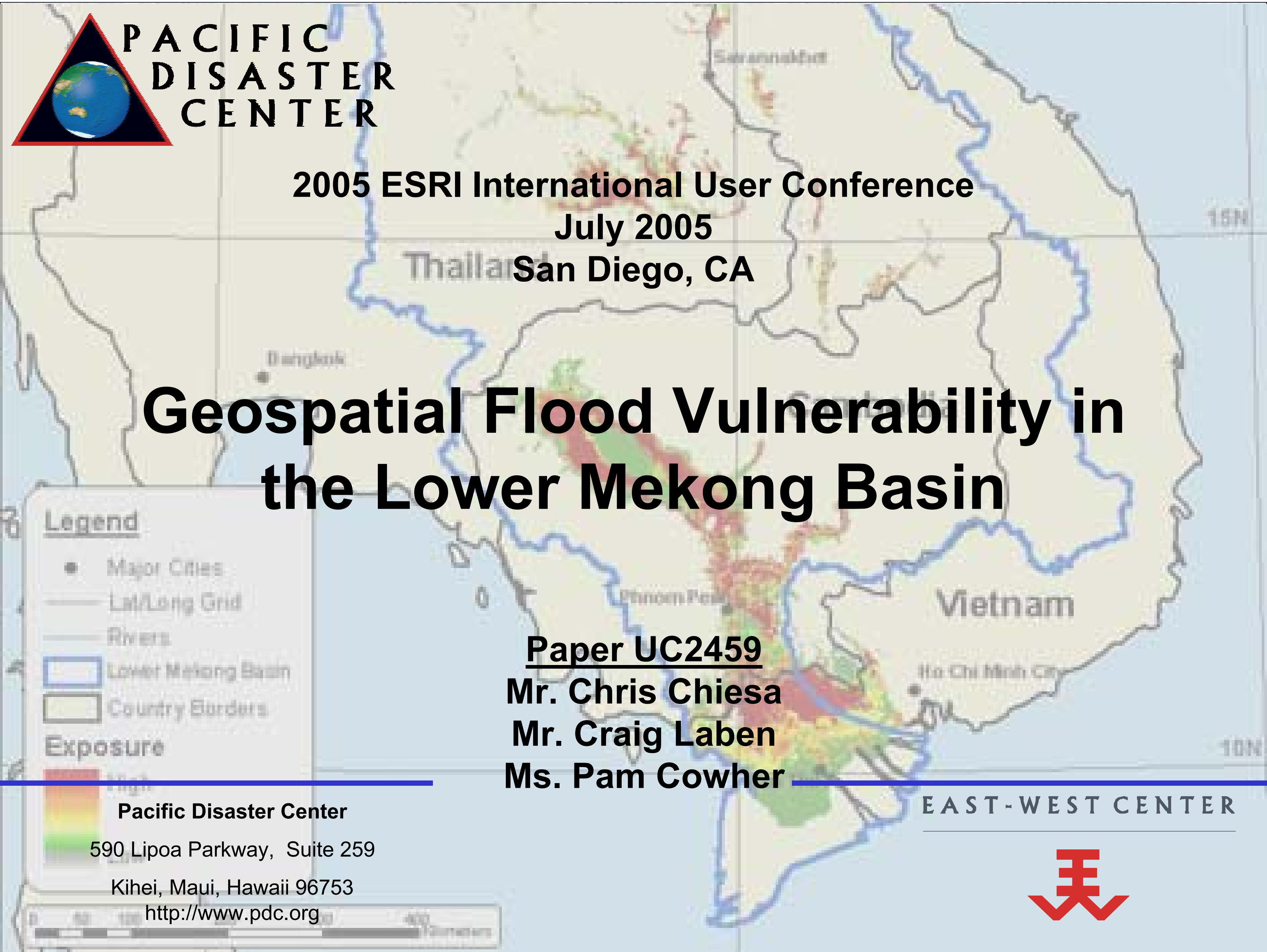

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Geospatial Flood Vulnerability in the Lower Mekong Basin

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Project Overview

Objective

– Identify, characterize & assess the impacts of riverine flooding on population and infrastructure within the Mekong River region

Approach

– Implement geospatial Vulnerability-Exposure-Sensitivity-Resilience (VESR) model to characterize and map spatial distribution of vulnerability and its components within the region

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VESR Definitions

Vulnerability = *f*(Exposure, Presence, Sensitivity, Resilience)

Vulnerability (V)

- The degree to which a system (e.g., human, environmental, biological, etc.) is likely to experience harm due to exposure to a hazard

Exposure (E)

- The frequency and magnitude a hazard event within an area over time (e.g., floods, storms, earthquakes, etc.)

Presence (P)

- The presence of people or structures and their location relative to the hazard

Sensitivity (S)

- Susceptibility of an exposed system to negative impacts of the hazard event

Resilience (R)

- Ability of a system to maintain certain structures and functions despite disturbance and its ability to bounce back to a reference state

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Geospatial Implementation of VESR

Flood Vulnerability Indicators / Parameters

Exposure

- Flood plain characteristics (slope/elevation/drainage network)
- Historical rainfall and flooding patterns

Presence

- Gridded population density
- Infrastructure density / inventory

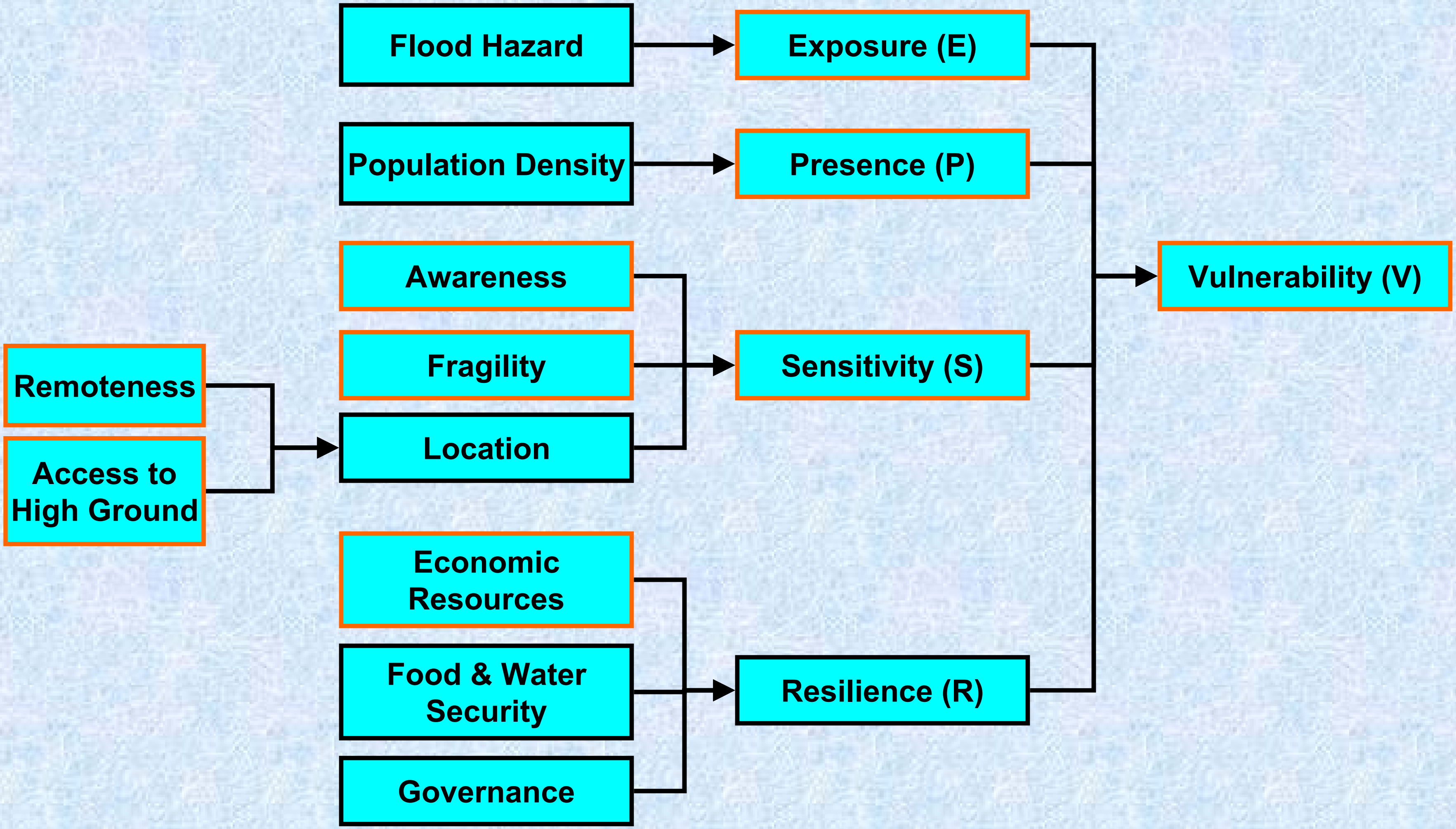
Sensitivity

- Ability to provide warnings of impending events
- Population characteristics (education; age distributions; health and welfare measures)
- Ingress / egress; proximity to transportation networks

