



# Reefs at Risk in the Caribbean

Lauretta Burke  
Jon Maidens  
World Resources Institute

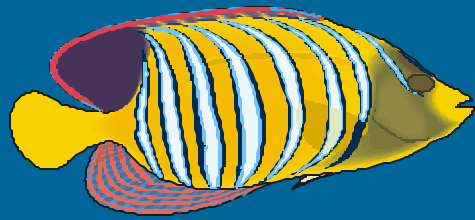
Presentation at NOAA  
April, 2003

# Reefs at Risk Project Goals

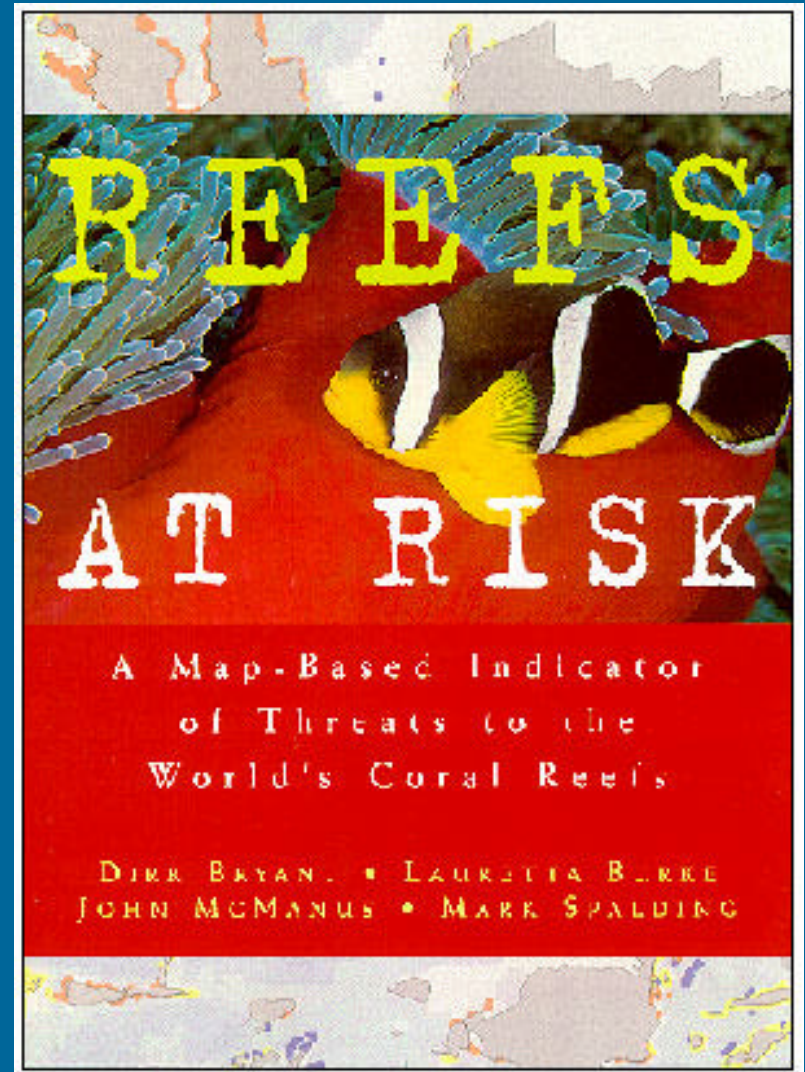
- Assemble the best available information on coral reef status, estimated threats, and protection and management of coral reefs
- Develop useful tools for linking human activities with threats to coral reefs
- Make a clear case (in economic terms) for better management and protection of coral reefs
- Raise awareness - share results widely

# Reefs at Risk project: a Response to an Information Need

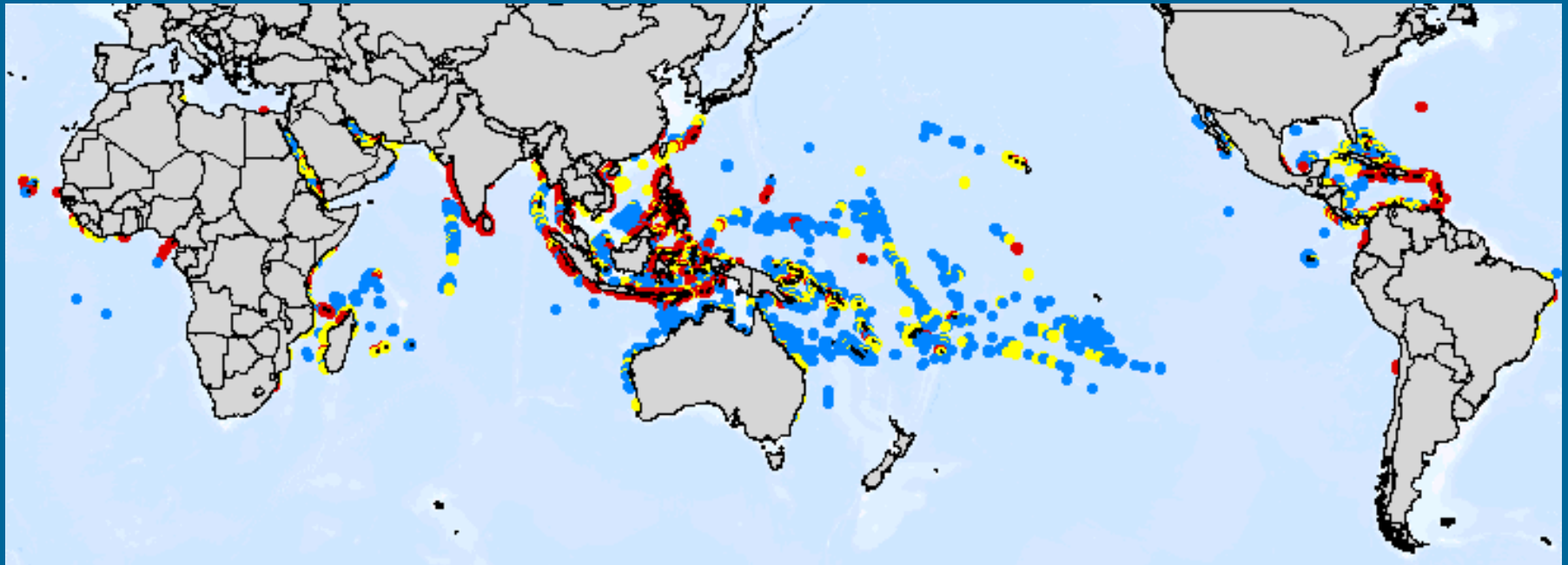
- Few coral reefs have been monitored
- Inadequate information on changes in coral reefs
- Much data is unavailable
- Integrated monitoring programs are needed



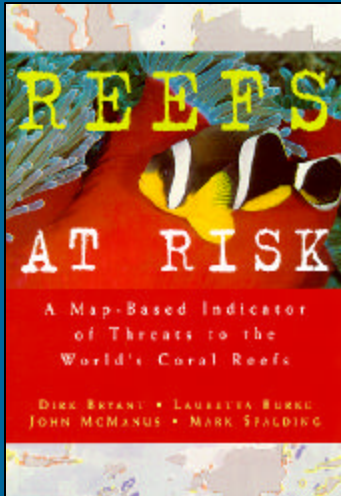
Global Analysis  
released in 1998 by  
World Resources Institute,  
in collaboration with  
ICLARM, WCMC and UNEP



