

A large, semi-transparent image of the Earth from space, showing blue oceans, white clouds, and brown/green landmasses, serves as a background for the title and author information.

Structured Decision Support for Natural Resource Management

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Global issues for society and the environment

Competition for, and natural threats to, natural resources

Availability of water for people and ecosystems

Effects of climate change on resources, ecosystems, human health

Effects of wildlife disease on human health

An urgent need for authoritative science information

US Geological Survey

- The US Government's Independent Scientific Advisor
- Conduct Applied Research in the Public Interest
- Collect and Deliver Natural Resource Data
- Support Informed Decision Making



Structured Decision Support for Natural Resource Management

- Multidisciplinary Programs
- Focused Studies

Support for Natural Resource Management Decisions in Asia

- **Structured Decision Support**; Glen Canyon Dam, Arizona USA (application: Mekong R.)
- **Decision Support Modeling**; Everglades, Florida USA (application: Mekong R.)
- **Disease Risk Assessment** for Emerging Infectious Diseases; Republic of Korea, Thailand (application: SE Asia)
- **Biodiversity Protection** for Viet Nam
- **Groundwater Modeling** Viet Nam – Cambodia



Data for Informed Decision Making

- Where have we been?
 - Baseline
- What questions can we ask?
 - Develop creative valuation of diverse resources
 - Forecasting trends; Impacts of changes
- How can we manage sustainably for people?
 - Considering conflicting demands on resources
- Quality-assured data in compatible formats required

Structured Decision Support: Dam Operations

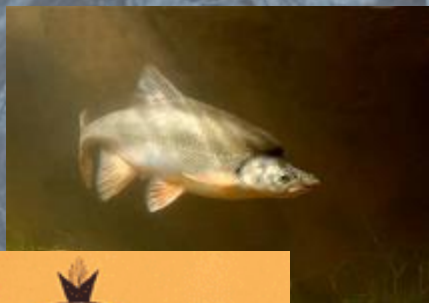


- Dam built for flood control now also provides substantial hydropower
- Dam operations impact many users
 - Electricity customers
 - Native peoples' cultural traditions
 - Native and nonnative fish
 - Recreation
 - Natural area conservation
- Comparisons of dam operation (flow) alternatives impacts on resources needed



Social Ecological System

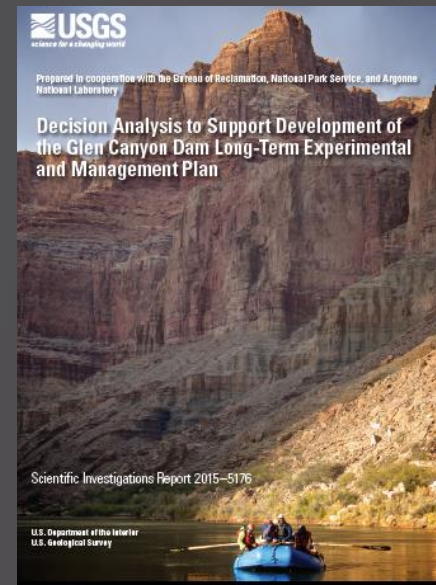
- Diverse approach needed for meaningful decision support



Multi-Criteria Decision Analysis Process



- MCDA steps to frame and analyze a decision
 - Elicit objectives from participants
 - Develop a set of creative alternatives for flows
 - Evaluate the alternatives
 - Elicit values-based tradeoffs
 - Evaluate uncertainty (compare to Expected Value of Perfect Information EVPI)
- Discern and integrate social values and scientific understanding



