Climate, Risk and Services

Practice-Relevant Adaptation Science across climate timescales

Roger S. Pulwarty

Climate and Societal Interactions Division and

National Integrated Drought Information System

National Oceanic and Atmospheric Administration

Experts say rainfall may lessen drought

By Julia Glick

The Associated Press

DALLAS—Heavy rainfall that

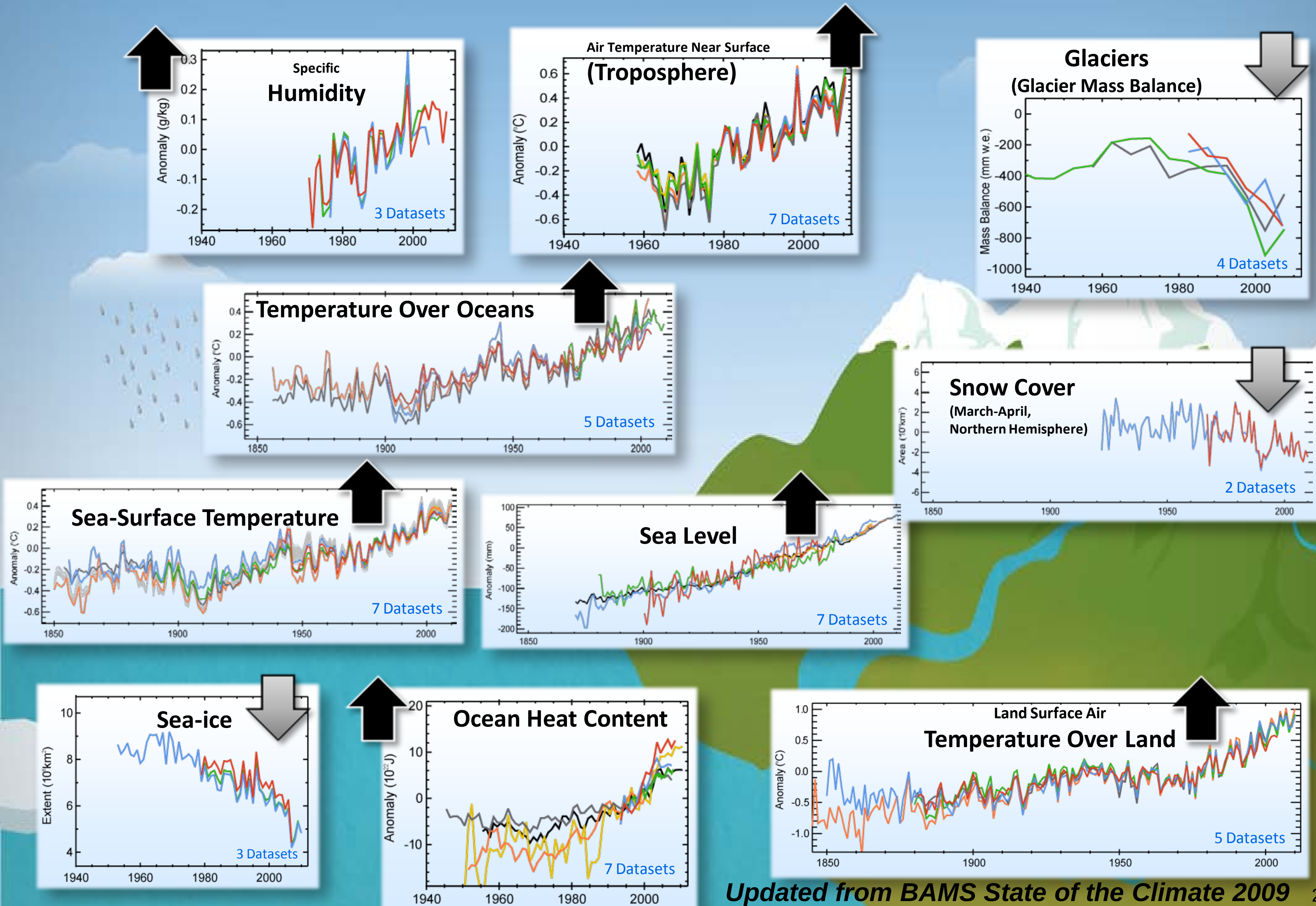
WCRP CONFERENCE FOR LATIN AMERICA AND CARIBBEAN:

DEVELOPING, LINKING AND APPLYING CLIMATE KNOWLEDGE

17–21 March 2014, Montevideo, URUGUAY

http://www.cima.fcen.uba.ar/WCRP/

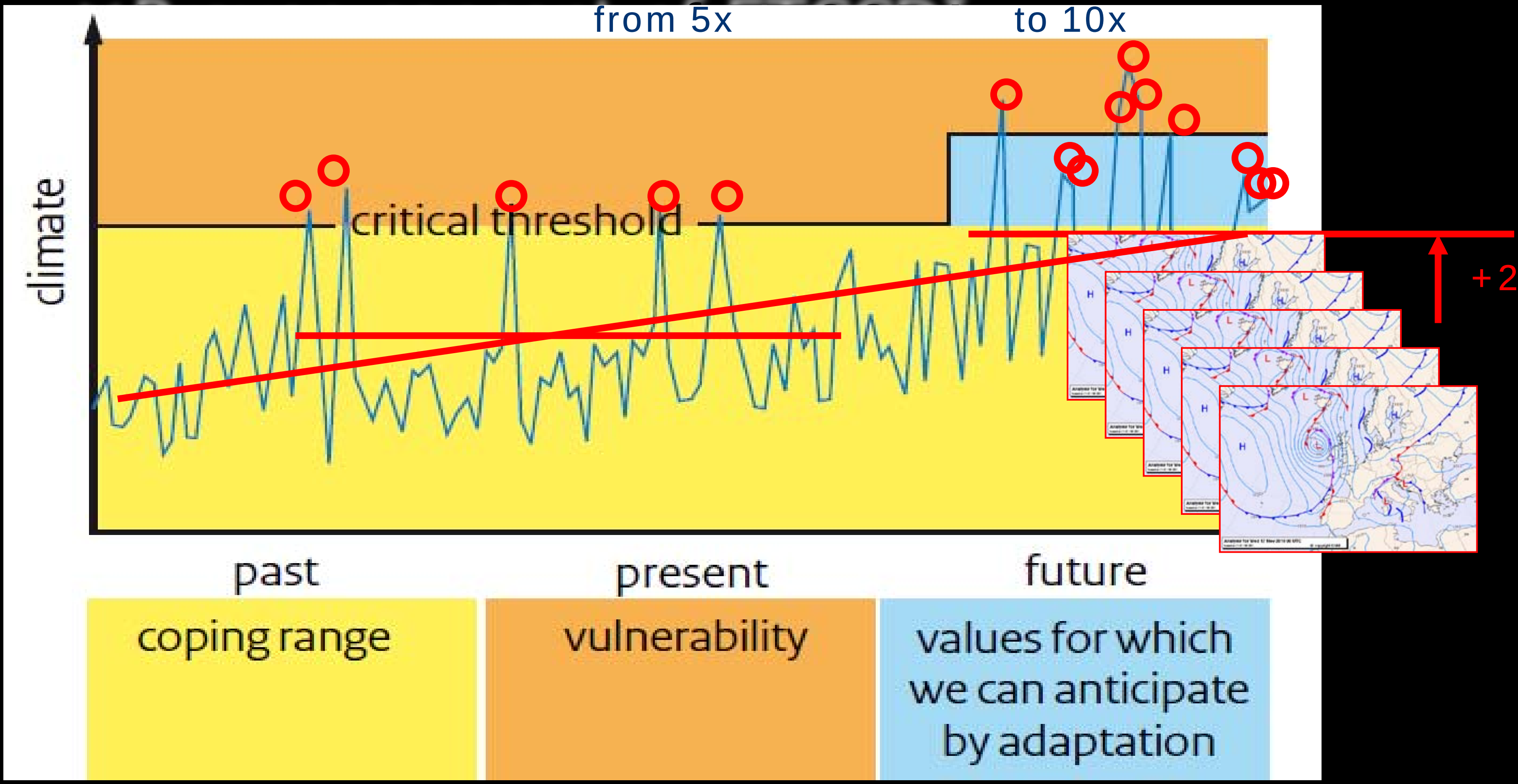
Observed Physical Changes

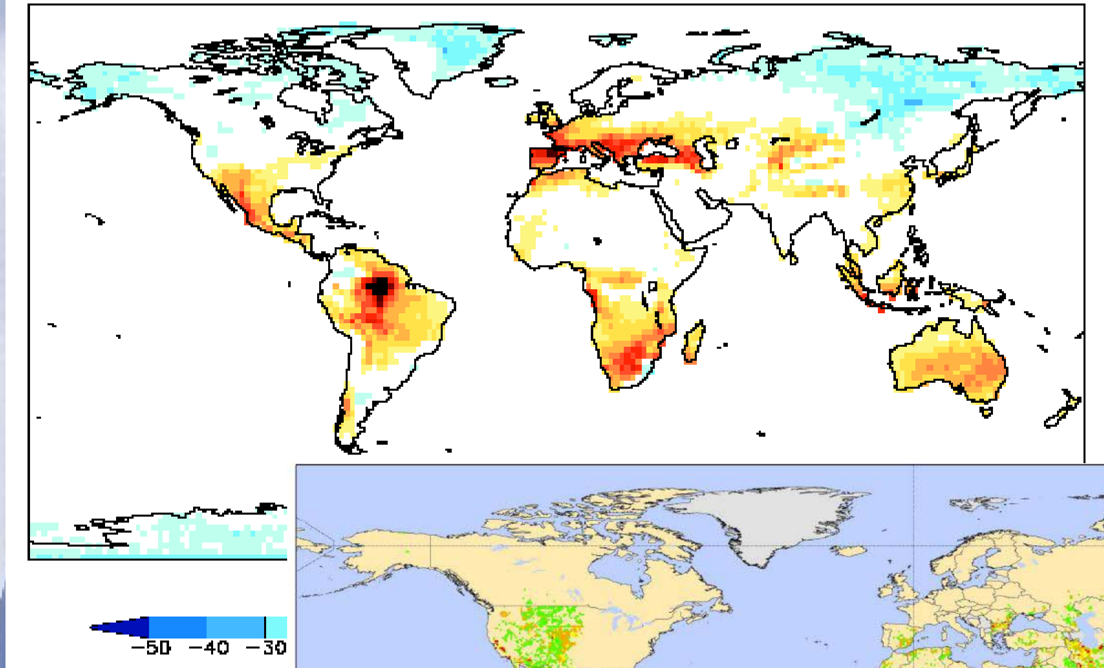


Updated from BAMS State of the Climate 2009

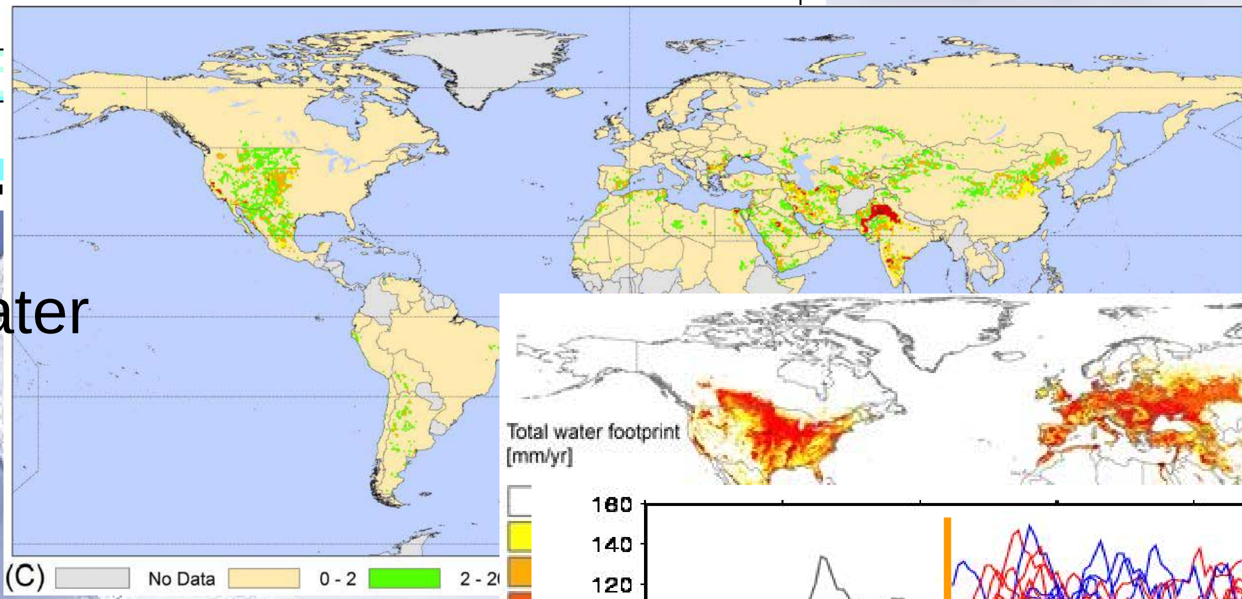
Changing risks-a classical view

Willows and Connell, UKCIP, 2003

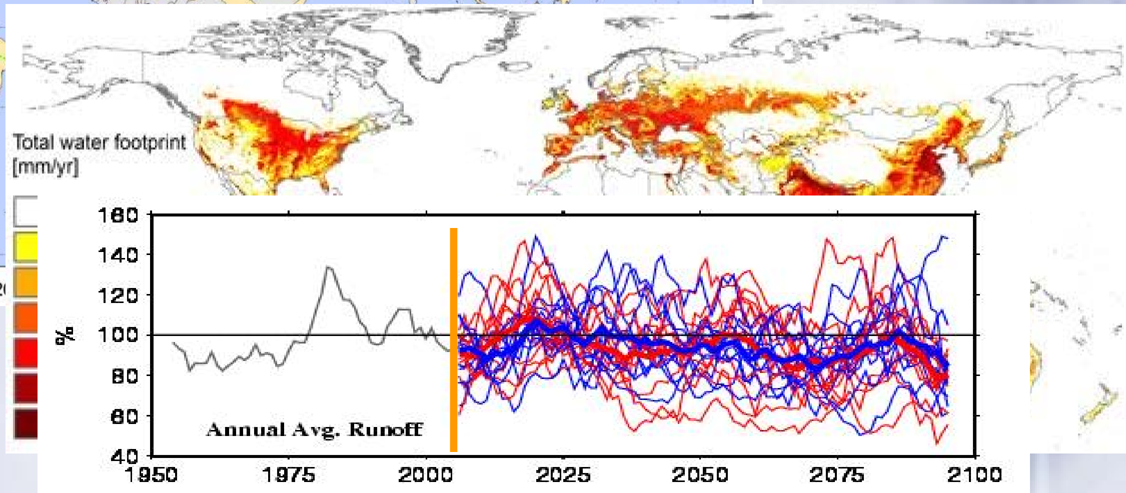




Model agreement (2050)



Groundwater depletion



Water footprint

Many potential futures:

Adaptation requires science that analyzes decisions, identifies vulnerabilities, improves foresight, and develops options

Goals

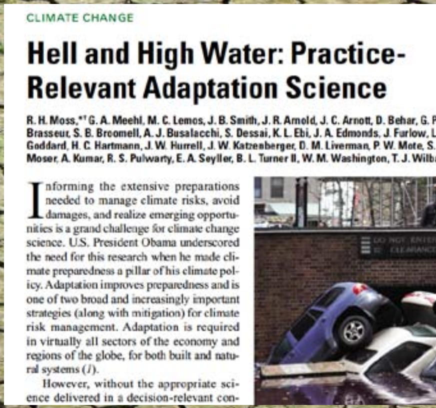
Identify research themes critical to improve our understanding of sources and intrinsic levels of predictability on intraseasonal, interannual, decadal and longer time scales

Promote discussions across WCRP emerging initiatives relevant to LAC such as grand challenge on regional climate, grand challenge on water availability, and CLIVAR Monsoon activities

Contribute to the identification of knowledge needed to establish relevant regional climate services with the advances in the above research topics

Adaptation requires science that analyzes decisions, identifies vulnerabilities, improves foresight, and develops options

Most estimates of disaster losses exclude indirect losses – livelihoods, informal economies, intangible losses including ecosystem services, quality of life and cultural impacts


CLIMATE CHANGE

Hell and High Water: Practice-Relevant Adaptation Science

R. H. Moss,* G. A. Meehl, M. C. Lemos, J. B. Smith, J. R. Arnold, J. C. Arnott, D. Behar, G. F. Brasseur, S. B. Broomell, A. J. Busalacchi, S. Dessai, K. L. Ebi, J. A. Edmonds, J. Furlow, L. Goddard, H. C. Hartmann, J. W. Hurrell, J. W. Katzenberger, D. M. Liverman, P. W. Mote, S. Moser, A. Kumar, R. S. Pulwarty, E. A. Seyller, B. L. Turner II, W. M. Washington, T. J. Wilb

Informing the extensive preparations needed to manage climate risks, avoid damages, and realize emerging opportunities is a grand challenge for climate change science. U.S. President Obama underscored the need for this research when he made climate preparedness a pillar of his climate policy. Adaptation improves preparedness and is one of two broad and increasingly important strategies (along with mitigation) for climate risk management. Adaptation is required in virtually all sectors of the economy and regions of the globe, for both built and natural systems (1).

However, without the appropriate science delivered in a decision-relevant con-

For exposed and vulnerable communities, even non-extreme weather and climate events can have extreme impacts

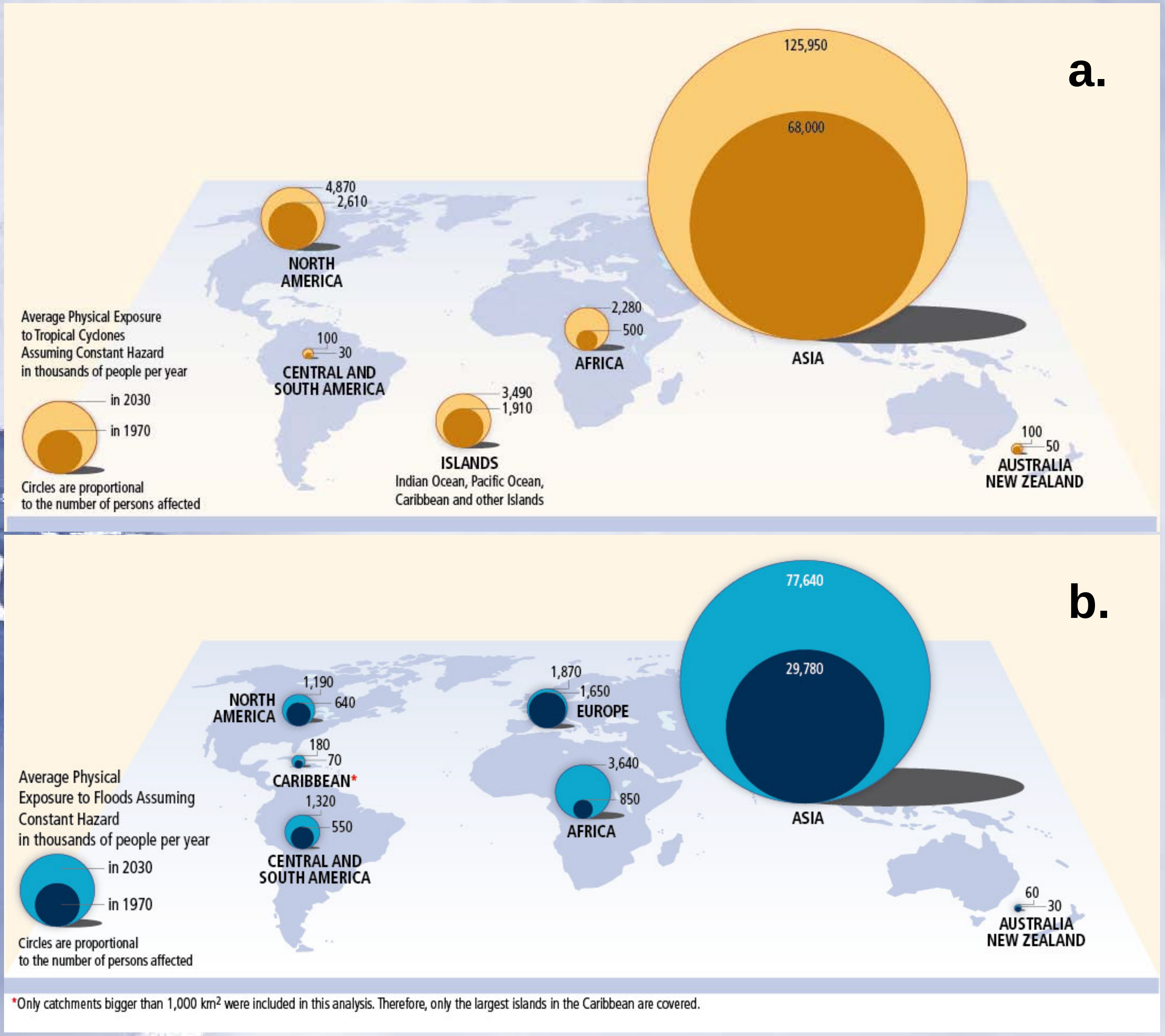
ISDR

ipcc INTERGOVERNMENTAL PANEL ON climate change

The Romans Ignored The AD 205 IPCC Report!

Source: InfoRoma, 2004. www.inforoma.it

DEFERRED MAINTENANCE?