# *The Reefs at Risk Index*

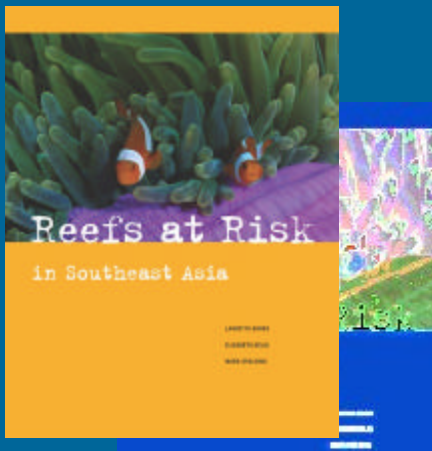


■ Low    ■ Medium    ■ High

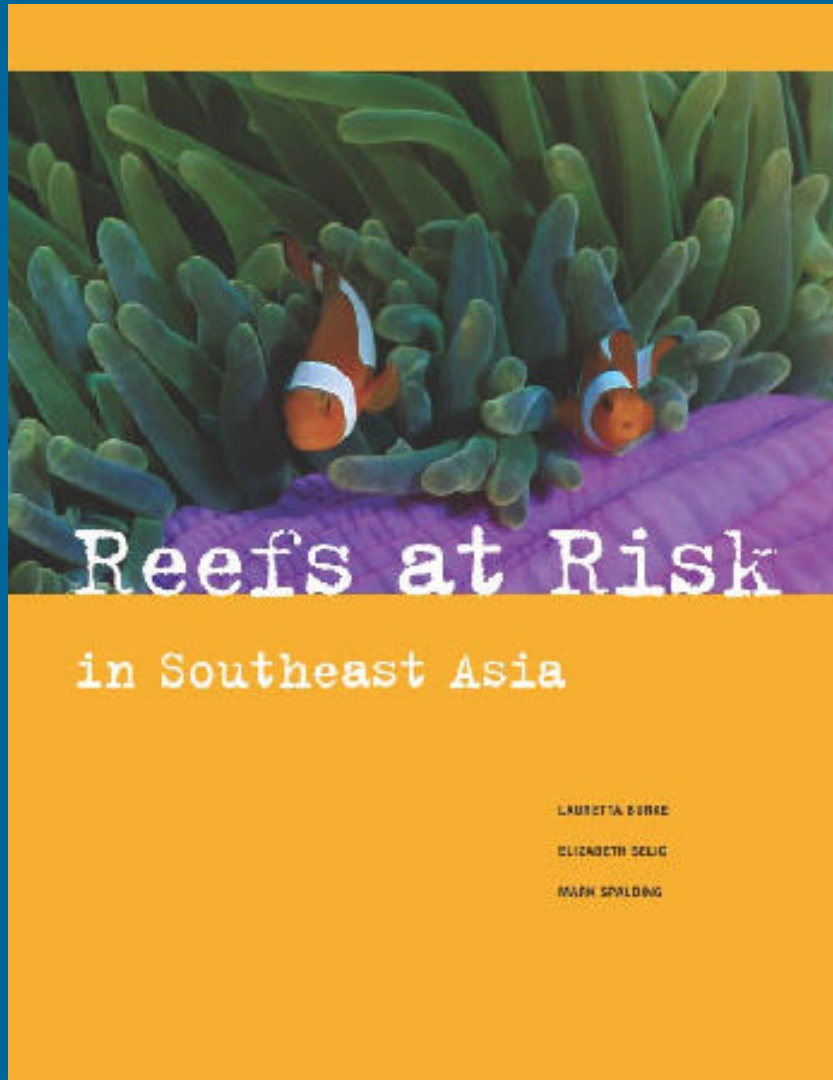


- *Global Reefs at Risk* successful at raising awareness.
- Relatively coarse-scale (4km.)

### *Regional Reefs at Risk series*



- Higher resolution analysis – valuable for management
- More integration and improvement of data
- Collaborative analysis – better validation of results



# Reefs at Risk in Southeast Asia

by  
Laretta Burke  
Elizabeth Selig  
Mark Spalding



# Five categories of threat examined for Southeast Asia:

- Coastal development
- Marine-based pollution
- Sediment and pollution  
from land-based sources  
(LBS)
- Overfishing
- Destructive fishing

```
graph LR; A[Coastal development] --> B[Integrated into Reefs at Risk Threat Index]; C[Marine-based pollution] --> B; D[Sediment and pollution from land-based sources (LBS)] --> B; E[Overfishing] --> B; F[Destructive fishing] --> B;
```

Integrated into  
Reefs at Risk  
Threat Index



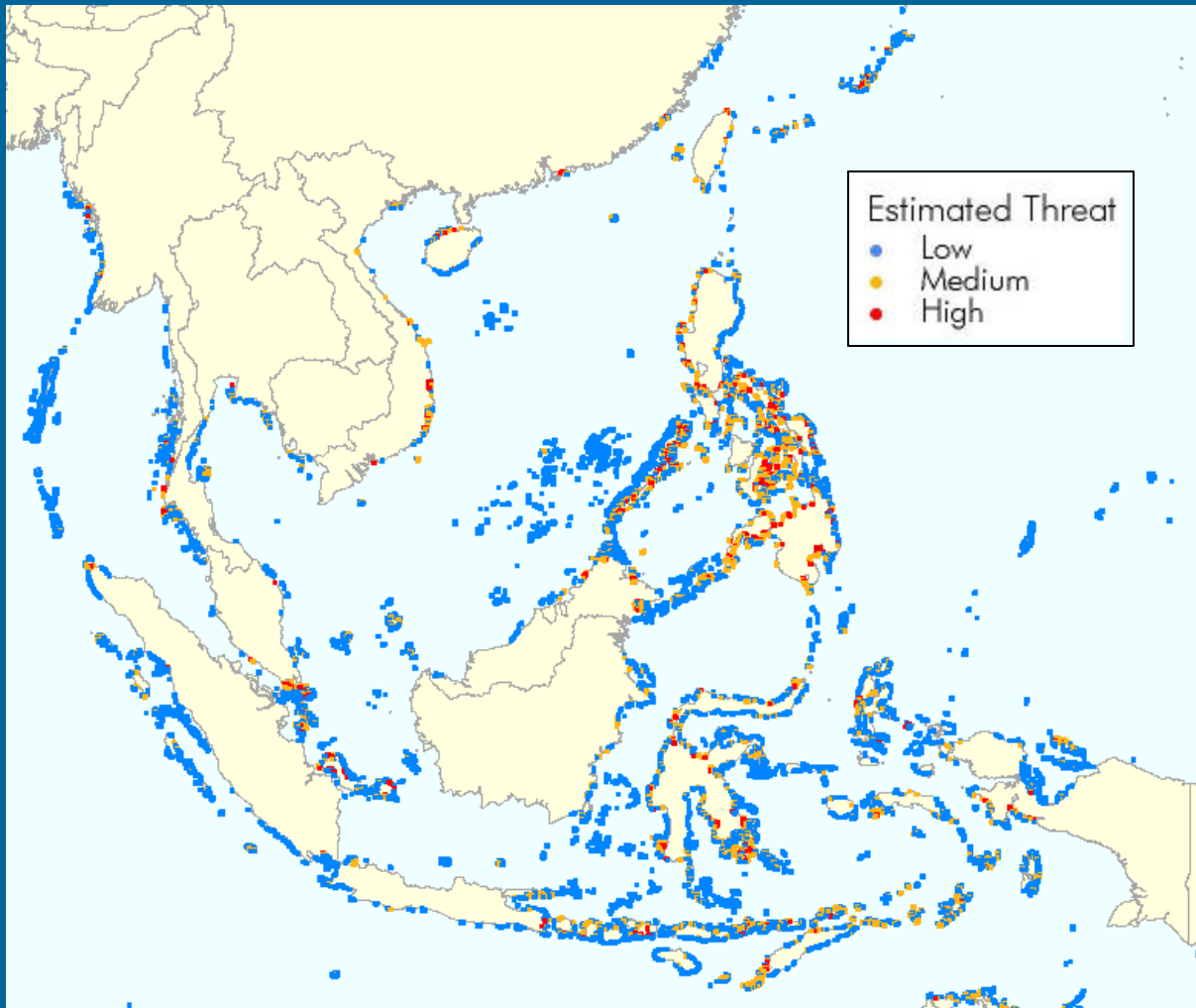
# Main Components of Regional Reefs at Risk project:

- Development of background data sets on coral reefs and factors contributing to reef degradation
- Modeling of threats to coral reefs
- Calibration of model
- Review and revision of data and model
- Development of outputs / products

# Integrated Data Sets for Region- on CD

- Coral reef and mangrove locations
- Coral reef status parameters
- Physical landscape data
- Infrastructure
- Socioeconomic variables
- Estimated threat to coral reefs

# Coastal Development

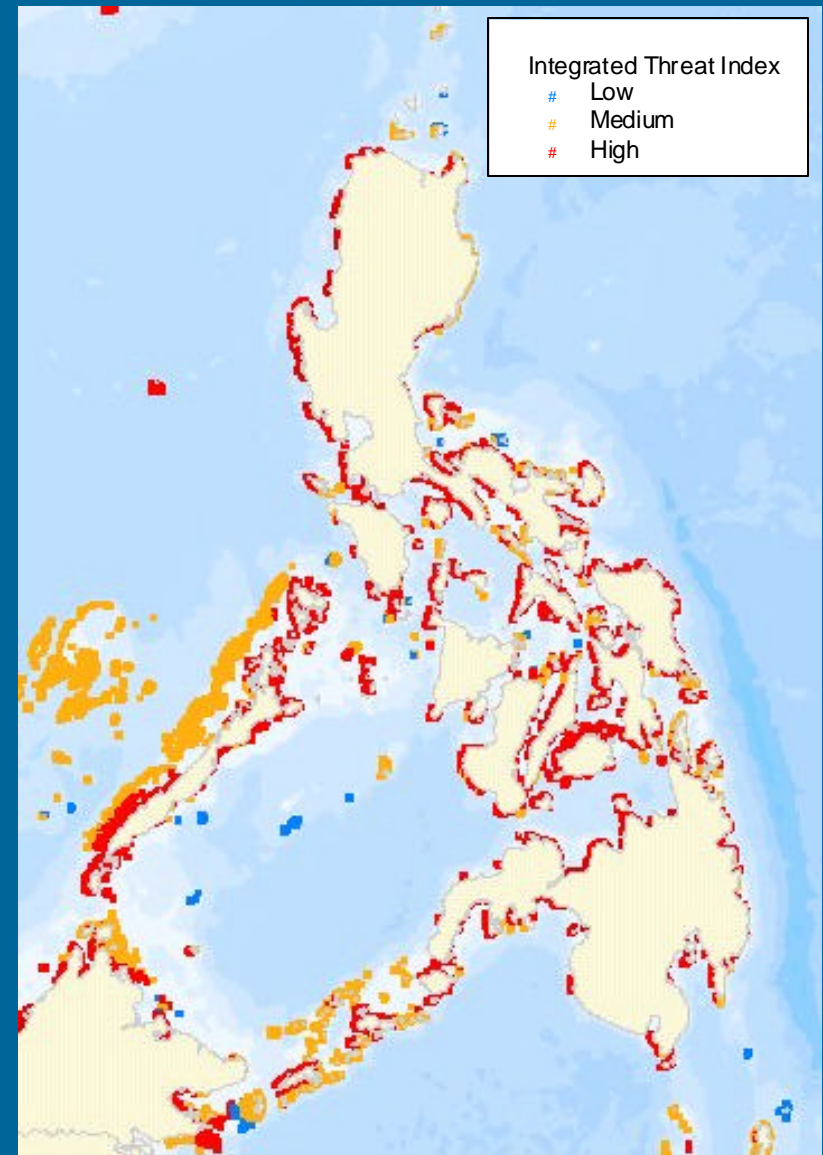
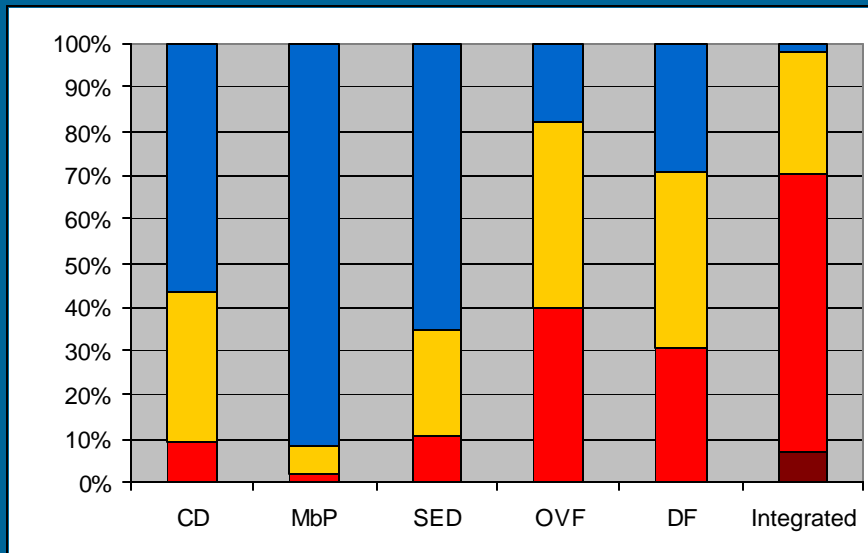


• Modeled based on distance to settlements, airports, mines, and tourist centers, and population growth along coast.

• 25 percent of Southeast Asia's coral reefs are threatened by coastal development

# Philippines Country Summary

Reef area estimate-  
26,000 sq. km.  
(26% of regional total)



# Reefs at Risk in the Caribbean



# Reefs at Risk in the Caribbean

Supported by:

- United Nations Foundation (through UNEP and the ICRAN Partnership)
- US Agency for International Development
- Munson Foundation
- Henry Foundation
- 
-

# Information Objectives

- a good mapping of the region's coral reefs
- for each coral reef location, estimates of degree of threat from human activities:
  - coastal development
  - pollution and sedimentation from LBS
  - pollution from marine-based sources
  - overfishing / overexploitation



# Information Objectives

- an analysis of other factors affecting coral reef condition
  - coral bleaching
  - coral disease
  - natural vulnerability (to pollution, sedimentation, and storms)

# Information Objectives (continued)

- a mapping of MPAs and which reefs are protected
- (and which reefs are really protected)
- an analysis of the economic value of the region's coral reefs