Consequence Table

Performance Metrics

Best

Better

Worse

Worst

Alternatives

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	HBC	Temp Suit	CPE	Trout Emig.	Qual. Trout	WTSI	GC flow	TOR	Power	Cap.	CAI	FI	GC raft	Veg	SLI	Wet-land	MR	TMF
	High	High	High	Low	High	High	Low	High	High	High	High	High	Low	High	High	High	Low	Low
A	4991	0.097	2.11	36,699	769	0.159	22.7	0.823	148.5	28.5	0.139	0.786	49	3.66	0.211	0.72	0.07	0.0
B1	5392	0.097	1.67	29,586	867	0.171	23.1	0.823	149.4	30.4	0.146	0.420	71	3.87	0.234	0.80	0.44	3.0
B2	5541	0.097	1.46	24,172	920	0.144	23.1	0.823	150.4	32.4	0.122	0.256	72	3.12	0.222	0.17	0.30	3.1
C1	5016	0.082	2.23	43,683	748	0.377	21.8	0.824	147.3	20.8	0.376	0.935	315	3.18	0.536	0.25	0.00	6.5
C2	4527	0.079	3.18	66,890	640	0.365	21.8	0.823	147.2	19.5	0.371	0.929	307	3.18	0.534	0.25	0.00	0.0
C3	5335	0.079	1.90	33,559	830	0.043	18.5	0.821	148.9	20.8	0.043	0.924	0	2.83	0.065	0.25	0.74	0.0
C4	4874	0.079	2.72	55,076	707	0.334	21.0	0.823	147.6	20.8	0.335	0.928	83	2.98	0.483	0.25	2.80	0.0
D1	5247	0.094	2.02	40,784	811	0.379	23.5	0.835	146.6	23.8	0.359	0.741	348	3.67	0.531	0.75	1.67	3.9
D2	5181	0.095	2.15	43,981	796	0.378	23.6	0.835	146.1	19.6	0.360	0.784	351	3.69	0.535	0.76	2.02	6.9
D3	4876	0.095	2.63	55,811	711	0.378	23.5	0.836	146.8	23.8	0.359	0.724	348	3.70	0.533	0.78	2.95	0.0
D4	5241	0.097	2.03	40,936	810	0.380	23.5	0.836	146.7	25.1	0.358	0.741	348	3.95	0.529	0.84	1.69	3.8
E1	5269	0.090	1.93	37,614	826	0.311	21.3	0.839	148.0	22.8	0.303	0.568	177	3.54	0.456	0.62	0.00	2.6
E2	5015	0.086	2.33	47,450	761	0.297	21.3	0.837	147.9	21.8	0.292	0.534	174	3.84	0.443	0.85	0.00	0.0
E3	5477	0.087	1.68	28,499	891	0.030	18.4	0.836	149.3	22.8	0.028	0.517	0	3.93	0.046	1.10	0.47	0.0
E4	5103	0.087	2.19	42,806	781	0.281	20.9	0.838	148.1	22.8	0.272	0.529	79	3.93	0.415	0.91	1.73	0.0
E5	5470	0.083	1.68	28,561	890	0.029	18.5	0.835	147.2	21.8	0.028	0.517	0	3.87	0.046	1.05	0.00	0.0
E6	5708	0.087	1.42	22,415	956	0.032	18.8	0.837	149.3	22.8	0.030	0.518	0	3.93	0.049	1.10	0.00	2.4
F	4450	0.030	3.37	71,869	592	0.299	36.8	0.749	141.0	11.2	0.406	0.997	919	3.14	0.558	0.14	0.00	0.0
G	4741	0.102	2.81	58,533	702	0.465	24.7	0.840	142.9	18.0	0.451	0.981	512	3.40	0.576	0.42	3.05	11.0

MCDA by Agency

Stakeholder Agencies

Best

Better

Worse

Worst

Alternatives

	Joint Lead	Federal	State	State	Utility	Utility	Utility	Tribe	Tribe	Tribe	NGO	NGO	NGO
A	0.479	0.508	0.483	0.448	0.472	0.448	0.459	0.515	0.530	0.477	0.508	0.450	0.429
B1	0.488	0.504	0.511	0.450	0.493	0.485	0.474	0.512	0.538	0.495	0.511	0.474	0.443
B2	0.454	0.434	0.447	0.402	0.491	0.495	0.484	0.457	0.477	0.446	0.504	0.416	0.384
C1	0.615	0.539	0.484	0.508	0.458	0.410	0.410	0.574	0.599	0.521	0.544	0.604	0.637
C2	0.602	0.515	0.465	0.518	0.426	0.376	0.391	0.570	0.591	0.511	0.549	0.589	0.631
C3	0.376	0.433	0.378	0.369	0.418	0.400	0.412	0.411	0.410	0.374	0.445	0.315	0.280
C4	0.559	0.507	0.452	0.497	0.441	0.392	0.405	0.532	0.544	0.488	0.529	0.555	0.573
D1	0.619	0.573	0.542	0.540	0.489	0.450	0.436	0.596	0.630	0.559	0.553	0.634	0.648
D2	0.607	0.574	0.526	0.535	0.470	0.424	0.414	0.581	0.615	0.547	0.534	0.630	0.642
D3	0.599	0.557	0.526	0.540	0.472	0.425	0.428	0.584	0.614	0.550	0.544	0.621	0.637
D4	0.628	0.590	0.560	0.553	0.500	0.460	0.445	0.610	0.646	0.574	0.559	0.647	0.662
E1	0.589	0.535	0.522	0.506	0.475	0.447	0.430	0.572	0.607	0.535	0.550	0.587	0.592
E2	0.583	0.539	0.533	0.515	0.459	0.428	0.418	0.579	0.616	0.542	0.547	0.588	0.594
E3	0.400	0.488	0.482	0.411	0.450	0.445	0.434	0.463	0.483	0.445	0.461	0.373	0.319
E4	0.560	0.543	0.532	0.509	0.468	0.436	0.427	0.563	0.597	0.536	0.534	0.575	0.569
E5	0.400	0.481	0.474	0.406	0.438	0.434	0.422	0.459	0.482	0.437	0.459	0.369	0.318
E6	0.412	0.498	0.492	0.415	0.460	0.462	0.440	0.469	0.491	0.451	0.467	0.382	0.326
F	0.559	0.465	0.396	0.484	0.311	0.269	0.293	0.509	0.536	0.431	0.475	0.535	0.622
G	0.605	0.559	0.478	0.532	0.456	0.385	0.397	0.563	0.588	0.524	0.514	0.634	0.669

