Space-based Application for Coastal Vulnerability Assessment in Indonesia

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Outline

- Introduction
- Coastal Vulnerability Assessment
- Remote Sensing vs Coastal Vulnerability Assessment
- Current Status of Research in Indonesia
- Future Research
- Conclusion

Introduction

World Environment News — PLANET ARK — Brought to you by PLANET ARK

SMALL ISLANDS SAY GLOBAL WARMING HURTING THEM NOW

Date: *05-Nov-98*
Country: EU
Author: Jason Webb

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A delegation from the idyllic but fragile Pacific islands travelled to Buenos Aires to try to convince world leaders at United Nations climate talks to take more action to stop global warming which they fear will cause rising seas to cover their low-lying nations.

Rising sea levels have already endangered sacred sites and drowned some small islands off the tiny nations of Kiribati and Tuvalu, including the islet of Tebua Tarawa, once a landmark for Tuvalu fishermen.

"It's very interesting how they disappear. To watch a small island when it's disappearing and seeing it now is a model of how the whole island is disappearing," Tewareke Borau of Kiribati told a news conference.

Kiribati has already had to move roads inland on its main island as the Pacific Ocean has eaten into the shore.

Mega-Stress for Mega-Cities

13 November 2009

A Climate Vulnerability Ranking of Major Coastal Cities in Asia
Many of the largest cities in Asia are located on the coast and within major river deltas, making them highly susceptible to the impacts of climate change. Mega-Stress For Mega-Cities shows that all of the cities analysed are currently extremely exposed to threats from storms and flooding to sea level rise, with huge numbers of people and assets at stake, and highlights the need for co-operation between developed and developing countries to prepare some of Asia's largest cities for the potentially devastating impacts of climate change.