# Coastal Development Pressure

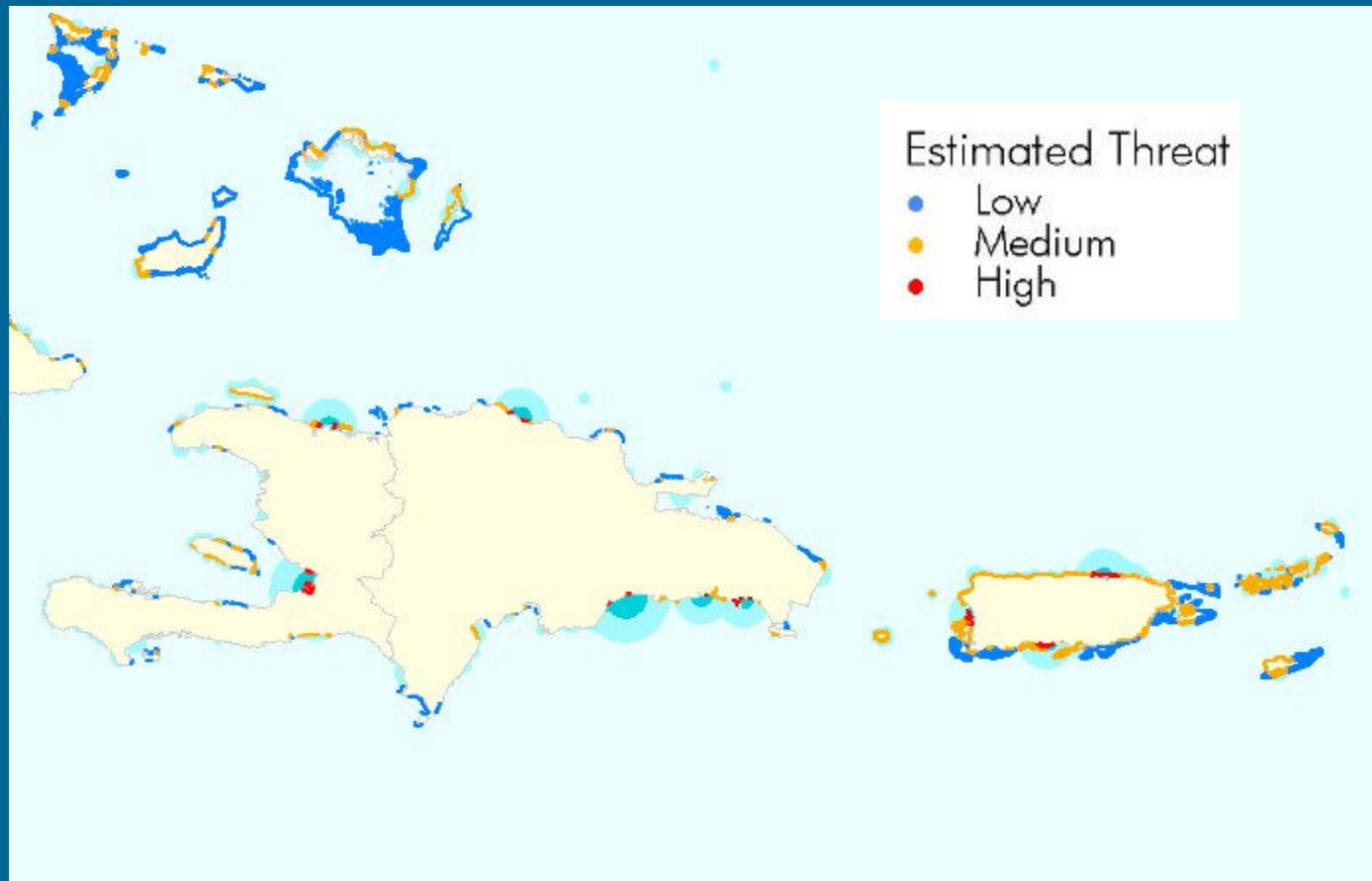


- Dredging, land filling and reclamation
- Mining of sand and coral
- Runoff from construction
- Sewage discharge
- Impacts from tourism

# CD Threat estimated based on mapped features:

- Populated Places \ City Size
- Population Density
- Population Growth
- Per Capita GDP
- Airports and Ports
- Tourism Centers / Dive Centers
- Tourism Growth

# Estimated Threat from Coastal Development



# Sediment and Pollution from Upland Sources



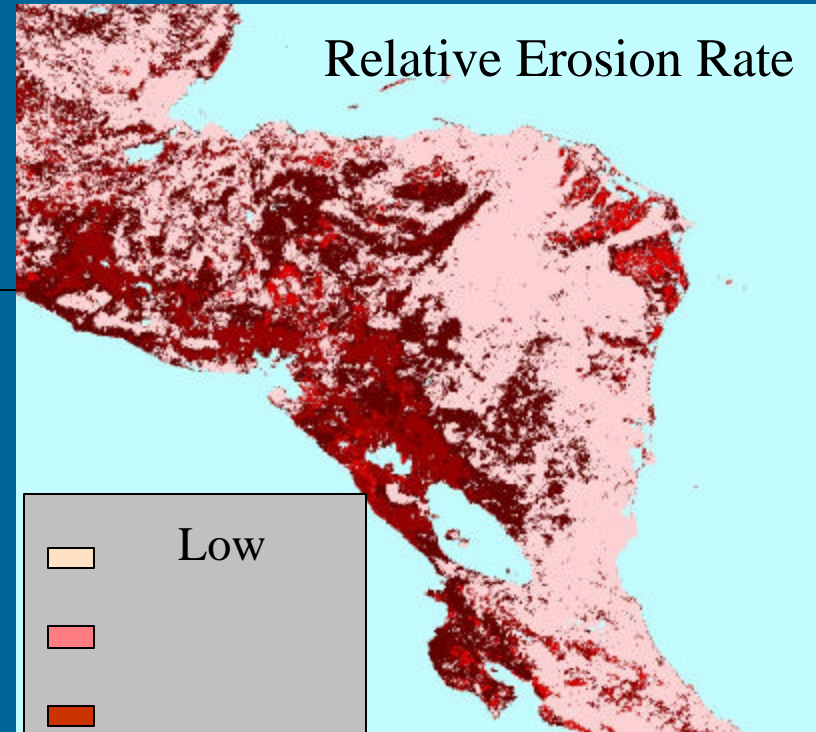
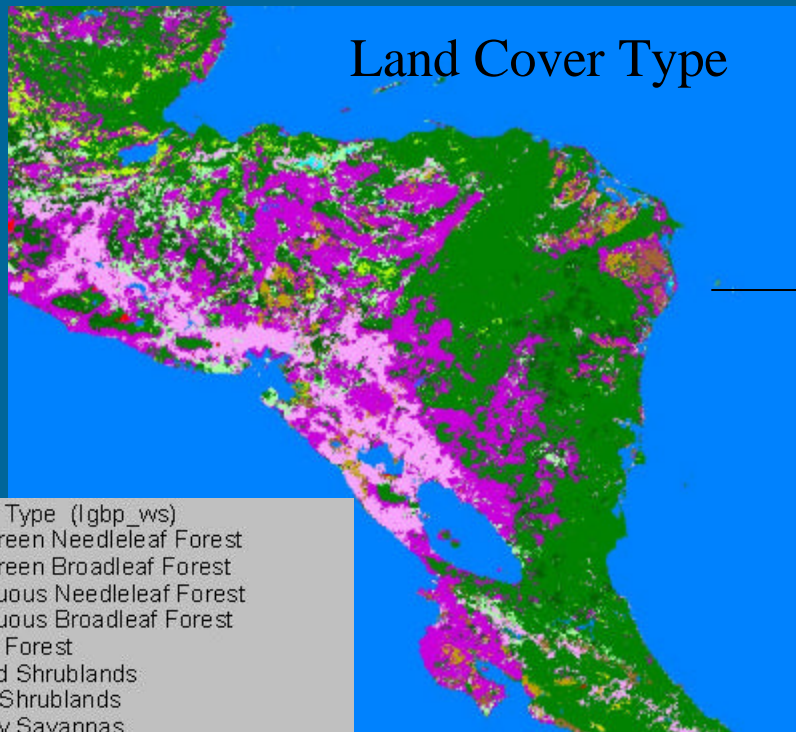
- Deforestation
- Poor agricultural practices
- Fertilizer and pesticide runoff

# LBS Threat Overview

- Watershed-based Analysis
- Relative erosion rates are estimated based on a simplified version of the RUSLE (USDA) -- based on four factors -- slope, land cover, rainfall, and soil type
- Relative erosion rates and precipitation are summarized by watershed
- Sediment dispersion estimate based on river flow and erosion during peak rainfall month



# Land Cover Type Determines Relative Erosion Rates



- Land Cover Type (Igbp\_ws)
- Evergreen Needleleaf Forest
  - Evergreen Broadleaf Forest
  - Deciduous Needleleaf Forest
  - Deciduous Broadleaf Forest
  - Mixed Forest
  - Closed Shrublands
  - Open Shrublands
  - Woody Savannas
  - Savannas
  - Grasslands
  - Permanent Wetlands
  - Croplands
  - Urban and BuiltUp
  - Cropland/Natural Vegetation Mosaic
  - Snow and Ice
  - Barren or Sparsely Vegetated

