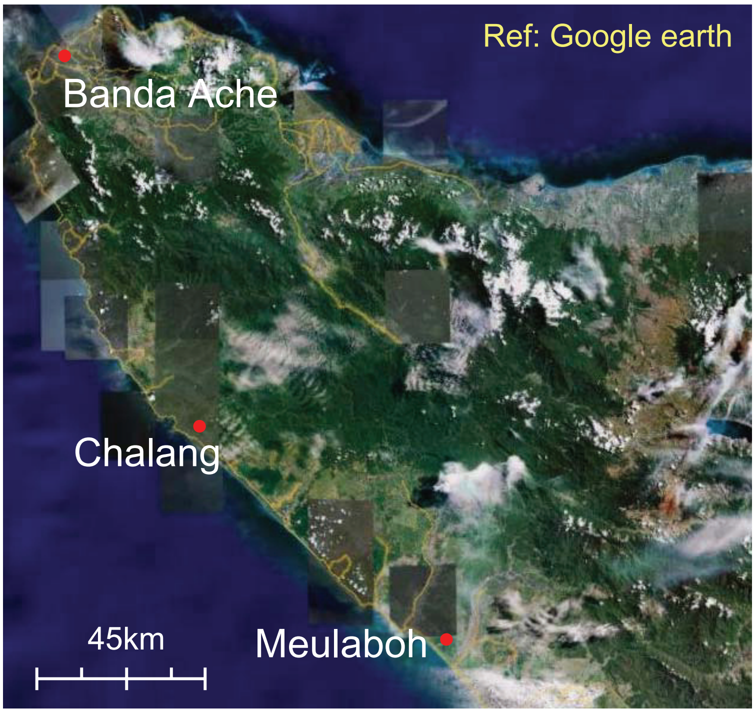


Inundation depth at the sites of subject bridges in Sri Lanka



Inundation height and tsunami runup height near the sites of subject bridges in Sumatra





Damage mode: rank A

- Washout and fall-down of a deck

Damage mode: rank B

- Movement of a deck
- Damage of an abutment
- Souring and erosion of a soil embankment around an abutment

Damage mode: rank C

- Damage to a deck attachment such as bridge railings

Fragility analysis

- Damage probability versus tsunami wave load

$$P_C^i = \int_0^z \frac{1}{\sqrt{2\pi} \cdot \sigma_Y \cdot z} \exp\left\{ -\frac{1}{2} \left(\frac{\ln z - \mu_Y}{\sigma_Y} \right)^2 \right\} dz$$ ← Logarithmic normal distribution

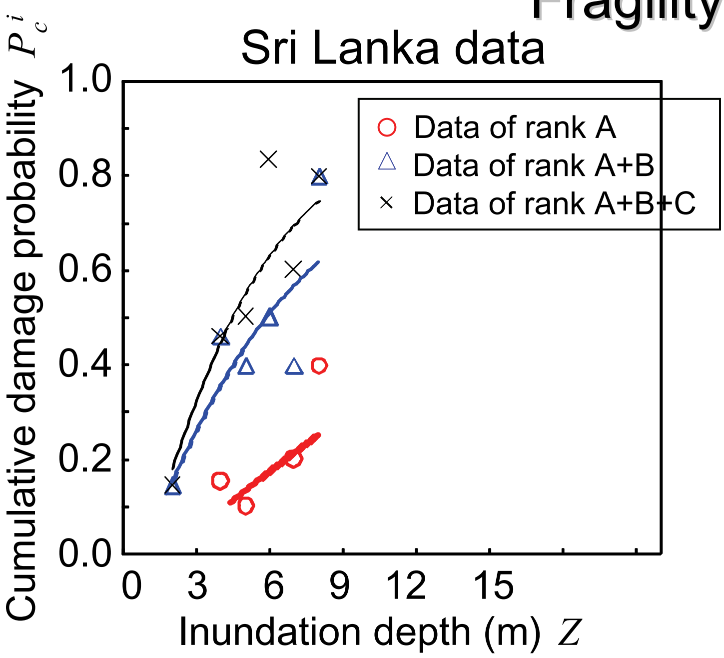
P_C^i : cumulative damage probability
i : damage mode
rank A
~ rank D, no damage

Z : tsunami wave load
inundation depth, assessing Sri Lanka data
inundation height, assessing Sumatra data

$Y = \ln Z$
μ_Y : mean-value of Y
σ_Y : standard deviation of Y

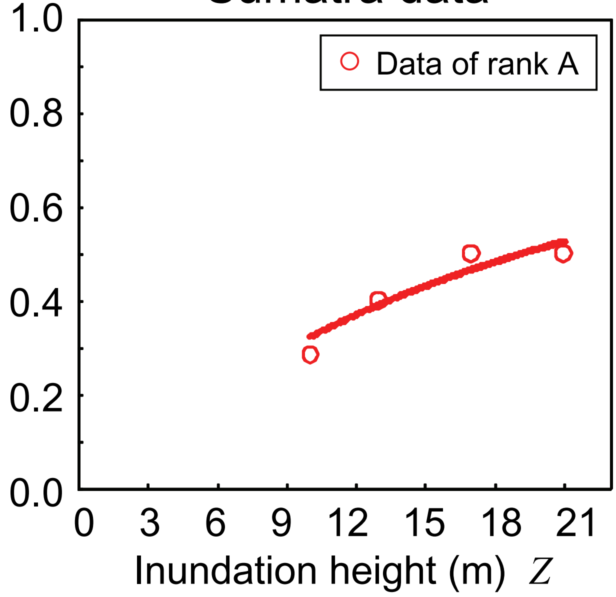
Fragility curve

Sri Lanka data



- Damage probability of rank A
  0.1 at Z = 4m
  0.2 to 0.25 at Z = 6m to 8m
- Damage probability of rank B
  0.3 at Z = 4m
  0.35 to 0.4 at Z = 6m to 8m

Sumatra data

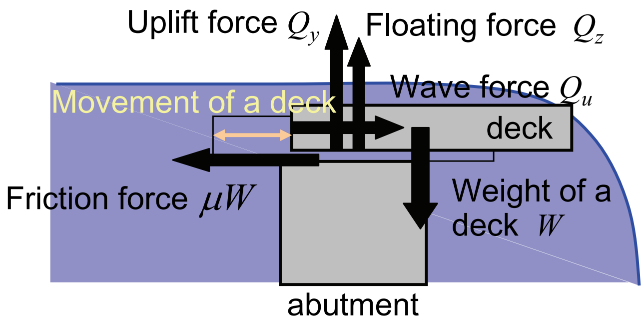


- Damage probability of rank A
  0.4 at Z = 12m
  0.55 at Z = 20m

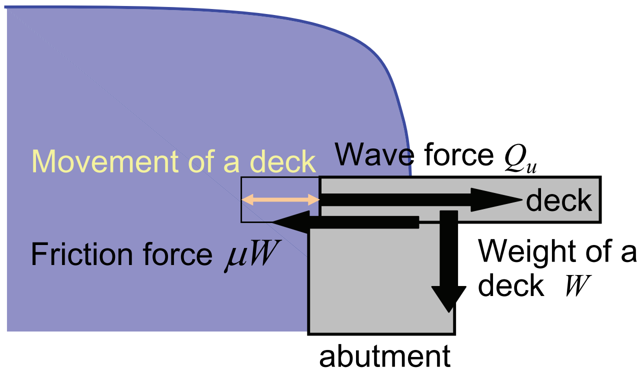
Questions ??