Mega-Stress for Mega-Cities

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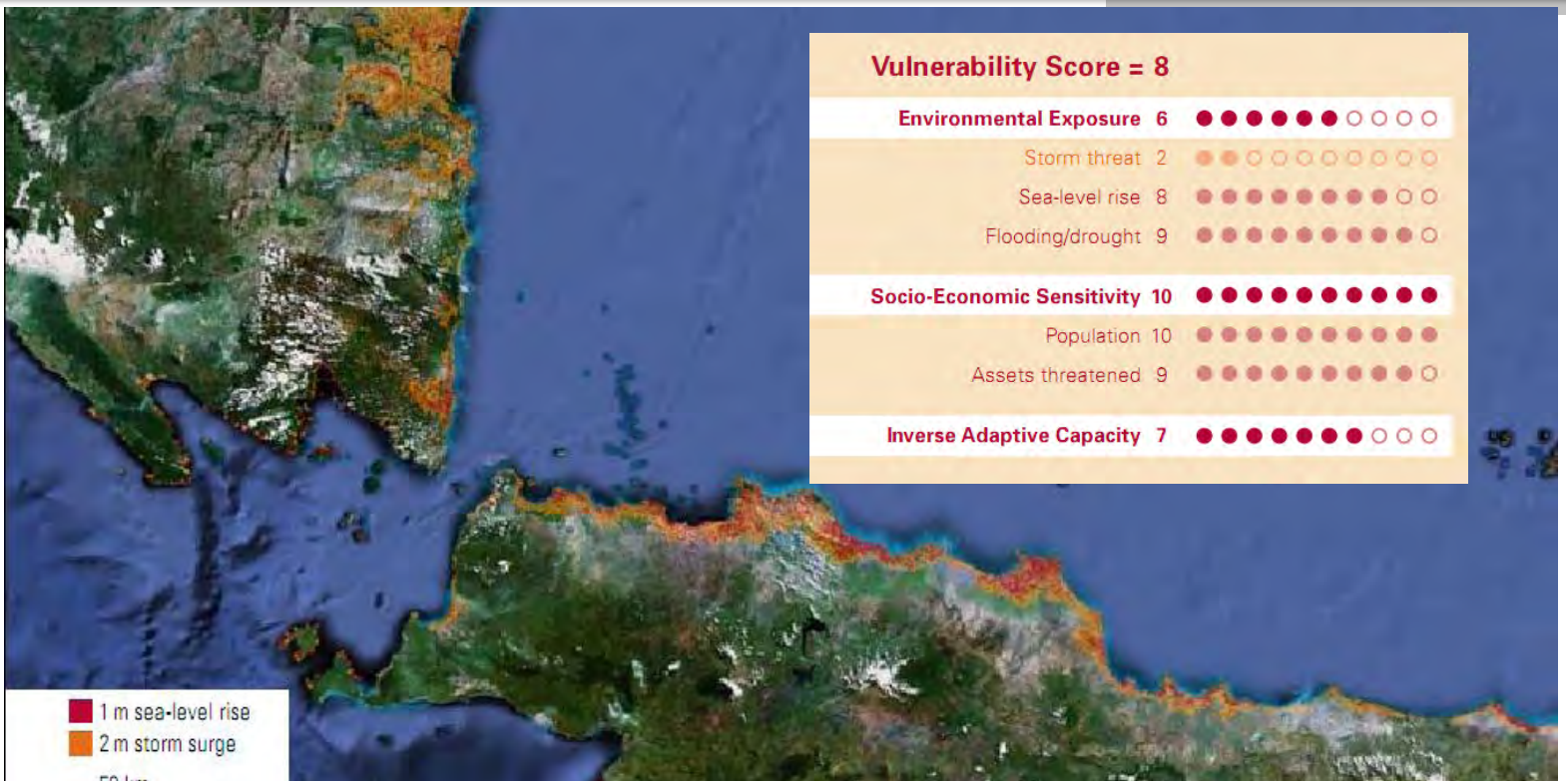
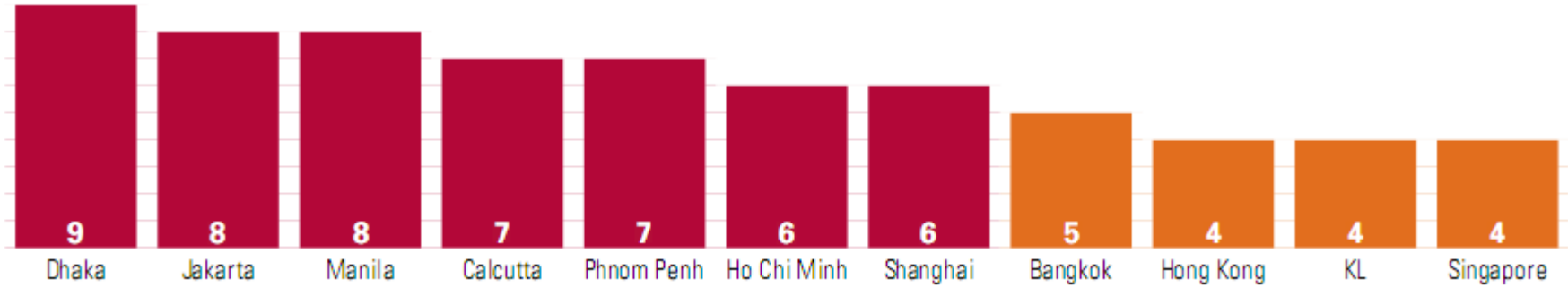
Sources:
http://www.epa.gov/climatechange/impacts-adaptation/coasts.html
http://www.planetark.org/dailynewsstory.cfm?newsid=2428&newsdate=05-Nov-1998
http://www.wwf.org.uk/news_feed.cfm?uNewsid=3454