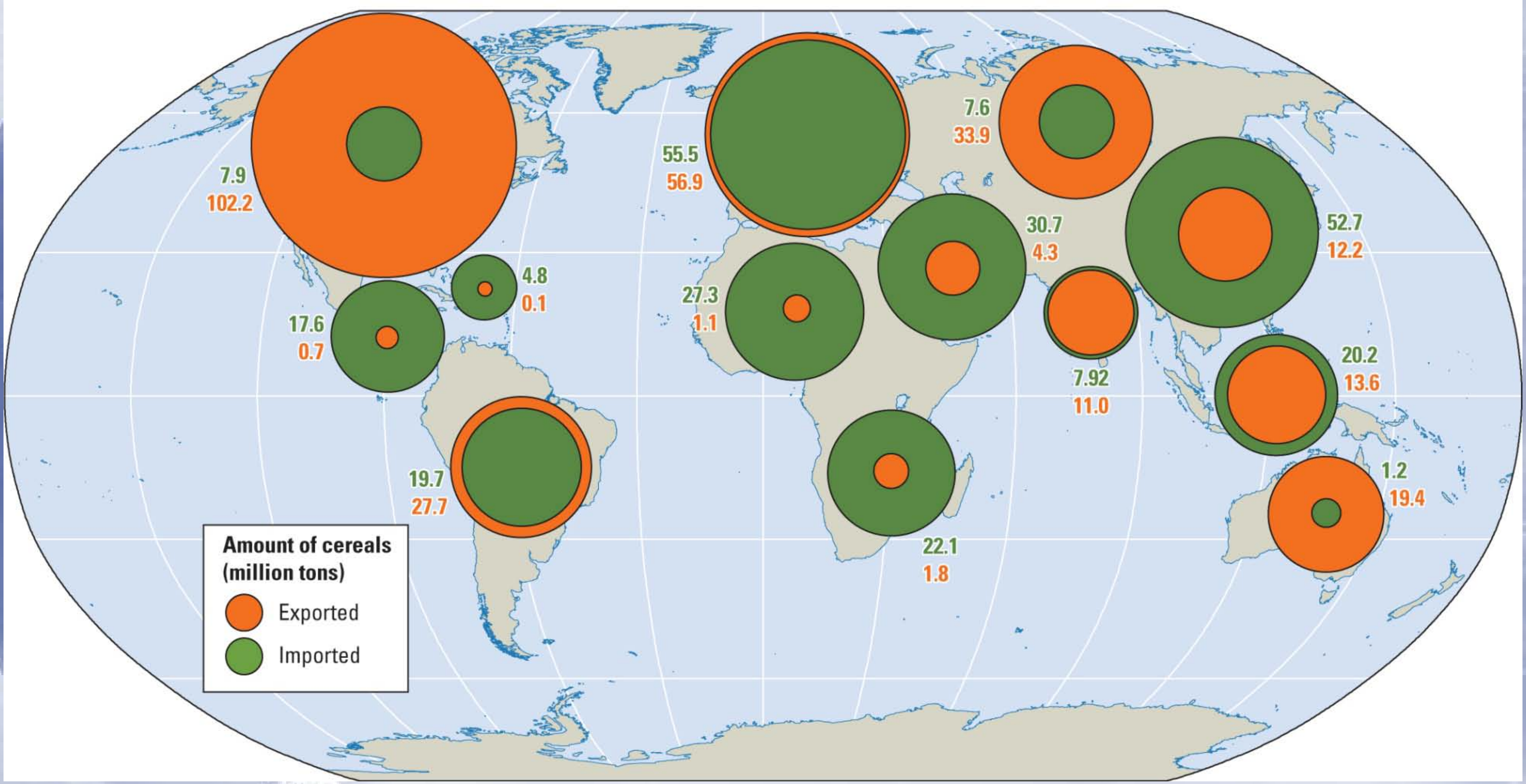


1970

2030

Average physical exposure (1970, 2030)
a. Tropical cyclones b. Flooding (IPCC, 2012)

World grain trade depends on exports from a few countries

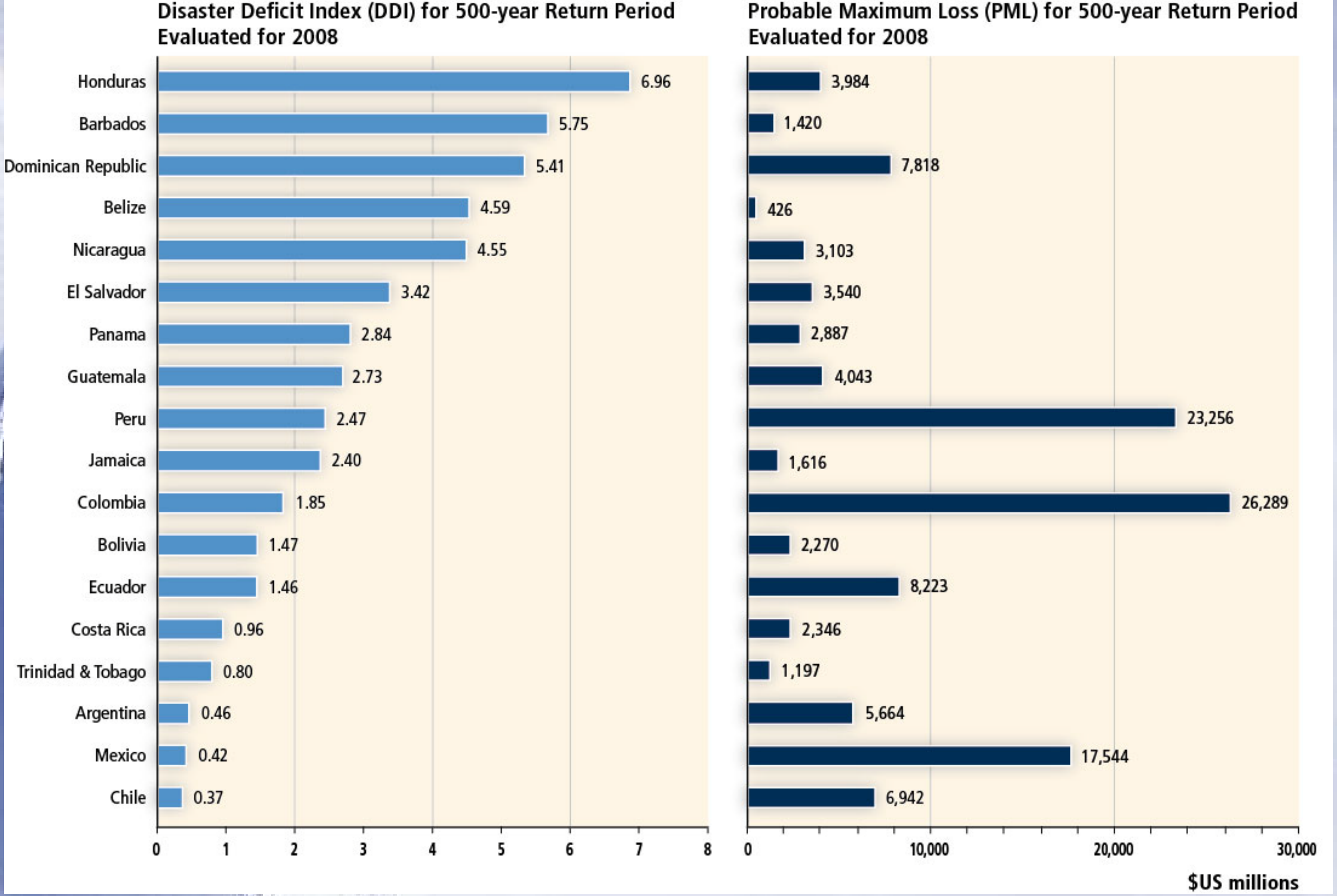


Source: FAO 2009c.

Note: Annual exports and imports are based on the average over four years (2002–2006)

Caribbean annual food import $3.5b.

World Development Report 2010



The DDI captures the relationship between the demand for contingent resources to cover the losses caused by the Maximum Considered Event (MCE) and the public sector’s economic resilience (i.e. the availability of internal and external funds for restoring affected inventories).

DDI is greater than 1.0 = economic incapacity of the country to cope with extreme disasters even where indebtedness is carried to a maximum-greater the DDI, the greater the gap.

Country	Effects			
	Thermal Variations	Variations in Rainfall	Extreme Eve	
Argentina	Receding Glaciers	Floods Droughts	Storms Tornadoes	
Bolivia	Receding Glaciers	Floods Droughts Hailstorms	Intensification o El Niño and La N	
Brazil		Floods Droughts	Cyclones	
Chile	Receding Glaciers	Droughts		
Colombia	Receding Glaciers			
Costa Rica		Floods Droughts		
Cuba				
Ecuador	Receding Glaciers	Floods Rainfall		
El Salvador		Rainfall Drought	Hurricanes Tropical storms	
Guatemala			Hurricanes Tropical storms	
Honduras		Rainfall Drought	Hurricanes Tropical storms	
Mexico		Rainfall Drought	Hurricanes Tropical storms	
Nicaragua		Rainfall Drought Floods	Intensification o El Niño and La N	
Panama	Changing Patterns	Changing Patterns	Storms	
Paraguay		Droughts	Storms with hailstones	
Peru	Receding Glaciers	Rainfall Desertification	Intensification o El Niño and La N Emergencies du natural disasters	
Uruguay		25% increase in rainfall over 30 years	Intensification of extreme events	Rise i Floods
Venezuela				

Environment	Approved Joint Programmes - Title	Budget (USD)
Colombia	Integration of ecosystems and adaptation to climate change in the Colombian Massif	4,000,000
Ecuador	Conservation and Sustainable Management of the Natural and Cultural Heritage of the Yasuni Biosphere Reserve	4,000,000
Guatemala	Strengthening Environmental Governance in the face of Climate Risks in Guatemala	3,600,000
Nicaragua	Local / regional environmental management for the management of natural resources and provision of environmental services	4,500,000
Panamá	Integration of Climate Change Adaptation and Mitigation Measures in the Management of Natural Resources in Four Priority Watersheds of Panama	4,000,000
Peru	Integrated and adaptive management of environmental resources and climatic risks in High Andean micro-watersheds	3,900,000

Need for additional studies	Country
Vulnerability studies at national and local level.	Costa Rica, Guatemala, Nicaragua, Mexico
Studies on technological needs and potential for technology transfer/development.	Colombia, Mexico
Study on profitable sector-based mitigation activities, evaluation of collateral beneficiaries in the instrumentation of adaptation and mitigation measures.	Costa Rica, Mexico
Studies on adaptation of key economic sectors.	Guatemala, Mexico
Long term projections with different kinds of mitigation.	Bolivia, Mexico
Hydrometeorological and satellite studies to predict Climate Change.	Argentina
UNFCCC and Kyoto Protocol instruments.	Cuba, Paraguay, Peru, Uruguay

Mercosur – The Southern Common Market

IICA – The Inter-American Institute for Cooperation
on Agriculture

EuropeAid, 2009; IPCC SREX 2012; IPCC, 2007-2014)