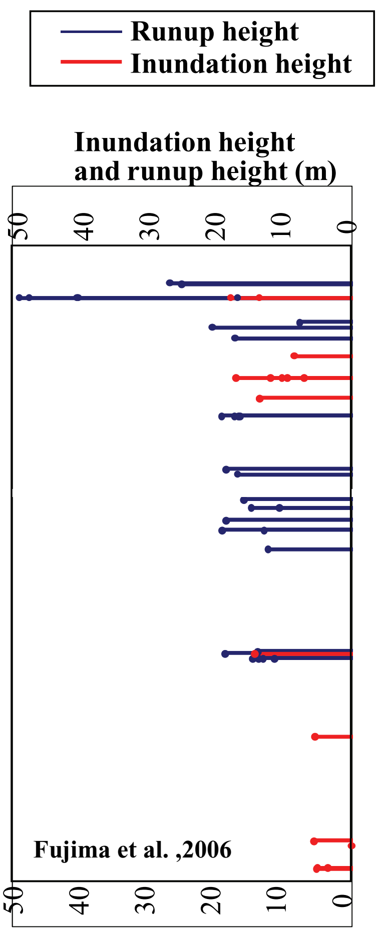
- Structural fragility analysis
- Structural fragility of a road structure due to a tsunami wave load is evaluated.
  by analyzing 58 data of bridge structures in Sri Lanka & 17 data in Sumatra, due to the 2004 tsunami
- A fragility curve of a bridge structure due to a tsunami wave load is revealed.

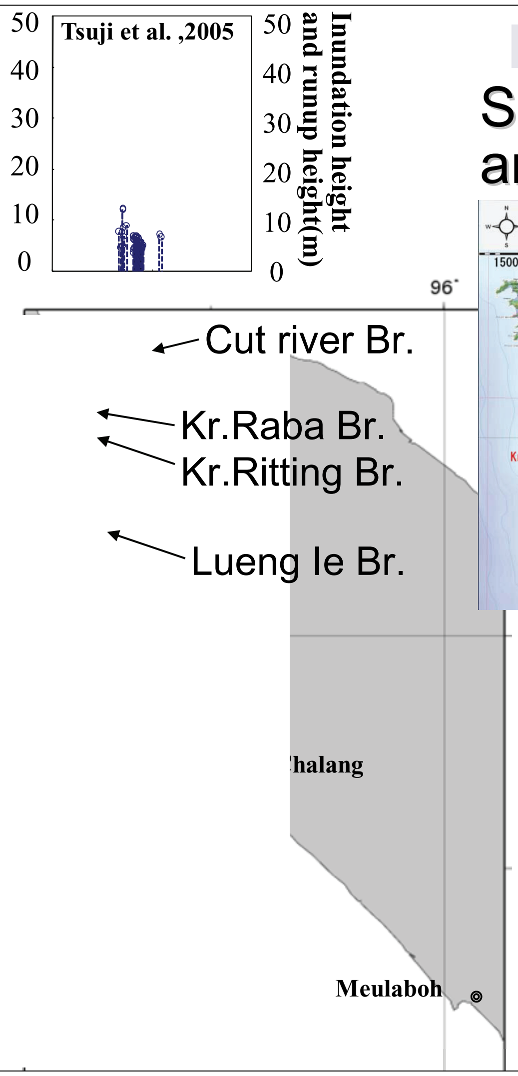
‘Major’ damage mechanism based on fragility analysis of Sri Lanka data @5-m to 10-m inundation depth level



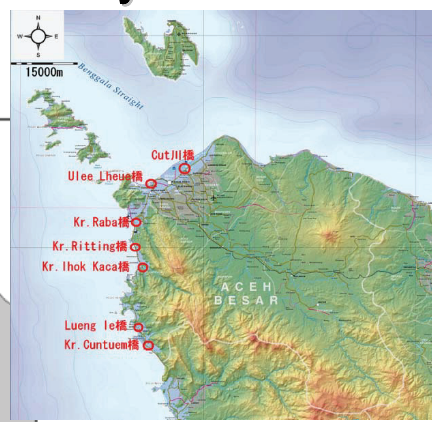
‘Severe’ damage mechanism based on fragility analysis of Sumatra data @20-m inundation height level







Subject bridges analyzed



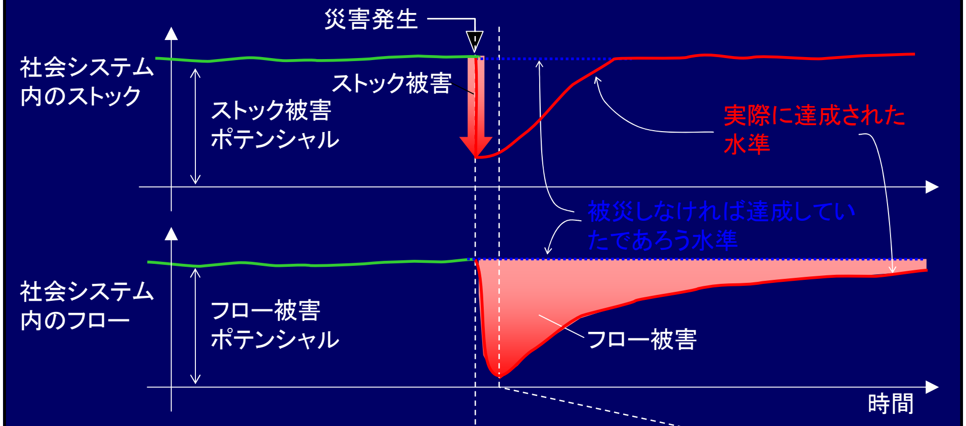

Kr.Ritting Br.
浸水高さ20.50m
2径間RCフォロー桁橋
欄干損傷
遡上高さ25.1m
遡上高さ20.1m
250m
Image © 2007 DigitalGlobe
©2007 Google


Kr.Raba Br.
浸水高さ18.38m
2径間鋼トラス桁橋
桁流出
セメント工場
1000 m
Image © 2007 DigitalGlobe
©2007 Google