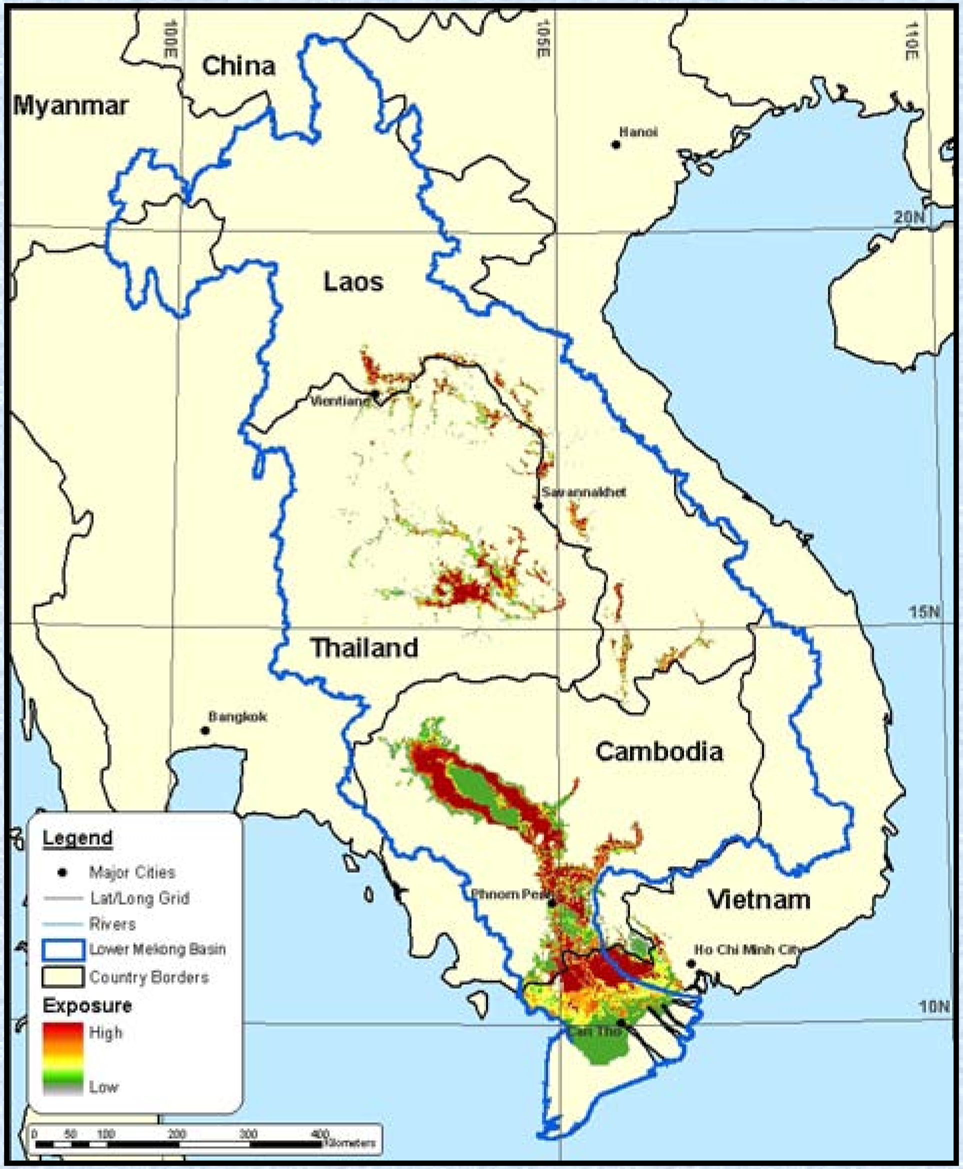
Resilience

- Wealth (GDP); availability of credit, savings rates
- Food and water security
- Governance (state level)

Geospatial Implementation of VESR

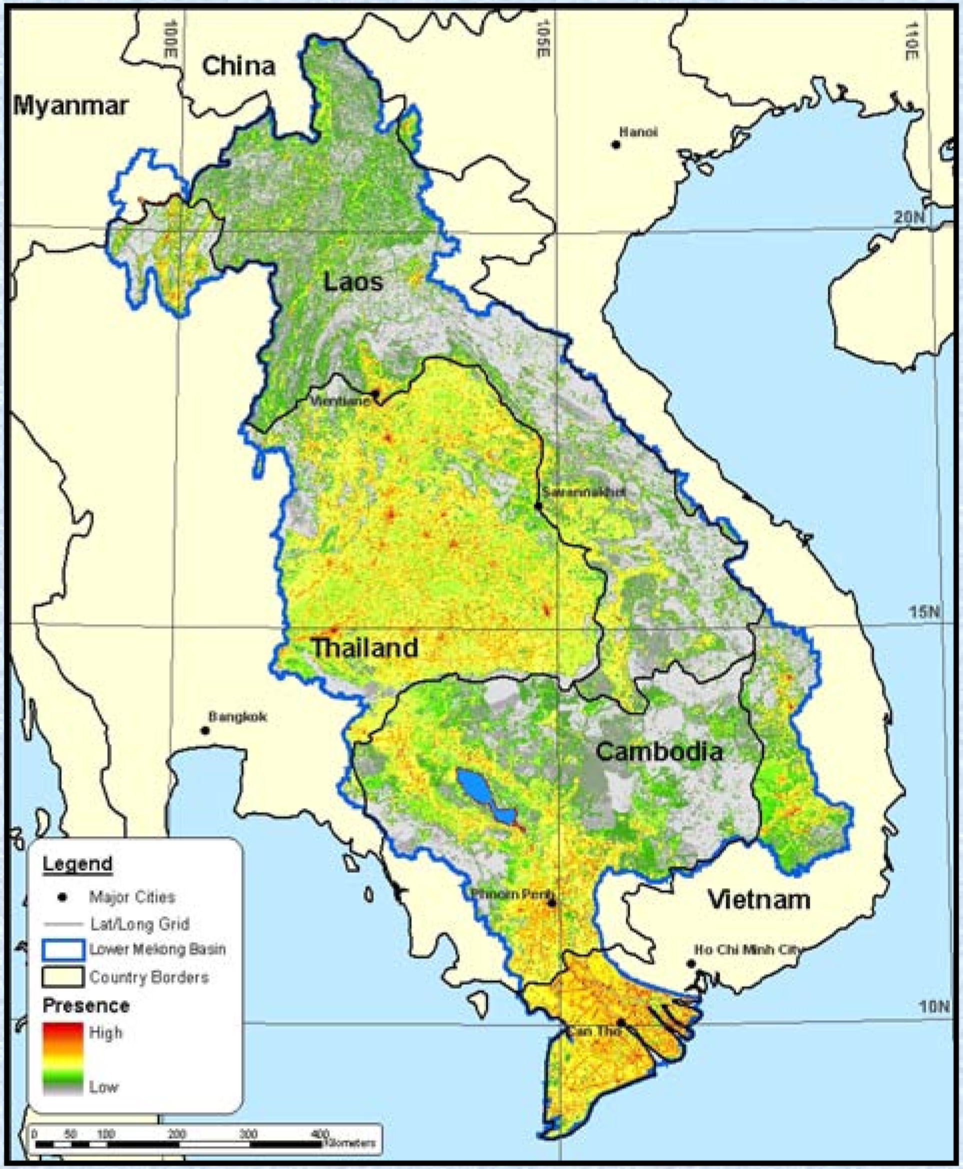


Preliminary Exposure (E) Surface



Flood hazard exposure is modeled as a function of the frequency (return period) and magnitude (duration and depth) of floods within the region. Numerical flood models were used to compute the extent, depth and duration of 5 and 20 year flood events.