Decision Support Modeling: Adapting to Climate Change

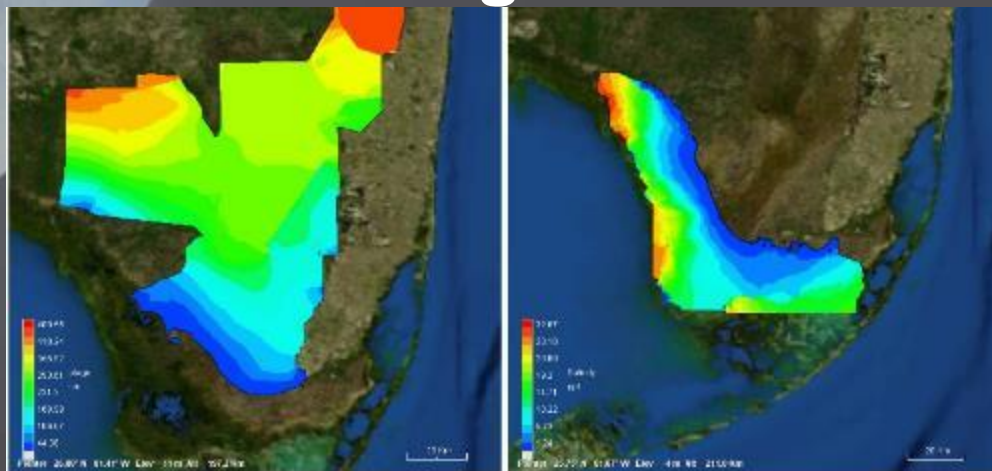
- Functioning Everglades supports rare species
- Water management critical for multiple stakeholders
 - Agriculture
 - Municipal
 - Native species
- Changes expected to impact species, habitats
- Models needed to compare alternatives



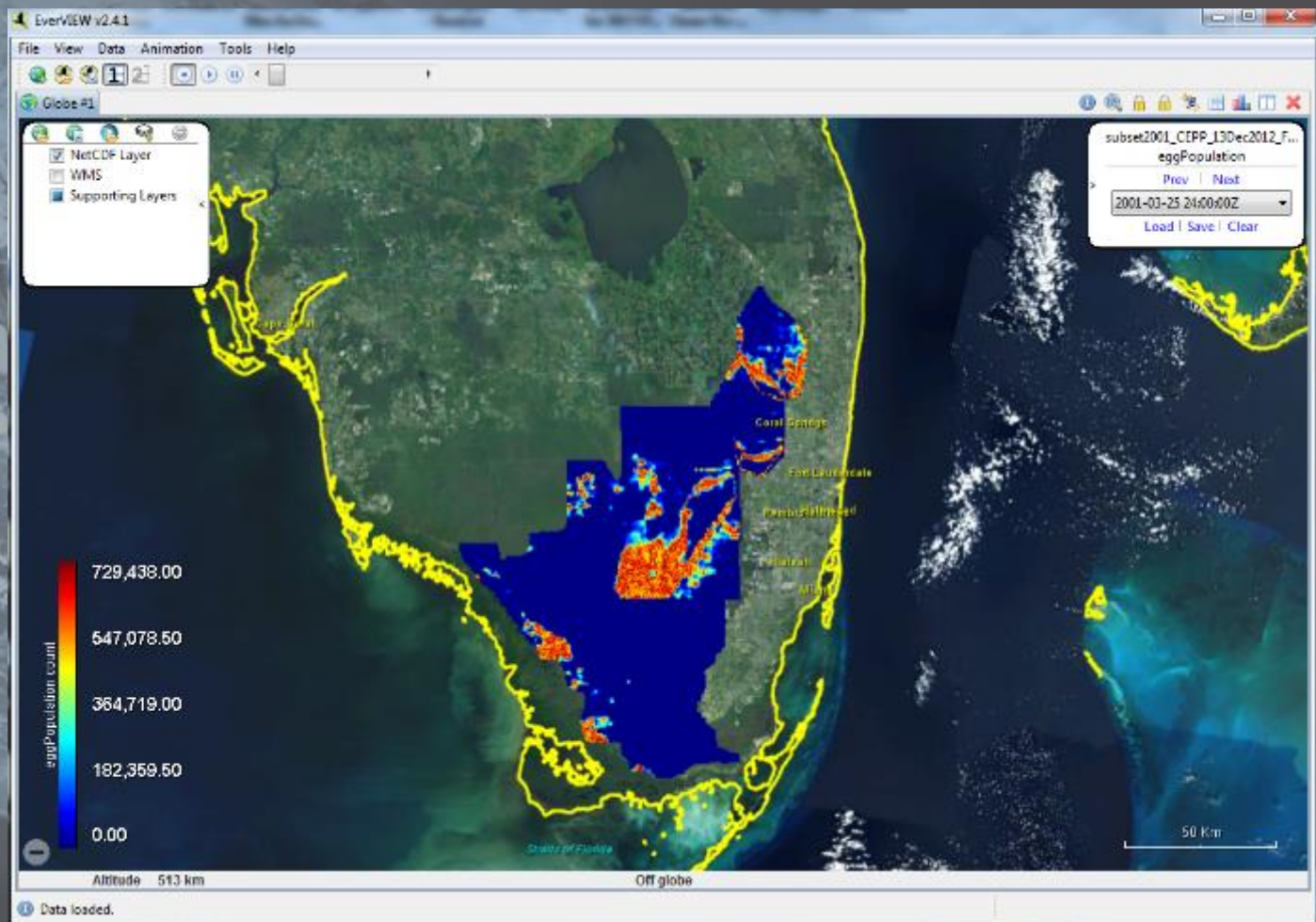
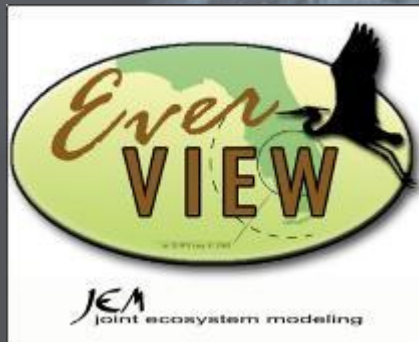


