
Bangkok
MARCH 15, 2018
CONSERVATION INTERNATIONAL
BOSTON UNIVERSITY
Cambodia
Phnom Penh
Ho Chi Minh Cit
Ca Mau
CAMBODIA
MIDAS
WORKSHOP

Agenda

Speakers:

Suchi Gopal
Joshua Pitts

Find Out More:
http://www.chansmodels.org

Presenter & Participant Introductions

Workshop Framework

MIDAS Tool

Demonstration of MIDAS

Interactive Exercises

Feedback & Questions

Introduction

Speakers:

Suchi Gopal
Joshua Pitts

Dr. Suchi Gopal

Professor, Decision Support

Joshua Pitts

Software Design & Engineering

Workshop Framework

Speakers:

Suchi Gopal
Joshua Pitts

Decision Support Tools

Context

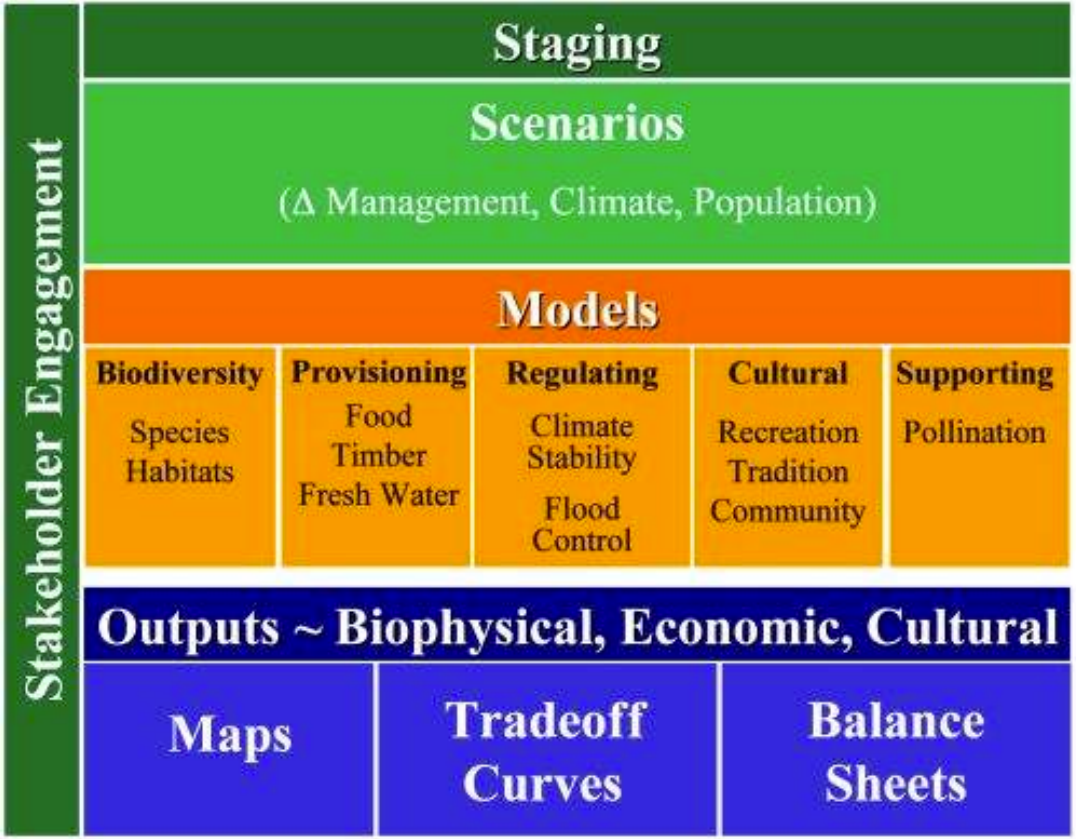
Data & Model Building

MODELS & Data

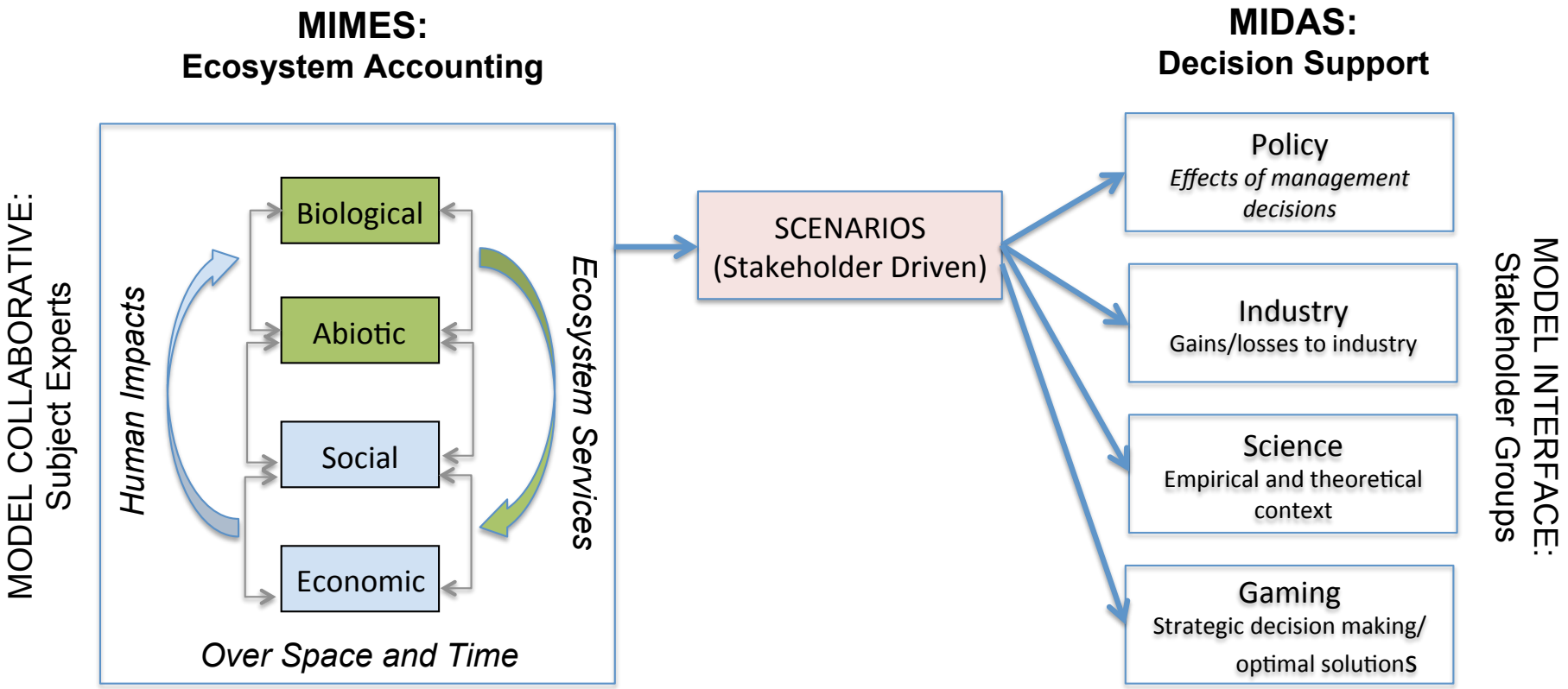
Analysis & Results

Stakeholder Engagement

Framework : Environmental Valuation & Tradeoffs



MIMES & MIDAS


MODEL COLLABORATIVE:
Subject Experts
MIMES:
Ecosystem Accounting
Human Impacts
Biological
Abiotic
Social
Economic
Ecosystem Services
Over Space and Time
SCENARIOS
(Stakeholder Driven)
MIDAS:
Decision Support
Policy
Effects of management decisions
Industry
Gains/losses to industry
Science
Empirical and theoretical context
Gaming
Strategic decision making/ optimal solutionS
MODEL INTERFACE:
Stakeholder Groups

MIDAS Tool: Assisted Decision-Making

Speakers:

Suchi Gopal
Joshua Pitts

Food, Water & Energy Analysis in MIDAS

Overview

1.MIDAS has kept pace with technology - Web enabled
2.Multi-source data from NASA, Cambodian Govt, Crowd sourcing (volunteered information - ratings just as in Amazon)
3.Multi-stakeholder collaboration – each wants a different output and can share/collaborate
4.Many tools being added to enhance your needs – Siem Reap Urbanization
5.Education & Outreach– Curriculum developed, Webinars, Undergrad and graduate students
6.MIDAS used now in Belize, Brazil, Key Biscayne (USA), Cambodia etc.

