SCIENCE AND TECHNOLOGY FOR SOCIETY

- DEVELOP SOLUTIONS TO GLOBAL CHANGE PROBLEMS

Jiaguo Qi
Director, Center for Global Change, Michigan State University, USA
qi@msu.edu
Background & Career Path

• Background
  – A degree in “Soil, Water and Environmental Sciences”
  – USDA-ARS-Southwest Watershed Research Center (93-98)
  – MSU Geography 98-
  – CGCEO 2003 –

• Career Path
  – Methods Development (RS, BRDF, VIs, Biophysical variables) (93-97)
  – Spatial Analysis (patterns of change, LULC) (97-05)
  – Processes (drivers and consequences of LULC) (05-10)
  – Interactions of CNH systems (11-??)
  – Solutions (science & technology for society)
Australia; Brazil; China; SEA (Thailand, Vietnam, Philippines); Africa (Kenya, Tanzania, Senegal); Central Asia (Kazakhstan, Uzbekistan)
From Drivers & Exposure, to Impacts and Vulnerability, to Risk Assessment and Ultimately to Resilient & Sustainable Growth

**Drivers & Exposures**
- Climate Change
  - Extreme events
  - Changing trends
  - Sea level rise
- Population Dynamics
  - Growth
  - Migration
- Human Activities
  - Land use change
  - Nearshore projects
  - Economic development
  - Policy implementation

**Impacts and Vulnerability**
- Ecosystems
  - Nearshore Ecosystems
  - Fisheries
  - Aquaculture
  - Wetlands
  - Urban systems
  - Salt water intrusion
  - Deltas discharges
  - and seasonality
  - Materials exchanges
  - Biodiversity
  - Ecology and chemistry
  - Contaminations
  - Flood and risks
  - Vulnerability
- Social Systems
  - Human
    - Infectious disease, heat stress; nutrition, mortality, gender and age, vulnerability, risk
- Economy
  - Food production, fishery industry, recreation, tourism, ports and other industries,
  - Basic Infrastructure: Transportation, warning systems, emergency plans, and human and financial resources

**Adaptive Capability**
- Social Capital
  - Governance, policies, community access, atheistic, shared values, mutual understanding, shared responsibility, social networks
- Natural Capital
  - Freshwater resources, land...
- Economic Capital
  - GDP, financial infrastructure, economic resources, foreign investment
- Basic Infrastructure
  - Transportation, mobility, networks, education, and risk management programs

**Priority Areas**

**Mainstream Adaptation Strategies to Decision-Making**
- Policy recommendation; Decision support; Information dissemination; Societal engagement, Capital investment, and Education.
An Example
Asia-Pacific: Flood Risk

Flood Risk
Disaster risks can increase or decrease over time according to a country's ability to reduce its vulnerability and strengthen response capacities. In recent decades, countries in the Asia-Pacific region have strengthened their capacities to reduce mortality risks associated with major weather-related hazards such as floods.

Flooding can happen anywhere, however certain areas are especially prone to serious flooding. This map shows a subset of the global estimated risk index for flood hazard. The unit is estimated risk index from 1 (low) to 5 (extreme).

This product was designed by UNEP/GRID Europe for the Global Assessment Report on Risk Reduction (GAR). It was modeled using global data.

Credit: GIS processing UNEP/GRID Europe. http://preview.grid.unep.ch

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Feedback: ochacoap@un.org Creation date: Dec 2014 Map Doc Name: OCHA_ROAP_Floods_v1_2014 Sources: UN Cartographic Section, FAO, Global Discovery, UNEP/GRID

Flood Risk
- Low
- Moderate
- Medium
- High
- Extreme
- Insufficient data

Kilometers
1. Climate Change:
   Extreme climate events, typhoon, storms surges, floods and heat-waves

2. Landscape Alterations:
   Urbanization, livestock, agriculture, hydro-projects.

3. Human Development:
   Fish farming, fishing, large-scale engineering projects, land reclamation.

4. Ocean Dynamics:
   Sea level rise, strong surface dynamics such as waves, current, temperature gradient, acidification,
Fish farms impose ecological risk

Landfills – imposes environmental hazards

Industrial build ups Imposes health hazards

Ocean reclamation imposes flood hazards
Adaptive Water Management under Climate Change in the Mekong River Basin

Leg A. Economy
Leg C. Social
Leg B. Environment

Balancing Water, Environment & Quality of Life

Climate Change: Water Recharge from Ridge Glaciers & Precipitation

Water Input

Climate = CR³
SEA will experience increasing climatic variability (2050)
Sea Level Rise

Coastal regions are very critical and vulnerable!