Data Collection and Modeling

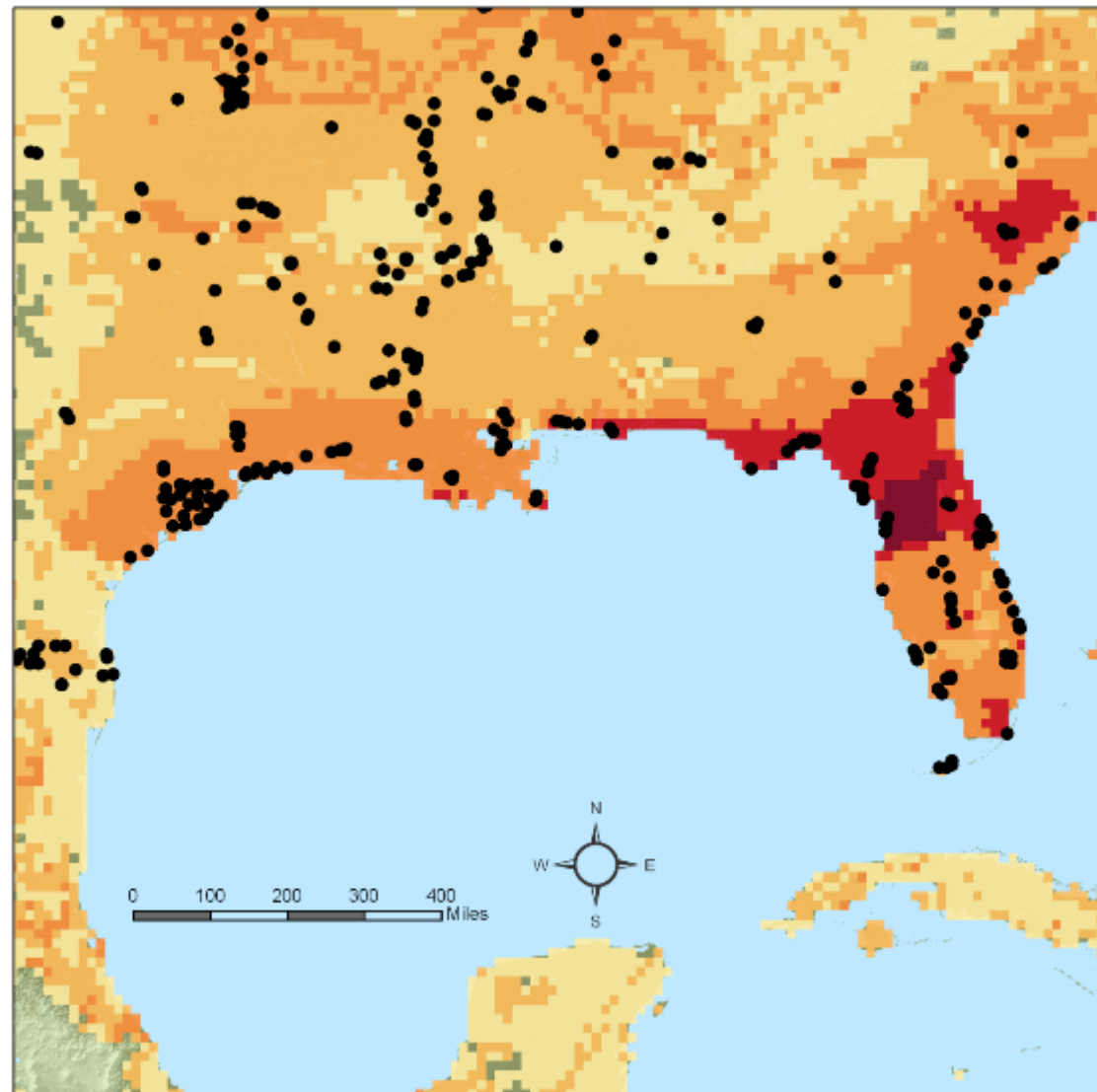
- Developed data standards allowed for rapid & effective collaboration
- Used in ecological models developed for Central Everglades Planning Process (CEPP)
- Joint Ecosystem Modeling developed tools to help display information from model outputs to help in decision making