Source of Data

MIDAS is based on the primary and secondary data gathered by our team, Professors Les Kaufman, Suchi Gopal, Irit Altman, Roel Boumans, and Josh Pitts, as well as many graduate students at Boston University. A number workshop delegates from Cambodia at the Ministry of Fisheries, NGOs, and other stakeholders helped to develop, improve and enhance MIDAS.

MIDAS

MIDAS is web browser based – i.e. it can be run through no more software than an up-to- date internet browser, such as Mozilla Firefox.

Access at

Chansmodels.org or

http://45.55.215.153/midas/#

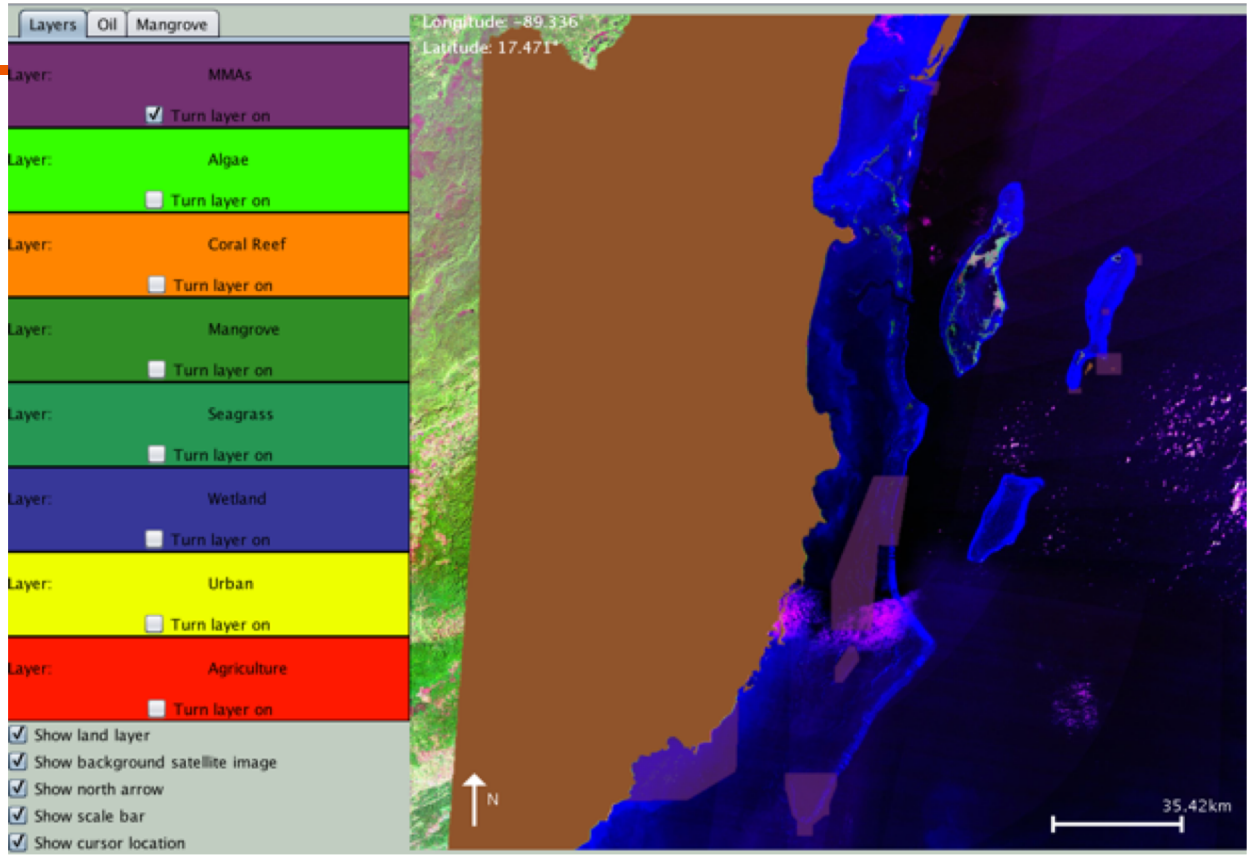
History of MIDAS

Speakers:

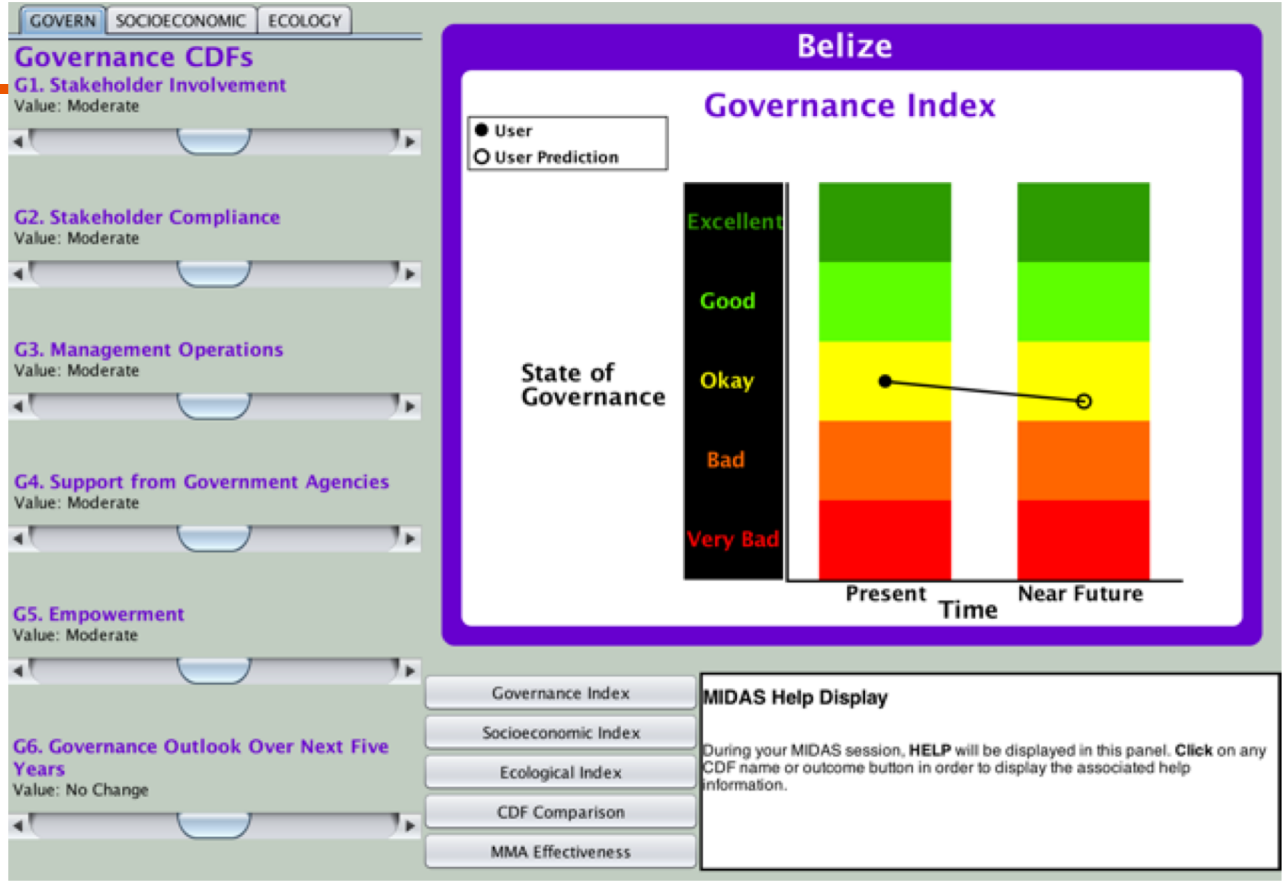
Suchi Gopal
Joshua Pitts

Food, Water & Energy Analysis in MIDAS

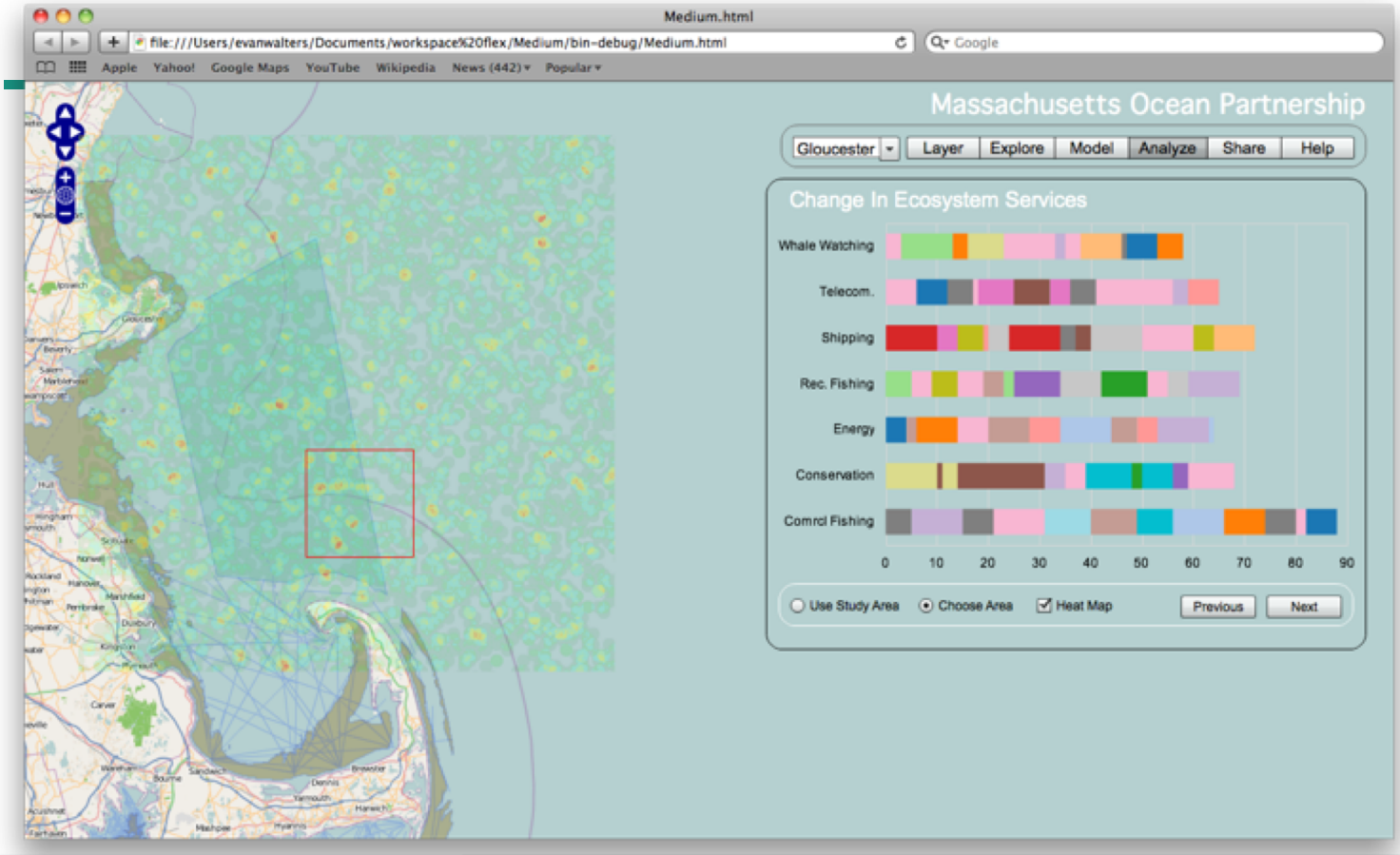
MIDAS In Belize



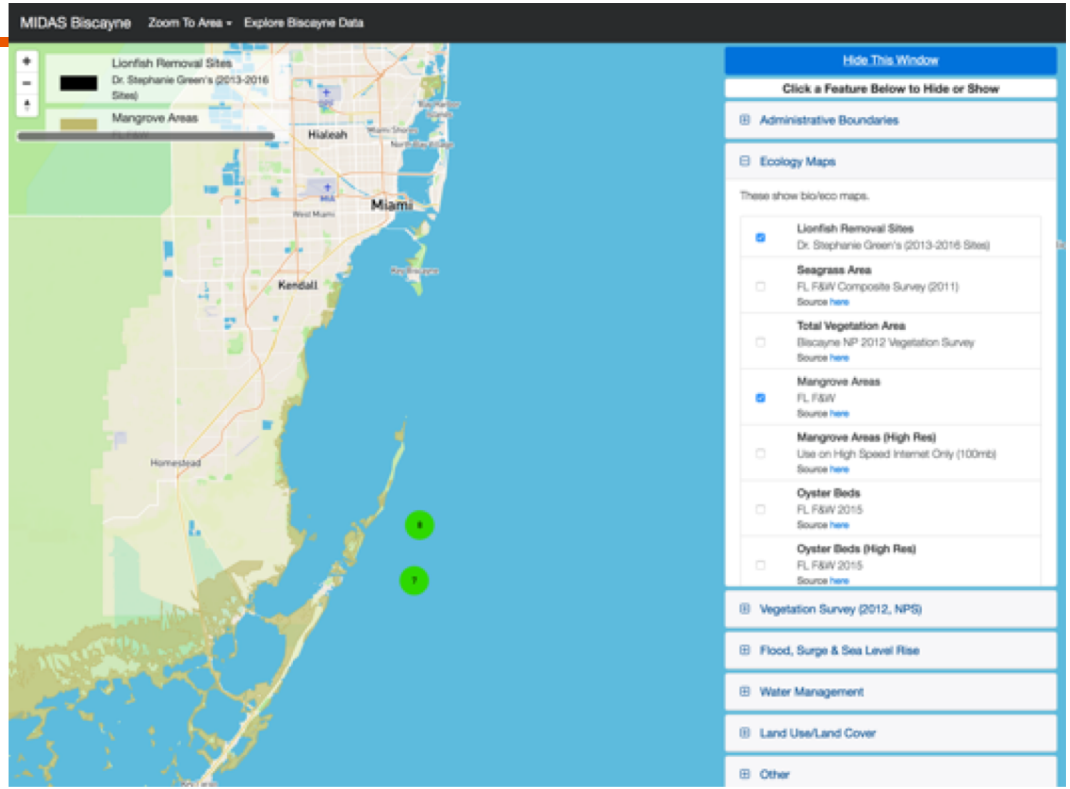
MIDAS In Belize: (1) Identify Motivations



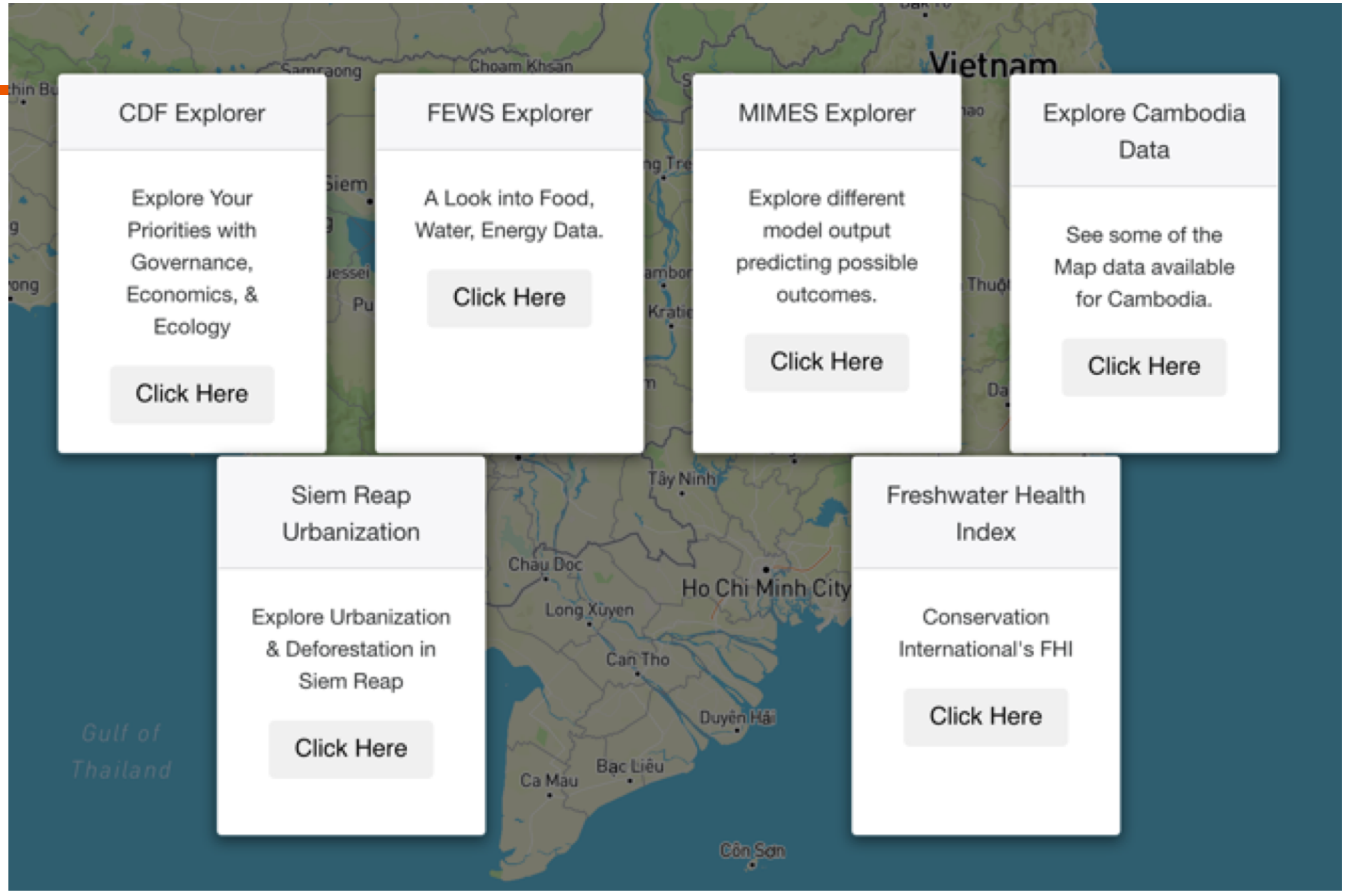
Tradeoff Analysis in Massachusetts, United States