- Low
- High

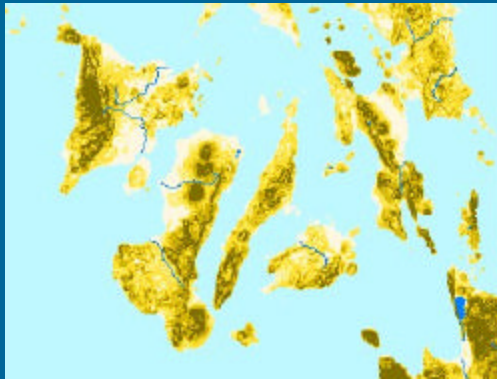
# Erosion Factors by Land Cover Type

LAND COVER CATEGORY	RELATIVE EROSION RATE
Forest	15
Shrubland	45
Woody Savanna	60
Savannas	80
Grasslands	125
Permanent Wetlands	80
Croplands	210
Urban and Built-up	210
Cropland/Natural	120

# Inputs to “Relative Erosion Potential” (REP)

## Percent Slope

(derived from elevation)



## Precipitation

(mean for peak month)



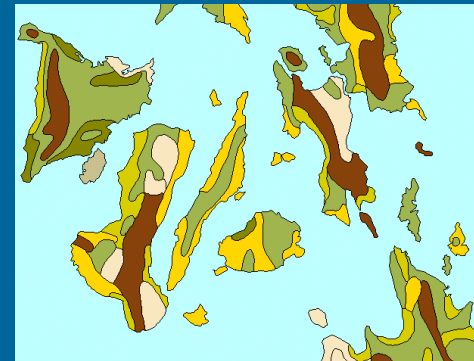
## Relative Erosion Rate

(by land cover type)



## Soil Porosity

(based upon soil type and texture)



# Relative Erosion Potential (REP)

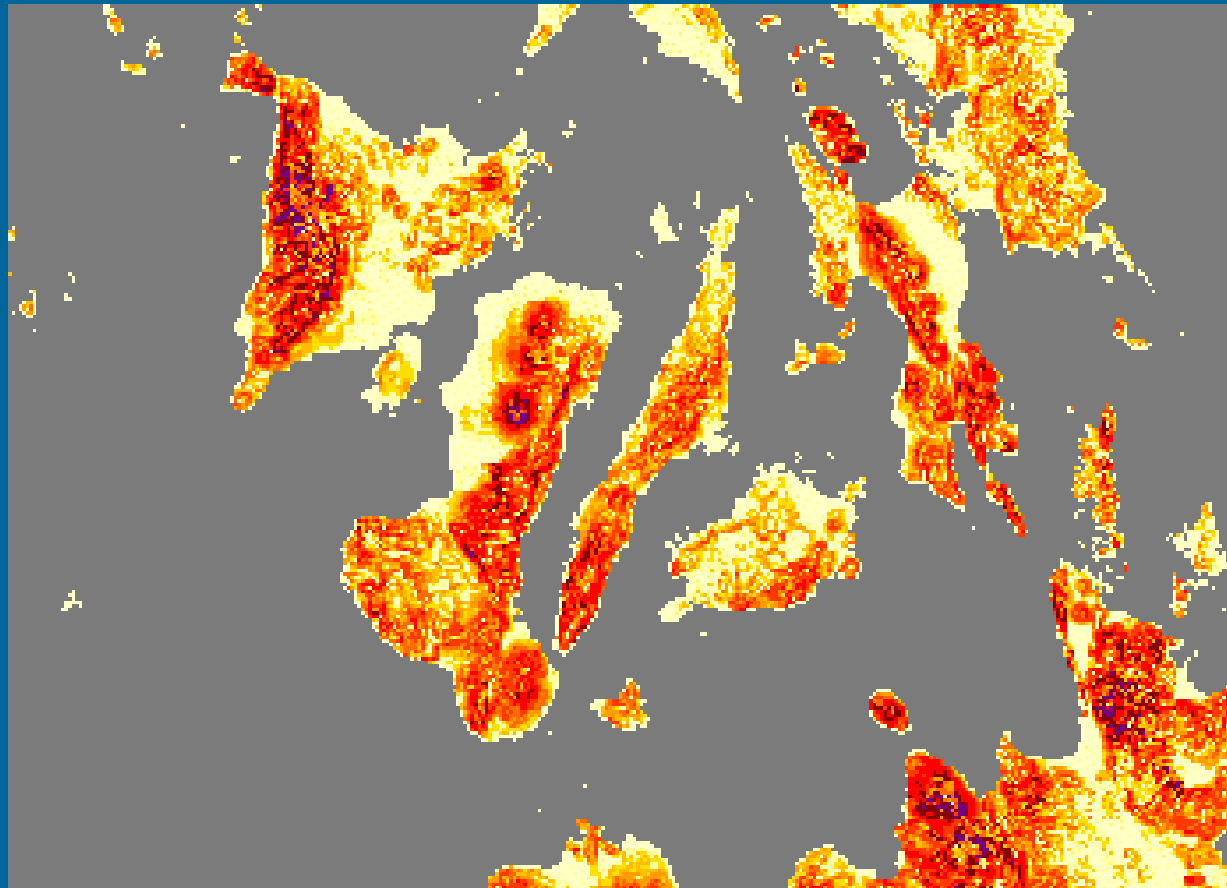
- Based on Revised Universal Soil Loss Equation (RUSLE) of USDA, 1989.

*Equation: (for each 1 km grid cell)*

$$\mathbf{REP} = \mathbf{SLOPE} * \mathbf{LC\_RER} * \mathbf{PRECIP} * \mathbf{SOIL}^{1.5}$$

# Relative Erosion Potential

(by grid cell)