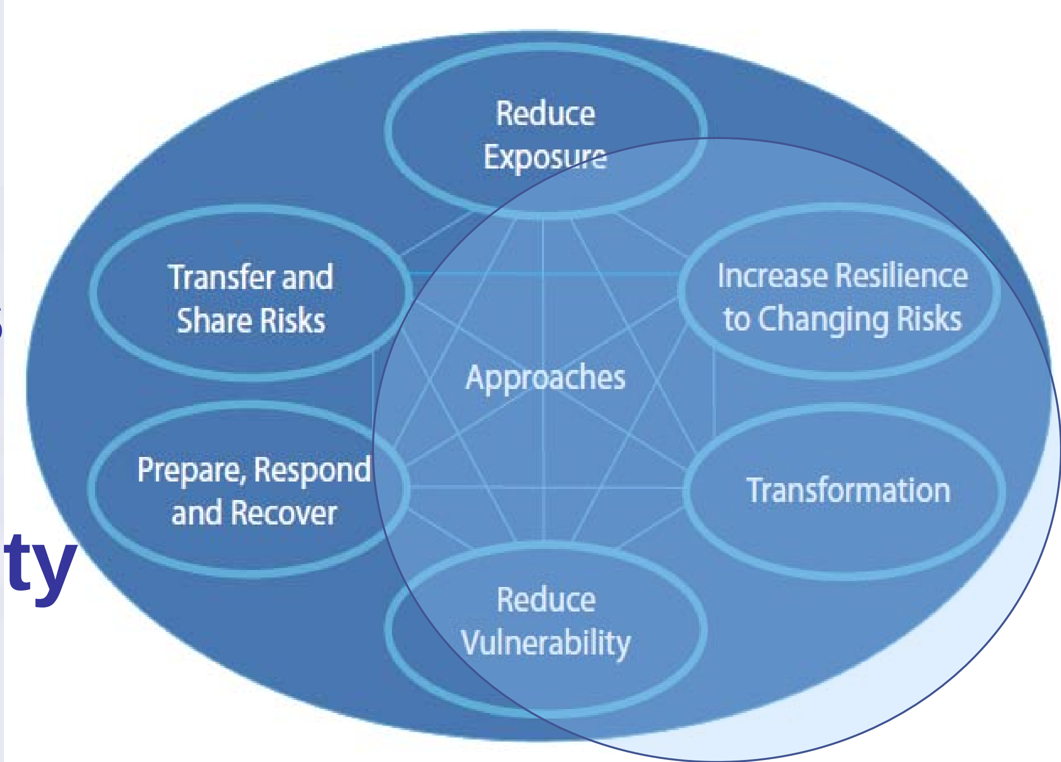
CAN – The Andean Community
CAPRADE – The Andean Committee for Preventing and Dealing with Disasters

OLADE - The Latin American Energy Organisation

Linking Preparedness and adaptation

- **Information systems**
- **Infrastructure/technology**
- **Insurance**
- **Integrated systems**
- **Institutional capacity**

IPCC SREX-the Solution Space



'No or low regrets' practices with demonstrated evidence of having integrated observed trends in disaster risks to reduce the effects of disasters

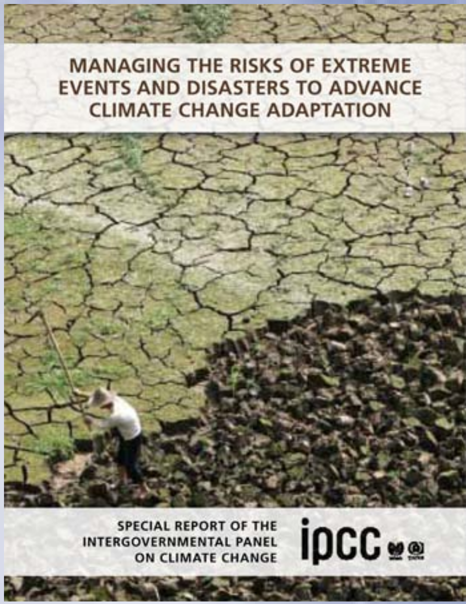
- Effective early warning systems and emergency preparedness (*very high confidence*)
- Integrated water resource management (*high confidence*)
- Rehabilitation of degraded coastal and terrestrial ecosystems (*high confidence*)
- Robust building codes and standards reflecting knowledge of current disaster risks (*high confidence*)
- Ecosystem-based/nature-based investments, including ecosystem conservation measures (*high confidence*)
- Micro-insurance, including weather-indexed insurance (*medium confidence*)
- Vulnerability-reducing measures such as pro-poor economic and human development, through for example improved social services and protection, employment, wealth creation (*very high confidence*)

Practices that enhance resilience to projected changes in disaster risk

Effective early warning systems and emergency preparedness

- Integrated coastal zone management integrating projections of sea level risk and weather/climate extremes (*medium confidence*)
- National water policy frameworks and water supply infrastructures, incorporating future climate extremes and demand projections (*medium high*

Vulnerability reducing measures such as pro-poor economic and human development, through improved social services and protection



If it's so easy…why is it so difficult?

- The cumulative nature of hazards, extremes and disasters
- Difficulties of proactive decision-making: Learning and policy windows
- The socialization of lessons learned by particular individuals and organizations through direct trial and error experiences- Practical confusion regarding what is included in the term climate adaptation
- Information services to support adaptation in changing environments

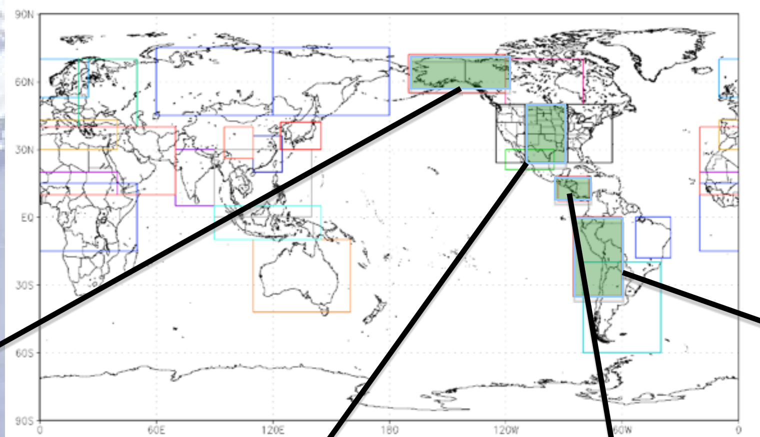
Climatic drivers of extremes- a continuum and adaptation deficits

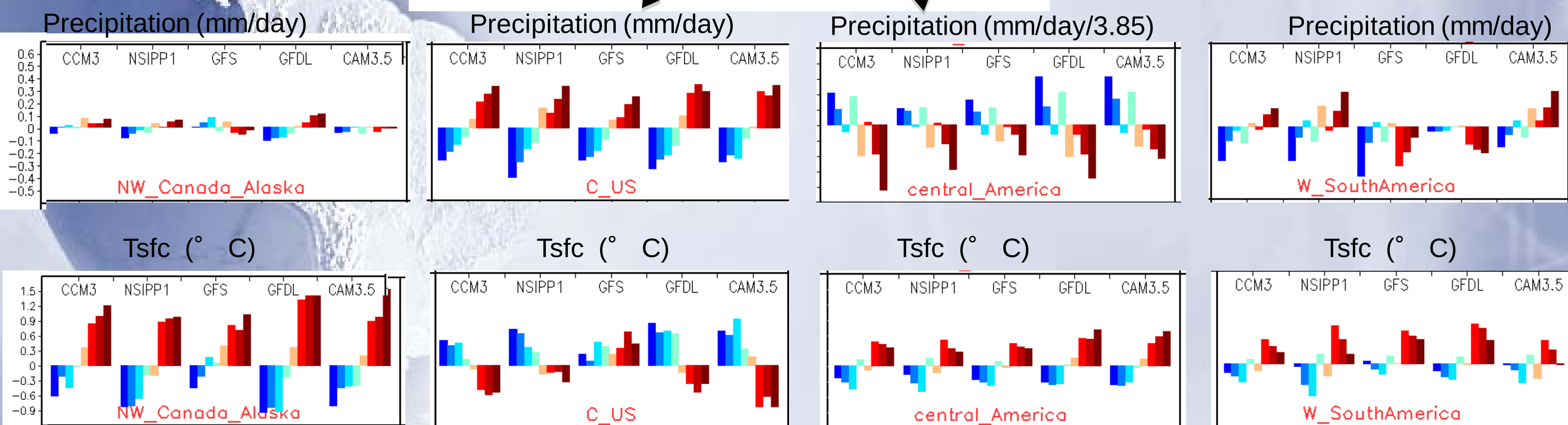
It's not just about trends-
Short-term actions do not always provide long term risk reduction- can reduce or increase longer-term risks

Annual Mean Responses to Pacific and Atlantic SST

(for each model: CCM3, NSIPP1, GFS, GFDL, CAM3.5)