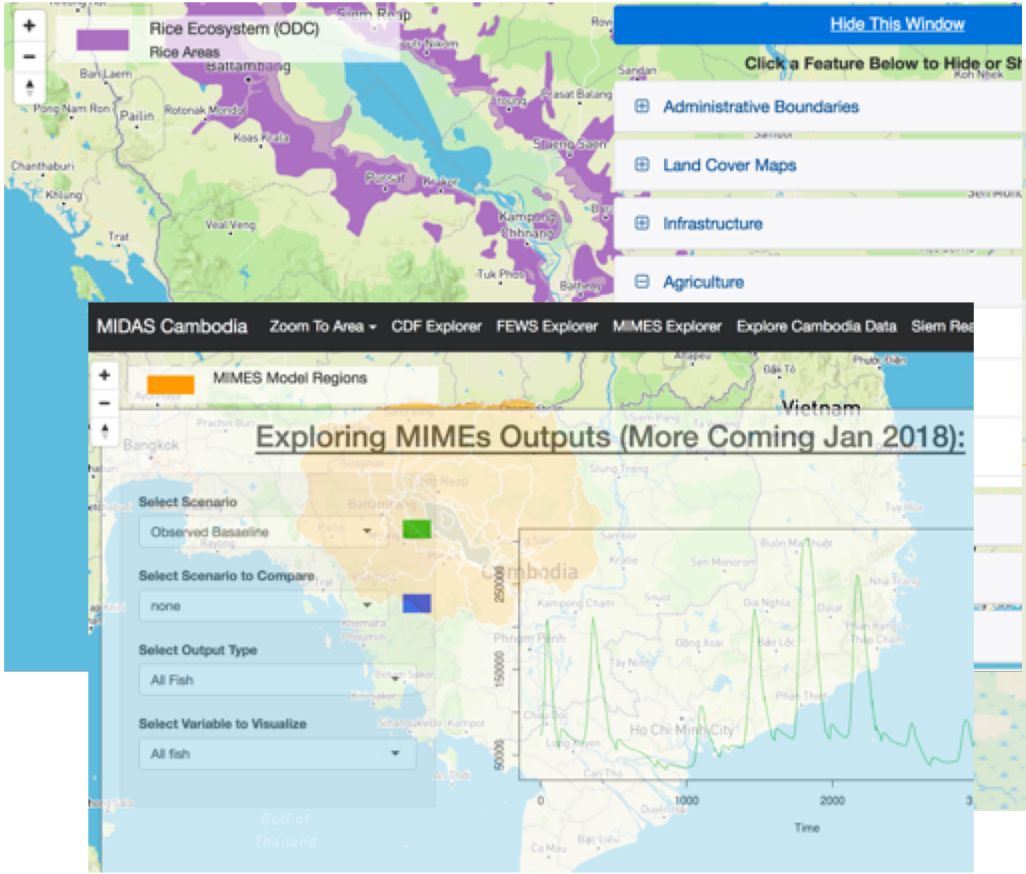
Data Explorer in Florida, United States

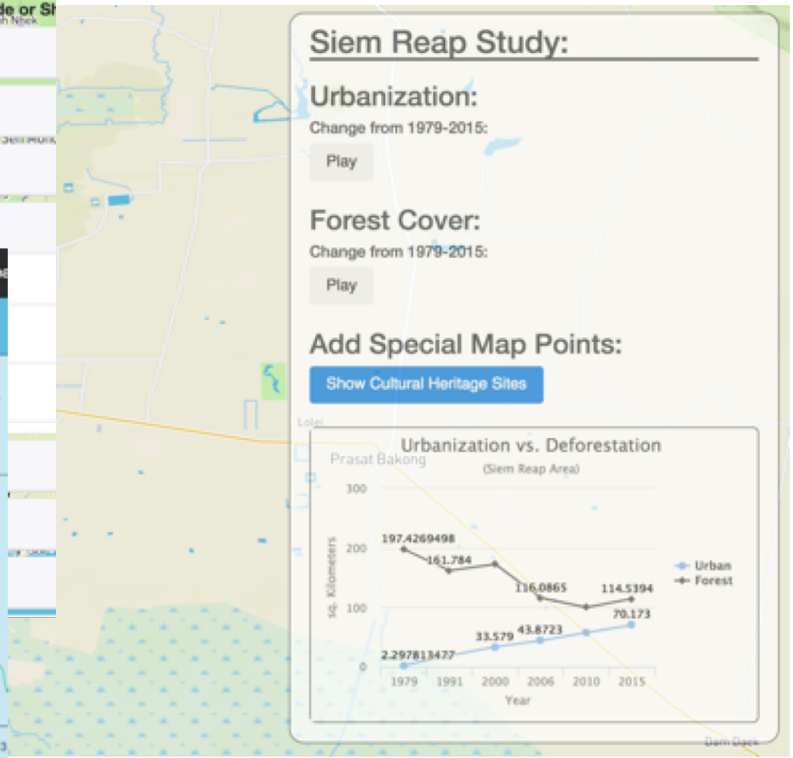


MIDAS in Cambodia



MIDAS in Cambodia: Many Activities Help Decision Making





MIDAS Demonstration

Speakers:

Suchi Gopal
Joshua Pitts

MIDAS: Walkthrough

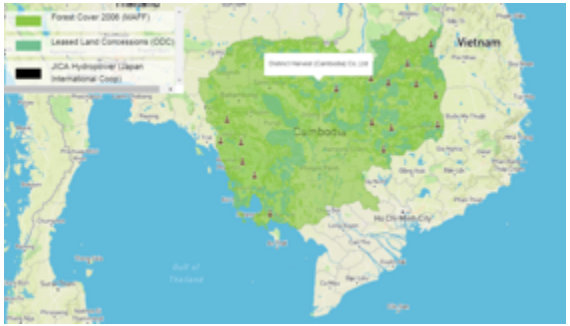
- **Zoom to Area**
- **CDF Explorer**
- **FEWS Explorer**
- **MIMES Explorer**
- **Explore Cambodia Data**
- **Siem Reap Urbanization**
- **Freshwater Health Index**

MIDAS: Walkthrough

Siem Reap Urbanization: Rapid urbanization in Siem Reap near Angkor Wat is causing rapid depletion of water as population growth has accelerated in the last two decades. We show the deforestation and urbanization trends in this region using Landsat image analysis.
Freshwater Health Index: CI's Freshwater Health Index is a tool that measures ecosystem system health by making clear connections between freshwater ecosystems and the benefits they provide to people. The user can access the information through links.

