

# Bio-optical Model for Mapping Spatial Distribution of Total Suspended Matter from Satellite Imagery

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## Outline of Presentation

### Introduction

- Background, Objectives and Study area

### Methodology (Analytical Approach)

### Results:

- TSM Concentration using Bio-optical Model

### Conclusions and Recommendations

## Introduction

The major problems in the coastal zone management of Teluk Banten is the high concentrations of suspended sediment.

### Other problems:

- Degradation of natural ecosystem
- Decrease of water quality
- Increase of sediment material
- Construction of large infrastructure works
- Pressure on marine resources
- Coastal zone mismanagement

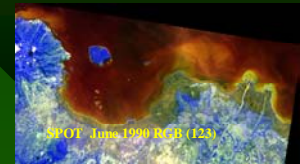
### Interesting Phenomena in Teluk Banten:

The area accommodates valuable marine ecosystems such as seagrass fields, coral reefs and a bird sanctuary of international importance at a peninsula near the town of Banten.

## Introduction

### The sources of sediment in Teluk Banten:

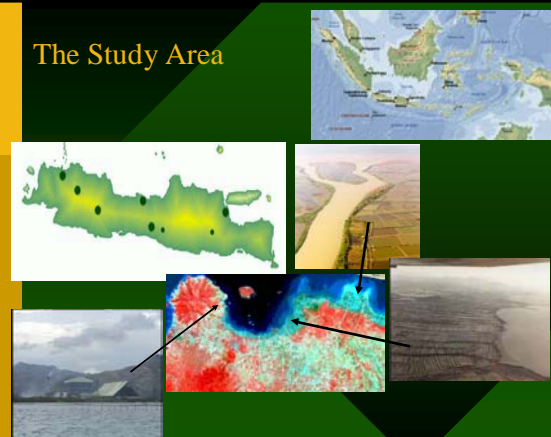
1. The buoyant foam of Ciujung river
2. The sediment discharge from other rivers
3. The re-suspension and deposition of old ciujung delta
4. The tide and current



## The Objectives:

To retrieve total suspended matter (TSM) concentrations of Teluk Banten coastal waters from remotely sensed data

## The Study Area



## Data Available

### Landsat TM 5:

- 1995 ( May 27, 1995)
- 1996 (June 14, 1996)
- 1997 (June 14, 1997)
- 1997 (January 30, 1997)

### TSM Concentrations from *in situ* measurements:

1. TSM from NIOZ wet season ( February 1999)  
TSM range between : 2.4- 28.4 mg/l)
2. TSM from NIOZ dry season ( October 1998)  
TSM range: 2.06 – 31.25 mg/l)
3. TSM from Wignyowinoto dry season (October 2001)  
Turbidity: 0 mg – 60 NTU

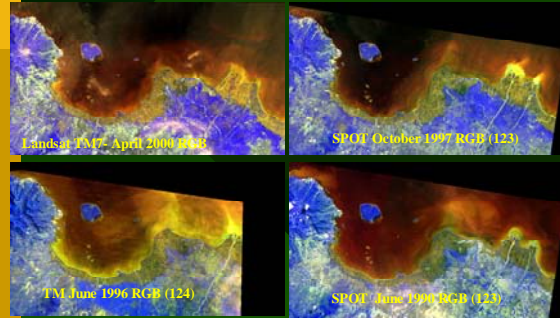
### SPOT

- 1990 (June 12, 1990)
- 1996 (April 8, 1996)
- 1997 (October 8, 1997)

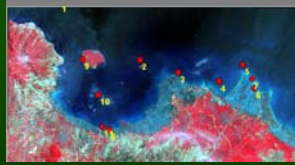
### Landsat TM 7:

2000 (April 6, 2000)

## Some satellite data of Study area



## Fieldwork Stage



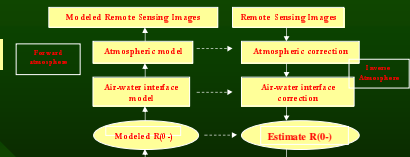
### Type of Activities and Instruments

### Sample Locations

Activity/Instrument	Location/Context	Parameters/Measurements
Water samples	Laboratory analyses in Vrije Universiteit, Amsterdam	IOP Concentrations of TCHL and TSM
A portable spectroradiometer, CE500	In the ITC	R(0-) Calibrated the Images
digital water checker	In situ measurements	turbidity, salinity, temperature, conductivity, pH and Dissolve oxygen, bottom depth and transparency
GPS	In situ measurements	Geographic position all location

## TSM Concentration Using Bio-optical Model

### The Basic Concepts



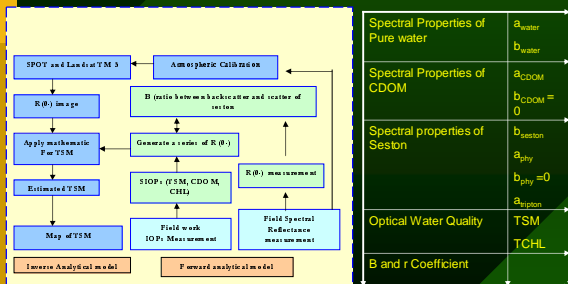
### The Algorithms:

$$R(0-) = r \frac{b_s}{a + b_s}$$

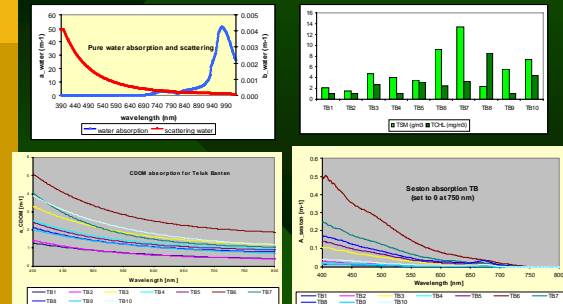
$$b_b = 0.5 \cdot b_w + B \cdot b_{tr} \cdot TSM$$