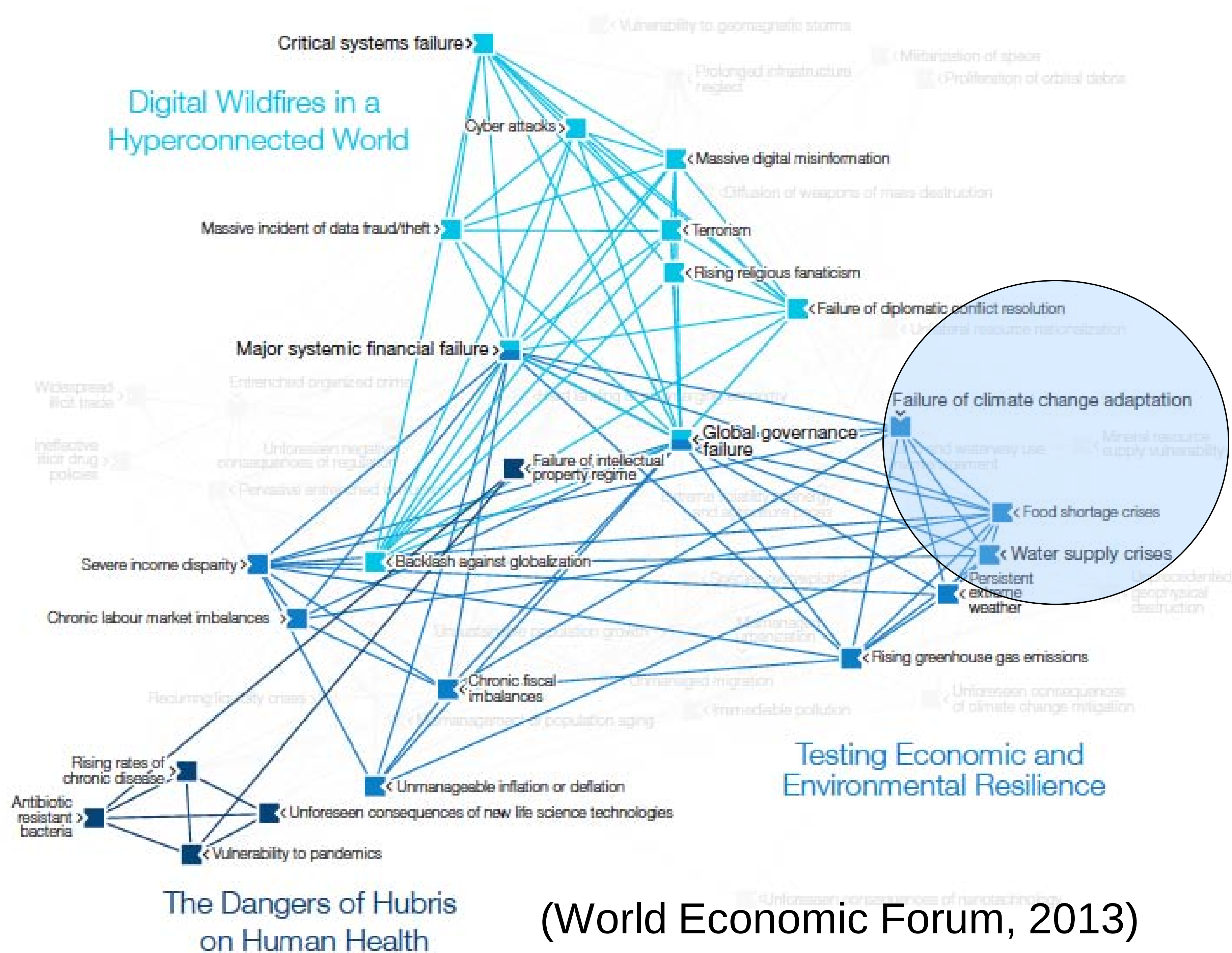
Regions: Land Only





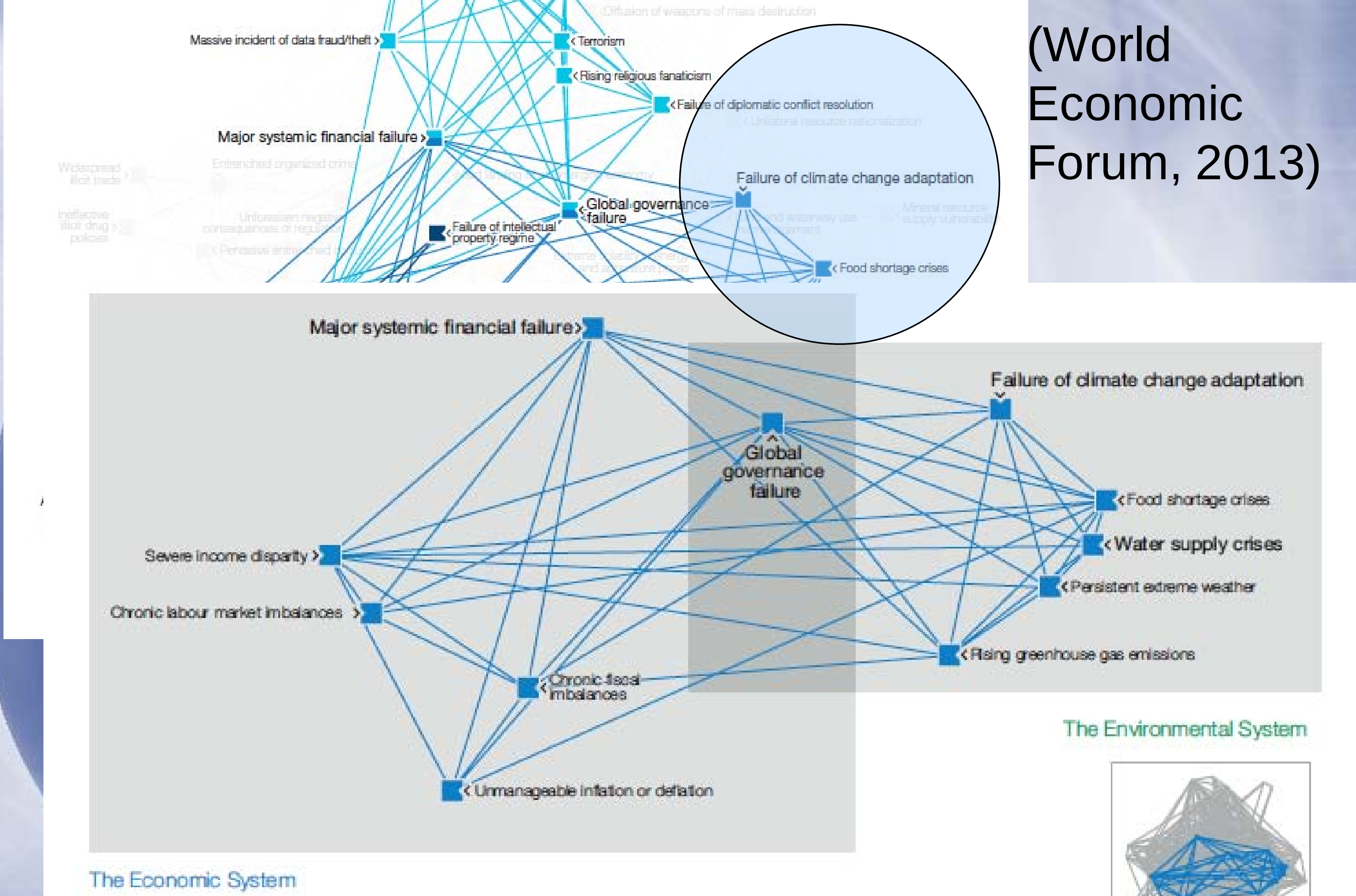
PcAw PcAn PcAc PnAw PnAc PwAw PwAn PwAc

Color Code of SST Combinations



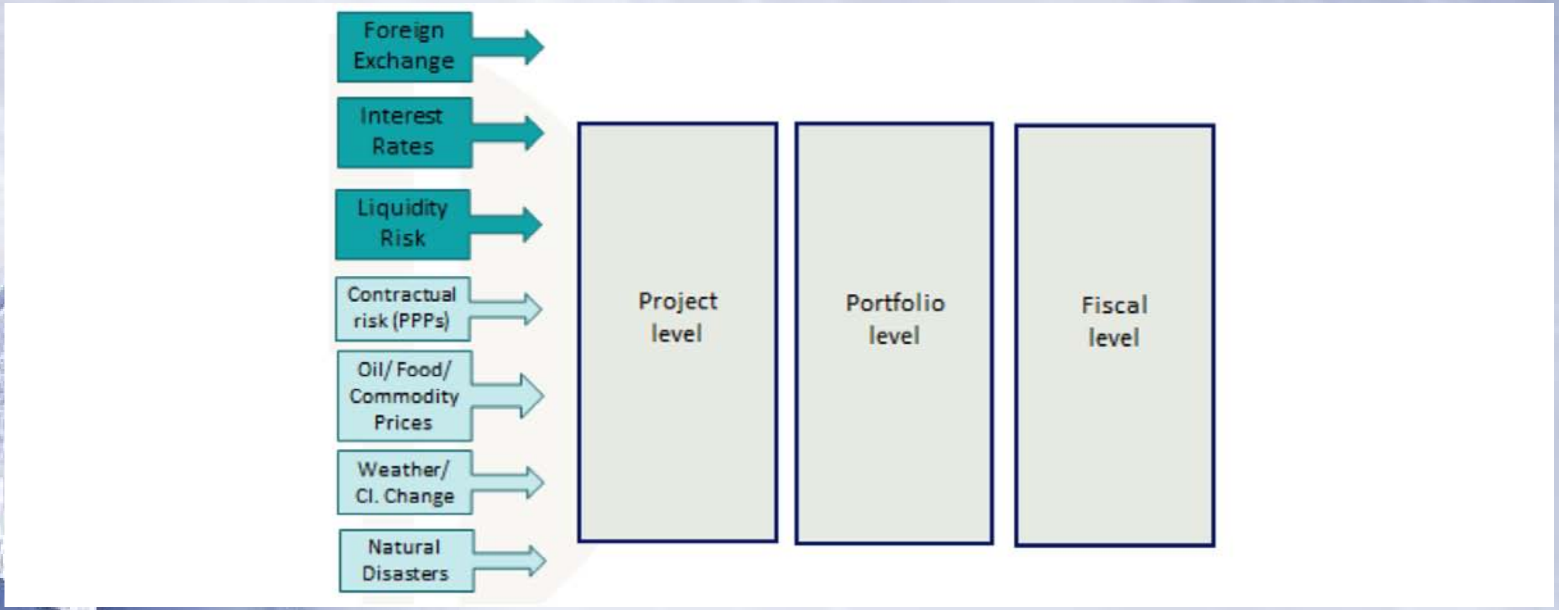
(World Economic Forum, 2013)

(World Economic Forum, 2013)



How is the capability of societies to respond to climate change enabled or constrained by other social, ecological and political dynamics?

How can improved climate services help to deal with these interconnected dynamics?



Opportunities exist for synergies in international finance for disaster risk management and adaptation that produce co-benefits, but these have not yet been fully realized-

Governments want to be able to answer questions such as:

How should we compare the marginal benefits of expenditures for infrastructure investments, price hedging instruments, insurance programs, catastrophe reconstruction bonds, or building retro-fitting? for near-term vs. long-term risks?

Integrated Risk Management in Latin America 2014 (Brandon, World Bank, 2014)

Is it possible to develop comprehensive systems in the case of climate ?

- Data limitations-Spatial and temporal complication.
- Heterogeneous contexts for impacts management- regional scales of projections frustrate local decision makers.
- Financial resources
- **Lack of national and regional policy frameworks**
- **Lack of coordination among institutions that provide different types of early warning and adaptation interventions**

Demand for Climate Information is Increasing Across Space and Time Scales

A suite of products from near term forecasts to long term projections, tailored to stakeholders' needs.

Global Framework for Climate Services

- Goal:
  - Enable better management of the risks of climate variability and change and adaptation to climate change at all levels, through development and incorporation of science-based climate information and prediction into planning, policy and practice.

World Meteorological Organization
Weather • Climate • Water

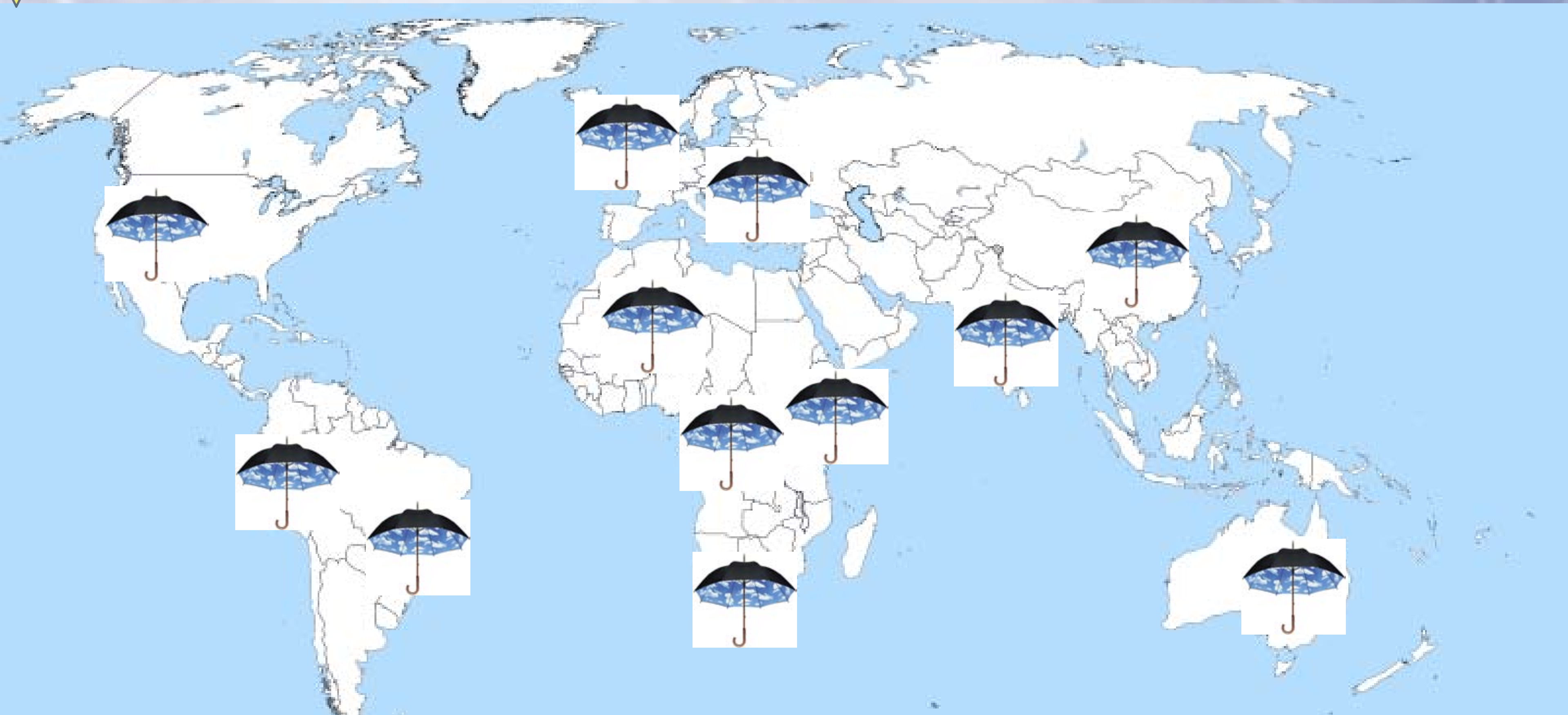
WORLD CLIMATE CONFERENCE - 3

Geneva, Switzerland

31 August–4 September 2009

GFCS Components

- User Interface Platform (UIP)
- Climate Services Information System (CSIS)
- Observations and Monitoring
- Research, Modeling and Prediction
- Capacity Building