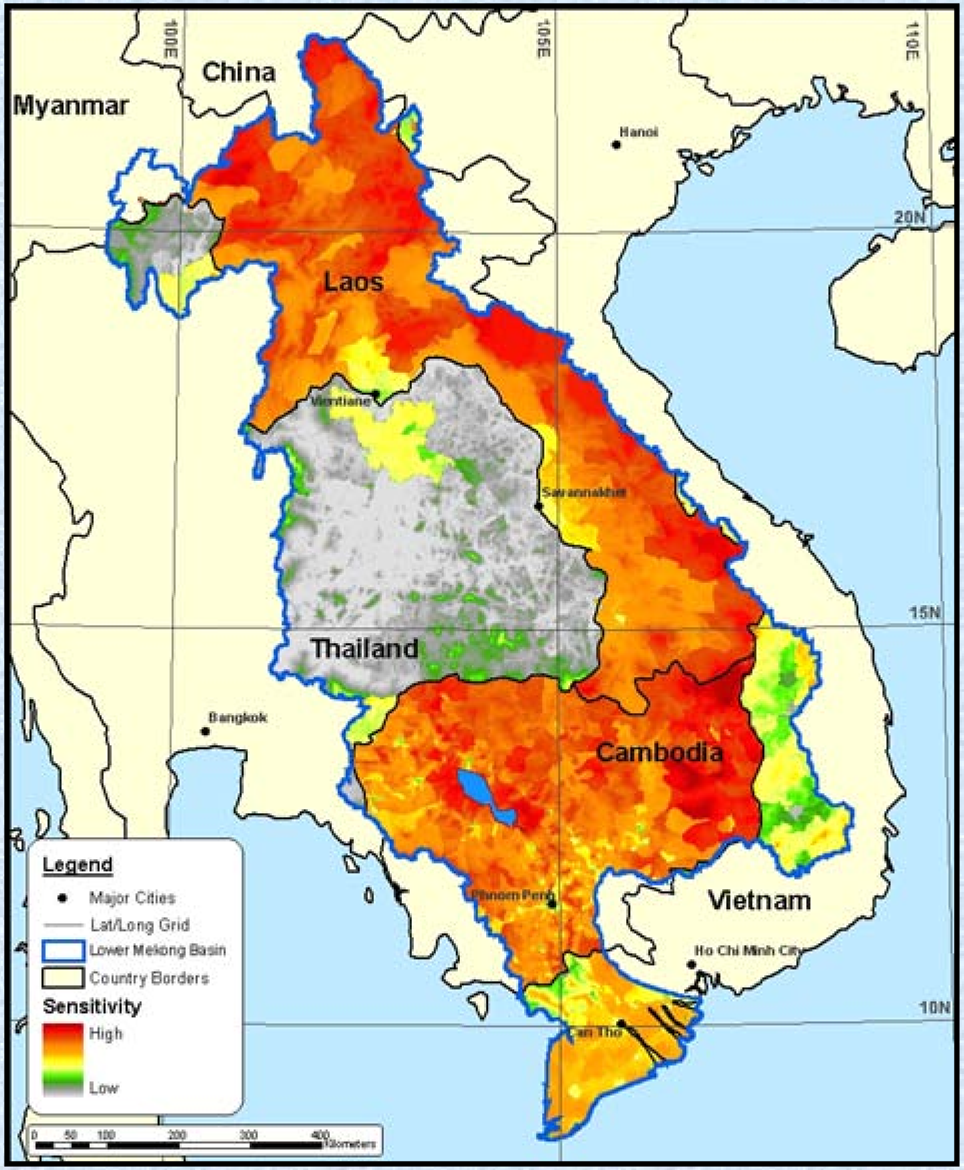
Population Density (P) Surface



Population data are computed at a 1km resolution by disaggregating census data differentially as a function of land use (e.g., urban vs. rural, agricultural vs. forested, etc.) and along transportation corridors.

Presence surface could also be constructed to reflect infrastructure (e.g., roads, buildings) or critical landuse (e.g., agriculture, forestry)

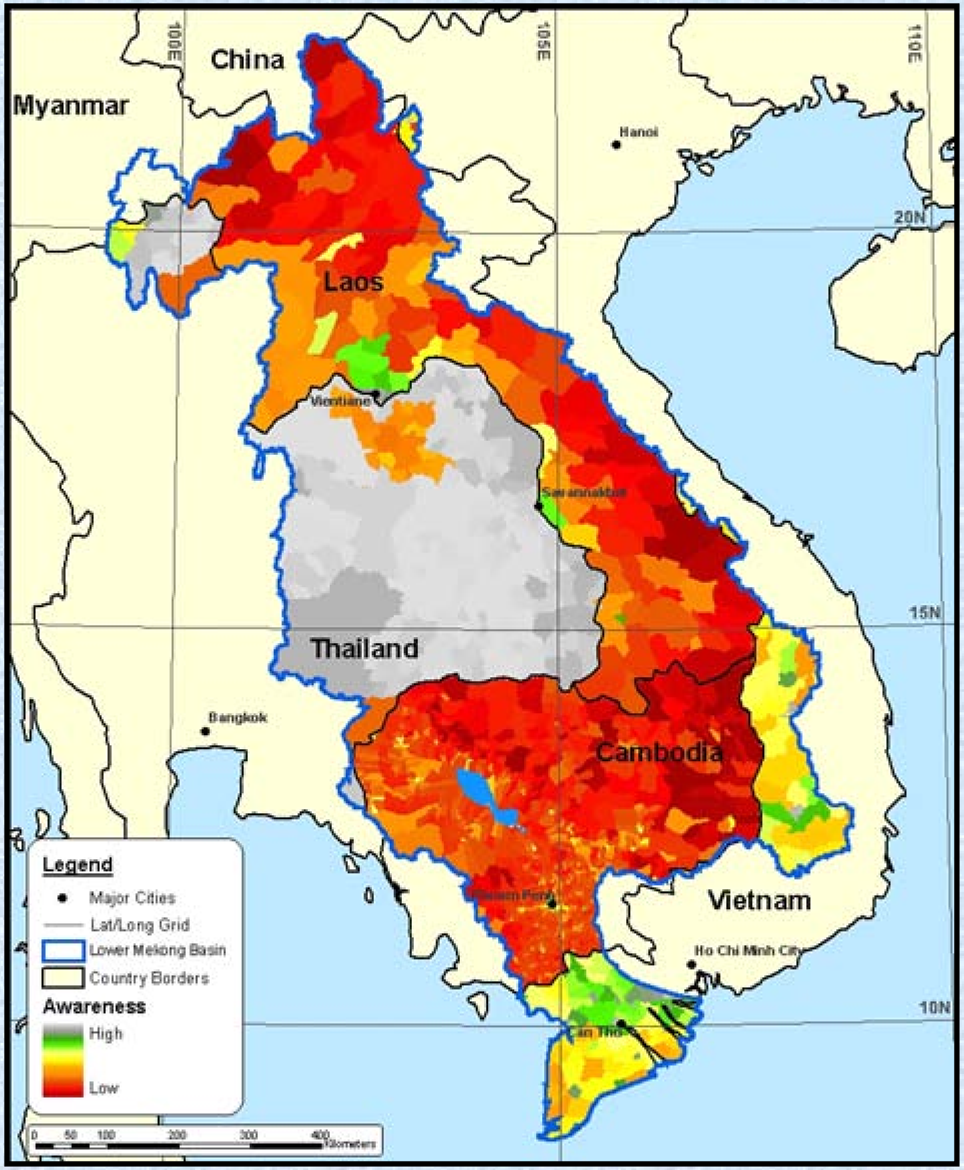
Preliminary Sensitivity (S) Surface



Sensitivity characterizes the susceptibility of an exposed system to negative impacts of the hazard event. For flooding, sensitivity of population is computed as a function of:

- Location
  - Ability to reach high ground or receive aid
- Awareness
  - Ability to receive and interpret warnings
- Fragility
  - Inherent strength/weakness of population/social structures