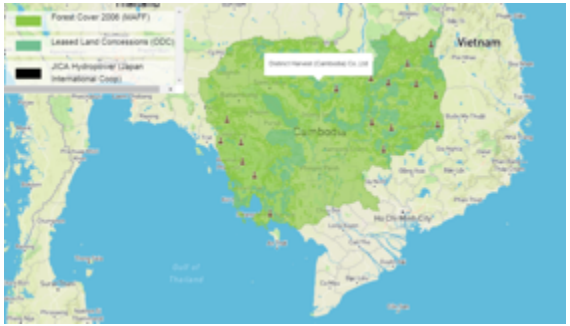
1. Map Exploration

The map exploration tool enables the user to display a series of data layers including administrative units, forests, population, watersheds and rivers. MIDAS shows map layers based on identification of user types. Users for Cambodia are classified into the following groups based on our interactions with user groups in stakeholder workshops from 2014-2017. We will survey if more user groups are needed. Our goal is to create a multi-stakeholder platform that can provide specific layering of our models to the user groups. For example a commercial fisher may need details of fish catch, fish biomass and no-take zones while an environmental group may want detailed information of areas at risk.



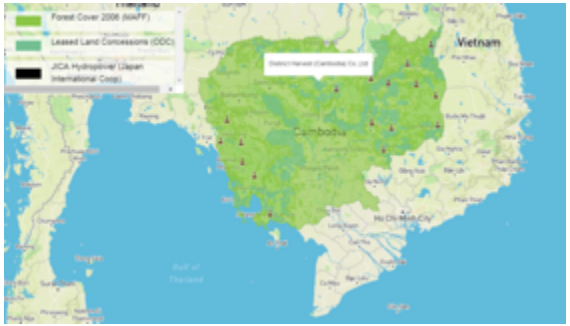
1. Map Exploration

1. Frame a problem.
2. Select relevant data
3. Gather insights from your visual map overlay – quick and easy way of gathering insights
4. For example, ADD *forest concessions, forest in 2006 and key biodiversity areas.*
5. Zoom into Mondulkiri – What is the spatial pattern here? Locate all leased concessions here.
6. Locate Phnum Prech Wildlife Sanctuary? What are the threats here?



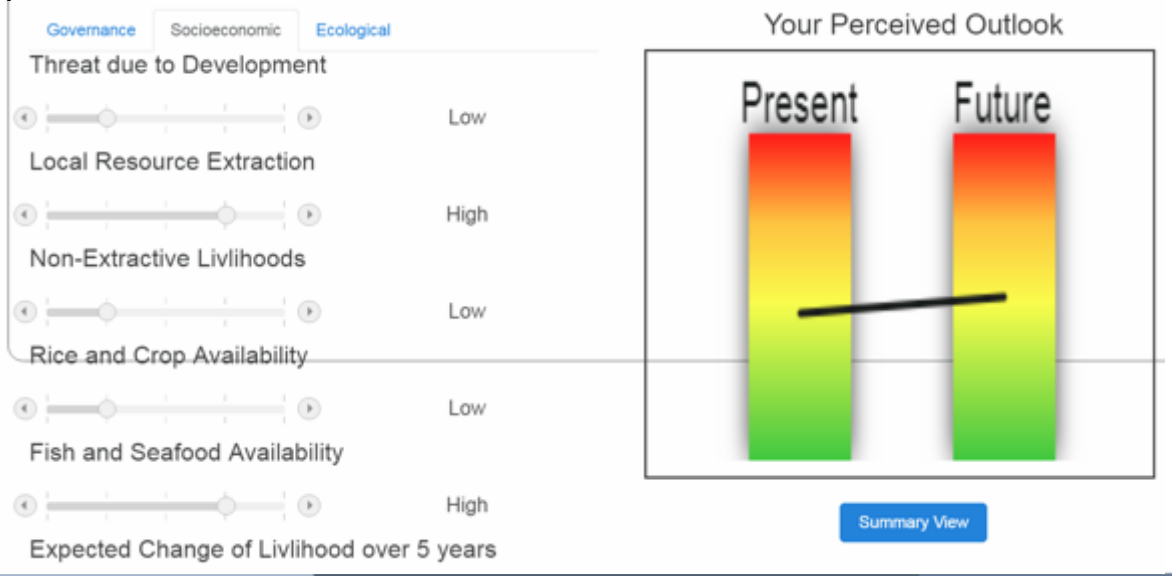
1. Map Exploration

1. Examine forest and threats in Ratanakiri, Mondulkiri, Kratie and Stung Treng that are the richest and largest intact block of forest in southeast Asia. What data layers would you use?
2. What are the threats here – how would you assess ecotourism potential here?
3. What are alternate livelihoods here?



2. Collaboration Via CDFs

Users have their intuitive and experiential understanding of the political, social, and environmental dimensions of the state of the system. MIDAS enables users to rate or review the system on critical determining factors, gathered from our prior research in other regions and revised to fit the Cambodian context:



CDF Example

1. Stakeholder involvement: This variable defines the level of stakeholder involvement that results in an overall positive impact on the region. Level of stakeholder involvement in surveillance, monitoring and enforcement is a useful measure of how successful a region would be in the present as well as in the future. (Cho, 2005; Pomeroy et al., 2000). Stakeholder involvement can be effective in controlling non-compliance behavior through social and peer pressure. Increased participation of stakeholders provides them with more ownership over the resources (such as fishing and forestry) which should result in overall improvement. Active involvement in stakeholder activities is highly beneficial to any governance. This measures how active people are in resource management. This user group ranking gives us an overall view of the significance of resources to the public. The more people value the resources, the more likely they are to participate in management (Bunce et al, 2000). An increase in participation would be a positive impact of any development or conservation effort (Pomeroy et al, 1997).

- Very low: The level of participation is almost non-existent and hence resources are not well managed.
- Low: Low level of participation may lead to negative impacts.
- Moderate: Moderate stakeholder participation levels resulting in a slightly higher positive impact for the region.
- High: Involves high level of involvement from a relatively large proportion of stakeholders
- Very High: Surveillance, monitoring and enforcement leads to improvement in overall community compliance and enforcement.

V. Low	Low	Moderate	High	V. High

2. Collaboration Via CDFs

Users have their intuitive and experiential understanding of the political, social, and environmental dimensions of the state of the system. MIDAS enables users to rate or review the system on critical determining factors, gathered from our prior research in other regions and revised to fit the Cambodian context:

- How would you manage sensitive areas in Ratanakiri? How would you support human livelihoods here? Use CDFs to assess the situation as a group?
- Which CDF was considered most important? Why?
- Which CDF produced largest variation in your group? Why?

3. Food, Energy and Water Securities Assessment

The food-energy-water nexus (FEWS) is among the highest priorities of the Rio + 20 Declaration and is very relevant in the context of Cambodia, where food, energy and water systems are inextricably linked throughout Cambodia. Rapid changes from hydro-power development, over-fishing, forest clearing, and urbanization threaten the future of the Cambodia's tightly linked natural and human systems. These pressures are aggravated by rapid human population growth, migration (increasing urbanization), and the impacts of global climate change. Specific development strategies around FEWS must be critically evaluated in order to consider their system-wide effects and understand the net gain and loss to the suite of ecosystem services that Cambodians depend upon.

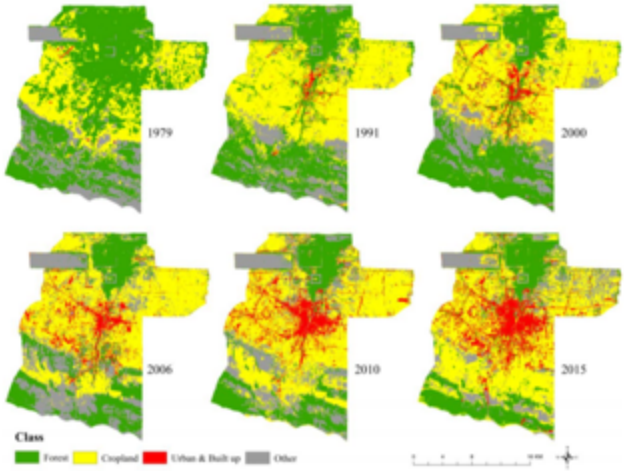
3. FEWS modeling

Engie, a French multinational electric utility company, and Devenco, a local enterprise, have entered a partnership that could lead to the construction of a solar power plant in Kampong Chhnang province,

- Describe geography of this province? What is its population?
- What is the solar power potential here?
- What is the electricity usage here?

4. Assessment - Siem Reap Urbanization

Our stakeholder workshop in 2016 in Siem Reap kindled an interest in evaluating change in urbanization around the tourist destination of Angkor Wat, formally recognized as a World Heritage site by UNESCO in the 1990's. The temple is located to the north of the city.



In this study, we used several Landsat images during the period of 1979 to 2015, including satellite images from Landsat MSS, Landsat TM and Landsat OLI. We derived the land use and land cover maps based on a random forest classifier using 1979, 1991, 2000, 2006, 2010, and in 2015 images. We classified the landcover into forest, crop, urban and others, seen left, to investigate the urbanization and deforestation.