REP

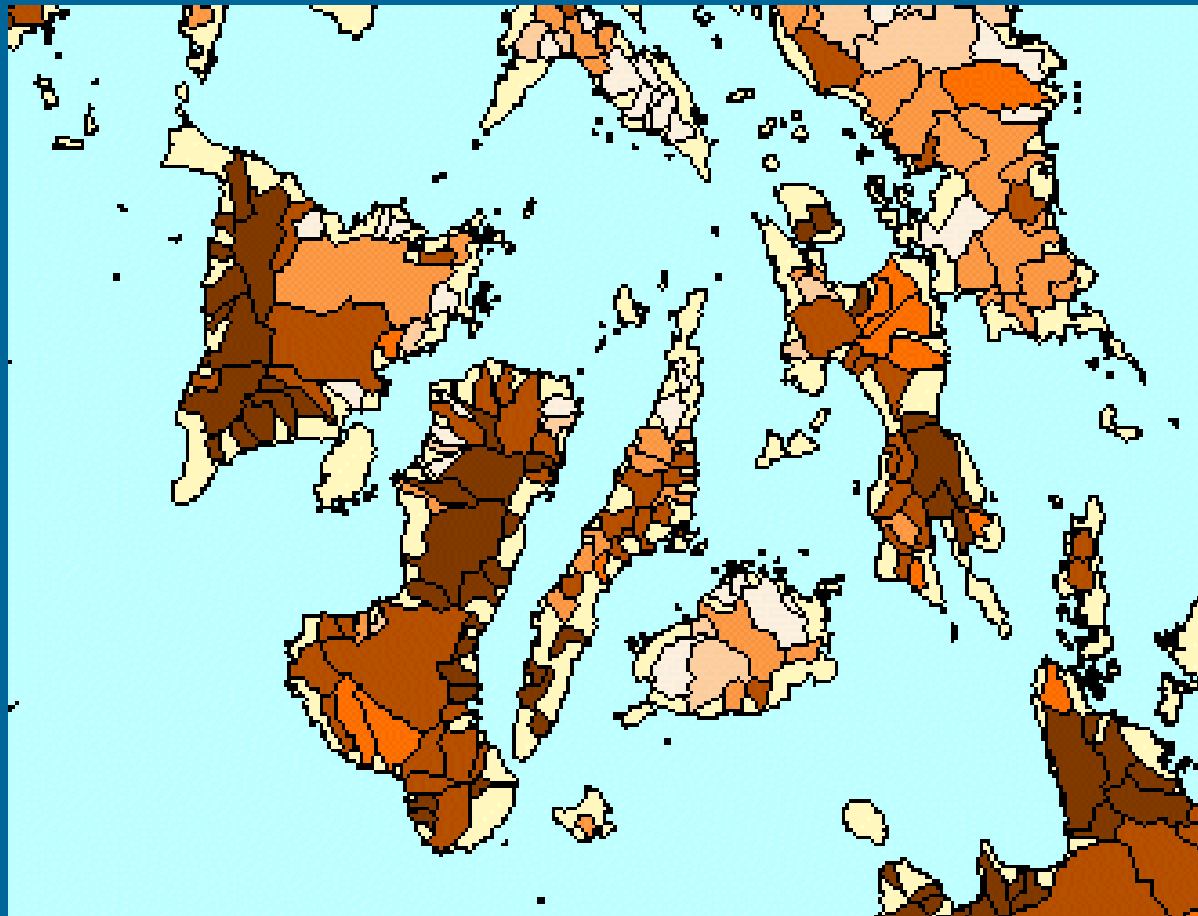


Low



High

# Watershed delineations - summary unit



Mean REP for  
Basin

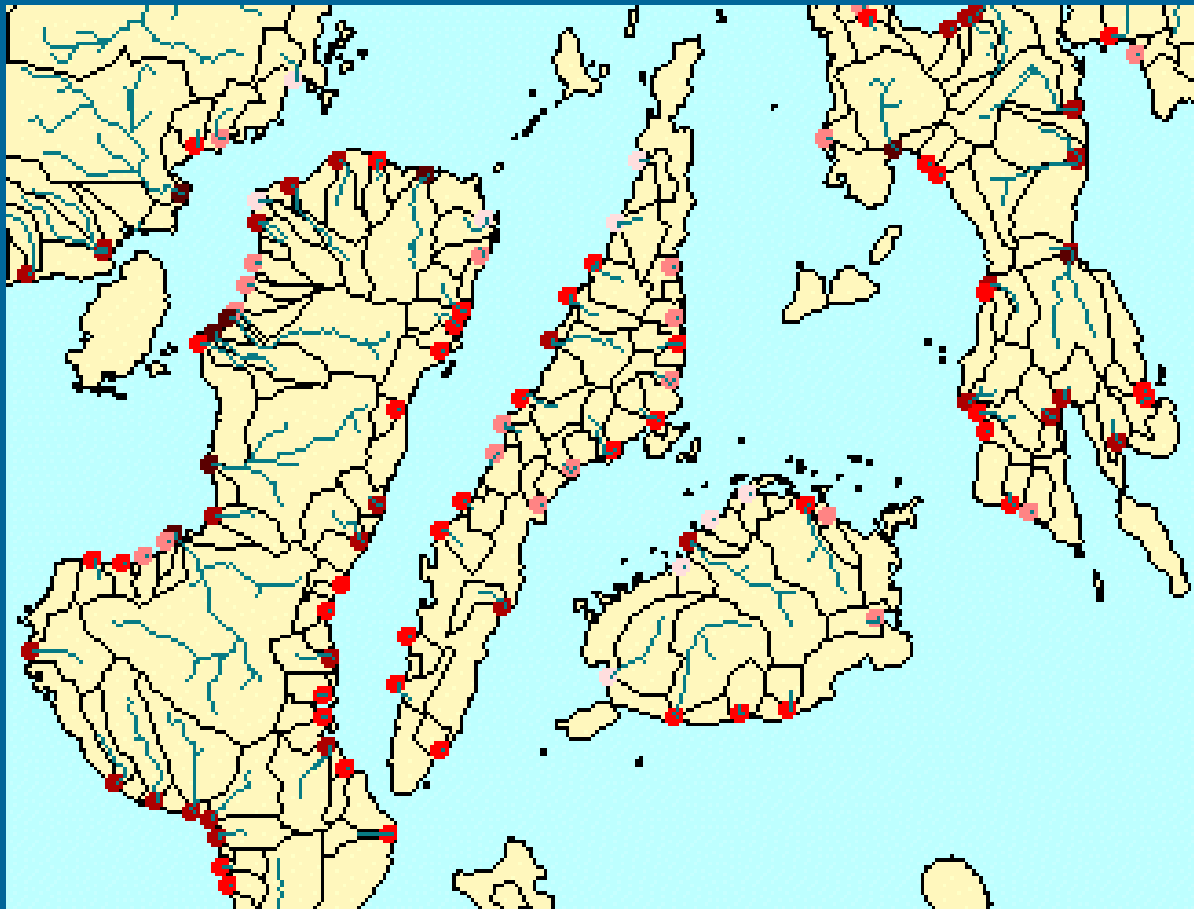


Low



High

# REP and river flow estimates for basin reflected at river mouth

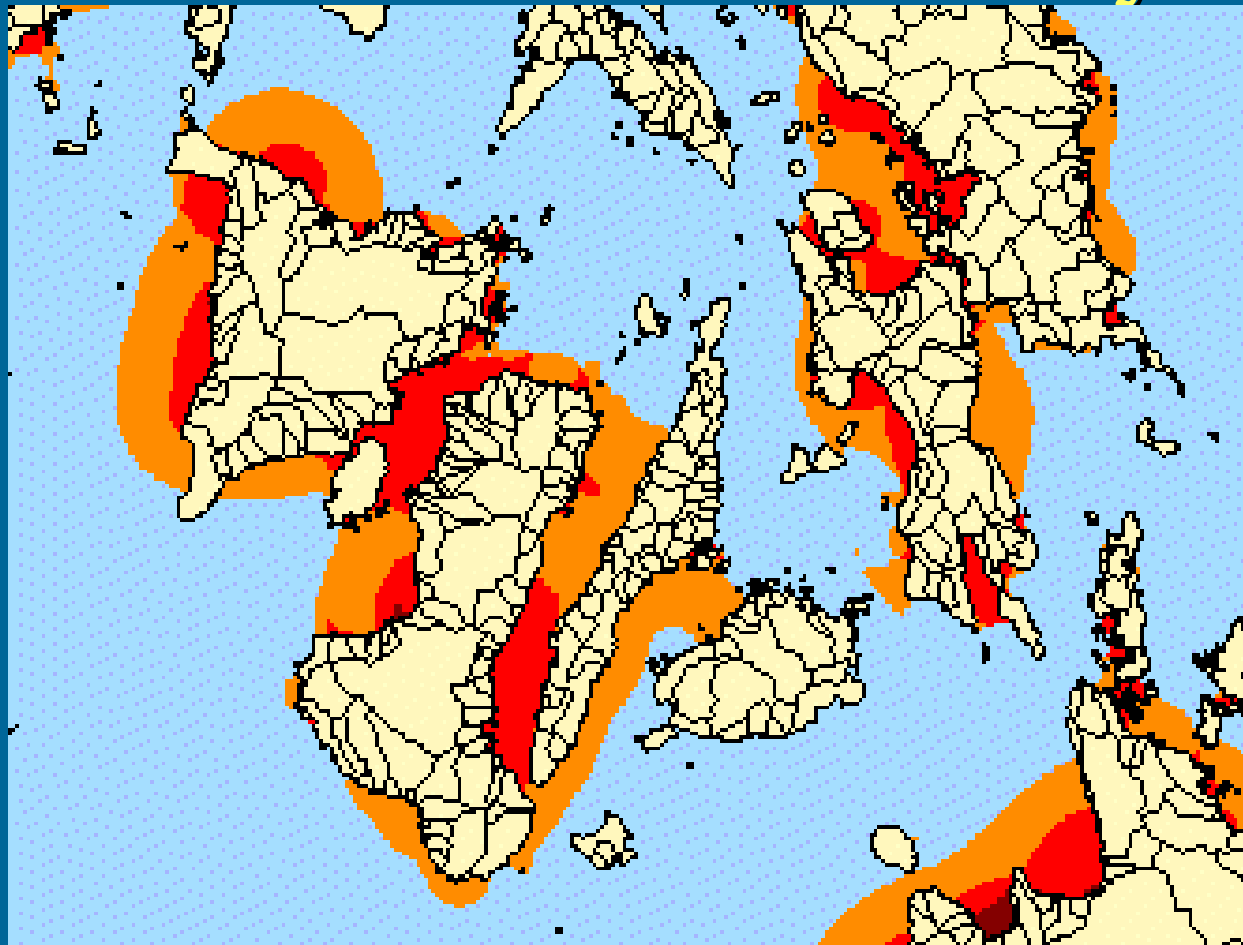


REP estimate  
at “pour point”

- Low
- Medium
- High
- Very High



# Sediment plume estimates based upon river flow, REP, and vulnerability



Estimated Threat

- Low
- Medium
- High
- V.High

# Overfishing Threat



# Impacts of Overfishing

- Alter ecological balance on the reef
- Shifts in fish size, abundance and species composition
- Reduces biodiversity