Desktop visualization of complex time series modeling outputs



Using data and models to recommend conservation areas



Climate envelope

Florida's threatened and endangered species

Time period: Contemporary

Climate Dataset: CRU/
Worldclim consensus

Suitable climate space

- 1 species
- 2-4 species
- 5-7 species
- 8-10 species
- ≥ 11 species

(based on 26 total species)





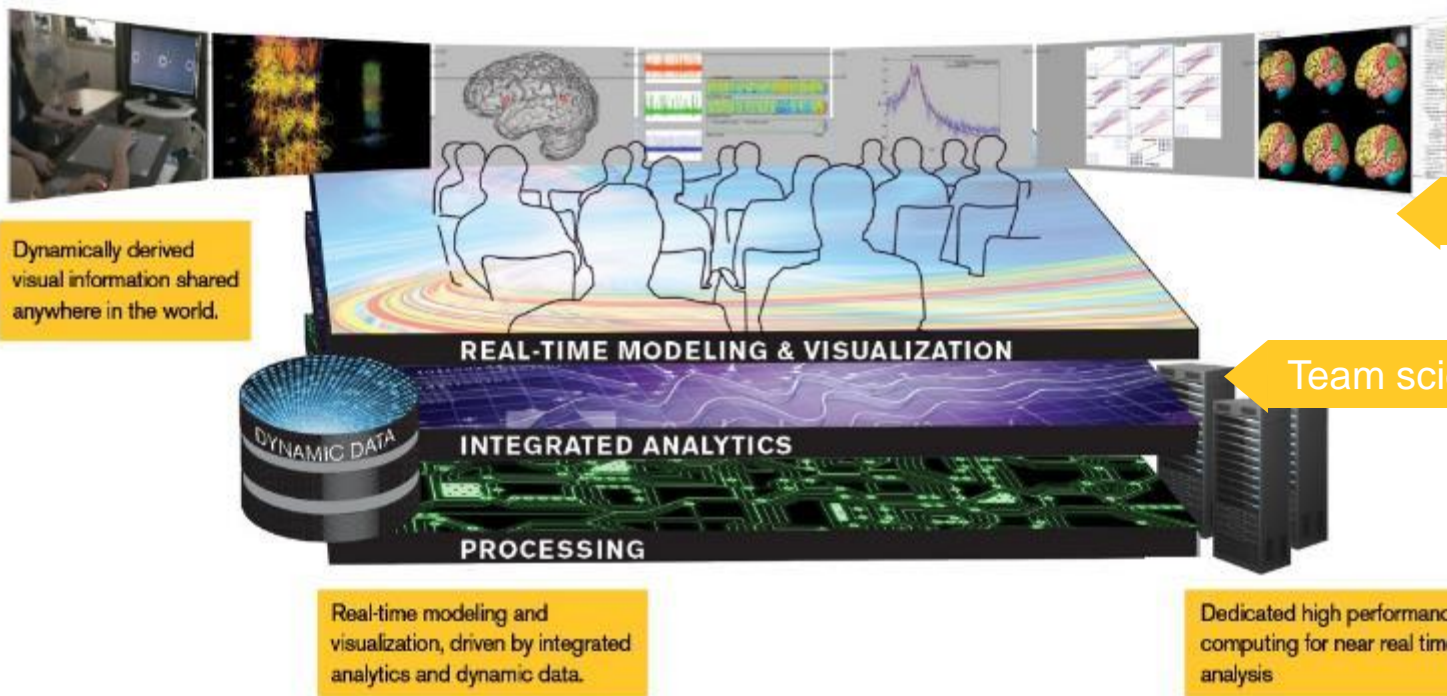
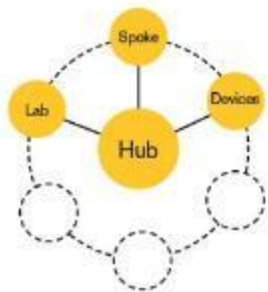
ARIZONA STATE UNIVERSITY

DESIGNING

VISUALIZING

solutions to complex problems in
the face of uncertainty

Linked via synchronized browsers, distant researchers participate real-time using inexpensive "Hub and Spoke configurations" with the ASU Decision Theater "Hub"





Disease Risk Assessment Specialties

- Emerging Infectious Disease, EID
- Human – Livestock – Wildlife Interface
- Emerging infectious disease assessment
- Capacity Building

“Need to increase the capacity of all countries worldwide to conduct surveillance, early detection, and initiate appropriate response to outbreaks and spread of diseases in wildlife”

OIE Global Conference on Wildlife
2011



Risk and Prioritization

■ EID Risk Factors

- Ecological change, climate change, human demographic and behavior changes, international travel and trade, microbial adaptation, infrastructure deficiencies

■ EID Prioritization

- Relative importance of wildlife diseases and risk factors varies among regions; simultaneous management prohibitively expensive