DMSPを用いたハリケーンカトリーナ被災地の復興状況のモニタリング

富士常葉大学大学院　環境防災研究科
高島　正典

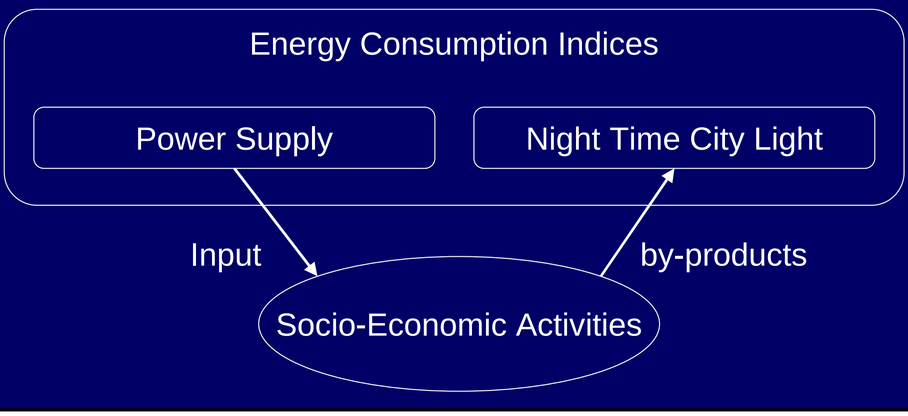
災害発生前後の各フェーズで必要となる被害の予測，推定･把握手法

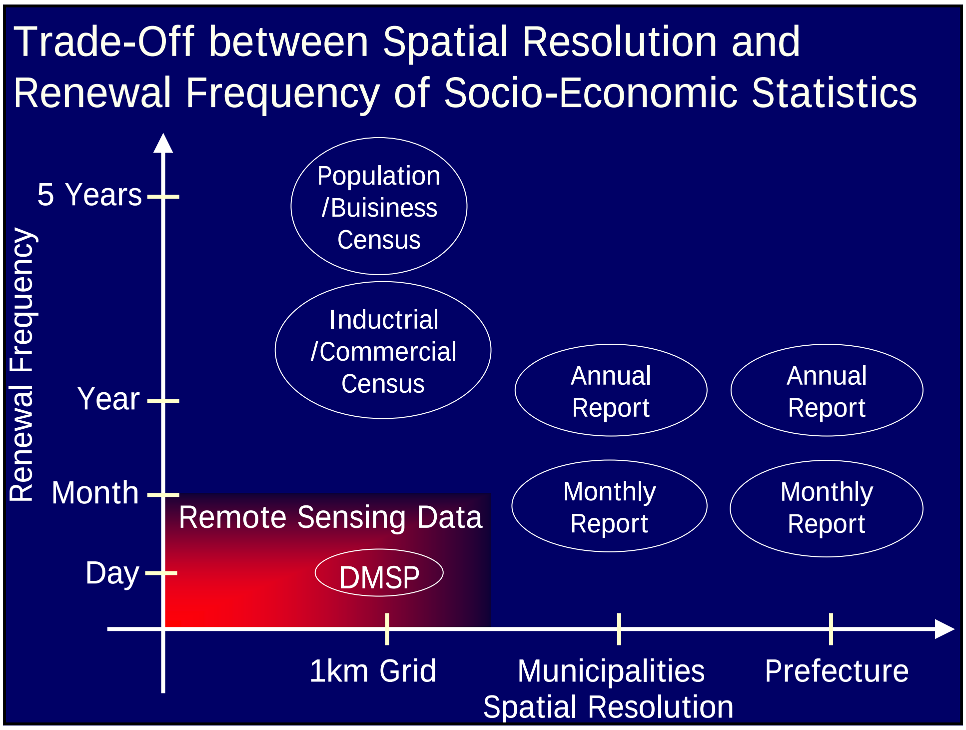


平常期	緊急対応期	復旧･復興期
･社会システムのモニタリング ･予測される災害における被害の想定	･迅速な被災地の把握	･災害による影響のモニタリング

被災地の復旧復興状況のモニタリング

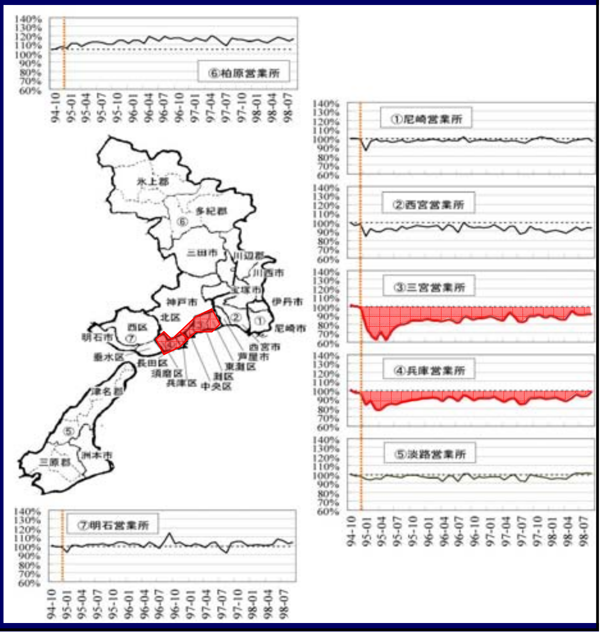
- 被災地の社会経済活動の復旧状況を定量的に把握することで復旧復興施策の立案・効果の検証に活かす。
- エネルギー消費の観点から被災地の社会経済活動の復旧状況を捉えられないか？