# The Approach

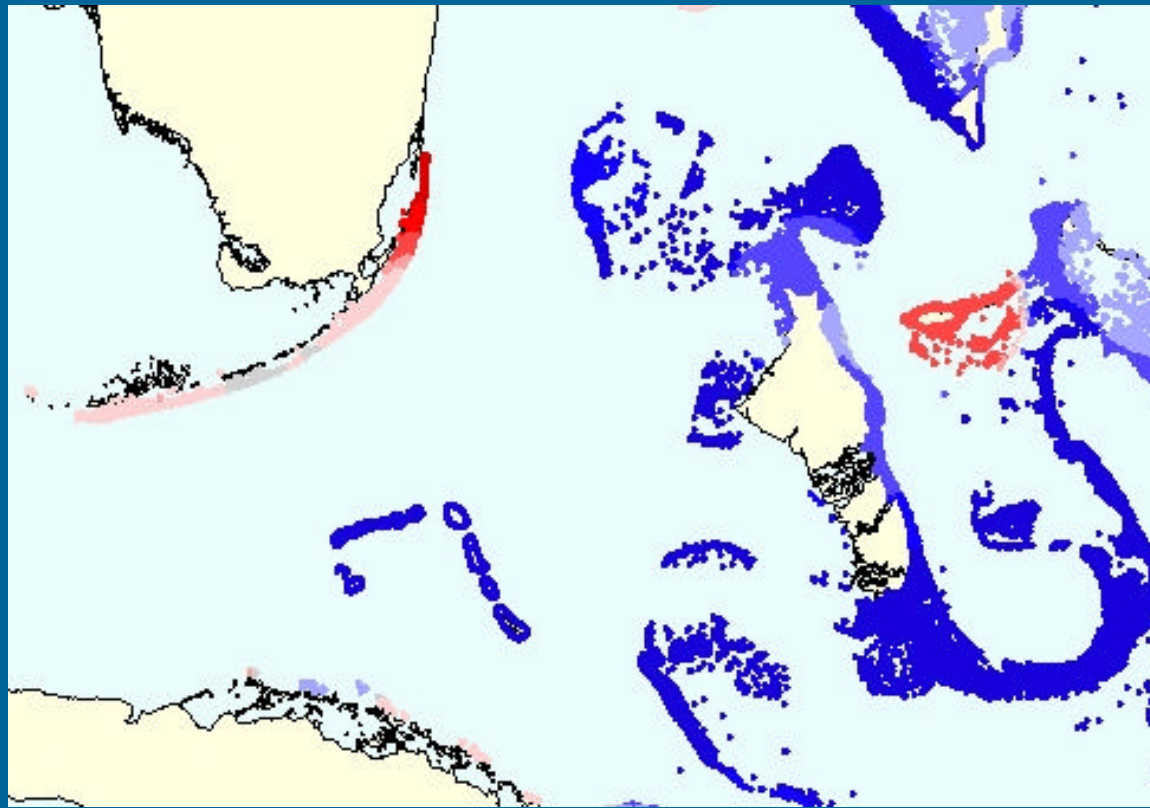
- A region wide indicator
- Fisheries data of ranging quality
  - Format
  - Availability
  - Scale
- Innovative use of other data sources

# Coastal Population Density Model

Use population density as a proxy of fishing pressure on adjacent reefs

- Identify populations within 10km of coastline
- Produce surface of total population within 20km of a given location
- Adjusted for protection and weighted by shelf area
- Overlay coral reef locations to produce indicator of population within 20km of reef location

# Reefs Classified by Population Density



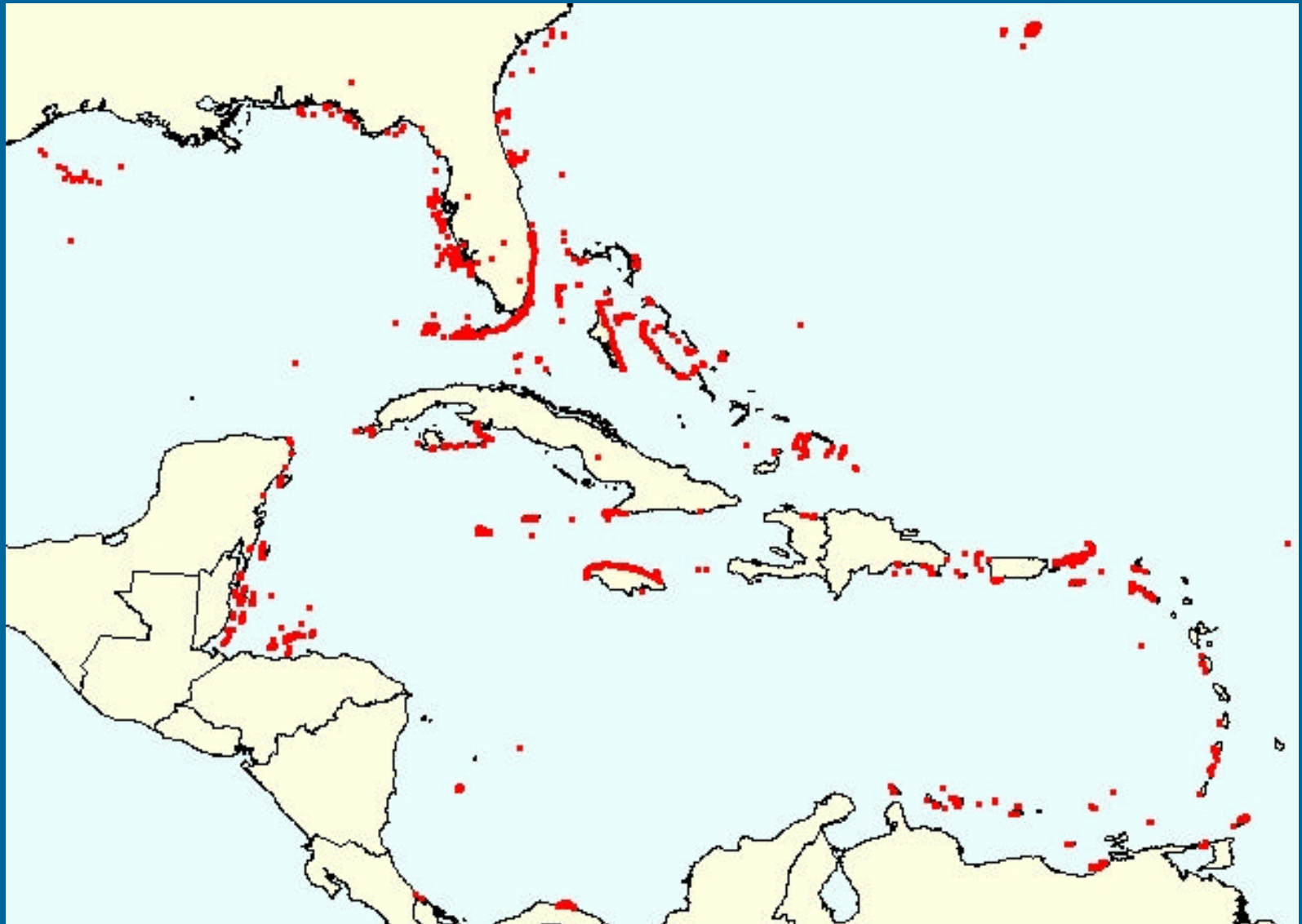
Thousands of people within  
40km of reef location