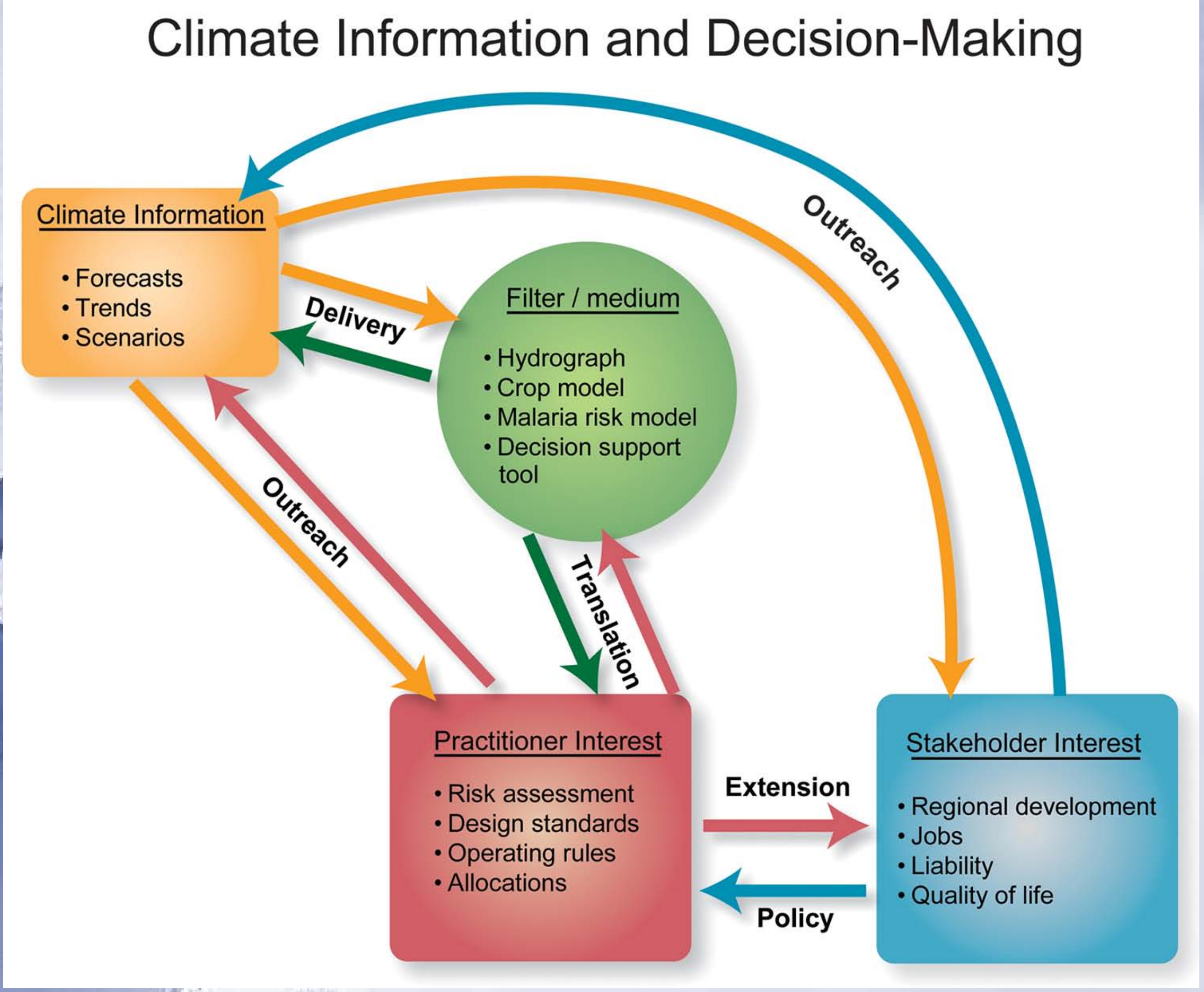


Climate Risk Management - Current Issues and Challenges

Improving Climate Risk Management at Local Level – Techniques, Case Studies, Good Practices and Guidelines for World Meteorological Organization Members

R. Martínez, D. Hemming, L. Malone, N. Bermudez,
G. Cockfield, A. Diongue, J. Hansen, A. Hildebrand, K. Ingram,
G. Jakeman, M. Kadi, G. R. McGregor, S. Mushtaq, P. Rao, R. Pulwarty,
O. Ndiaye, G. Srinivasan, Eh. Seck, N. White and R. Zougmoré

- **Assessing International Drought Information Systems: Cases (HMNDP, Pulwarty and Sivakumar, 2014)**



Four dimensions of improvement desired by most public and private resource managers—(i) model agreement, (ii) narrowing the projection range, (iii) higher-resolution spatial and temporal scales, and (iv) improved shorter time-horizon projections

Adaptation: Crisis, learning and redesign

What has led to being "proactive"?

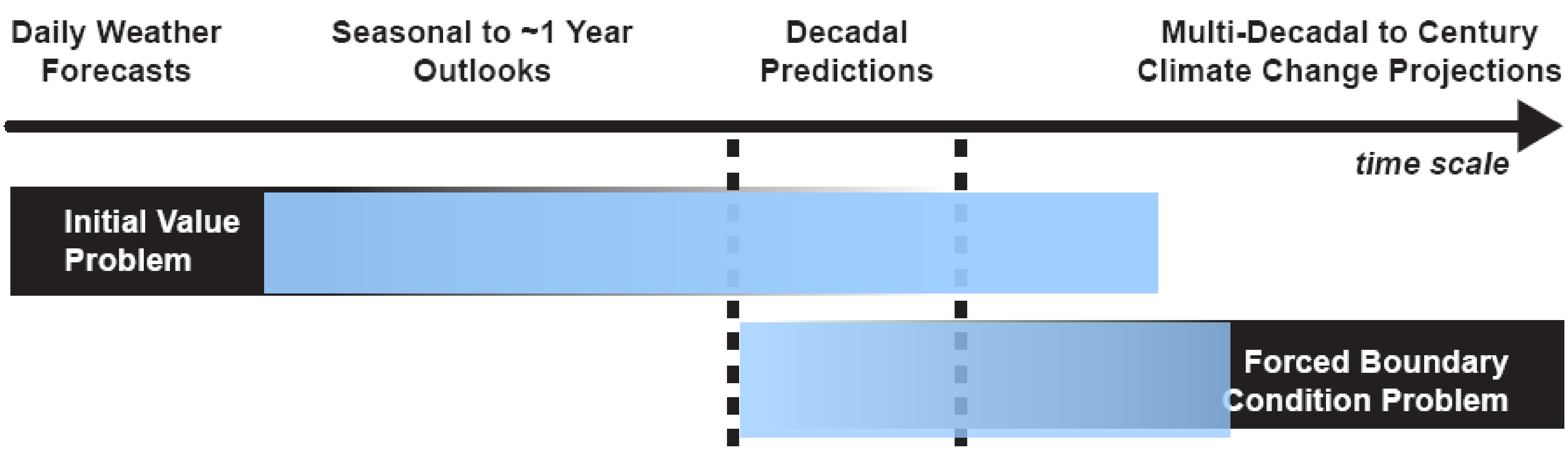
1. Focusing events and windows of opportunity- extremes, legal decisions etc.
2. Leadership <u>at different levels</u> and the public are engaged
3. <u>Supported framework for collaboration between research and management-</u>
4. Existing social basis or even pressure for collaboration

Moving ahead on developing climate services to inform preparedness and adaptation

Guiding principles

1. Acknowledge the cross-scale nature of climate, of early warning information-and corresponding monitoring and research needs

Decadal prediction lies between initialized weather or ENSO forecasts, and future climate change projections-not just “extremes” or “trends”