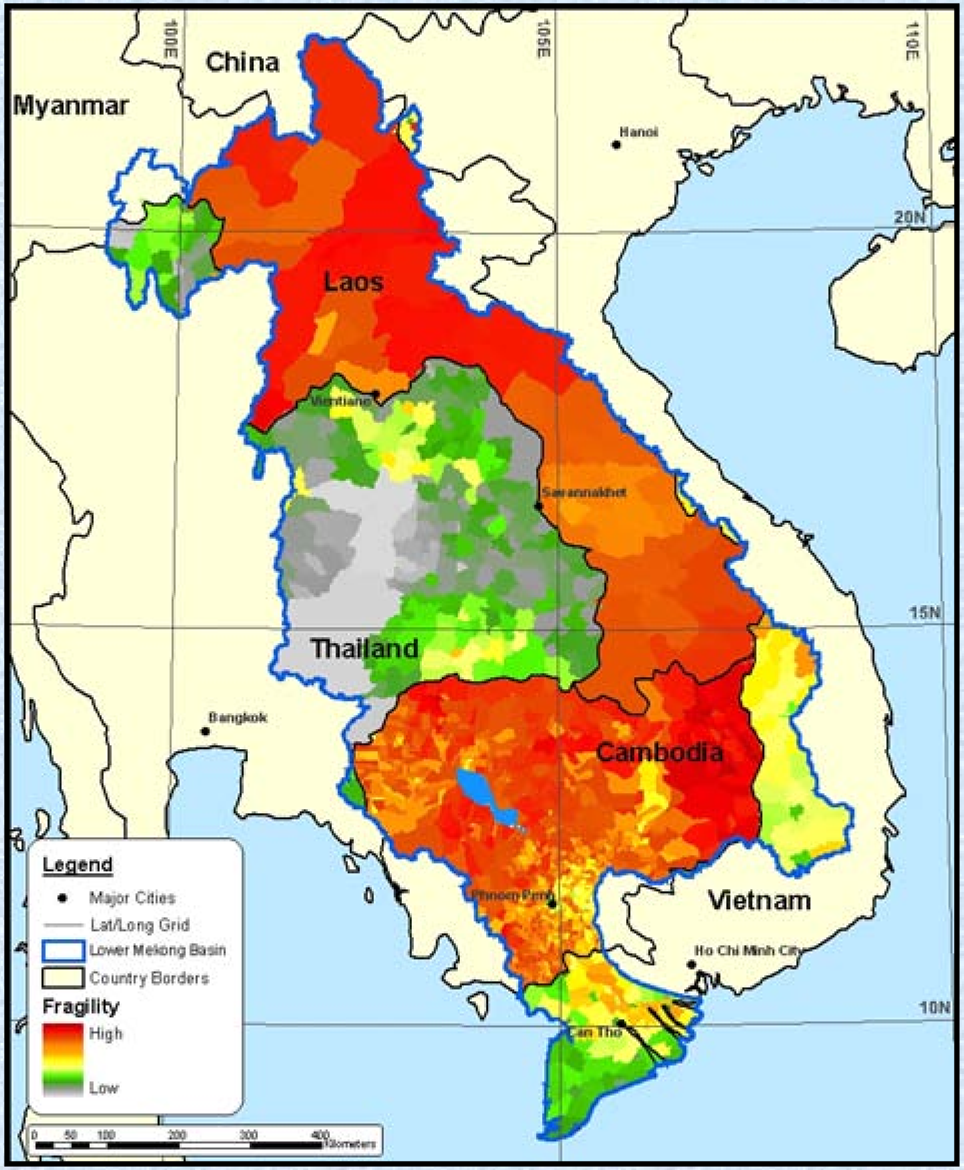
Awareness Surface



A community that is aware of an imminent natural hazard, is less likely, in general, to be injured by that hazard.

The Awareness Surface is computed by combining two indicator variables: literacy and access to electricity, proxies for process by which an official warning is communicated to local units of government and then to the citizens of that locality.

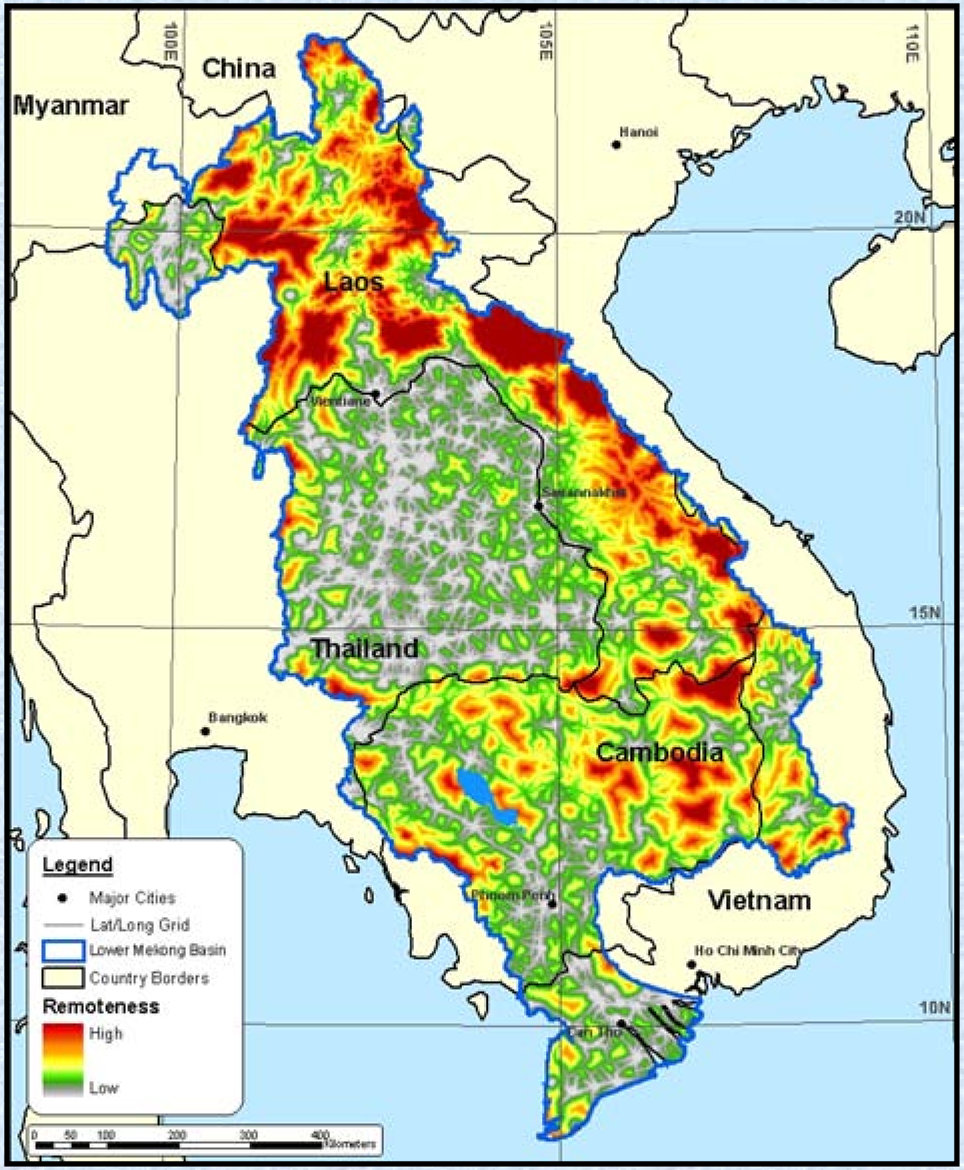
Fragility Surface



Fragility is a measure of the "strength" of the members of a community.

It combines the dependency ratio (working-age adults to children and elderly) and infant mortality. Locations with high numbers of children and elderly relative to working adults or experiencing high-levels of infant mortality are more sensitive to natural hazards.