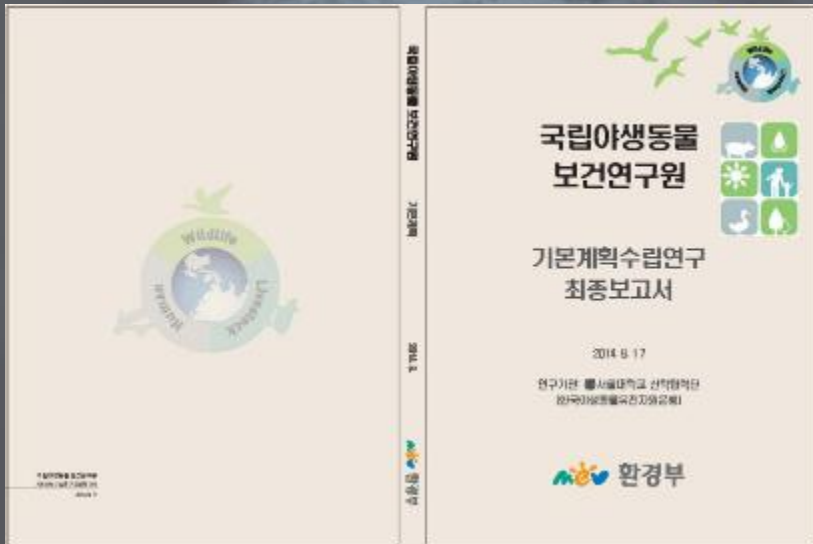


EID Risk Assessment Capabilities

- Expertise in qualitative and quantitative models and risk assessments
- Expertise in Bayesian modeling
- Expertise in writing and conduct of questionnaire surveys and subject matter elicitation workshops
- Development of novel technologies

Wildlife EID Risk Assessment: Republic of Korea

3 GOOD HEALTH
AND WELL-BEING



Korea National Wildlife
Health Center

Nationwide online
questionnaire survey of
subject matter experts



Assessment and Ranking

- Assessed wildlife disease release risk, exposure risk, consequences, and uncertainty
- Ranked disease exposure pathways and disease amplification risk factors

Cluster Analysis of Priority Diseases and Pathogens

High Risk, Low Uncertainty	Risk Group
African swine fever	Livestock
Aujeszky's disease	Livestock
Canine distemper virus	Wildlife
Canine parvovirus	Wildlife
Classical swine fever	Livestock
Porcine circovirus	Livestock

Cluster Analysis of Priority Diseases and Pathogens

High Risk, Medium Uncertainty	Risk Group
Bovine tuberculosis	Livestock
<i>Brucella abortus</i>	Livestock
<i>Campylobacter</i> spp.	Humans
<i>Coxiella burnetti</i>	Humans
<i>Ehrlichia chaffeensis</i>	Humans
Hepatitis E	Humans
HPAI	One Health
<i>Neospora caninum</i>	Livestock
Rabies	One Health
<i>Salmonella</i> spp.	One Health
SFTS	Humans
TBEV	Humans
West Nile virus	One Health

Exposure Pathways

Rank	Risk Score	Exposure Pathway
1	3.70	International human movement/migration
2	3.76	Illegal importation of wildlife and wildlife parts
3	3.85	Migration or natural movement of wildlife
4	4.18	Accidental introduction of disease vector
5	4.35	Smuggling of livestock products
6	5.59	Legal importation of wildlife and wildlife parts
7	6.14	Legal importation of livestock and products
8	7.63	Importation of biological materials and pathogens
9	7.72	Importation of vegetables and plant material
10	8.08	Bioterrorism or the deliberate release of pathogens

Disease Amplification Risk Factors

Rank	Risk Score	Risk Factor
1	3.68	Proximity of humans, livestock, and wildlife
2	4.64	High density of livestock populations
3	4.84	Habitat loss and environmental degradation
4	5.10	Climate change
5	5.96	Geographic location and proximity to neighboring countries
6	6.05	Overpopulation of species (wild boar, water deer)
7	6.39	Geological factors and location of Korea (longitude/latitude)
8	7.04	High density of human population
9	7.24	Environmental pollution
10	7.39	Agriculture and farming systems
11	7.67	Loss of biodiversity in Korea

Disease Transmission in Bats

- Prince Mahidol award presented to USGS researcher for contributions to understanding zoonotic disease transmission in bats in Thailand
- Tracking and modeling bat behavior



O'Shea, Cryan, et al. 2014





Conclusions, Future Direction

- Evidence-based priority setting when allocating resources to address EID risks
- **One Health** approach enhances coordination and improves infrastructure to address emerging infectious diseases
- Useful for countries or regions that wish to conduct similar large scale risk assessments



Projects

OIE Twinning Mahidol U.,
disease risk assessment

Asian Society of
Conservation Medicine
Conference Support



The Joint Conference of the Asian Society of
Conservation Medicine (ASCM) and Wildlife
Disease Association Australasia (WDAA)