4. Siem Reap

Frame an urbanization problem for Siem Reap,

- What is the pattern of urbanization in Siem Reap?
- What is the role of the road network in this region?
- Describe the relationship between urban landuse with forest and cropland?

5. MIMES Tradeoff Modeling

Tonle Sap MIMES is a dynamic ecosystem model that connects knowledge about hydrological flows, landcovers, primary production, and fish. The goals of the model are multi-pronged including 1) to provide a framework for current and future knowledge integration and synthesis, 2) to provide a learning and educational resource to users in the system, and 3) to support the exploration of ‘what if scenarios’ to understand the system-wide effects of threats. The model was developed using many scientific insights about the system and its overall accuracy has been verified using available sources of observed data.

MIMES Tonle Sap Background

- Tonle Sap MIMES is a dynamic ecosystem model that connects knowledge about hydrological flows, landcovers, primary production, and fish.

- The goals of the model are multi-pronged including 1) to provide a framework for current and future knowledge integration and synthesis, 2) to provide a learning and educational resource to users in the system, and 3) to support the exploration of ‘what if scenarios’ to understand the system-wide effects of threats.

- The model was developed using many scientific insights about the system and its overall accuracy has been verified using available sources of observed data. However, there are also areas of the model that can be strengthened in order to increase the precision of outputs and expand upon the knowledge included.

MIMES Tonle Sap Background cont.

- An essential input that drives the model is a time series of water levels which sets the conditions for the annual flood pulse that drives many production processes across the system. In developing and verifying the model, a time series based on observed levels was used, thus allowing for outputs associated with production flows to be compared to available observations of this system.

- In contrast, when developing 'what if' scenarios to explore potential future impacts on hydrology and other factors, a time series of simulated water levels is used. This approach allows us to isolate hydrological factors of critical interest and also to remove sources of unexplained variability in the hydrological cycle. Furthermore, we have developed a supporting model tool that allows for easy construction and modification of simulated water levels, such that additional 'what if' scenarios can easily be run through Tonle Sap MIMES.

- All 'what if' scenarios are compared to baseline model run which relies on a time series of simulated water levels that isolate two critical hydrological signals identified from observed data. First is the signal associated with annual flood cycle which is the result of highly predictable seasonal monsoons that occur in the region. Second is a signal that occurs at an interannual scale (~every 5 years) and corresponds roughly to the pattern of greater than average flooding followed by drought events that together are often referred to as an El Nino Southern Oscillation (ENSO) cycle.

Scenario Design - Overview

- 'What if' scenarios in Tonle Sap MIMES are designed to explore the impacts of dams and climate change in this system.
- Dam impacts include two factors associated with the construction and operation of dams – a reduction in annual flood pulse and the presence of migration barriers . These are considered as independent factors within the scenario design.
    - First, dams are expected to reduce the annual flood cycle in this system. For Tonle Sap Lake, this will result in an increase in water levels and the area of permanent flood zone during the dry season and a decrease in the water levels and permanent flood zone during the wet season (on average). To explore this factor, 'what if' scenarios that include dam impacts rely on a simulated time series of water levels that reduce the amplitude of the annual flood cycle by 25% (a percentage which is in the range of the Definite Future dam scenario characterized by the Mekong River Commission).
    - Second, dams are expected to have major impacts on the ability of migratory fish species to move freely between spawning and growing areas. To model this factor, mortality of migratory fish species was reduced relative to baseline conditions.
- Climate change impacts are also considered within the scenario design via the general expectation that global warming will increase the intensity of the ENSO cycle. The climatological cycle associated with these events is known as the ENSO and occurs at an interdecadal scale. In 'what if' scenarios, the potential changes in ENSO are explored by increasing the amplitude of the ENSO-like cycle associated with the simulated water level input time series.

Scenario Factors

- Annual flood cycle (2 levels)
  - Baseline level (AO): Simulated water levels produced using wave that match the annual hydrological cycle in this system*
  - Definite Future Dams (A1): Simulated water levels which reduce the amplitude of annual flood cycle by 25% relative to the baseline
- ENSO-like cycle (2 levels)
  - Baseline level (EO): Simulated water levels produced using wave that match an interdecadal hydrological cycle observed in this system. The cycle is associated with higher than normal flooding and drought events and is consistent with El Nino Southern Oscillation (ENSO) patterns*
  - Increased ENSO intensity (EO): Simluated water levels which increase the amplitude of interdecadal, ENSO-like hydrological signal by 10% Fish migration
- Migration barriers (2 levels)
  - No migration barriers (MO): Low juvenile mortality rates set for all fish groups inlcluding migrators (the rate for for short and long-distance migrators = 0.01)
  - Migration barriers present (M1): juvenile mortality parameters for migrating fish groups is increased (long distance migrators = 0.1, short distance migrators=0.07)

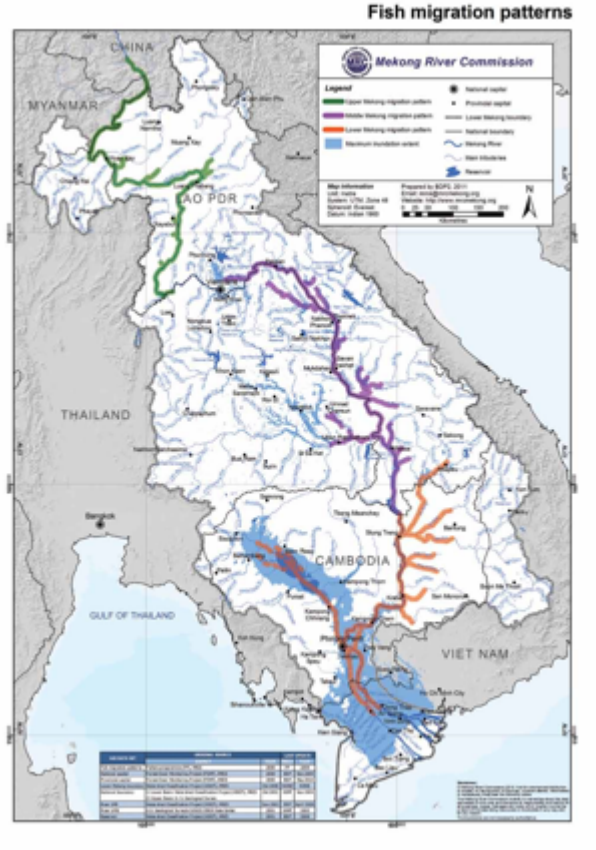
**Wave metrics (i.e. sin, cosine, period) were identified through a Fournier analysis of observed water levels over 30 years*

Annual flood cycle	Baselne (A0)	Based on wave metrics (sin, cosine, period) from Fourier analysis of observed water levels. The cycle represents the annual flood cycle in this system.
	Definite Future (A1)	The amplitude of the baseline annual flood cycle is reduced by 25%.
ENSO-like cycle	Baseline (E0)	Based on wave metrics (sin, cosine, period) from Fourier analysis of observed water levels. The cycle occurs at interdecadal scale, is associated with higher than normal flooding and drought events, and is consistent with some aspects of El Nino
	Climate Change (E1)	The amplitude of the baseline ENSO-like cycle is increased by 10%.
Migration	Baseline (M0)	Low juvenile mortality rates set for all fish groups inlcluding migrators (the rate for for short and long-distance migrators = 0.01)
	Migration Barriers (M1)	Juvenile mortality parameters for migrating fish groups increased (long distance migrators = 0.1, short distance migrators=0.07)

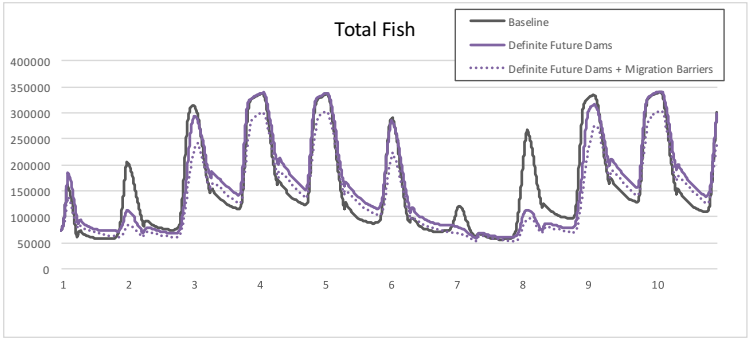
Tonle Sap Fish Functional Groups: Life History Strategies (3)

