ABOUT
WATER, ENERGY, & CLIMATE

Global Energy and Water EXchanges

A Core Project of the

World Climate Research Programme

GEWEX

WCRP
World Climate Research Programme

World Climate Research Programme's Grand Challenge on Water for the Food Baskets

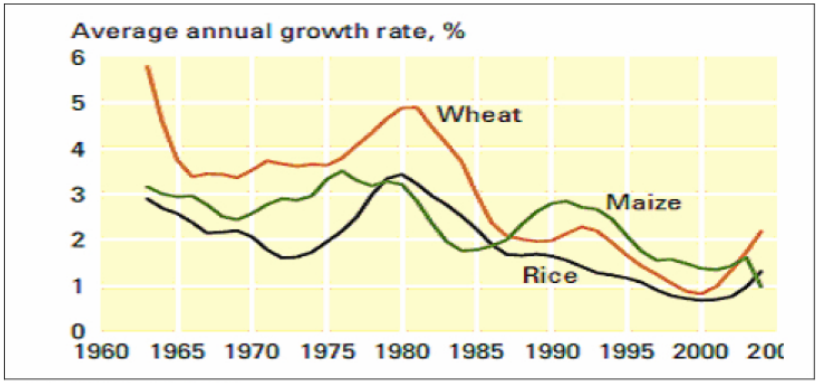
and the ANDEX Regional Hydroclimate Project

Peter J van Oevelen – Int. GEWEX Project Office, USA
Roy Rasmussen – NCAR, USA
Jan Polcher – IPSL, France
Alex Ruane – NASA-GISS, USA
German Poveda – Universidad Nacional, Colombia
Rene Garreaud – Universidad de Chili, Chili

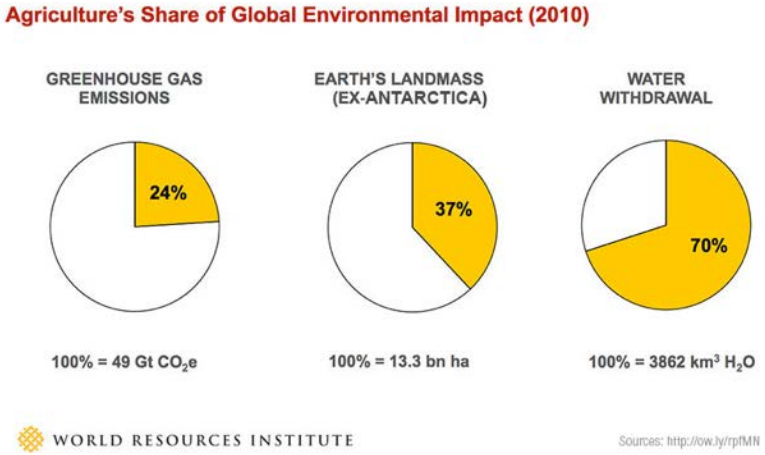
Current State

Challenges for Food Production

Growth rates of yields for major cereals, 1960 - 2000



Source: World Bank (2008)



- Population growth *(Asia and Africa primarily)*
- Globalization
- Urbanization
- **Water scarcity**
- Declining yield
- **Climate variability and Climate Change**
- Modernization of agriculture has lagged behind industrialization in developing countries
- Transfer of land from the production of food to production of fuel
- Transfer of land to livestock (high protein food)
- Biosecurity issues affecting Free Trade Agreements

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WCRP World Climate Research Programme

Starting Points

- Our knowledge on the water cycle is essentially of a system perceived as natural. How true is that currently?
- How well do we know the processes governing slower reservoirs (groundwater, snow, glaciers, …) ?
- Climate change will perturb the real system but how relevant is our knowledge of the natural cycle ?
- Practices for water resource management are based on past experience. Have they evolved and taken into account knowledge on climate change ?
- Is our science relevant for the practitioner … what do we need to make the transfer of knowledge effective ?

The WCRP Grand Challenge on Water Availability

Water for the Food Baskets of the World

- **Water Cycle Main Driver of Food Production**
- **A Warmer Climate Pushes the Water Cycle into Unknown Territory**
- **The Terrestrial Water Cycle is not Natural Anymore**
- **Urgency to Understand the New State of the Water Cycle in which Natural and Anthropogenic Processes Interact**