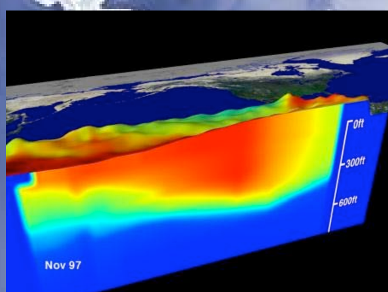


Pathways to Predictability

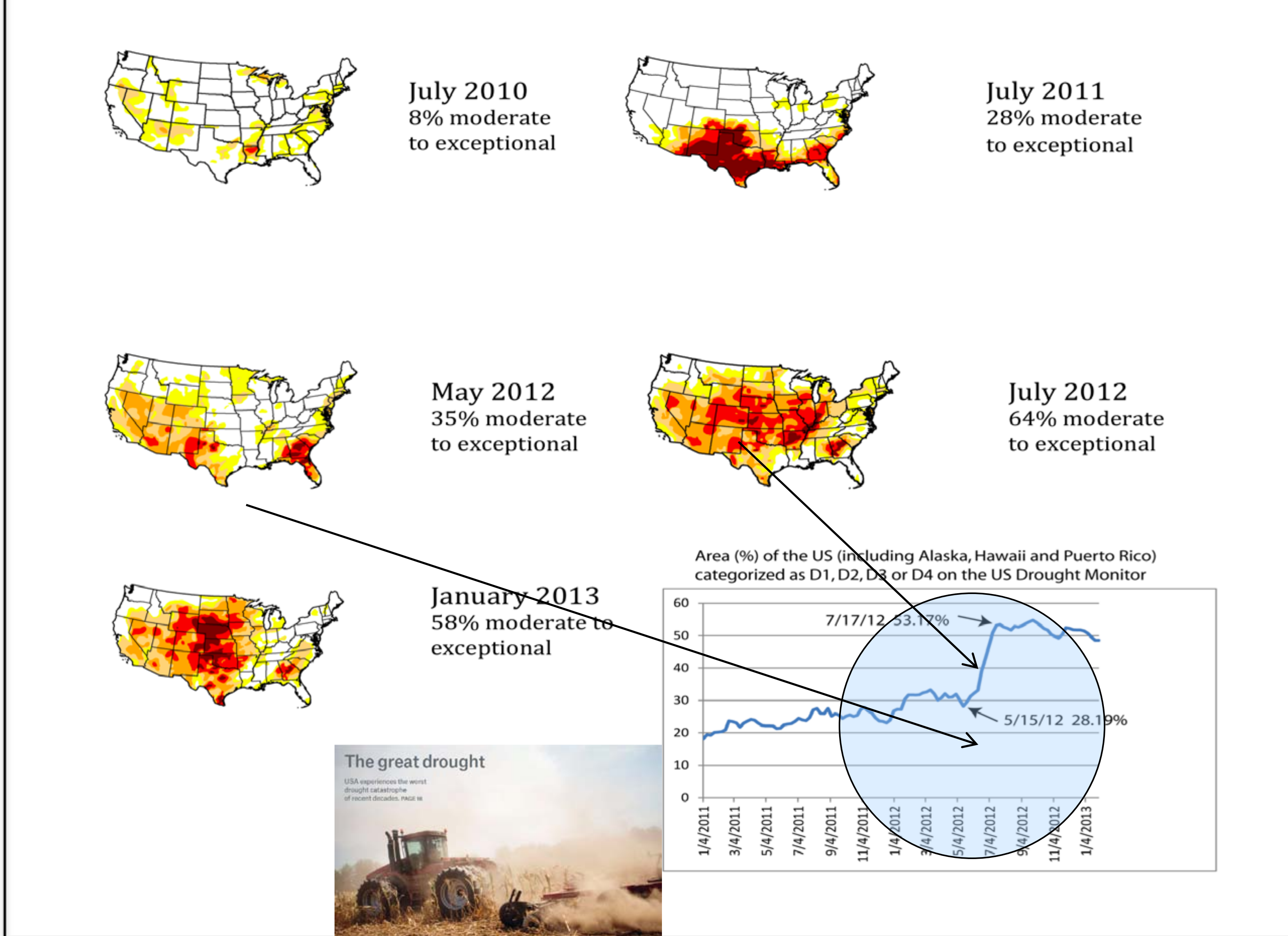
Key Phenomena, variables

Modeling Issues

SST anomalies	Global-Scale Atmospheric Changes	Regional Forcing and land feedbacks	Local Impacts, user needs
ENSO, PDO, AMO, warm pool variability, Global Warming, etc	planetary waves, hydrological cycle, monsoons, Hadley Cell, Walker	precipitation, soil moisture, snow, low level jets, dust, vegetation, land/atmosphere contrasts, changes	soil moisture, stream flow, precipitation, ground water, lakes, reservoirs

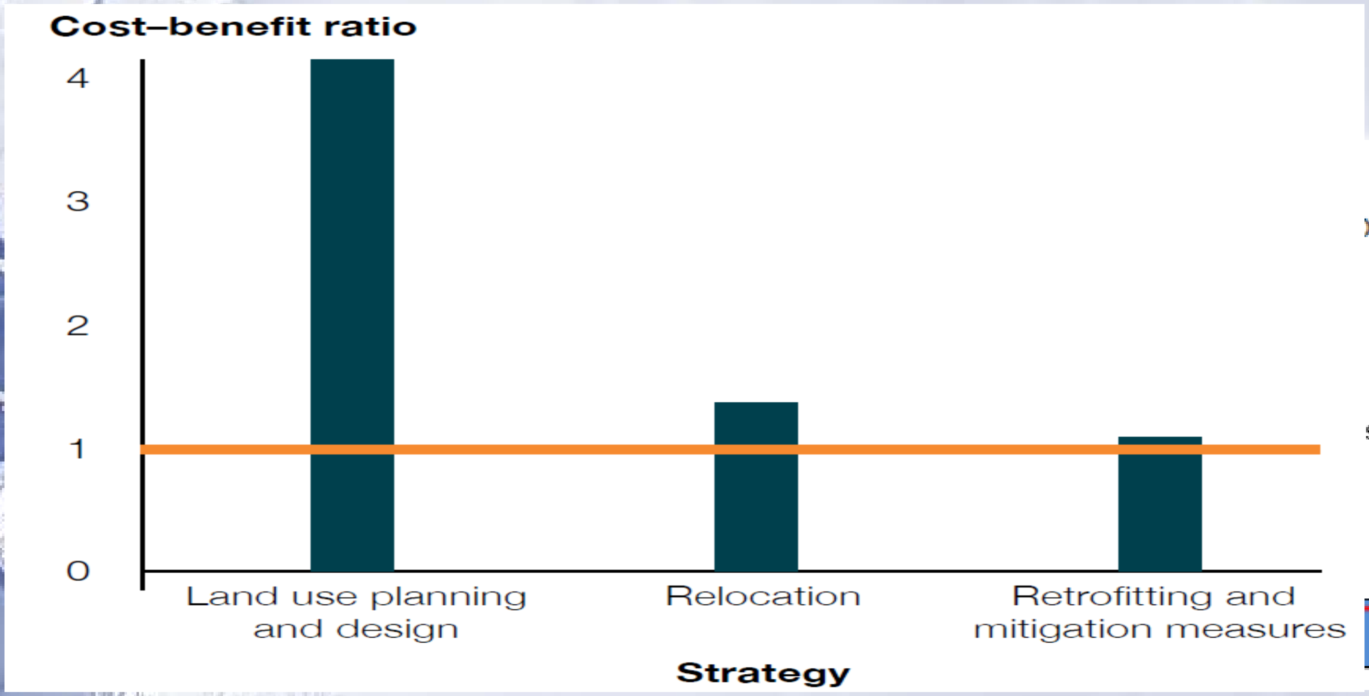


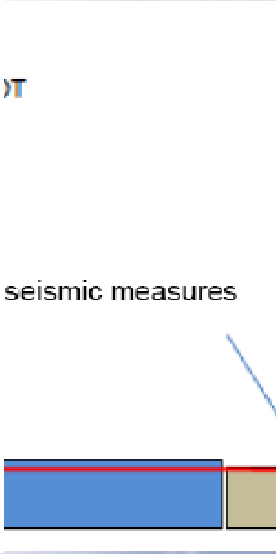
SST anomalies	Global-Scale Atmospheric Changes	Regional Forcing and land feedbacks	Local Impacts, user needs
Improvements in global coupled models, estimates of ocean variability and predictability, GHGs	Reduce uncertainties in atmos. response to SST, water cycle, atmos. variability and predictability	Reduce uncertainties in modeling land/atmosphere interactions, predictability of weather "regimes", regional	Improved modeling of "downstream" impacts on land hydrology, higher resolution, downscaling



•**A complete explanation of these droughts must invoke not just the ocean forcing but also the particular sequence of internal atmospheric variability - weather - during the event.**

1. Understand and communicate the economic value of early warning information systems and the relative contributions of system components





Globally

The total benefits of improved early warning systems would reach between 4 and 36 billion USD per year. Benefit-cost ratios between 4 and 35 with co-benefits (World Bank, 2011)

3. Recognize "communication" as necessary but not sufficient

Broad societal processes that create dynamic pressures and unsafe conditions are not easy to change, yet are fundamental to human vulnerability

- Social process(es) of risk communication are more than "one-way" AND more than "two-way"
- The "push" supply of new information by would-be providers of information/technology , and the "pull" demand for new information from would-be learners is never linear
- Need not just for "translators" but for policy entrepreneurs focused on overcoming impediments to the flow fo infor4mation and lessons

4. Governance and knowledge management
Improving policy coherence and adaptive management

Frame the goals and objectives of international and country and local-level program intervention strategy in terms of "securities" -water, food, energy, national

Rules for gathering, storing communicating, using and evaluating information are essential elements of operating procedures- Relationship between public and private research is not linear

Identify policies and practices that impede or enable the flow of information among information system components- Conspicuous over-consumption of information

(March and Feldman)

Monnik, 2000; Pulwarty and Verdin, 2013)

Climate knowledge and risk management-governance

Accountability- CRM needs to be located with planning oversight and some fiscal responsibility-provide political authority and policy coherence across sectors. **Emergency management organizations can rarely play that role**

Efficiency- only occurs when CRM is carried out in partnership with at-risk sectors and communities and organizations that represent them. Benefits are cost-effectiveness, sustainability, citizenship and social cohesion.

Climate Services:

"The timely production and delivery of useful climate data, information and knowledge to decision makers" (NRC, 2001)

More specifically:

"Network of activities that maintain well-structured paths from observations, modeling, and research to the development of relevant place-based knowledge and usable information

- *Sustained administrative framework.*

No single structure is optimal –

Requires flexibility, alignment and permeable boundaries-

- set up selected case studies

Role of WCRP-LAC- Informing Risk reduction and management

Overcoming the "adaptation" deficit-lack of investment in crucial infrastructure

- **Lead in climate risk analysis**; minimum standards for building codes (building codes are inconsistent, particularly on the Gulf coast) and understanding external risks;
- **Promote climate risk awareness** among customers-Risk-based pricing of insurance;
- Link relief/**recovery assistance** to climate resiliency planning and **investment in water, energy, food …security**
- **Inform the use of resilience approaches- of soft paths** to mitigate damage and protect lives and property; Promote sound land use and management practices;
- <u>**Climate information systems**</u>- e.g. information assimilation, early warning impacts and climate risk scenarios

Regional Climate Information Services
A Pathway

Knowledge development and Management

MONITORING/RESEARCH

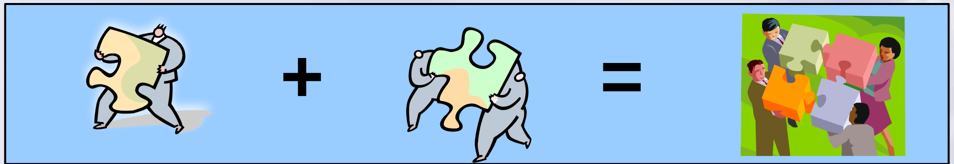
Products and services: Impacts Assessment, Decision support tools

DEVELOPMENT AND ENGAGEMENT (data analysis, products)

Capacity and Coordination:

PROTOTYPING (applying scenarios etc.)

DELIVERY, EVALUATION.



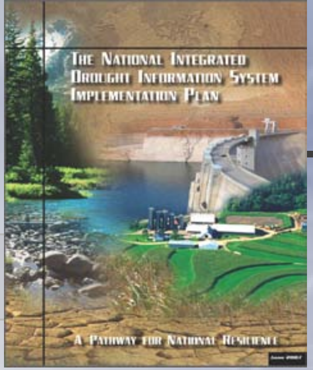
Mexican National Drought Programme (Pronacose) (Lopez et al, 2014)

NIDIS Governance: Executive Council

NATIONAL

NIDIS Program Office

NIDIS Implementation Team:



Public Law 109-430

NIDIS Technical Working Groups

REGIONAL

Public Awareness And Education

Engaging Preparedness Communities

Integrated Monitoring and Forecasting

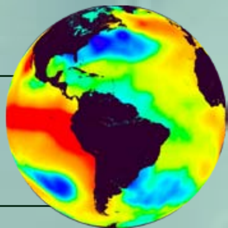
Interdisciplinary Research and Applications

U.S. Drought Portal

WATERSHED/URBAN/LOCAL

Regional Early Warning Information Systems

Information clearinghouse,prototypes, and Implementation



US National Integrated Drought Information System
(Federal, State, Tribal, Local Communities)

NIDIS

Monitoring & Prediction

Drought and Flood Impacts Assessments and Scenarios

Climate Information Systems

Communication and Outreach

Engaging Preparedness Communities

<u>Extremes in the context of change: Securing</u> investments and “capitals”

- **Value of existing observations to improve impacts assessments and warnings**

- **Develop reference resource/water data accounting/architecture**

- **<u>Early warnings of Rates and transitions</u>-Are <u>critical</u> climate (extremes+ variability+change) impacts occurring/predicted in 1, 5-20 yrs? Useful analogs?**

- **<u>Prototyping/ policy gaming:</u> Given better data and information coordination, would responses have been improved for past events?**

- **Approach climate model output far more critically than at present, <u>especially for</u> impact assessment and scenario development at the local level-No substitute for monitoring and understanding local climates**

Are we better off? How will we know?