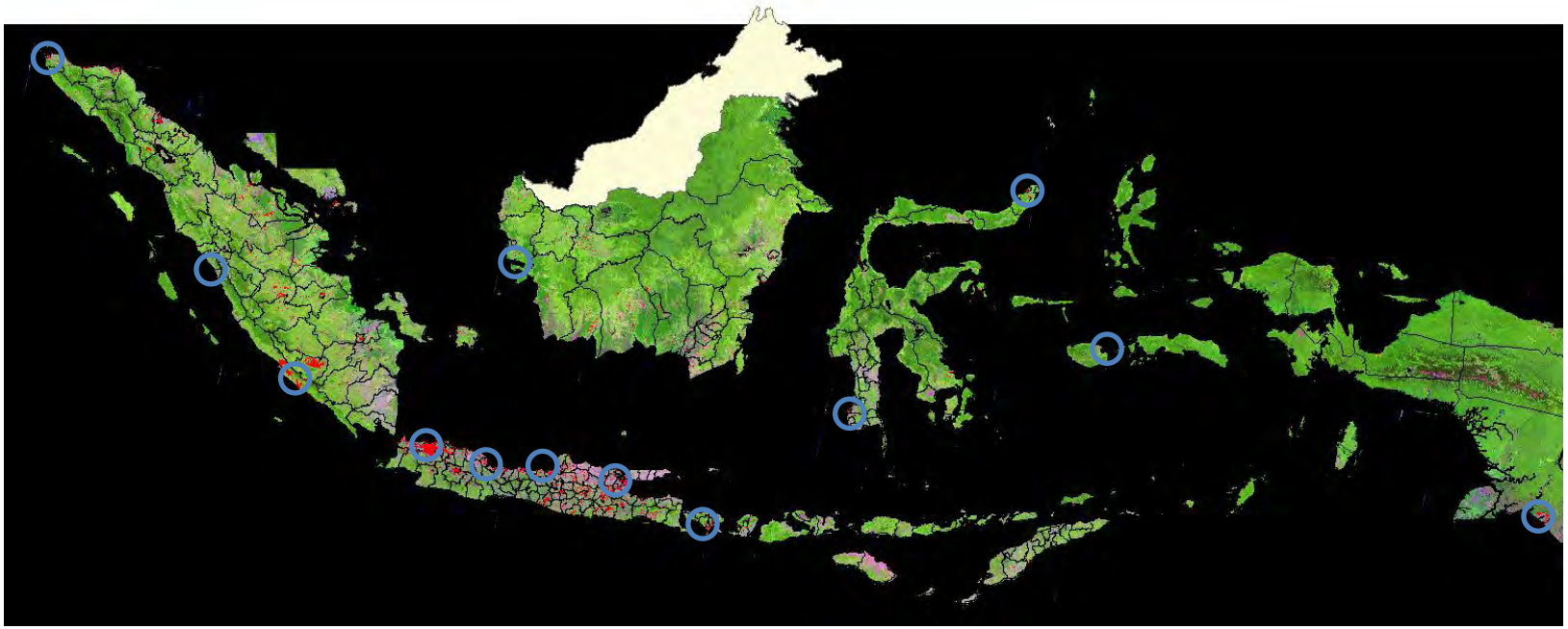
Introduction (Source: WWF)





Introduction

- Indonesian Facts



-Number of people: 237.6 million (65% people lives in the coastal areas)
-Number of islands : 17,508 islands
-Coastline : 95,181 km (number 4 in the world)
-Number of cities in coastal area : 75%

Introduction

So..?	Coastal Vulnerability Assessment is needed
Whats is?	A coastal vulnerability assessment is the result of a process of identifying, quantifying, and prioritizing (or ranking) the vulnerabilities in the coastal system. This involves social, economic and environmental aspects, but also the institutional context. (deltares.nl)
What for?	-Integrated Coastal Zone Management and Development, -Stimulating awareness -Long term sustainable development of coastal zones (deltares.nl) - Save people lives and reduce impact of climate change
Tools?	Remote Sensing?

Coastal Vulnerability Assessment

Assessment Methods

- Index-based methods;
- Indicator-based approach, also including related GIS applications;
- GIS-based decision support systems (DSS);
- Methods based on dynamic computer models

(EEA Paper (2011)

Coastal Vulnerability Assessment

- Multi-scale Coastal Vulnerability Index (McLaughlin and Cooper (2010))

Remote Sensing vs Coastal Vulnerability Assessment

- Coastal Forcing

No.	Variables	Remote Sensing Data Used
1	Significant wave height	Yaakob, et al. (2010), Durrant, et. Al (2009), Bueno, et al (2012), Carter (1993)
2	Tidal Range	Wang and Koopmans (1995), Ezer and Liu (2009), Murray, et al (2012)
3	Different in storm and modal wave height	Klemas, et al (2009)
4	Storm Frequency	http://www.nhc.noaa.gov/

Remote Sensing vs Coastal Vulnerability Assessment

- Coastal Characteristics

No.	Variables	Remote Sensing Data Used
1	Solid Geology	Yes
2	Drift Geology	Yes
3	Shoreline Type	Yes
4	Elevation	Yes
5	River Mouth	Yes
6	Orientation	Yes
7	Inland Buffer	Yes

Remote Sensing vs Coastal Vulnerability Assessment

- Socio-Economic

No.	Variables	Remote Sensing Data Used
1	Population	references
2	Coastal Heritage	Blue, et al. (2013)
3	Road	Yes (high resolution image)
4	Railways	Yes (high resolution image)
5	Landuse	Yes
6	Conservation Status	Need additional data

- Remote Sensing can generate the variables
- Remote Sensing is potential tools for calculating the coastal vulnerability assesssment
- The errors have to be considered

Current Status of Research in Indonesia

- Research on Coastal Vulnerability Assessment
  - Invidual Research

    Farhan and Lim (2013), Wibowo and Supriyatna (2011), Marfai and Hizbaron (2011), Ariff, *et. al.* (2011), Marfai (2009), Radjawane, *et. al.* (2011), Farhan and Lim (2010), Ali, et al. (2008), Marfai (2011), Sulma, *et. al*. (2012)
  - Grup Research