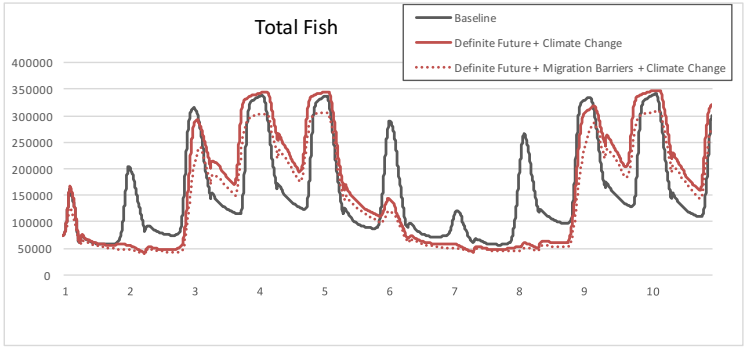
- Periodic
  - Synchronous episodes of spawning often occurring during periods that favor larval survivorship.
  - Egg size tends to be small with high larval and young of year growth rates
  - High spawning ***potential***, however highest level of spawning is only ***achieved*** when optimal environmental conditions arise as a result some predictable environmental cycles
- Opportunistic
  - Early maturation
  - Frequent reproduction over long spawning time periods
  - Rapid larval growth and high turnover, high intrinsic rate of increase
  - However, differ from ***r*** selected species in that clutch size is small
- Equilibrium
  - Mostly consistent with ***k*** selected species
  - Large eggs and high parental care → resulting in small clutches with higher survivorship upon maturation
  - However, do not have to be large in size for this designation

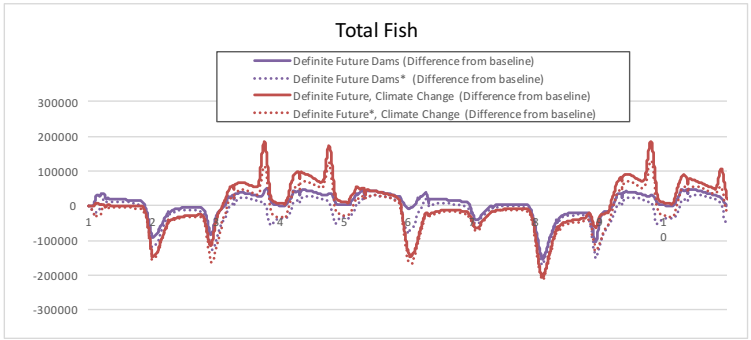
Tonle Sap Fish Functional Groups: Migration Strategies (3)

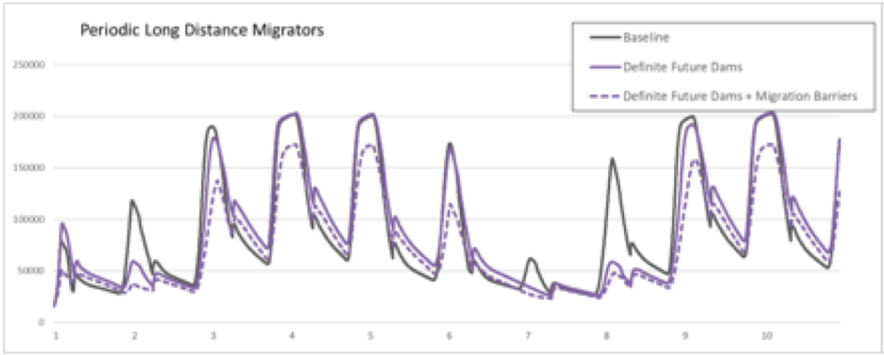


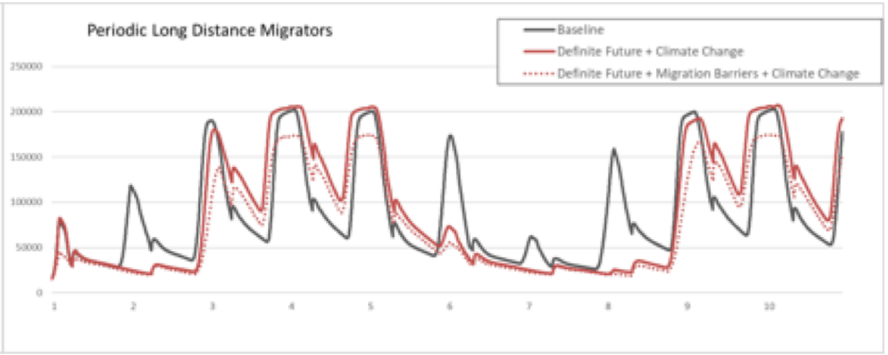
- Long distance migrators
- Short distance migrators
- Resident (Lateral migrators)

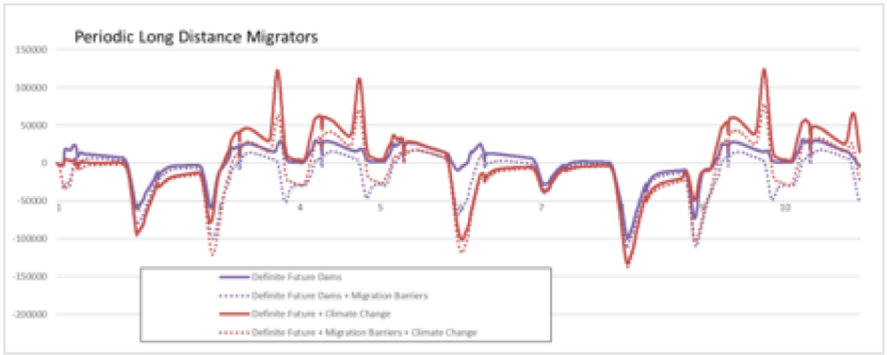












Case Studies

Speakers:

Suchi Gopal
Joshua Pitts

Break

Speakers:

Suchi Gopal
Joshua Pitts

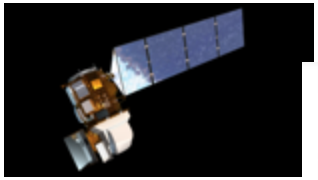
Food, Energy, Water Nexus

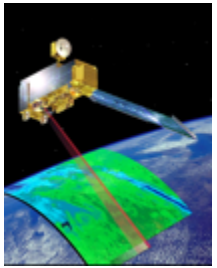
Speakers:

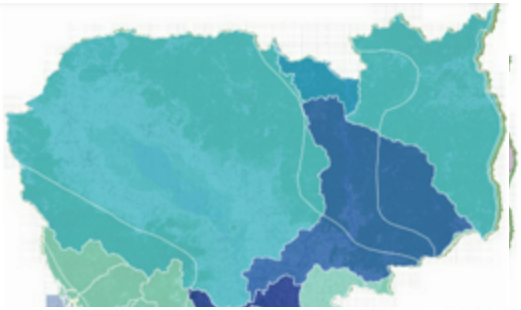
Suchi Gopal
Joshua Pitts

Goals of Building our Approach

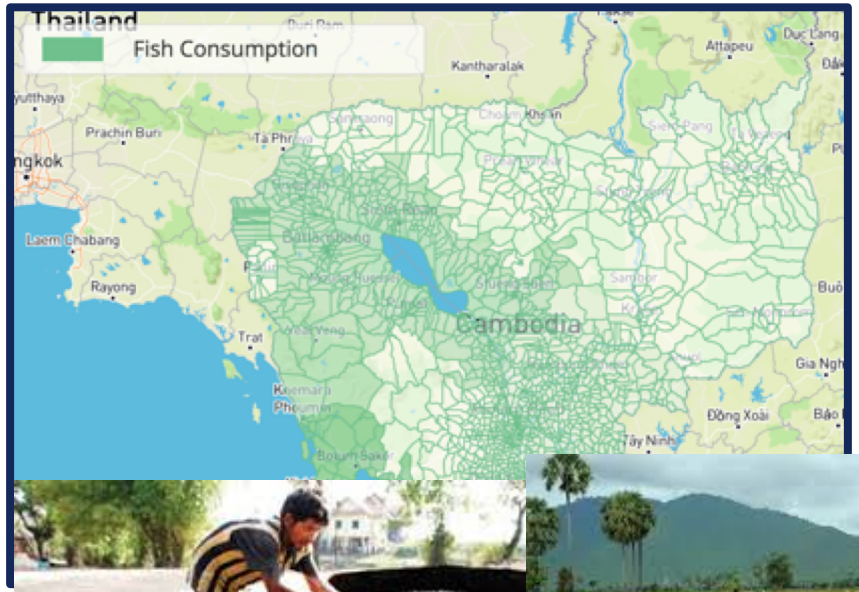
1. Develop and apply computational methodologies, e.g. *improved algorithms* to integrate different types of data (scales, sensors, types), understand system flows, & interactions;
2. Create models to understand the *coupled human-natural system;*
3. Translate findings into a user-friendly *decision tool* that supports cyber-human-natural system resource management.