$$a = a_w + a_{pig} \cdot TCHL + a_{tr} \cdot TSM + a_{CDOM} \cdot CDOM$$

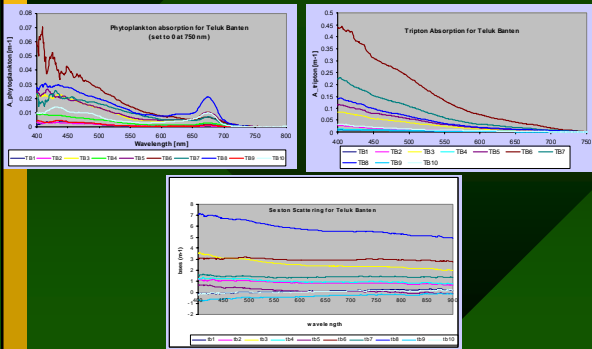
## Flowchart



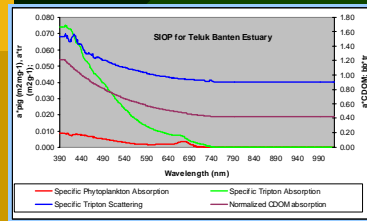
## Input of Forward Model: Inherent Optical Properties



### Input data (IOPs)



### SIOP of Teluk Banten

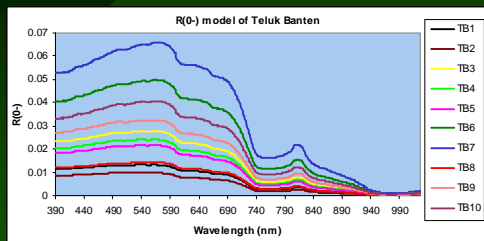


B and r coefficient from literature value

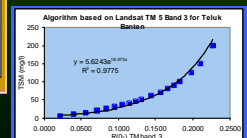
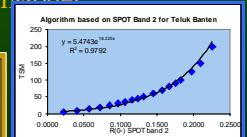
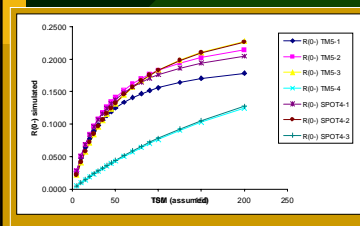
Bio-optical model

The Algorithms of Forward Model for determining TSM Concentration

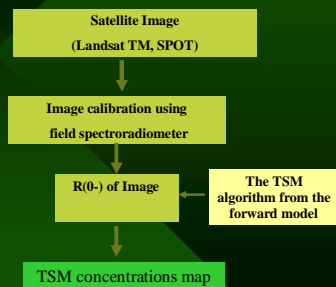
### The R(0-) modeled of Teluk Banten



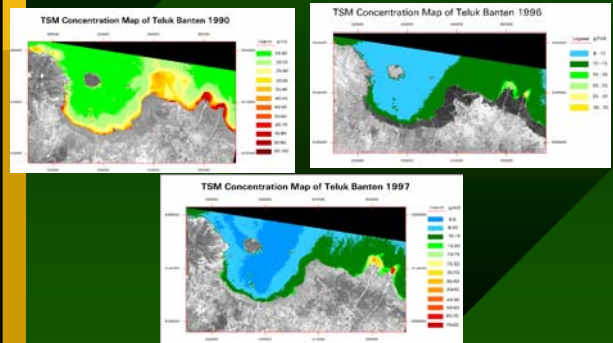
### Results of Forward Bio-optical Model



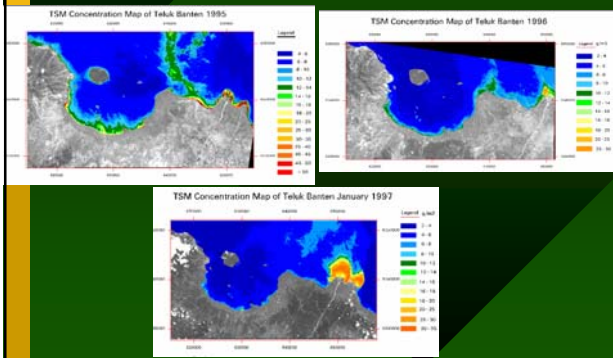
### Inverse Bio-optical Model



### Results



## Results



## Conclusions

- Bio-optical modeling, based on the knowledge of the *in-situ* inherent optical properties, leads to development of sufficient reliable multi-temporal algorithms for TSM retrieval for the data derived from SPOT and Landsat TM sensors. This methodology allows comparison of multi-temporal, multi-site (within this region) and multi-instrument TSM maps derived from satellite imagery.

- The results indicate that a non-linear relationship exists between the satellite radiance image data and the suspended matter concentration. The relationship is an exponential relationship.
- A bio-optical model has been presented in this research proved to be suitable for Teluk Banten and can easily be applied in other coastal areas in Indonesia with sufficient accuracy (Ambarwulan, 2002).
- The bio-optical model was also previously tested in Indonesian (Banjarmasin) coastal water and in the Netherlands waters (Frisian waters and Vecht Lake waters).

## Recommendation

- It is applicable to all type of sensors as long as the appropriate SIOP are available for the spectral bands of the sensor
- It allows the application of one algorithm based on the red band to a time series of image data from the same sensor for the same region

- It allows error analysis of the error propagation, which enables to predict the error in the retrieved concentration
- Only initial measurements are needed to establish optical properties of the relevant waters in an area, requiring only a little *in-situ* measurement.

Thank you