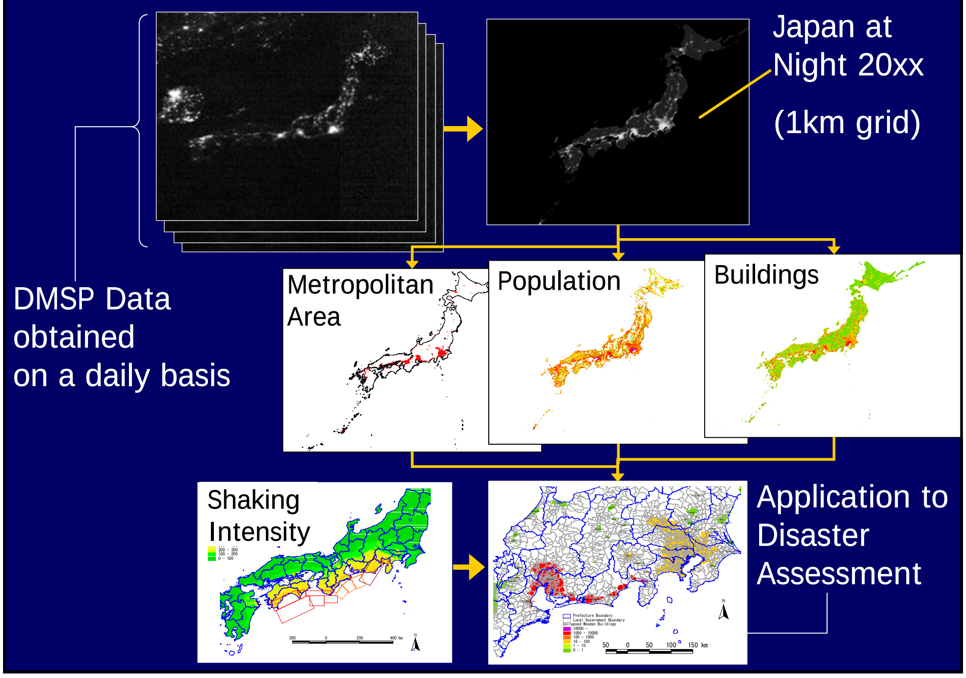


復旧・復興期における災害による影響のモニタリング

電力消費量時系列データを用いた復旧・復興状況の把握
阪神・淡路大震災への適用事例
（高島・林（1999a,b））



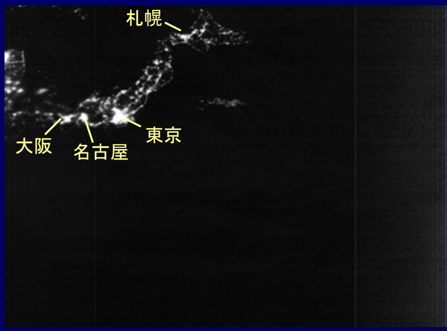
Overview of Research

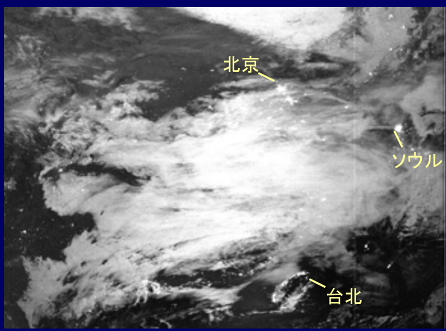


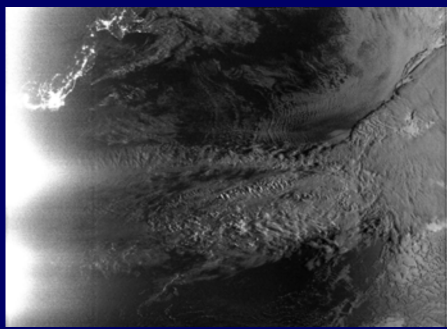
DMSP夜間可視画像と都市光抽出上の課題

・雲，雷，ノイズ等、unstableな光源の除去

・ゲイン調節による見かけ上の都市光の変動

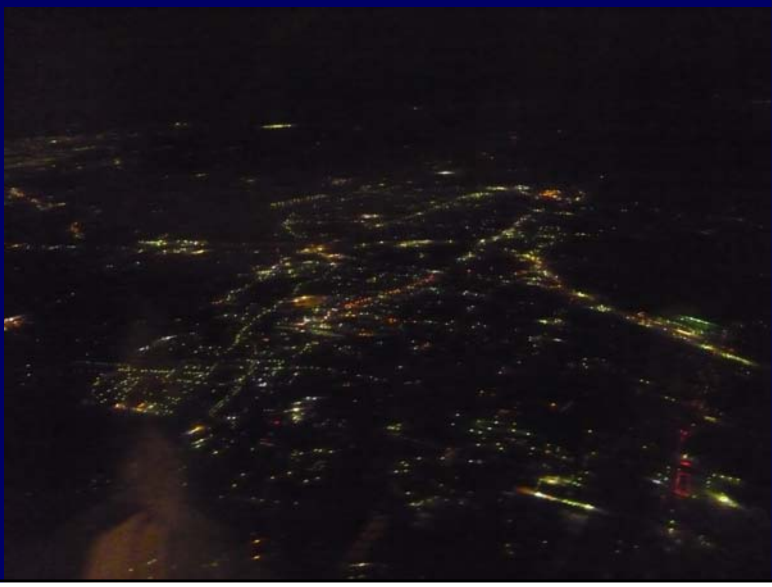


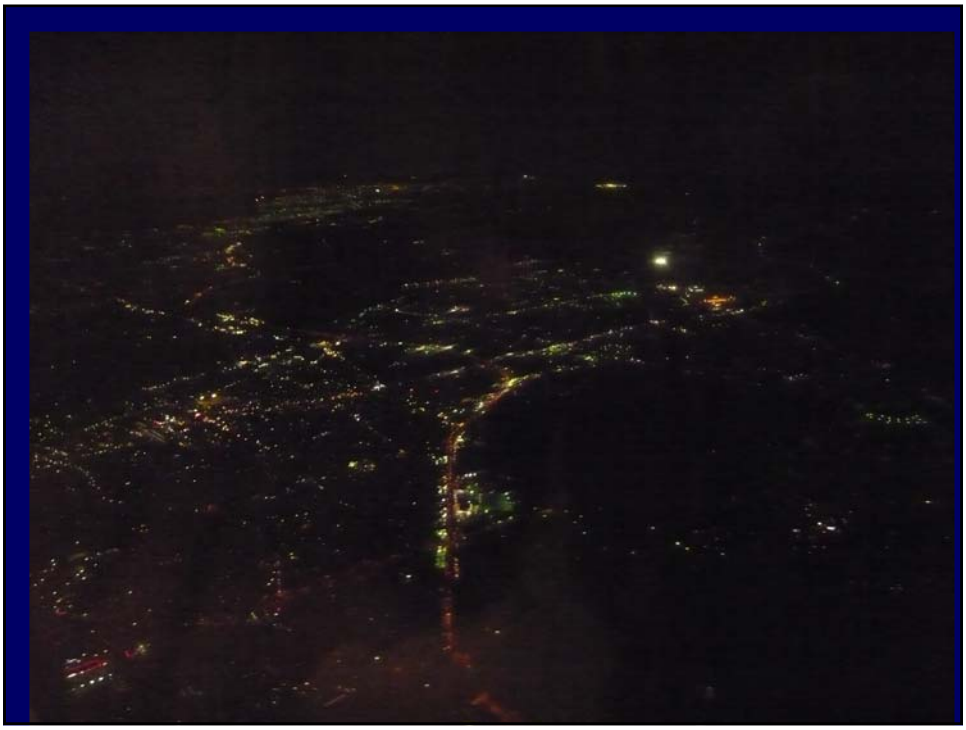




DMSP画像に何が写っているのか

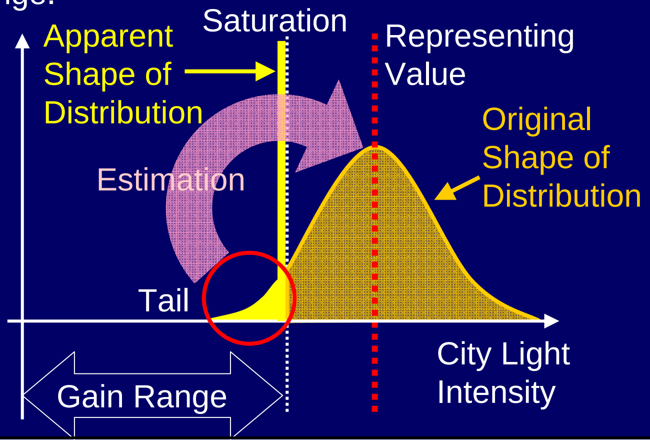
照明に照らされているもの（道路、駐車場、グラウンドe.t.c.）

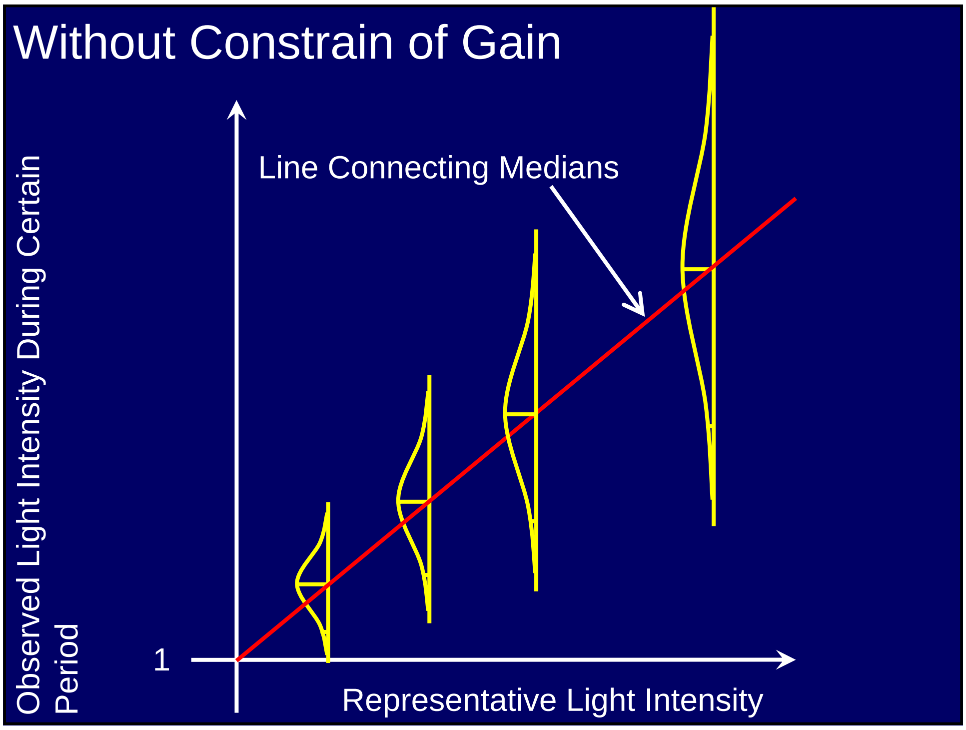


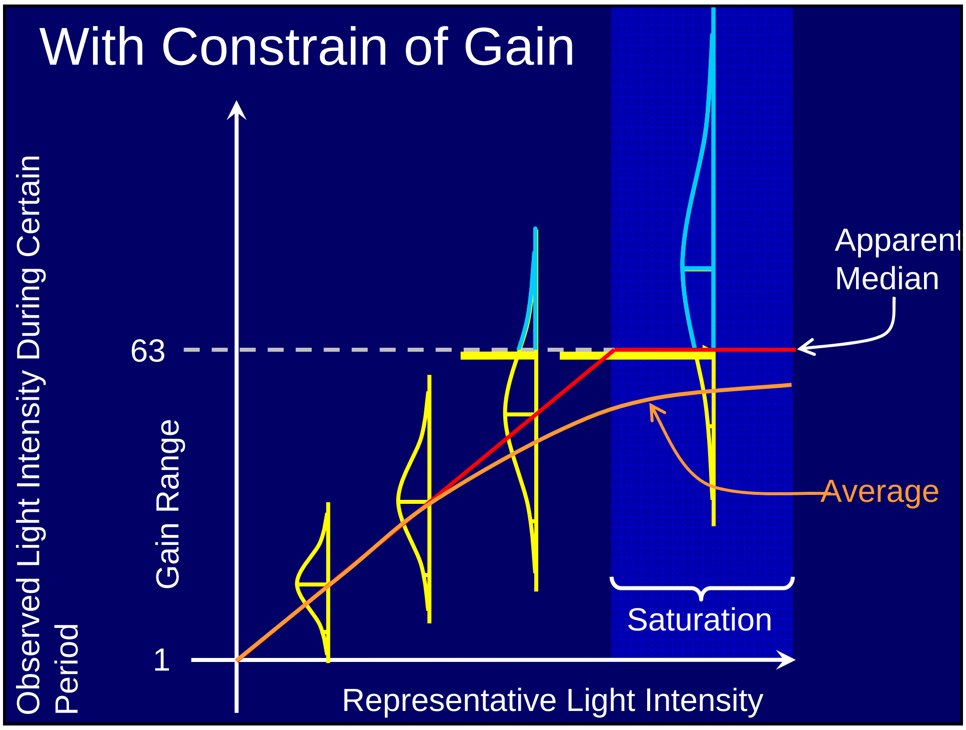


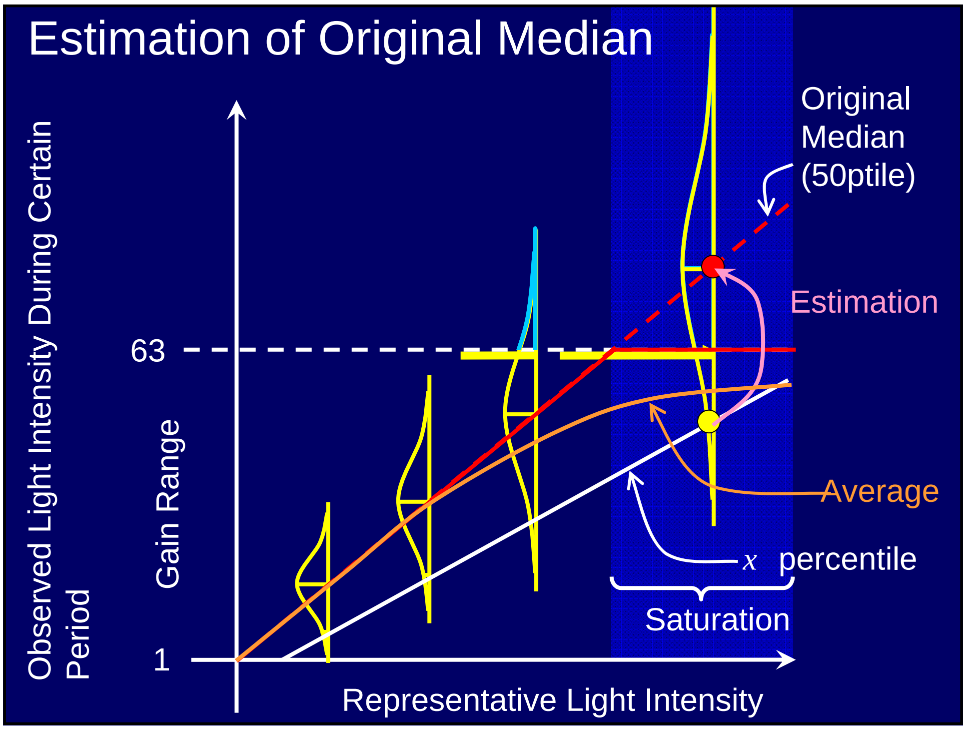
The New Methodology

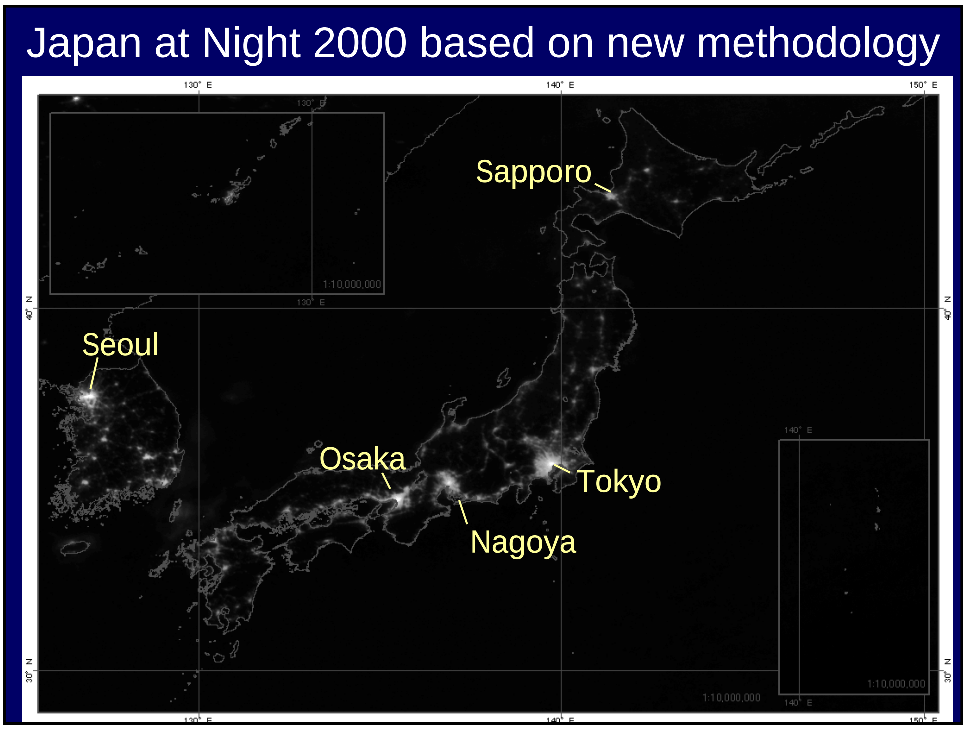
- Accumulate a large amount of imagery observed during a certain period to develop City Light Intensity distribution observed in each cell.