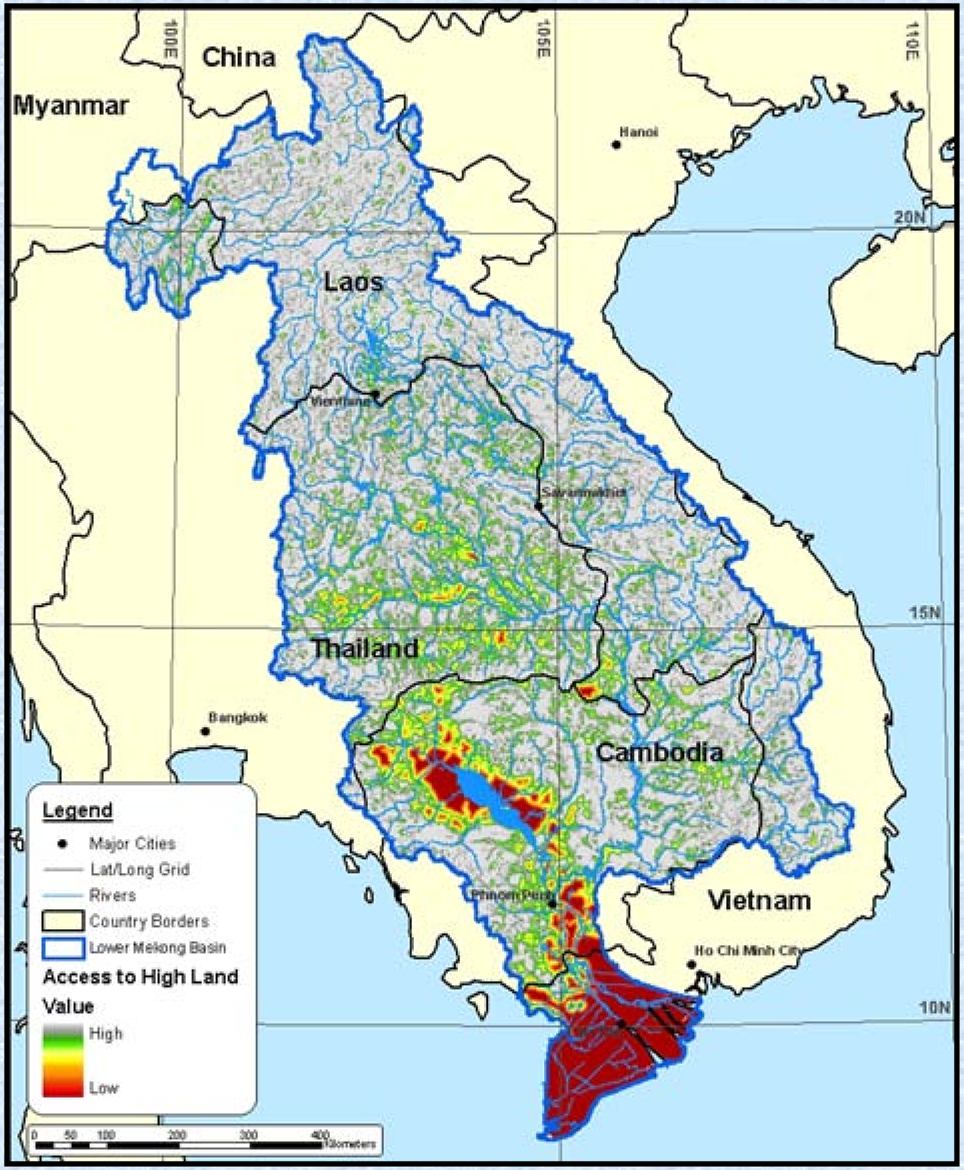
Remoteness



Remoteness is defined as the cost to travel to an urban area for relief resources -- the more remote a location, the higher the cost to travel to an urban area.

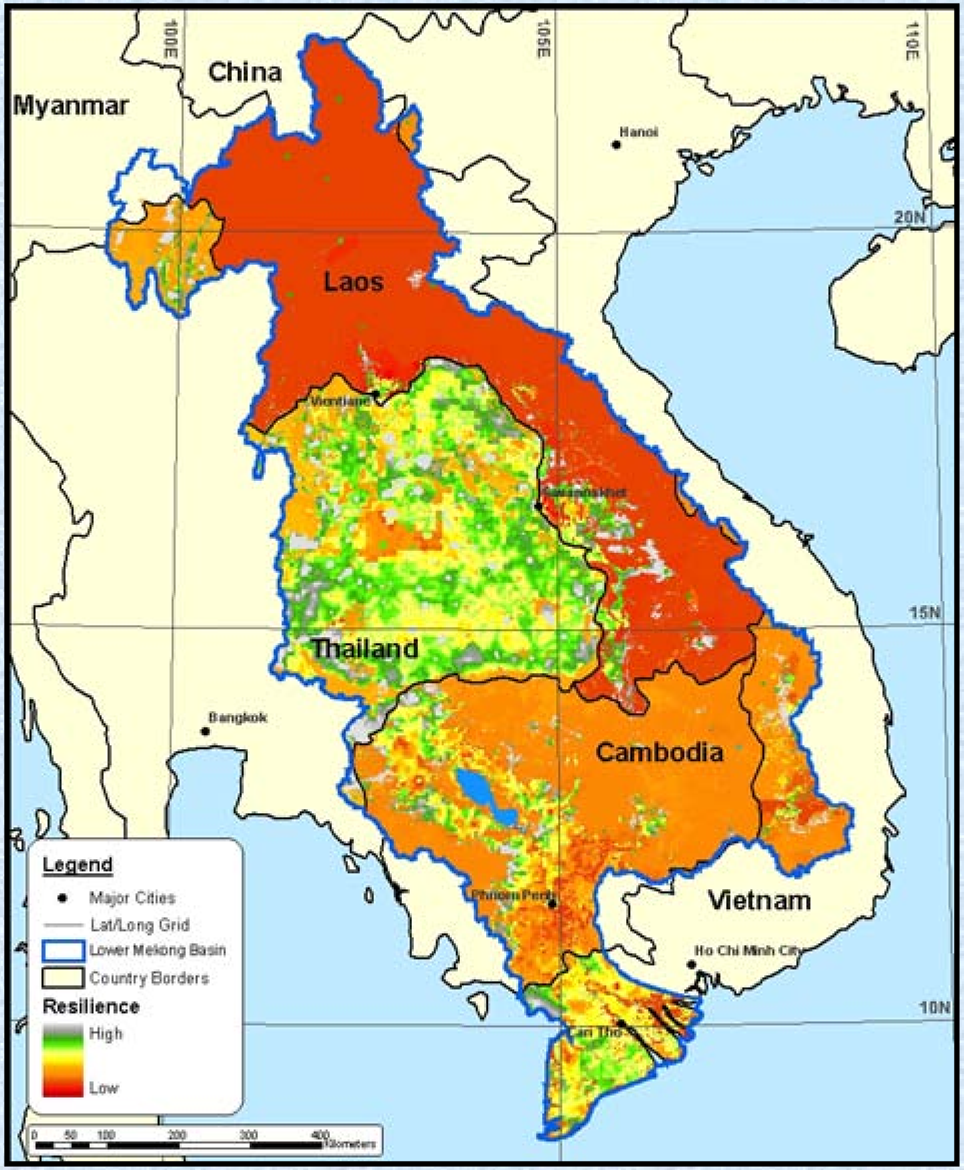
The three methods of travel considered are train, automobile and walking.

Access to High Ground



Access to high ground represents the presence of nearby high land and is defined as the cost to travel to an area of land which is 10 meters above the nearest water source -- the more difficult it is to get to higher ground, the higher the cost to travel to a safe area.