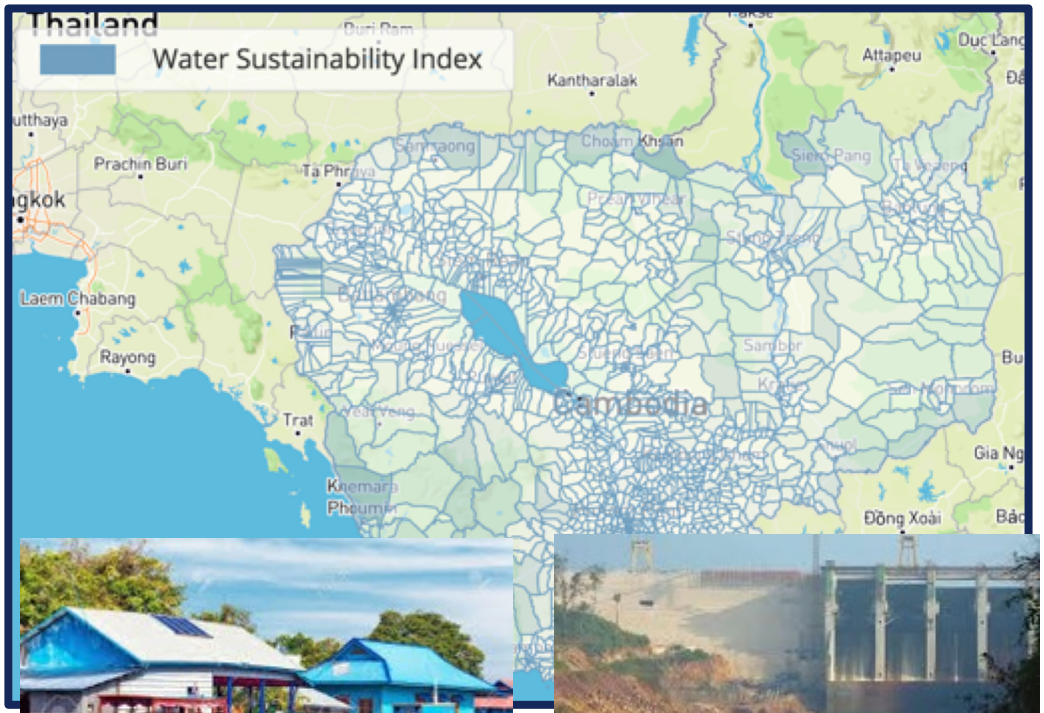
Data for Food Security



The components of food security include:

- Crops grown
- Family consumption patterns
- Fishing consumption
- Small farmers
- Livestock
- Population density
- Size of the household etc.
- Vulnerability to Climate Change

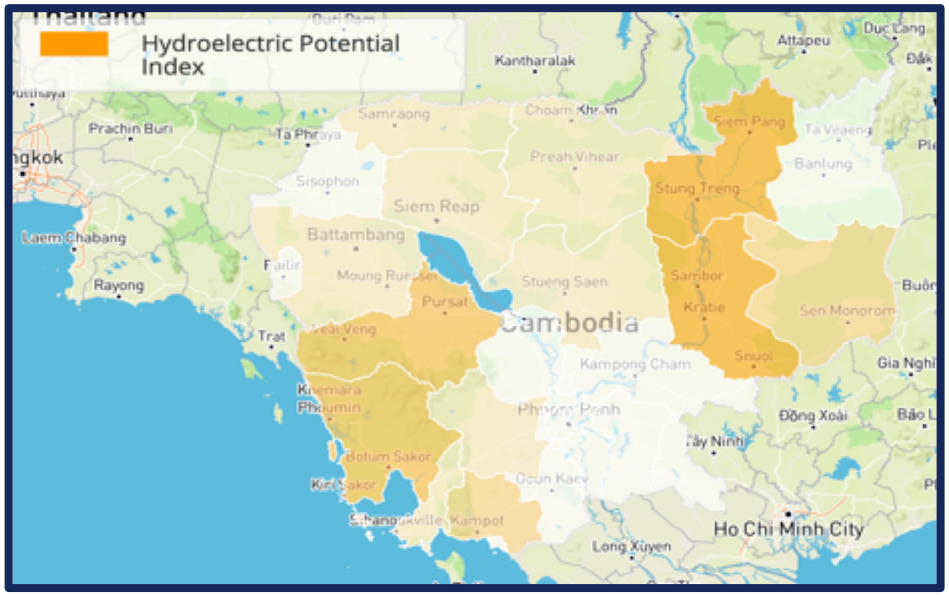
Data for Water Security



The components of water security (World Resource Institute) include:

- Total water withdrawal
- Consumptive and non-consumptive use
- Total blue water (Bt)
- Available blue water (Ba)
- Baseline water stress
- Inter-annual variability
- Seasonal variability.
- Flood occurrence.
- Drought severity…
- Upstream storage
- Groundwater stress
- Return flow ratio
- Upstream protected land

Data for Water Security

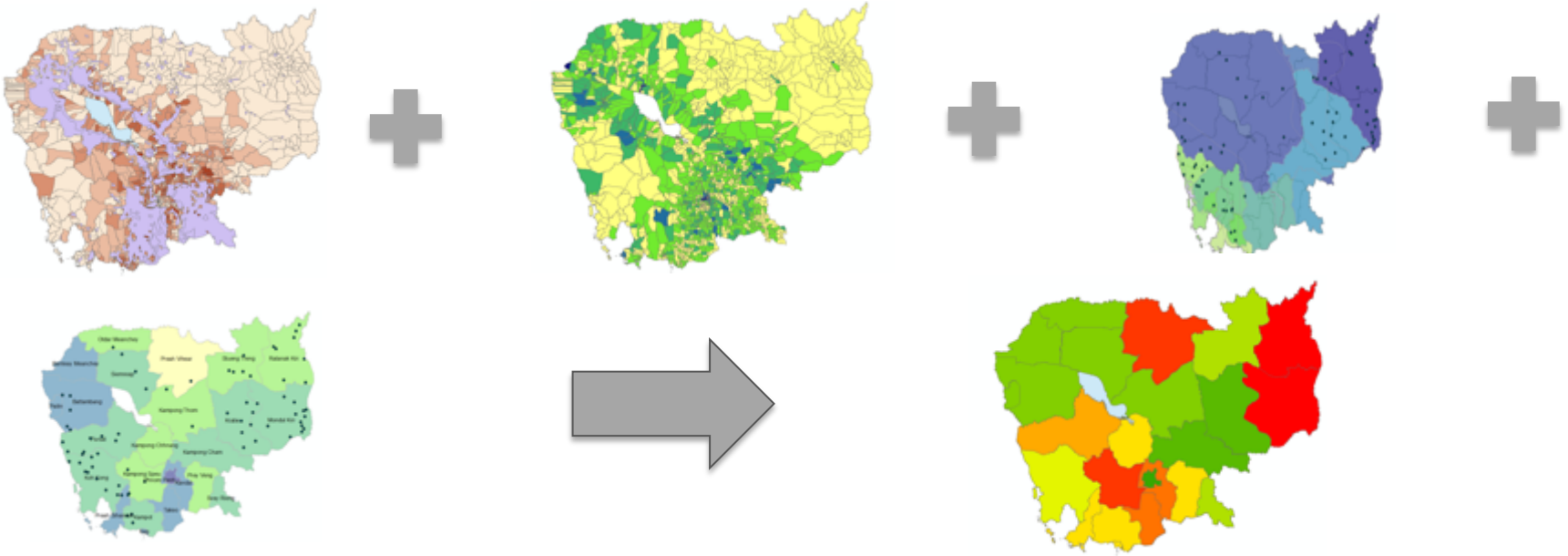


The components of energy security include:

- Per capita consumption of electricity
- Coal, HEP and oil consumption
- Renewables – solar, wind.
- Vulnerability to Climate Change
- Factory consumption
- Predicting future demand

Making Decisions with Big Data in F.E.W.S.

Agriculture + Population Density + Water Availability + Per capita consumption of electricity -> Vulnerability to Climate change (US DOS) at Commune Level



Conveying Decision Making to Stakeholders