- Estimate the total shape and the representing value of the distribution from the tail of the distribution which can be observed in the gain range.




Without Constrain of Gain
Line Connecting Medians
Observed Light Intensity During Certain Period
1
Representative Light Intensity


With Constrain of Gain
Apparent Median
63
Average
Gain Range
Saturation
Observed Light Intensity During Certain Period
1
Representative Light Intensity

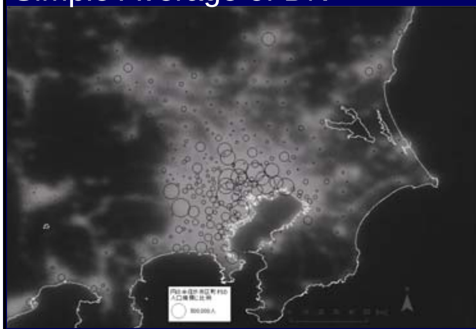

Estimation of Original Median
Observed Light Intensity During Certain Period
Gain Range
63
1
Original Median (50ptile)
Estimation
Average
x percentile
Saturation
Representative Light Intensity


Japan at Night 2000 based on new methodology
Sapporo
Seoul
Osaka
Tokyo
Nagoya

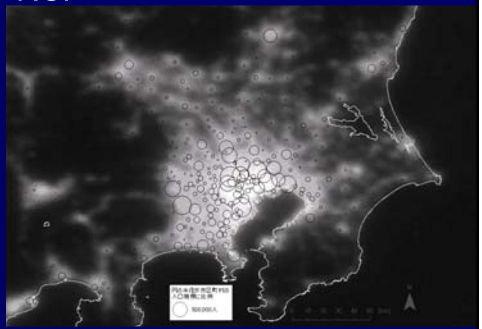
Comparison Between RCCL (Radiance Calibrated City Light, Elvidge et al. 1999) and RCI