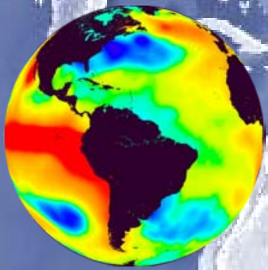
- The number of countries, communities, and institutions with improved capacity to inform climate risk management: ….regional drought information coordinator
- The number of staff in or working with institutions trained to develop and communicate local climate information and help reduce impacts
- The number of research projects that conduct and update climate drivers, impacts and user needs assessments in at-risk regions
- The percentage of the regional population covered by adequate climate risk and early warning information systems

Managing risks in a changing climate

How often should criteria for "robustness" be reconsidered?

Need more than just "translators" but "policy entrepreneurs" to manage this process

THANK YOU!



NIDIS

NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Translation?… … .Transfer?… … …..
Transformation?

IMPACTS

VULNERABILITY

DEVELOPMENT

RESILIENCE

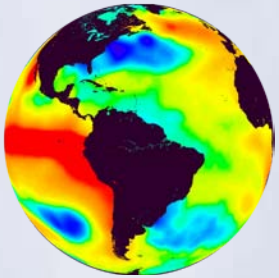
Coproduction should not become co-optation

Transitions from applications

Private vs public

<u>Applied</u>

Expanding the range of options



Social-ecological

Path dependence

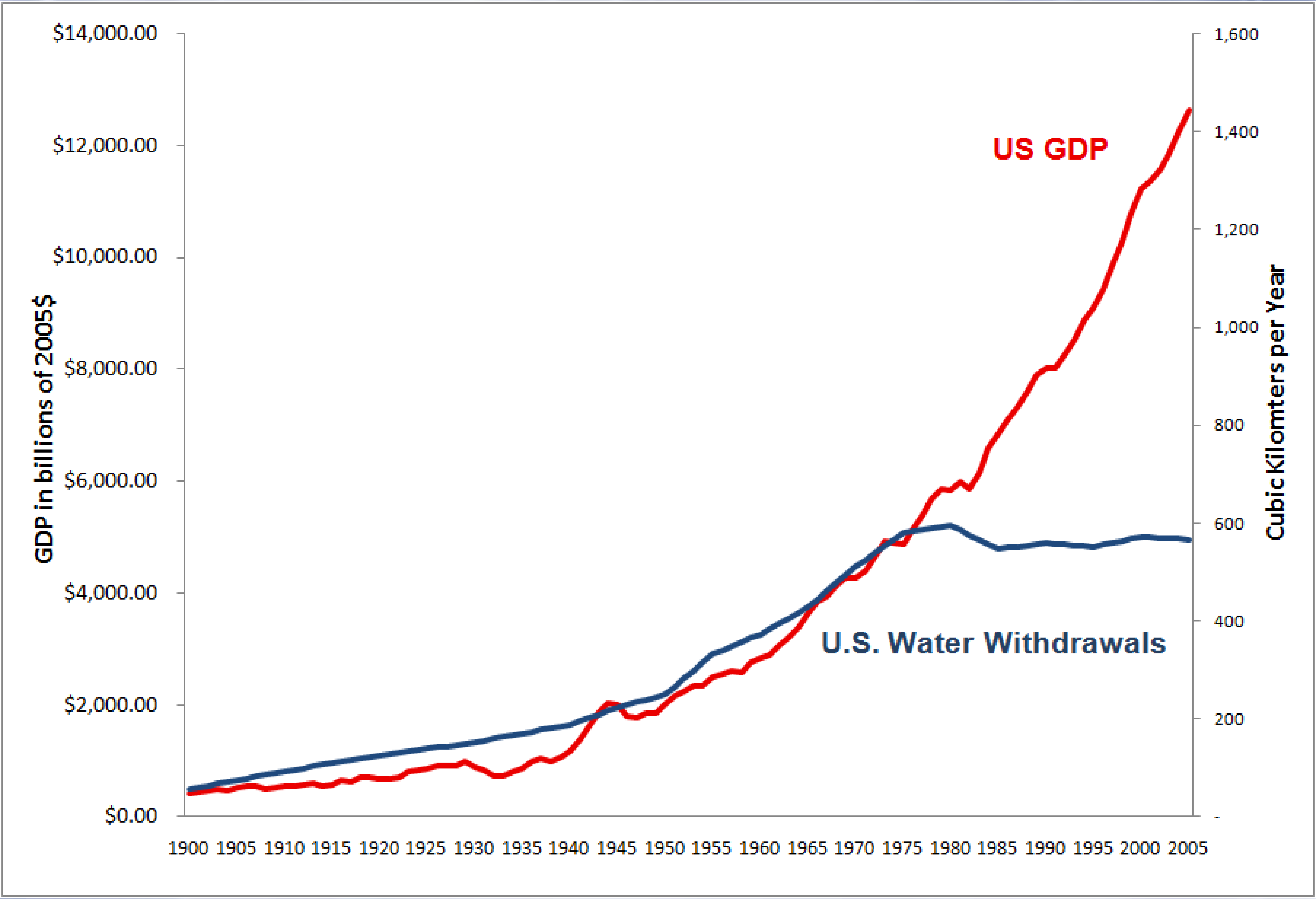
Across organizational boundaries

Joint monitoring and joint fact-finding

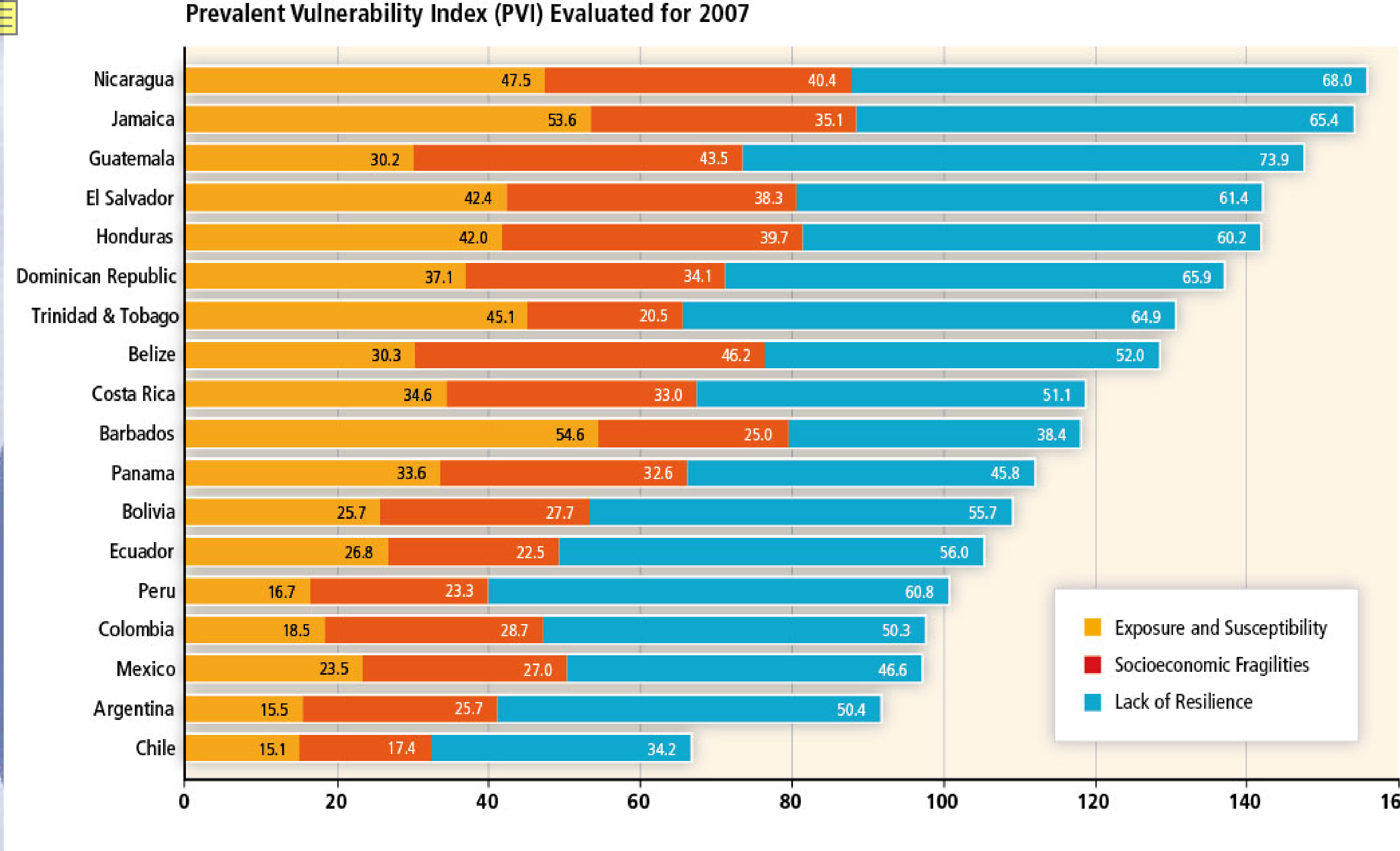
Categorization and Selected Driving Forces for Storyline Development

General Driving Force Category	Key CRBS Driving Forces Identified in Survey
Natural Systems (Hydroclimate)	• Changes in streamflow variability and trends • Changes in climate variability and trends (e.g. temperature, precipitation, etc.)
Demographics & Land Use	• Changes in population and distribution • Changes in agricultural land use (e.g. irrigated agricultural areas, crop mixes, etc.)
Technology & Economics	• Changes in agricultural water use efficiency • Changes in municipal and industrial water use efficiency • Changes in water needs for energy generation (e.g. solar, oil shale, thermal, nuclear, etc.)
Social & Governance	• Changes in institutional and regulatory conditions (e.g. laws, regulations, etc.) • Changes in flow-dependent ecosystem needs for ESA-listed species • Changes in other flow-dependent ecosystem needs • Changes in social values affecting water use • Changes in water availability due to tribal water use and settlement of tribal water rights claims

Thank You!



Source: Christian-Smith and Gleick 2012 "A 21st Century US Water Policy." Figure 1.10. Oxford University Press.



Prevalent Vulnerability Index: much >>> property and wealth

- Exposure and Susceptibility
- Socio-economic Fragility
- Lack of Resilience

Figure ES-1. Potential water savings (in million acre-feet) in a wet, average, and dry year