Preliminary Resilience (R) Surface

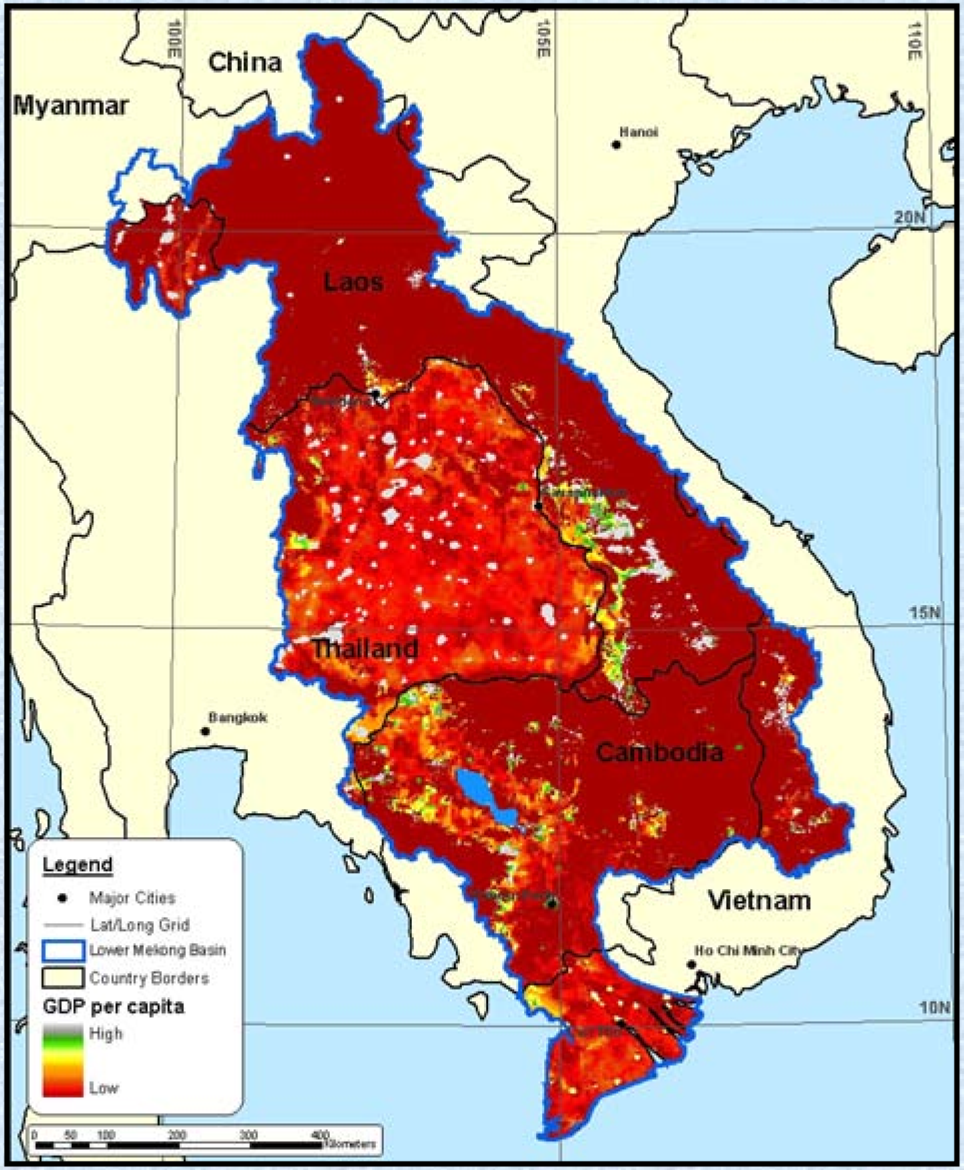


The Resilience Surface characterizes the longer-term ability of populations to recover from harm suffered by natural hazards such as flooding.

Key Factors:

- Resource Security (food, water)
- Government Effectiveness
- Social Capacity (GDP)

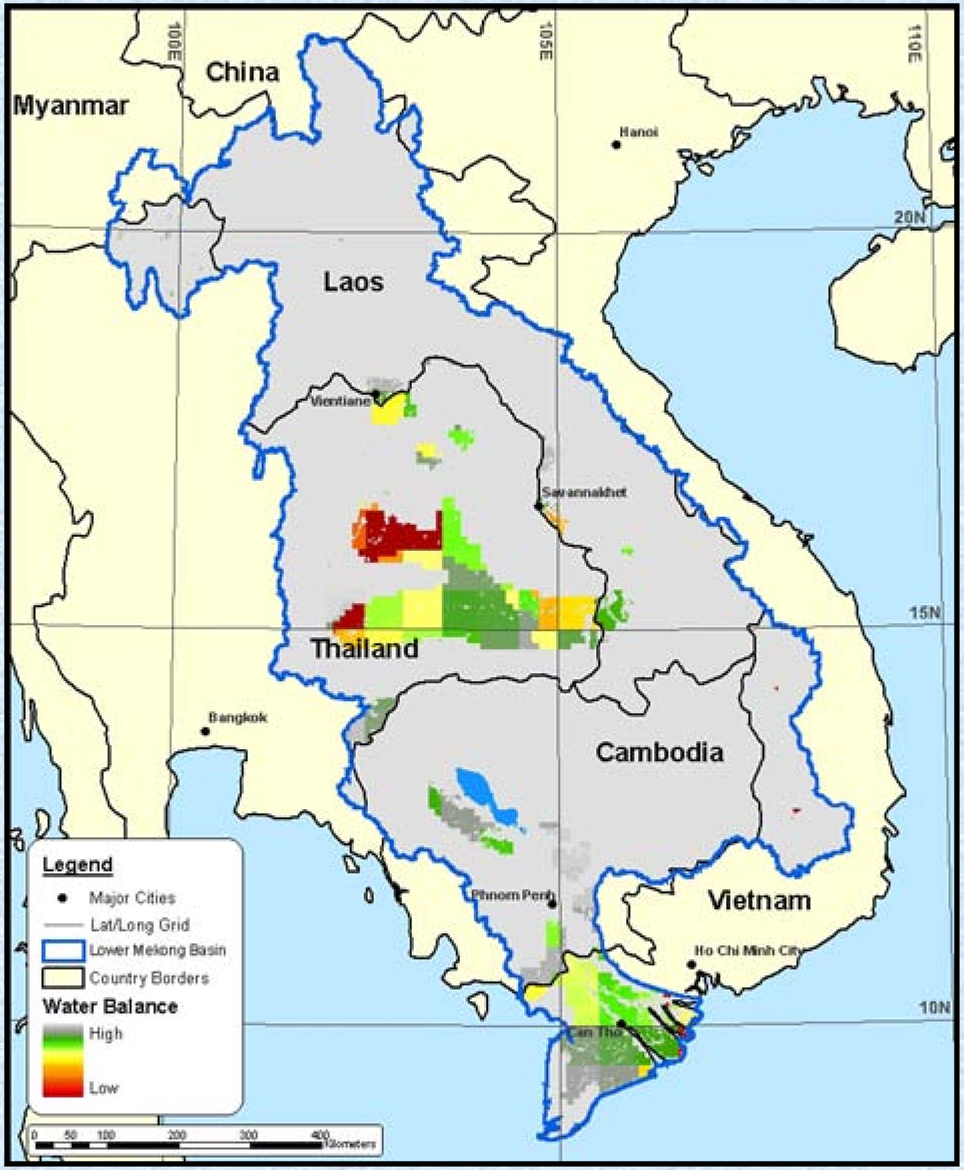
Disaggregated GDP per Capita



The Disaggregated Gross Domestic Product (GDP) per Capita Surface characterizes the distribution of wealth in the region. Wealthier areas are generally able to recover quicker from a natural disaster such as a flood.

It is computed by apportioning national level GDP to agricultural, industrial and service sectors according to landuse and other spatial data.