RCCL

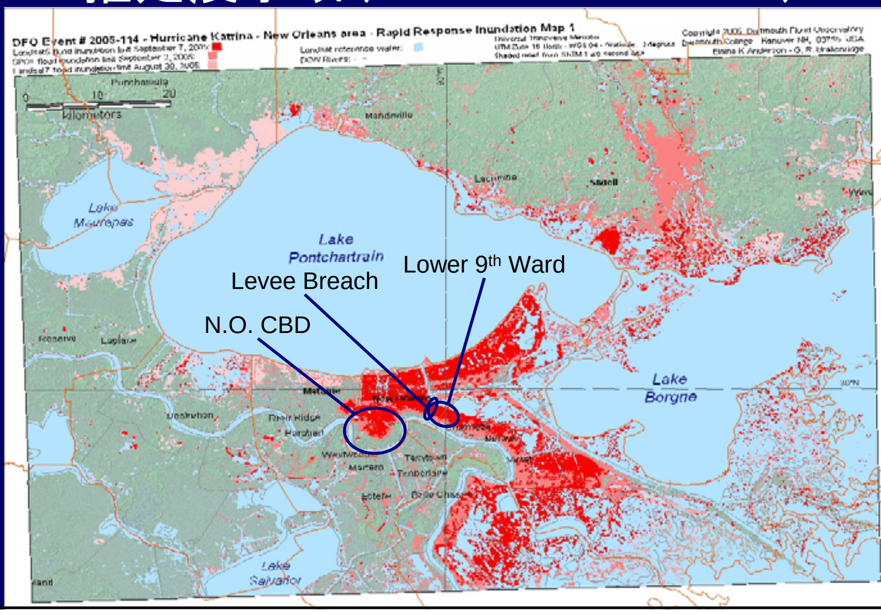
Simple Average of DN



RCI

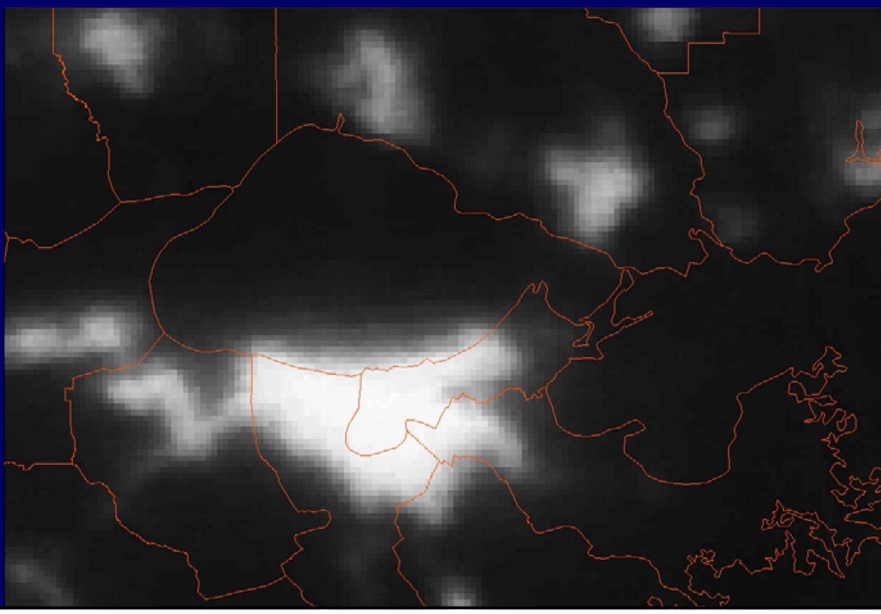


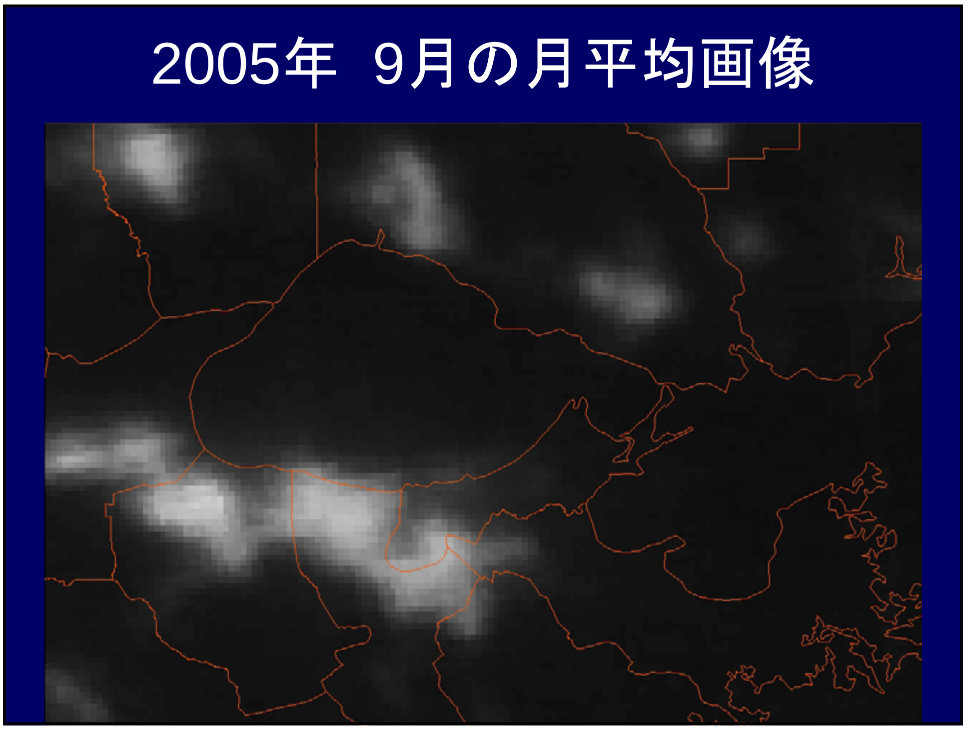
KatrinaによるNew Orleans 周辺の推定浸水域（LANDSAT/SPOT）