Dynamic Planet

• Approaches and Models
  - Drivers
  - Societal system
  - Observing

• States and Trends
  - Explaining
  - Understanding
  - Thresholds

• Critical Zones
  - Coasts
  - Tropical forests
  - Polar regions
Quantifying risks through modeling – training

**Basic GIS Layer:**
- Soil Property
- Admin. boundary
- Basic infrastructure

**Climate Change Downscaling:**
- Statistical downscaling or Regional Climate Models (RAMS, CWRF, MM5)

**Climate Drivers**
- Nutrient Discharges
  - GHG Emissions (N2O, CO2, CH4)
  - N, P leaching

**Drivers**
- Biogeochemical & Hydrological Processes & Modeling
  - DNDC, SWAT...

**In-situ, stations Cal/Val**

**Land Use & Management:**
- Fertilizer
- Pesticides
- Land uses / dams
- Irrigation...

**Management Options:**
- Balance benefits
- Consider trade-offs
- Best management practice
- Total maximum daily loads

**Ecosystem Services:**
- Yields, C storage, Biomass, economic values...
Key ideas

- Tipping points (Thresholds)
- Intensity (rate)
- Frequency
- Duration
- Extent

![Diagram showing Key ideas]

Risk Assessments

Drivers and Exposures

Risk Level (arbitrary)

low

high

Tipping point

Assimilative capacity zone

Management effort zone

Risk zone

Threshold

Risk management goal: lower the risk under limited stress exposures
Hangzhou Bay area urbanization

1994年，2.7%
2003年，4.7%
2009年，8.7%
N Leached from paddy rice fields
BMP vs Baseline Nitrogen Leaching

William Salas, AGS LLC
## Impacts of Baseline vs. BMP Scenarios on N$_2$O Emission and Other C and N Fluxes from a Tomato Field in Davis, CA

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>BMP</th>
<th>Change rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N$_2$O</strong> (kg N/ha)</td>
<td>5.9</td>
<td>2.7</td>
<td>-54%</td>
</tr>
<tr>
<td><strong>NH$_3$</strong> (kg N/ha)</td>
<td>4.4</td>
<td>2.1</td>
<td>-52%</td>
</tr>
<tr>
<td>N leaching (kg N/ha)</td>
<td>56</td>
<td>21</td>
<td>-63%</td>
</tr>
<tr>
<td><strong>Crop yield</strong> (kg DM/ha)</td>
<td>3718</td>
<td>3710</td>
<td>-0.2%</td>
</tr>
<tr>
<td><strong>dSOC</strong> (kg C/ha)</td>
<td>-1470</td>
<td>-1472</td>
<td>+0.1%</td>
</tr>
</tbody>
</table>

William Salas, AGS LLC
REAL – Remote Environmental Assessment Lab

- Stuart Gage
- Jiaguo Qi

"Our goal is to investigate the relationship between in situ observations and landscape level processes in order to better understand ecosystem dynamics."  (more)

Sensor Technologies
REAL sensor platforms transmit data over a hierarchical, wireless sensor network to bridge large distances while conserving overall sensor network power. Data is initially delivered to a sensor server for storage and relay to remote servers or grid services for further analysis and processing to better enable ecological inquiry... (more)

Soundscape Interpretation
A central theme of our acoustic monitoring is to be able to identify species based on their acoustic signatures in near real-time. A sensor data stream is a time series comprising continuous or periodic sensor readings. Typically, readings taken from a specific sensor can be identified and each reading appears... (more)

Ecosystem Assessment
Our case studies leverage sensor technologies, infrastructure, and on-line, automated analysis techniques to investigate the relationship between acoustics and ecological indicators. Our preliminary studies are promising and show that there is a positive correlation between acoustics and ecological indices... (more)

Data Stewardship
When ecological sensor platforms collect data continuously, automated processing facilitates the organization and searching of the resulting data repositories. Without timely processing, the sheer volume of the data might preclude the extraction of information of interest. Addressing these problems will... (more)