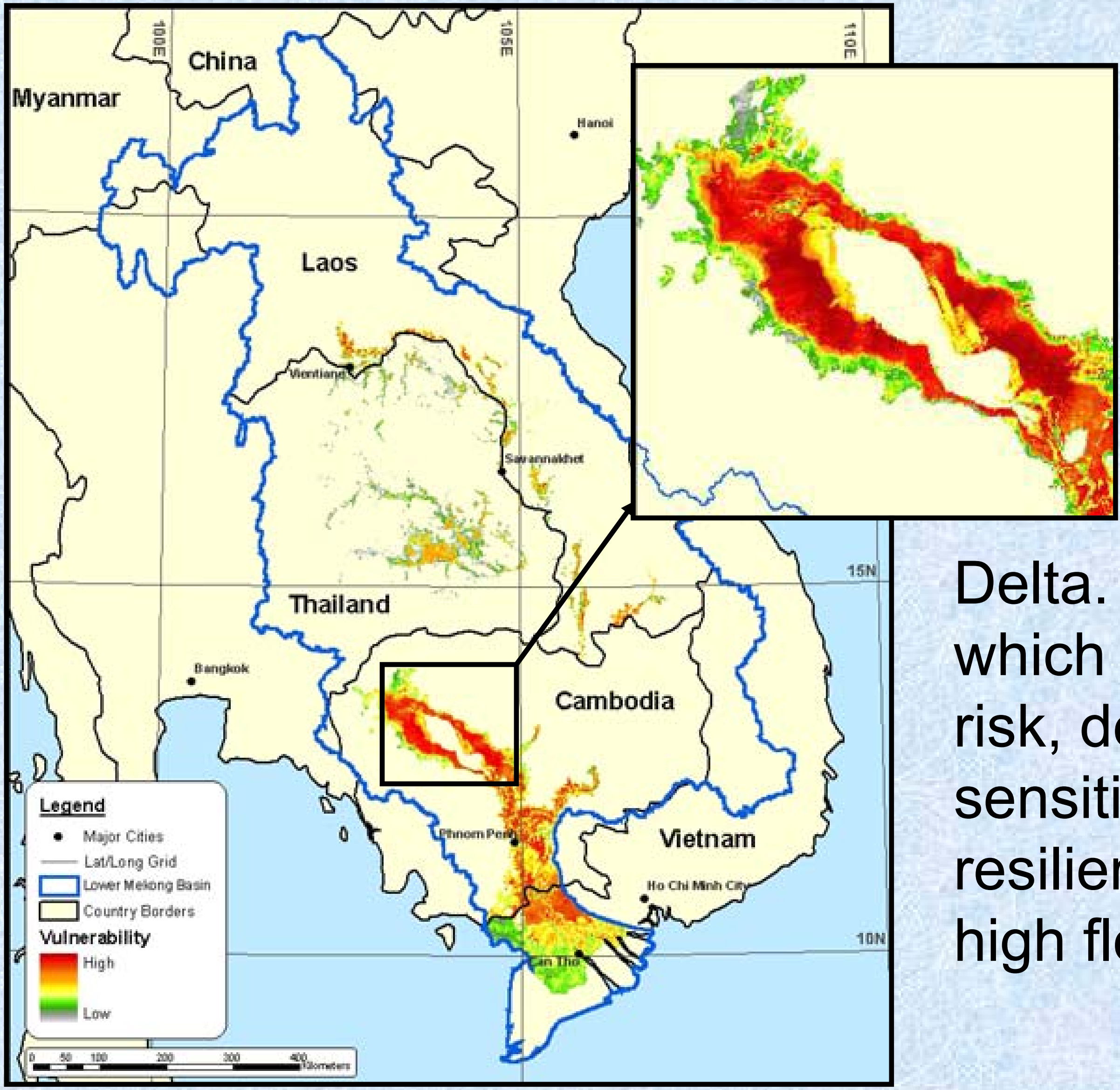
Water Balance



The Water Balance Surface provides an indicator of water stress or surplus.

It is an estimate of the relative degree of difficulty a region may have in obtaining needed food or water under normal conditions. Regions under chronic food/water stress likely take longer to recover from hazard event.

Preliminary Vulnerability (V) Surface



The resulting Vulnerability Surface highlights the areas around Tonle Sap, Phnom Penh and the throat of the Mekong Delta. These are regions in which high exposure to flood risk, dense population, sensitivity to harm, and weak resilience combine to lead to high flood vulnerability.

How is VESR used?

Identifying Regions of Highest Vulnerability

- Target locations for mitigation / risk reduction programs
- Understand the contributing components to high vulnerability in a location (i.e., high exposure, low resilience, etc.)

Examine Potential Impacts of related Projects (i.e., positive / negative externalities)

- "What if" scenarios … how is Flood Vulnerability affected by changes in
  - Flood frequency/severity based on dam construction
  - Precipitation patterns caused by El Nino, global climate change, etc.
  - Literacy, electrification, infant mortality, etc. as part of poverty alleviation programs.

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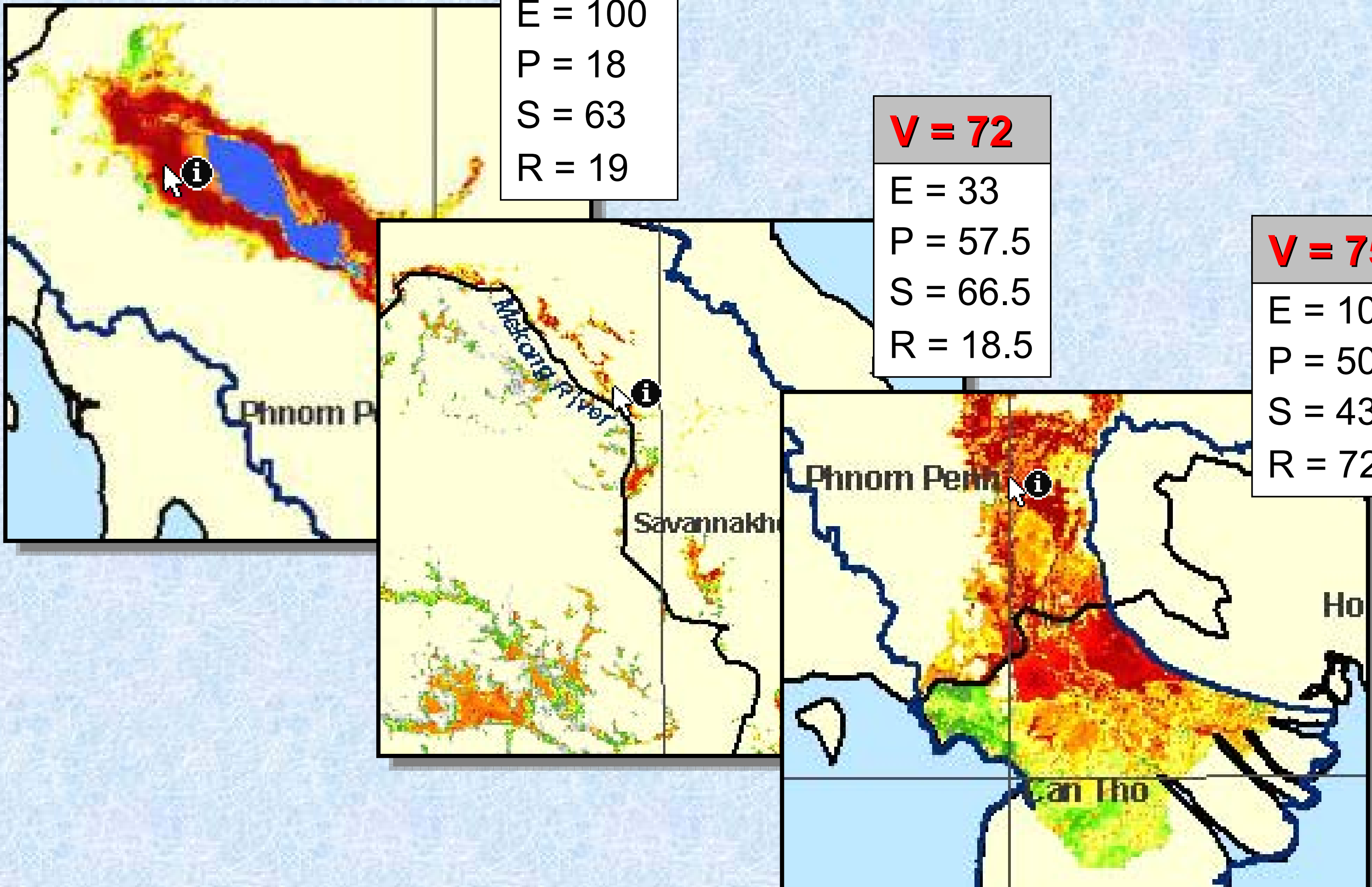
Exploring VESR Component Values