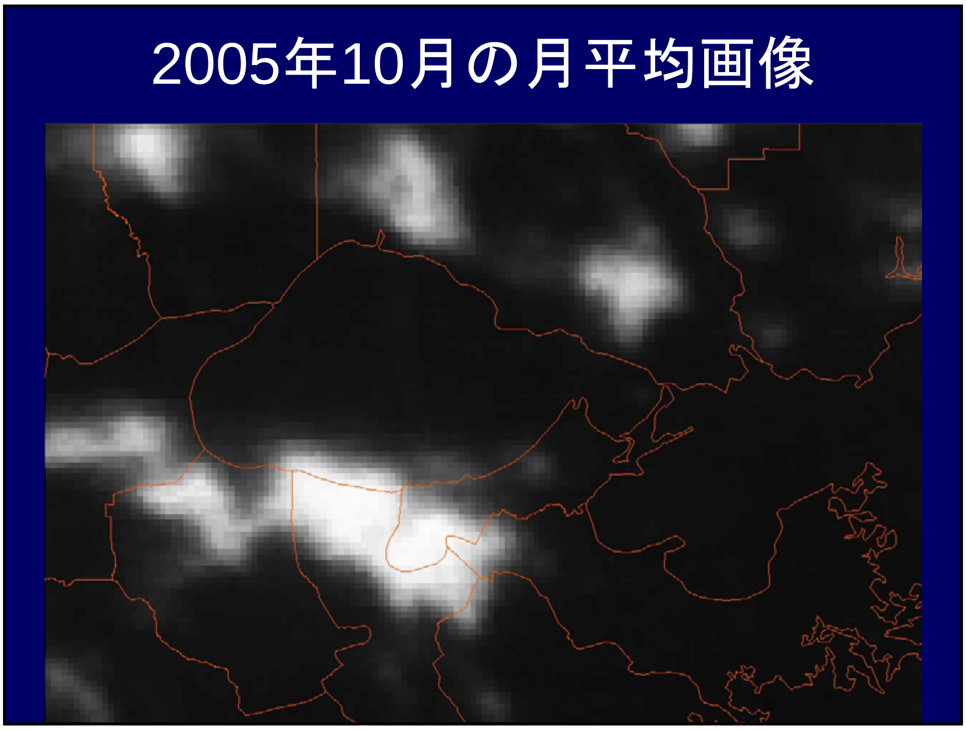


Lower 9th Ward

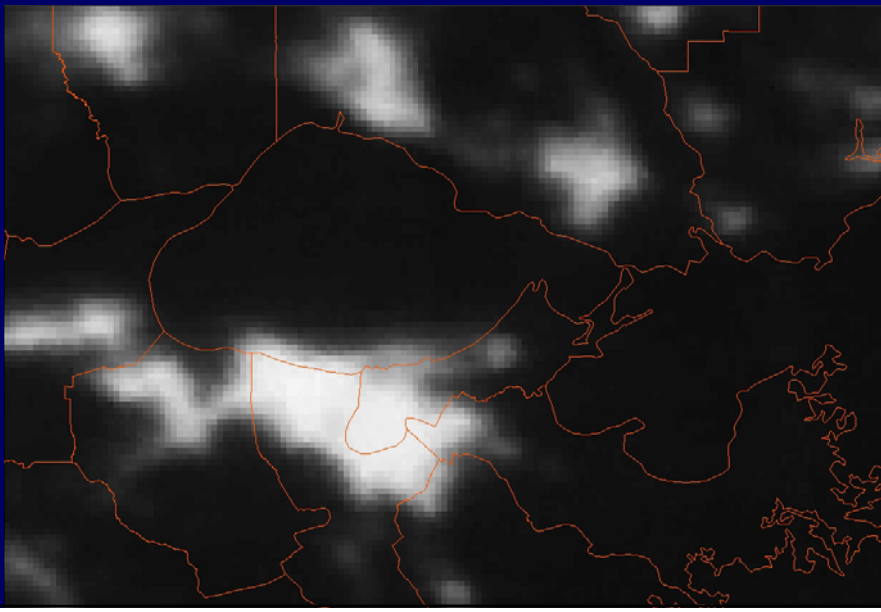
2005年 8月の月平均画像



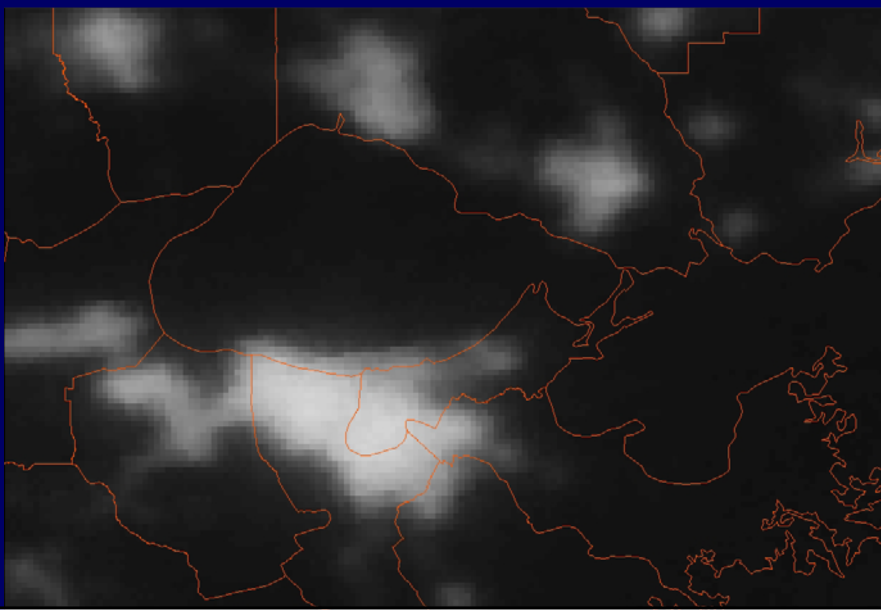

2005年 9月の月平均画像


2005年10月の月平均画像

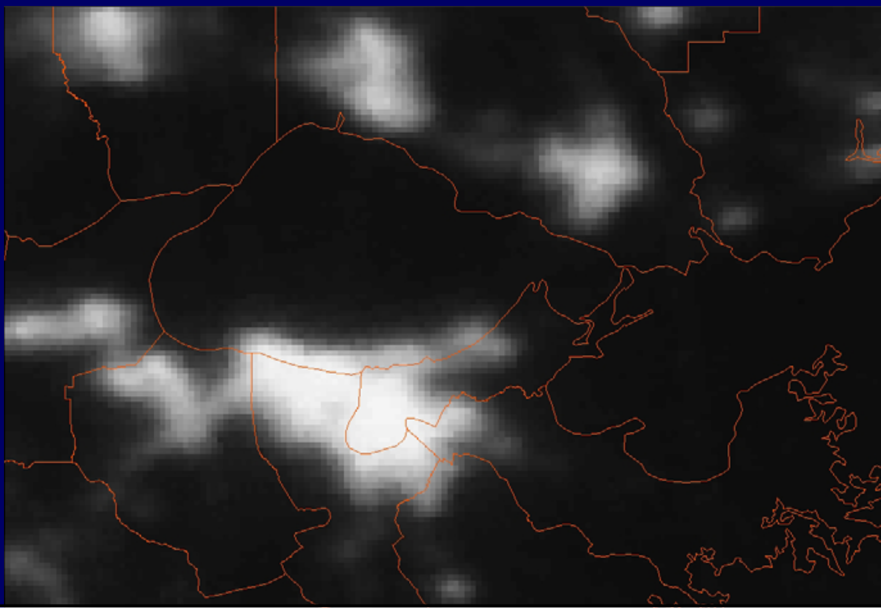
2005年11月の月平均画像



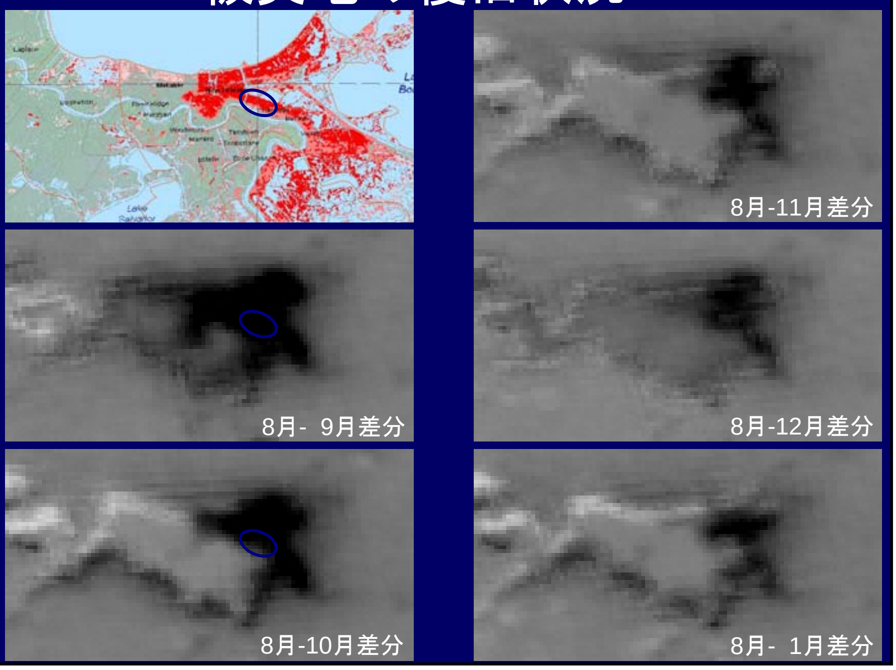
2005年12月の月平均画像



2006年 1月の月平均画像



被災地の復旧状況



まとめ

- ハリケーンカトリーナの被災地の復旧の過程を捉えることができた。
- Lower 9th Ward 周辺の復旧が遅れていることも反映されている。
- 少なくとも被災域が20km×20km程度のスケールを持っていれば、都市光分布から復旧過程を追跡できそうである。
- 電力消費量、人口分布、GDPの分布等の社会経済統計との対応関係について定量的分析が必要