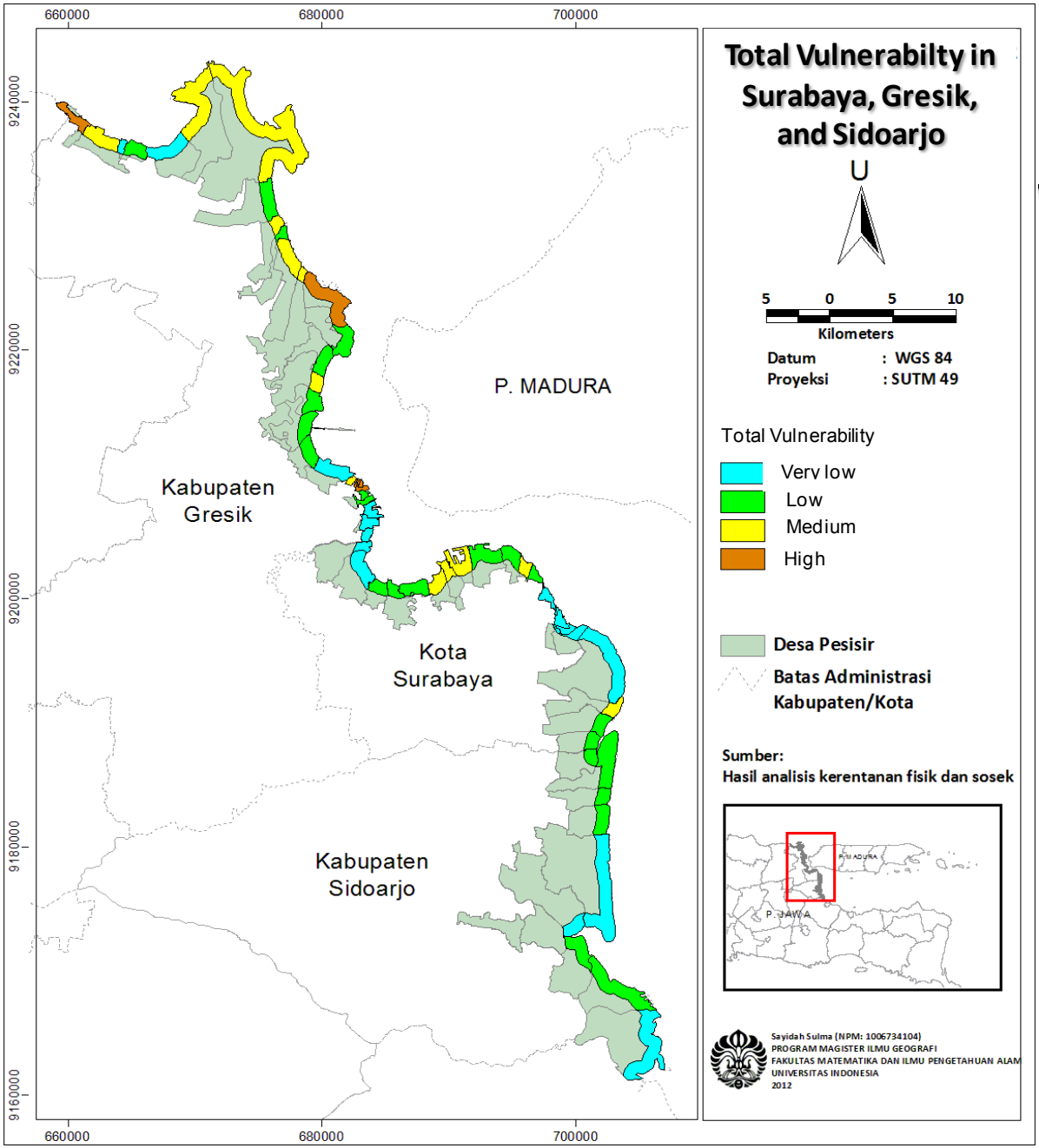
    ACCCRN (Asian Cities Climate Change Resilience Network - MercyCorps, EEPSEA-Woldfish climate change and coastal studies team, WWF

Current Status of Research in Indonesia

- The researches on coastal vulnerability assessment in Indonesia have made a great progress – comprehensive research
- Almost researches used the combination of remote sensing and the socio-economic data to calculate the coastal vulnerability assessment – remote sensing as secondary data
- The used of remote sensing data in the coastal vulnerability assessment has to be improved, especially on the physical characteristics of coastal area and the socio-economic data