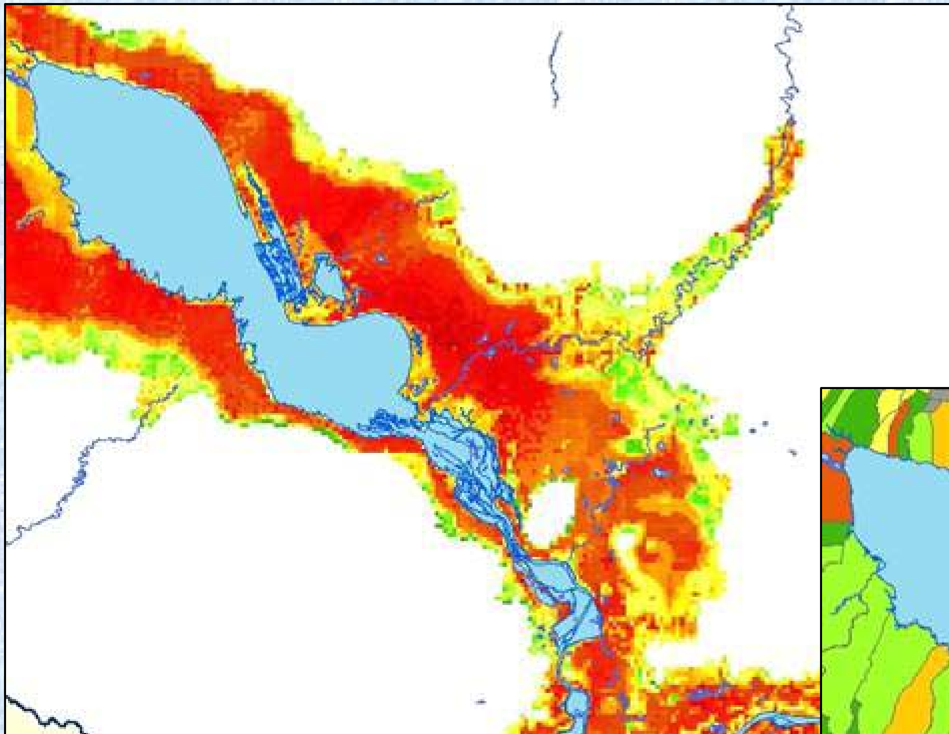


V = 81
E = 100
P = 18
S = 63
R = 19

V = 72
E = 33
P = 57.5
S = 66.5
R = 18.5

V = 75
E = 100
P = 50
S = 43
R = 72.5

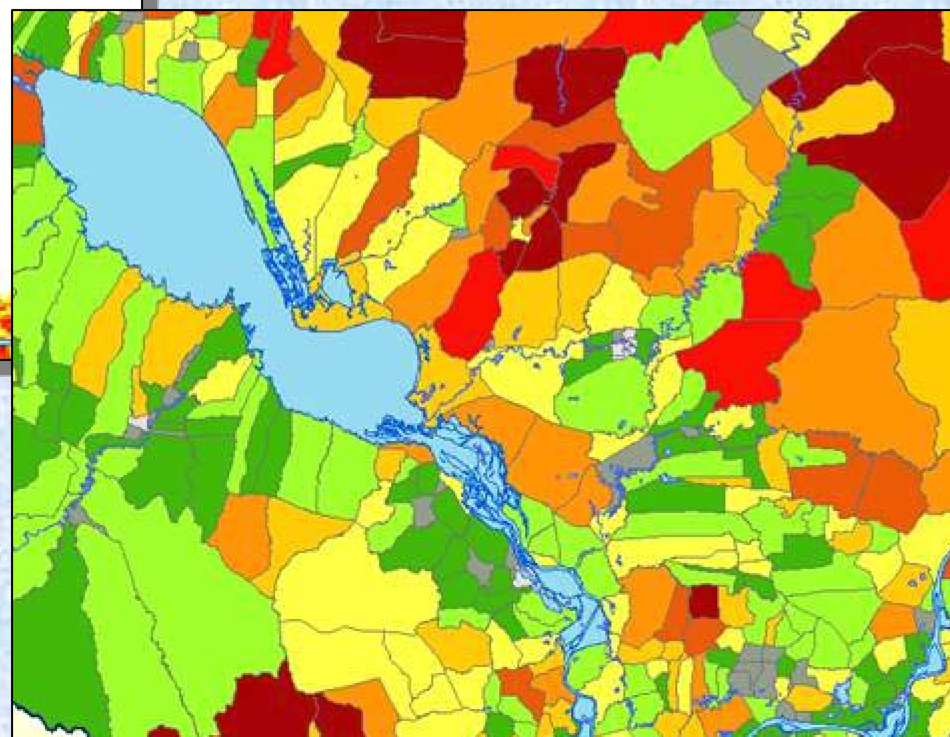
"What if?" Scenarios



Vulnerability

Areas of high Vulnerability, due in part to low literacy rates (high Sensitivity)

Literacy Rates



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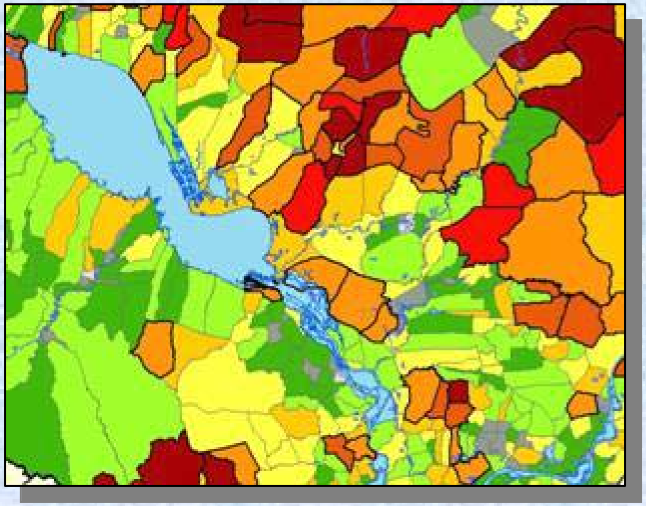
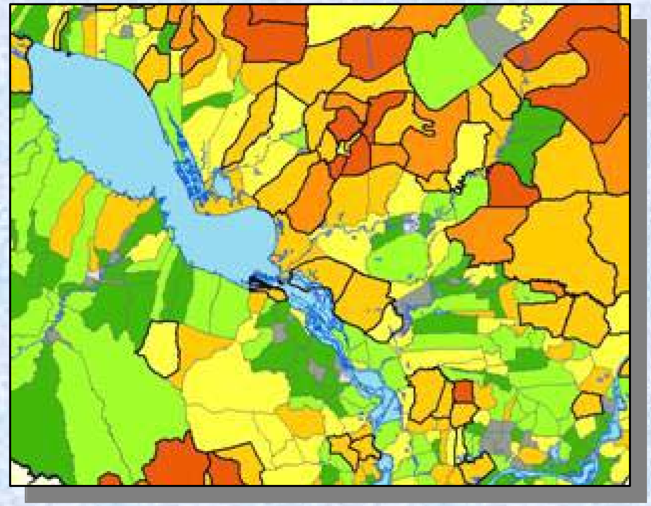
Examine Impact of Increasing Literacy

Baseline Literacy

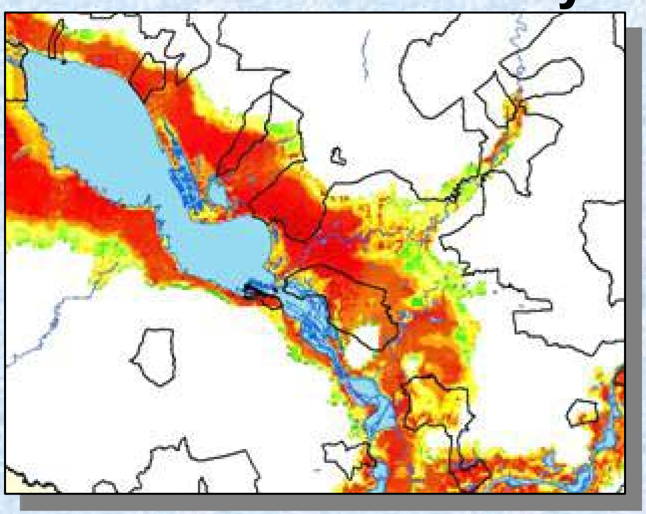


Improved Literacy

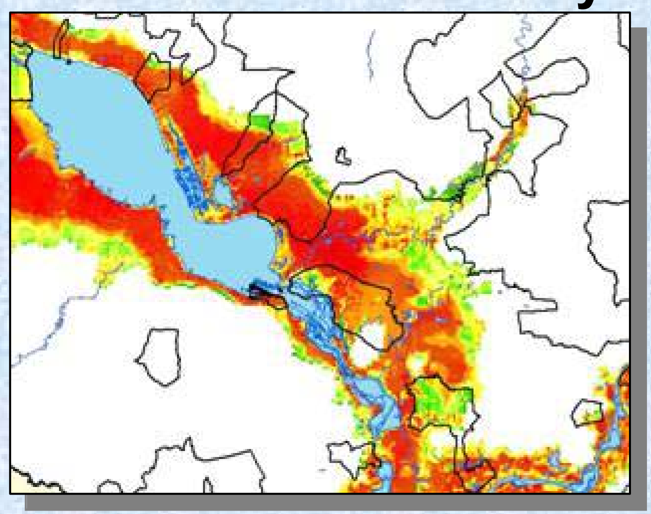


Districts in Cambodia with Literacy Rates below 60% were increased by 20%

Baseline Vulnerability



Reduced Vulnerability



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