- 0
- 0 - 1
- 1 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 300
- 300 - 1000
- 1000 - 3100

# Calibration of Modeling

Examine spatial relationship between model output and site-based fin-fish survey data that are reasonably widespread and comparable.

# 2,500 REEF Survey Sites



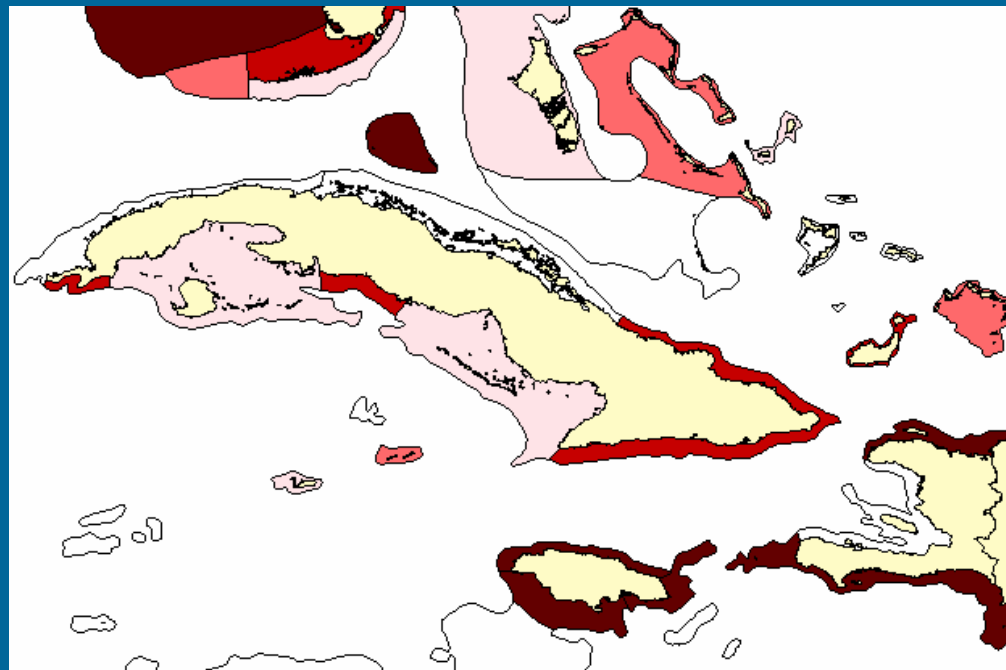


# Calibration Data Source

- Region wide REEF roving diver data
  - Divers swim freely throughout a dive site and record every observed fish species that can be positively identified
- Sixteen target species
  - Widely distributed around region
  - Reach fairly large body sizes (>30cm)
  - Known to be targeted at varying intensities around region
- Sighting frequency mapped for target species for each site

# Summarize Using Ecological Units

- Derived from the work of Sullivan Sealey and Bustamante, 1999
- Average no. species =  $\text{No. observed} / \text{No. expected}$



# Further validation

- Country level characterization of fisheries from literature and experts in the region on
  - Predominant, reef, conch, lobster fisheries
- Further validation of model outputs
- Enables country level comparison
- Added value

# Marine Protected Areas and Management Effectiveness

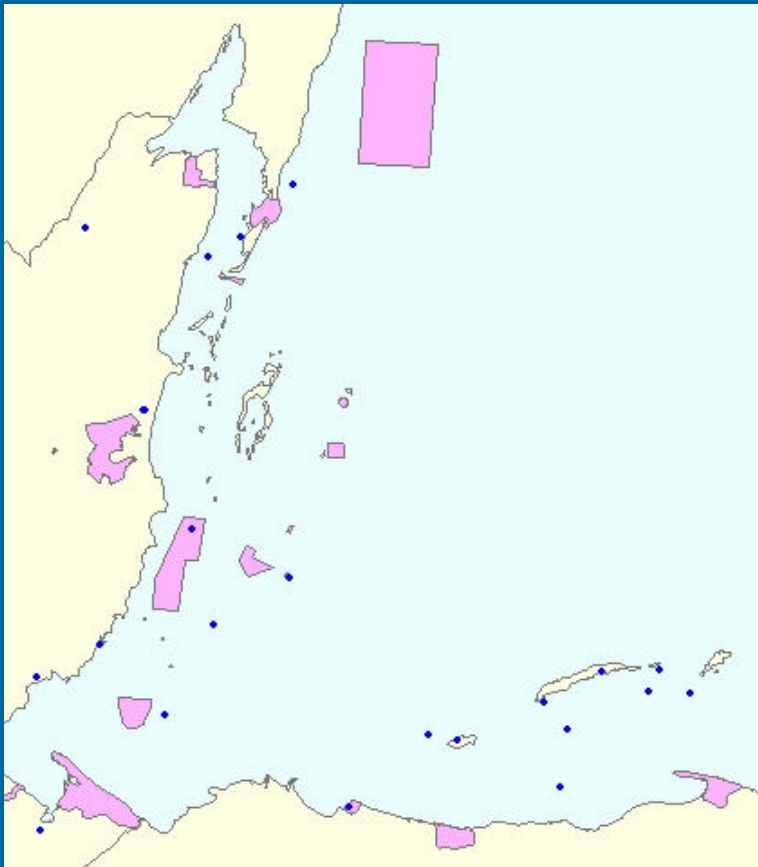
# Effective Management

- Reduces local human impacts
- Increases awareness
- Promotes coral reef health

# Use of MPA data in R@R analysis

- Map the coverage of MPAs
- Assess level of management effectiveness
- Mitigate threats – Coastal development and overfishing
- Quantify area and level of protection for reefs

# MPA Spatial Data



- UNEP-WCMC Point and Polygon data

# R@R SE Asia Assessment of Management Effectiveness

- 3 point scale  
(good, partial, inadequate)
- Based on as much attribute data and expert opinion as was available



# R@R Caribbean Assessment of Management Effectiveness

- Expert opinion
- Greater availability of information
- Amalgamation of various databases
- Derive 3 point scale  
(good, partial, inadequate)

# Coral Bleaching

# Reefs at Risk in the Caribbean

[www.wri.org/reefsatrisk](http://www.wri.org/reefsatrisk)

For additional information contact

Lauretta Burke ([lauretta@wri.org](mailto:lauretta@wri.org)) or

Jon Maidens ([jmaidens@wri.org](mailto:jmaidens@wri.org))



World Resources Institute