Case Study

Title of Research	COASTAL PHYSICAL VULNERABILITY OF SURABAYA AND ITS SURROUNDING AREA TO SEA LEVEL RISE
Researchers	Sayidah Sulma (LAPAN) , Eko Kusratmoko (UI), and Ratna Saraswati (UI)
Study Area	Surabaya
Methodology	Index-based Method Variables: Physics (Landform, coastline change rate, elevation, mean tidal range, mean sea level rise rate, mean wave height) Socio-economic (Land use, Population Density, Percentage of Poor People) *Combination of Remote Sensing data, in situ, and socio-economic data*
Results	See next slides



Total Coastal Vulnerabilty

Medium – High (33,89 %);

Gresik : Kec.Panceng, Ujungpangkah, Bungah, Sidayu, Manyar dan Gresik.

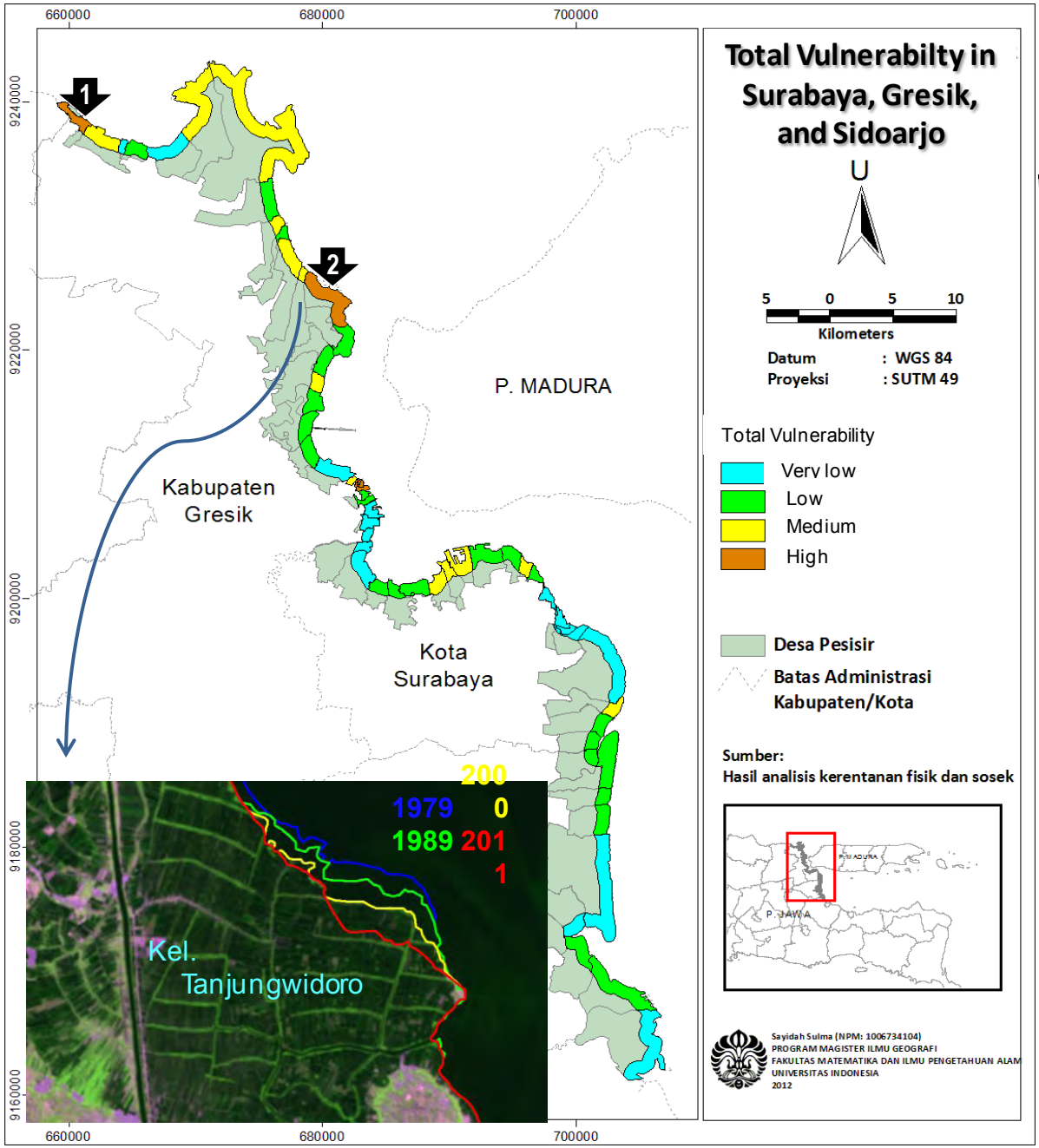
Surabaya:

Kec.Krembangan, Pabean cantikan, Kenjeran dan Rungkut.