Venue: Grand Inna Bali Beach Hotel, Sanur, BALI, INDONESIA

Date: October 28 – November 5, 2018 *(Please refer to Tentative Schedule)*

ASCM Link: <http://2018bali.ascm-aszwm.org/>



Biodiversity Protection Strategies for the Viet Nam Biodiversity Conservation Agency (BCA)

- 1. Enhance Scientific Understanding (Capacity Building)
- 2. Review Law, Draft Amendments
- 3. Enhance Offsets and Mitigations
- 4. Community-based Management
- Consistent with *Vietnam National Biodiversity Strategy to 2020* and the Biodiversity Corridors project

Enhance Scientific Understanding

- **Assessment – Stratification**
 - Organisms
 - Species Groups
 - Habitats
- **Database - GBIF**
 - Spatially referenced
 - QA/QC
 - Interconnectedness
 - Improved usability
 - Capacity building



Review Law, Draft Amendments

- Review VN and other biodiversity laws
- Draft amendments for BCA
 - Strengthen legal tools
 - Meet international obligations
 - Rationalize agency mandates
 - Strengthen enforcement



Enhance Offsets and Mitigation

- VN seeking to increase Heritage, Ramsar, etc.
- Assess and recommend options
 - Biodiversity offsets
 - Payments for environmental services
 - Conservation banking





Community-based Management

- Community outreach
- Recommended protected areas
- Legal review and draft recommendations
 - Goals and objectives
 - Prohibited activities
 - Penalties for violations
 - Roles and responsibilities



Regional Assessment of Lower Mekong River Groundwater

6

CLEAN WATER
AND SANITATION

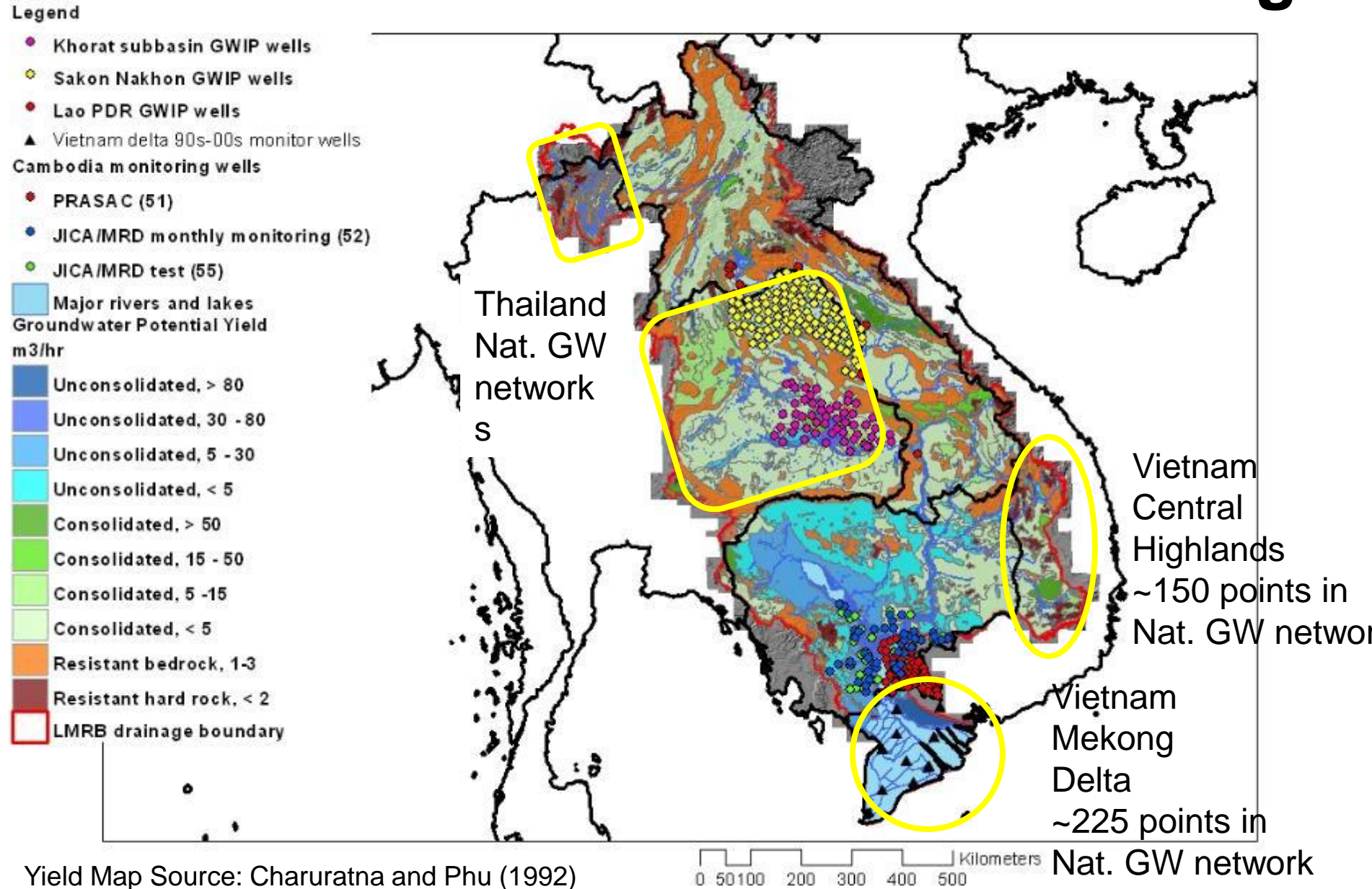




Groundwater Background

- Lower Mekong groundwater development accelerated since 1990s
- Groundwater – Surface Water (GW – SW) interactions not well understood
- GW increasingly important
 - Water supply
 - Agriculture
 - Maintaining surface flows
- USGS providing groundwater training to Thailand Dept. Groundwater Resources