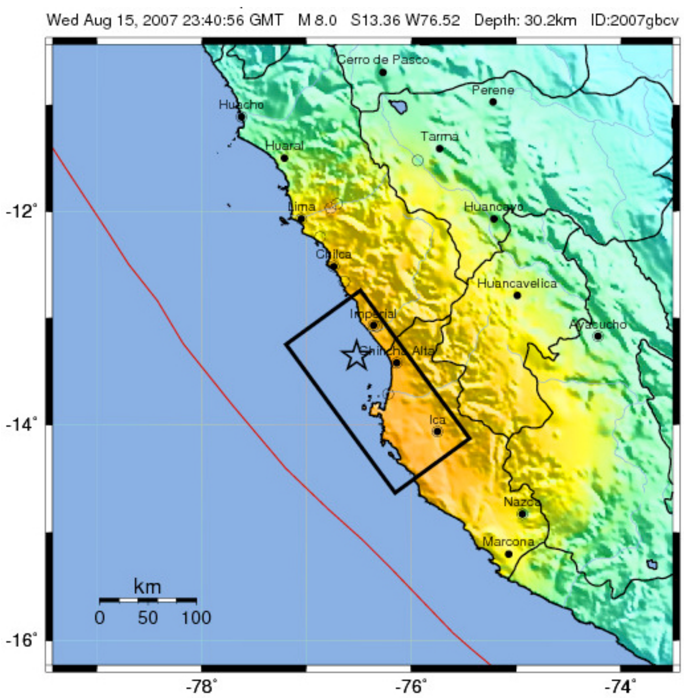
Damage Detection due to the 2007 Pisco Peru Earthquake Using PALSAR and ASTER Imagery

- preliminary result -

Grid Technology Research Center, AIST
Masashi Matsuoka

Pisco, Peru Earthquake

- Date: Aug. 15, 2007
- Earthquake: M8.0, 30km depth
- Death or Missing: 500 <
- Collapse or Severe damage: 35,000 <



Data Used

- ALOS/PALSAR
  - 2007/7/12, 2007/8/27
  - Pixel resolution: 12.5m, Polarization: HH
- Terra/ASTER (for base map)
  - 2006/4/11
  - Pixel resolution: 15m (VNIR)

AIST

ASTER Image (2006/4/11)

False Color

NDVI

AIST

PALSAR Images

2007/7/12

2007/8/27

AIST

Method

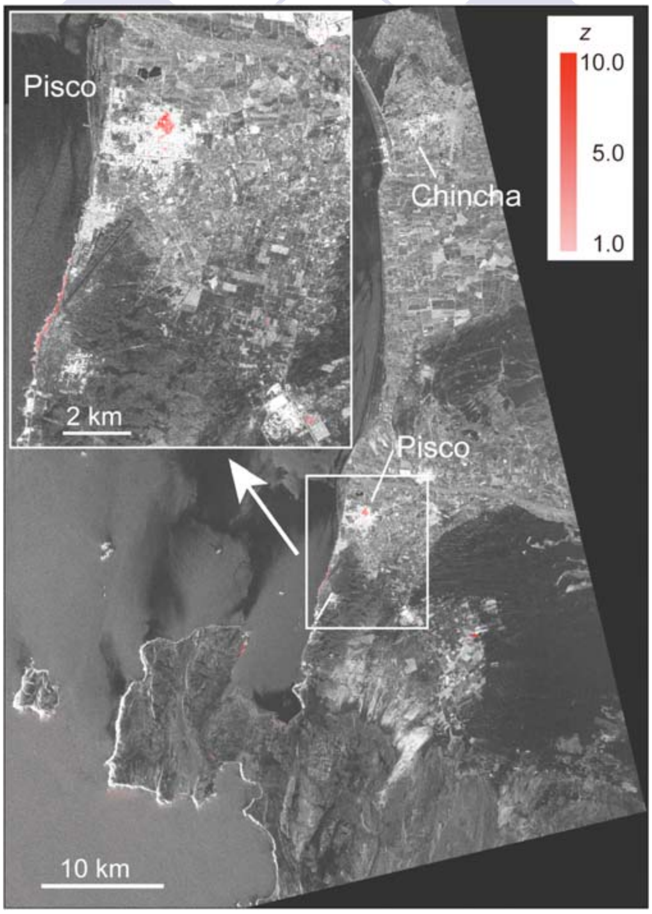
- Calculating the compound variable, z, that used the difference value and correlation coefficient of the backscattering coefficient within a corresponding window as explanatory variables using the pre- and post-event speckle-reduction filtered SAR images (Matsuoka and Yamazaki, 2004).
- Vegetated areas are masked by NDVI threshold value derived from ASTER base map for damage detection target selection.

Masashi Matsuoka and Fumio Yamazaki: Use of Satellite SAR Intensity Imagery for Detecting Building Areas Damaged due to Earthquakes, Earthquake Spectra, EERI, Vol.20, No.3, pp.975-994, 2004.8.

AIST

z-Value Distribution

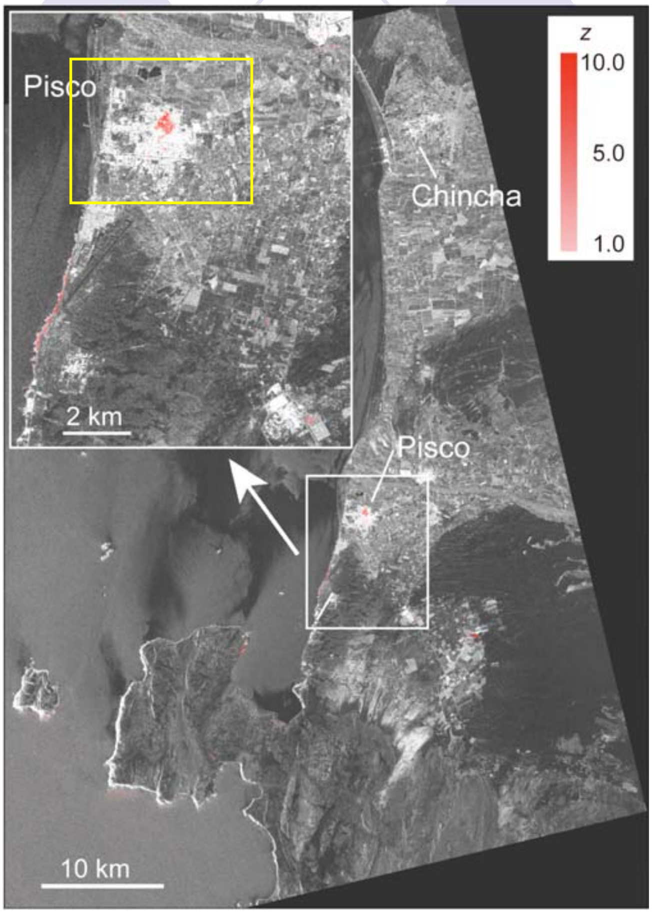
Damage map estimated from PALSAR

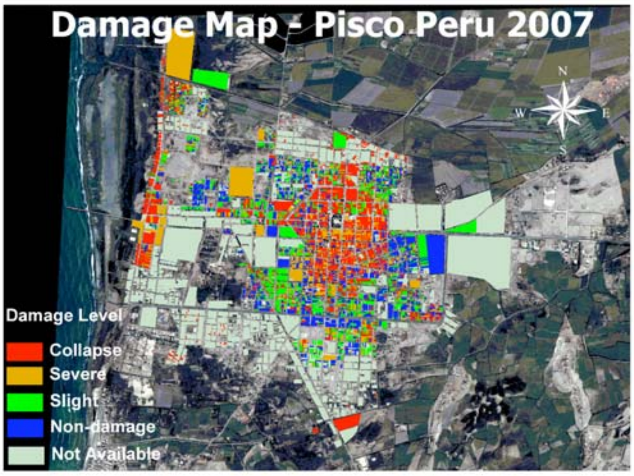


AIST

z-Value Distribution vs Actual Damage Map

Damage map estimated from PALSAR





Damage map classified by field survey (CISMID, 2007)

AIST