Sidoarjo:

There is no sub districts on this categories

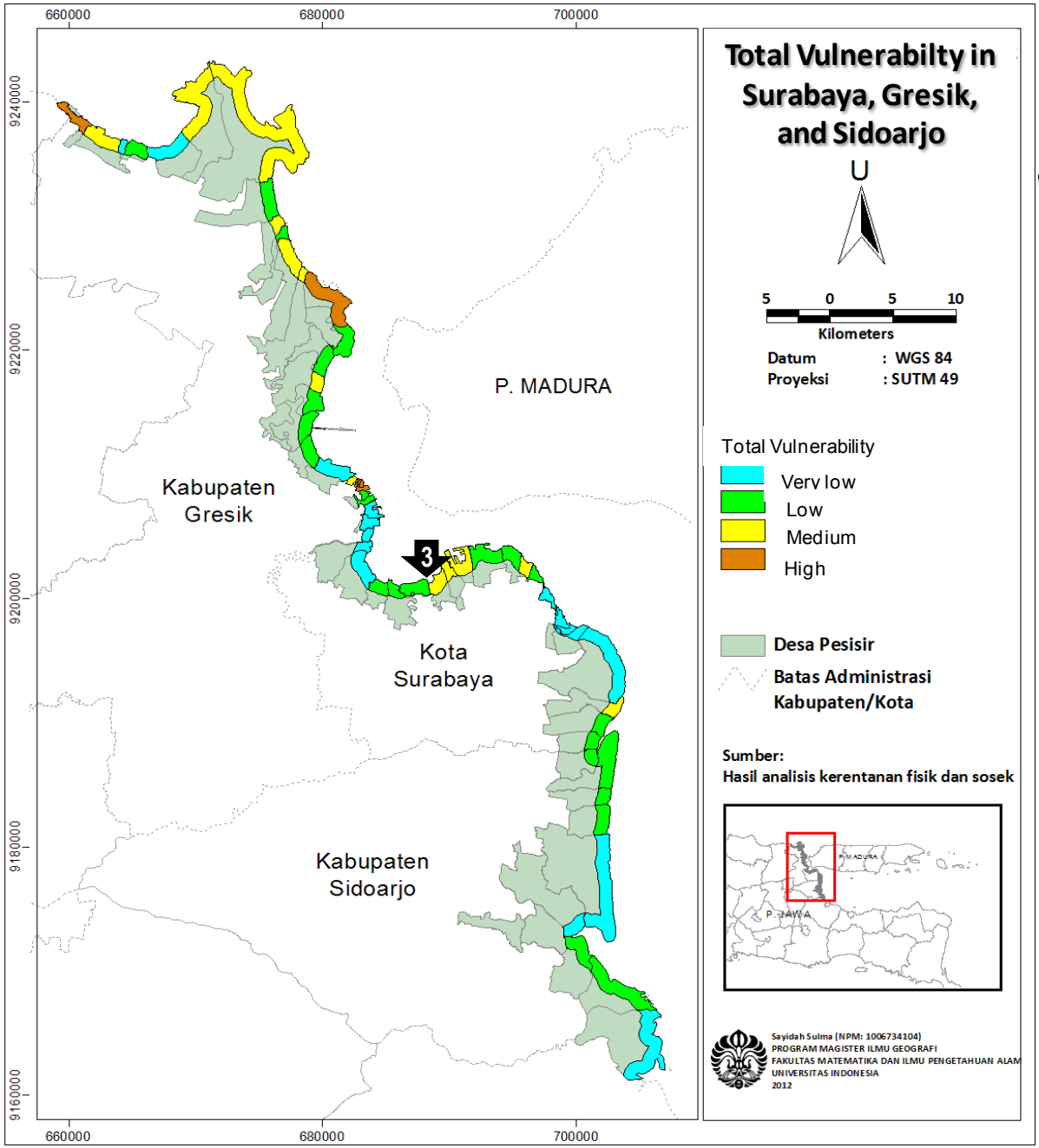
Coastal Vulnerability Gresik District



1. Fisherman Settlement

2. Abration in the fishpond area

Coastal Vulnerability Surabaya City



FUTURE RESEARCH

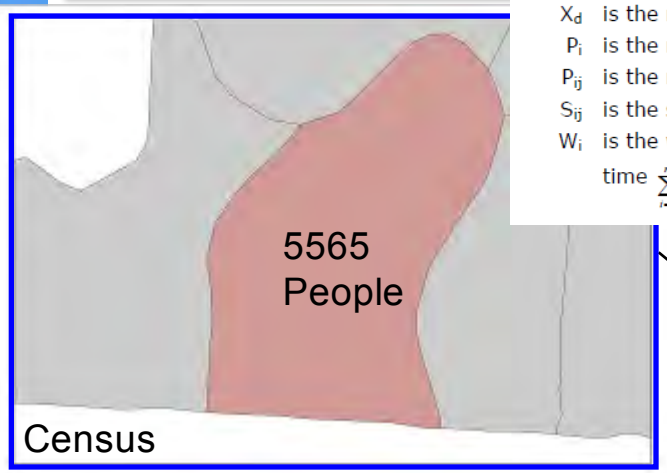
Population Numbers and Density Estimation

- Population Density Models from Urban Geography
- Areal Interpolation Methods
- Statistical Modeling Methods

Population Distribution Modeling

Where:

- X_d is the number of people in administrative unit