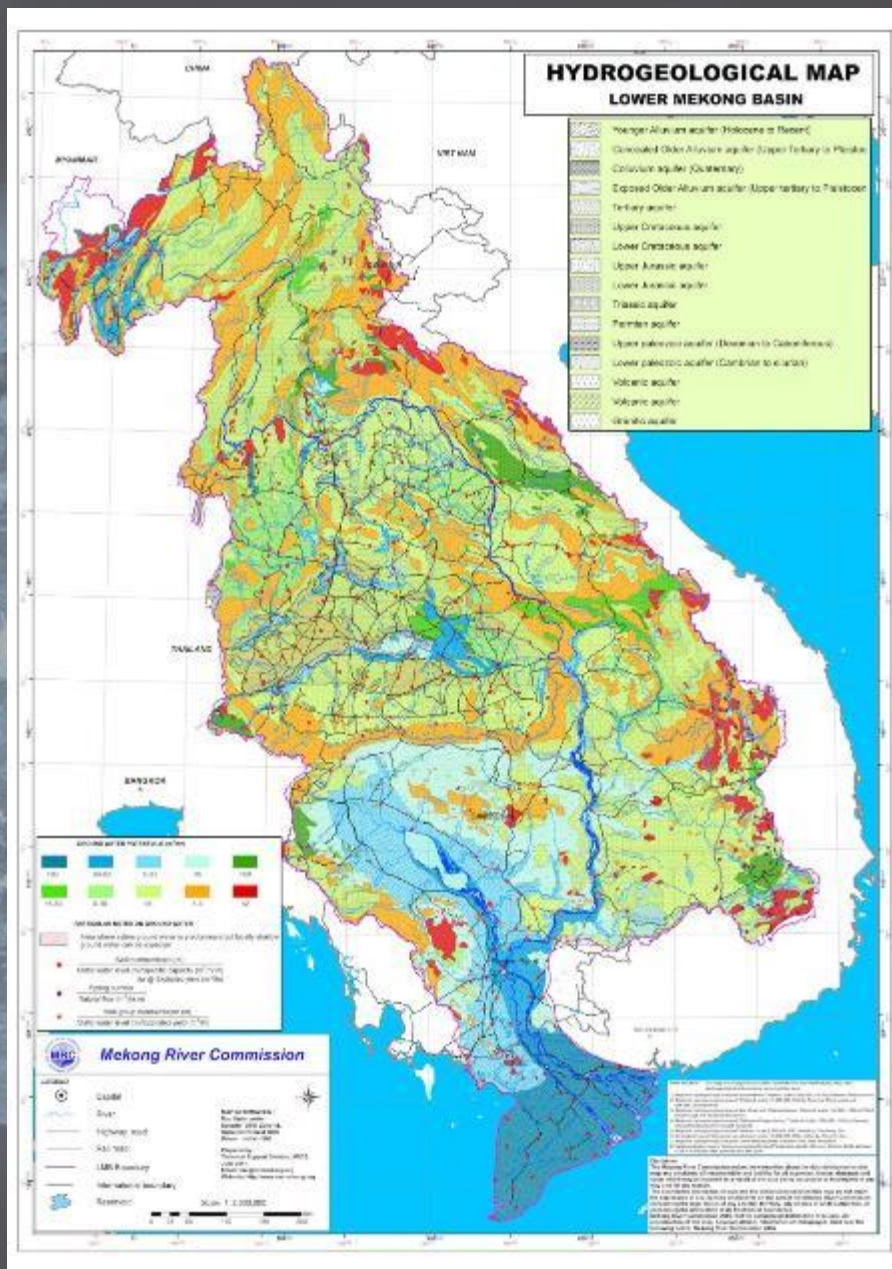
LMRB Current Groundwater Monitoring





Mekong River Groundwater Study

- Concept note with VIGMR for Viet Nam – Cambodia groundwater study
 - Train local scientists in GW study methods
 - Simulate groundwater – surface water interactions in Mekong Delta
 - Assess and forecast saltwater intrusion in response to withdrawals and sea level rise
 - Forecast responses to management, mitigation, development
 - Dynamic web-based interfaces for reporting and updating



A photograph of a multi-tiered waterfall cascading over mossy rocks in a lush forest. The water flows from the top left, down several levels of rocks, and finally into a pool at the bottom. The surrounding area is filled with green foliage and trees. The text "Thank You for Your Attention" is overlaid in the center in a white, cursive font.

*Thank You for
Your Attention*