- P_i is the number of people in land use *i*
- P_{ij} is the number of people in polygon j in land use *i*
- S_{ij} is the size of polygon j in land use *i* in administrative unit
- W_i is the weighting of land use *i*; it is different during the day and night time $\sum_{i=1}^{n} W_i = 100\%$.



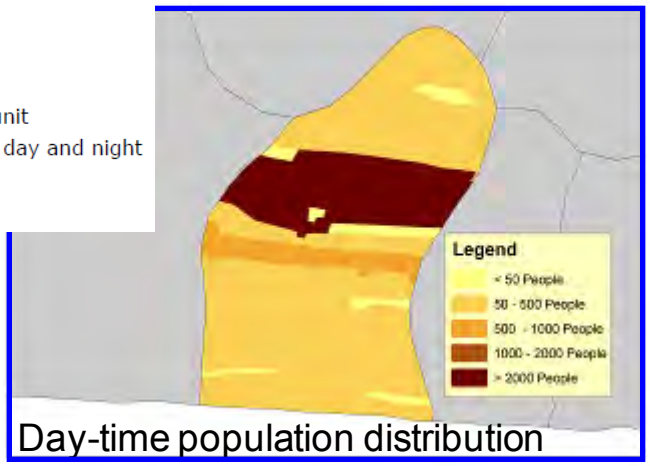
+

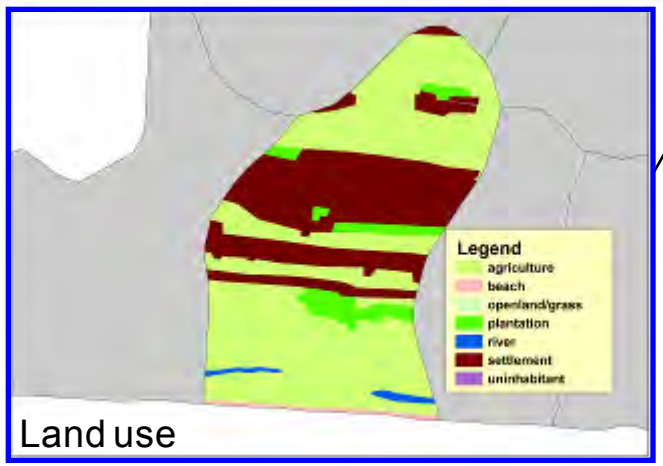
$$X_d = \sum_{i=1}^{n} P_i$$

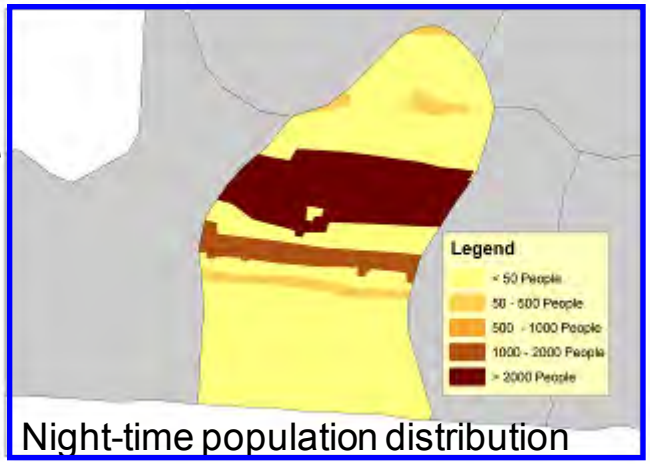
$$P_i = \sum_{i=1}^{n} P_{ij}$$

$$P_{ij} = \frac{S_{ij}}{\sum_{i,j=1}^{n} S_{ij}} W_i . X_d$$

=







Weighting is important!

Building Characteristics vs Socio-economic

Bussiness Area

Slum Area

Town housing

Rural Area

Night light vs GDP

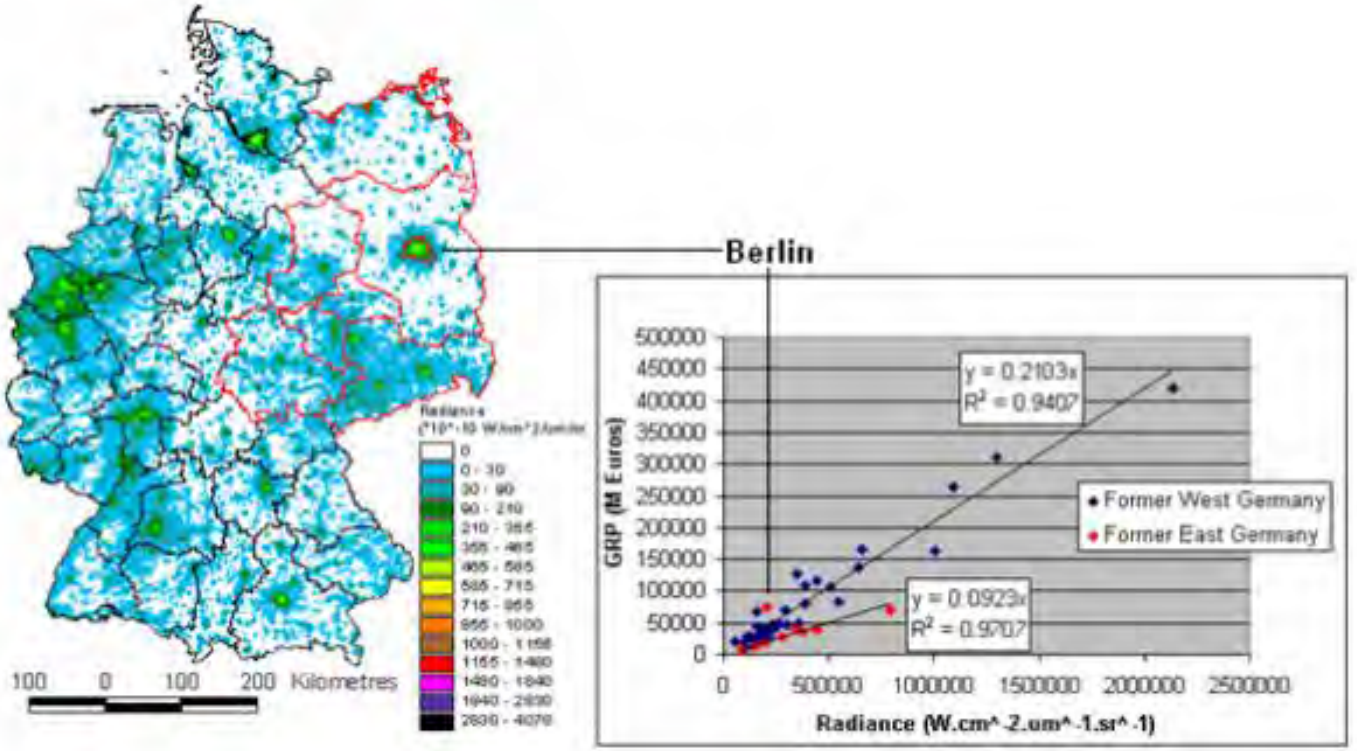


Figure 10. Light map of Germany and the associated graph of radiance and regional Gross Domestic Product. Note how points in the former East Germany have a different relationship to those in West Germany.

Source: Doll (2008)

Conclusion

- Research on coastal vulnerability assessment in Indonesia has made a great progress
- Remote Sensing is a potential tools for the Coastal Vulnerability Assessment
- Socio-economic variables estimation by using remote sensing data is a challenge for future research

THANK YOU FOR YOUR KIND ATTENTIONS