Proposed implementation plan

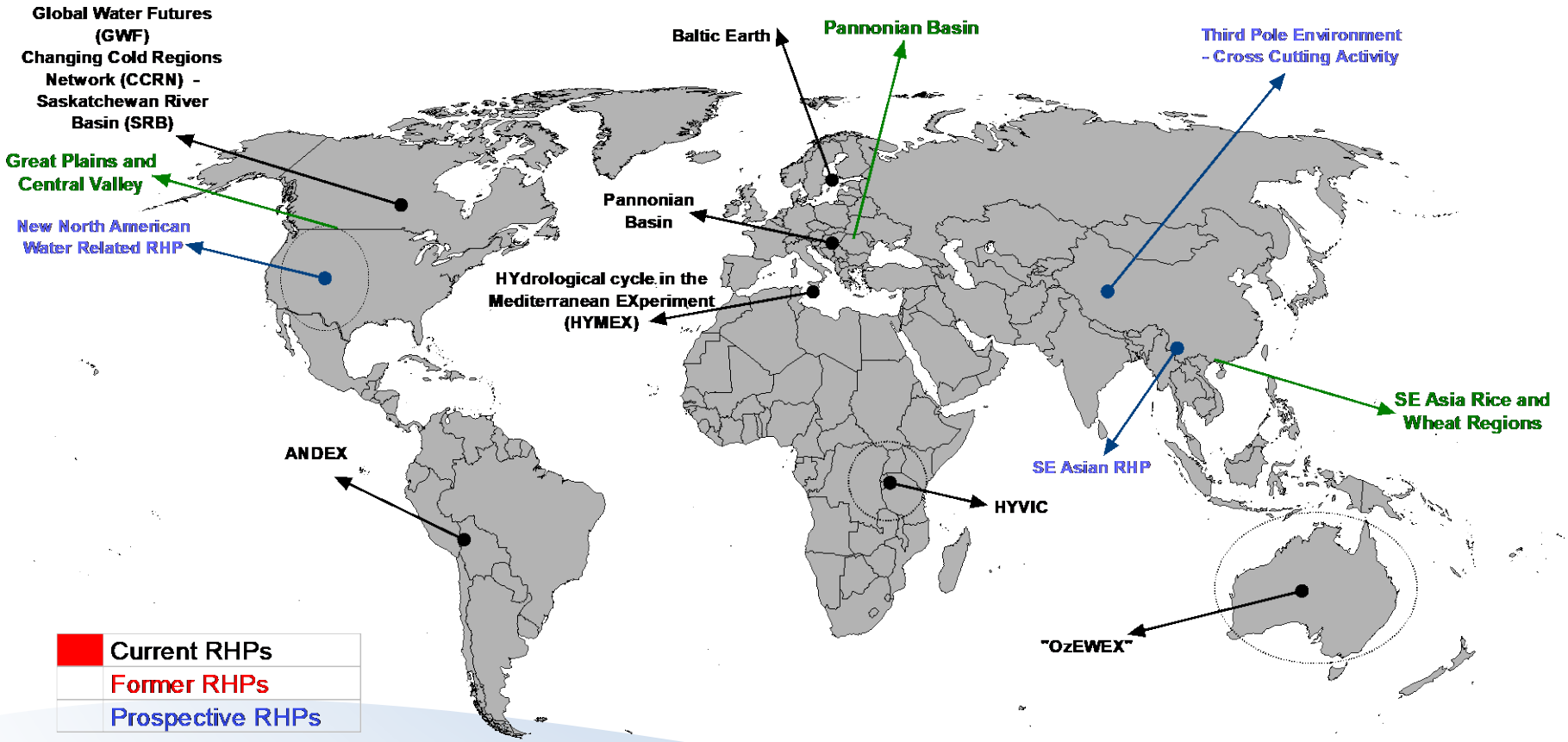
What we need to do!

- <u>Observational based studies</u> :
- Should be based on RHP *in regions of intense agriculture*.
- Better quantify human control on the water cycle.
- Process studies on surface atmosphere interactions.
- Promote *inter-disciplinary analysis*.

- <u>Enhancing predictive capabilities</u> :
- Propose *model inter-comparisons to promote model development*.
- Re-visit the past evolution which combine climate change and increasing human intervention.
- Consolidate process knowledge in our models (incl. crop, biosphere etc.).

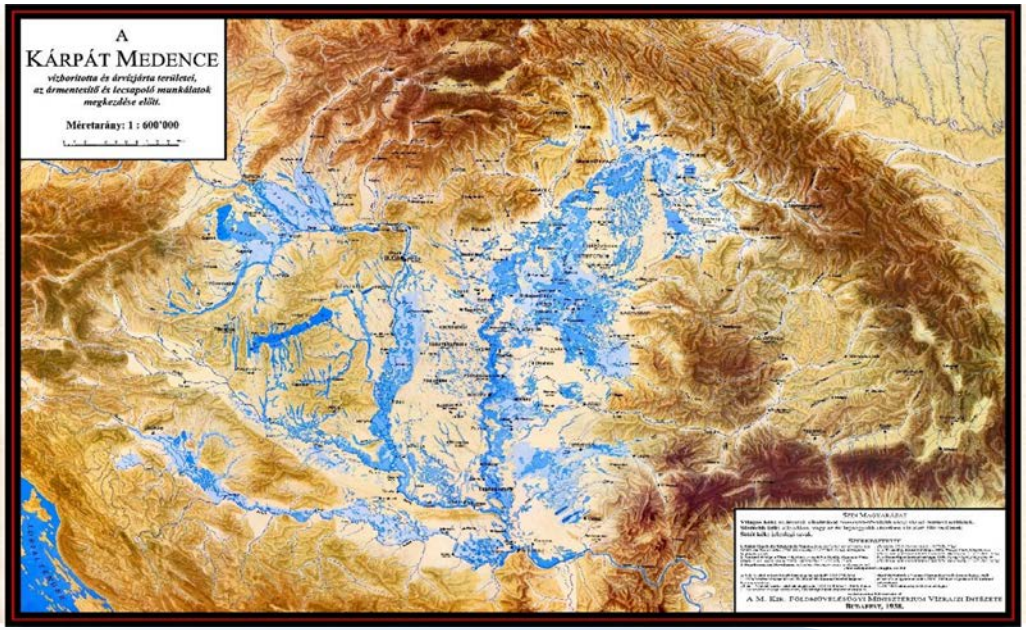
Regional Hydroclimate Projects

Proposed Food Basket of the World Focus Regions



The Pannonian basin (Initiating RHP)

- Since the 19th century flood control measures were introduced along the Danube and its tributaries
- Fields were drained to make them arable.
- The Danube was developed as a waterway (Tiza river was shortened by 453km between 1846 and 1880).



Blue regions used to be floodplains !

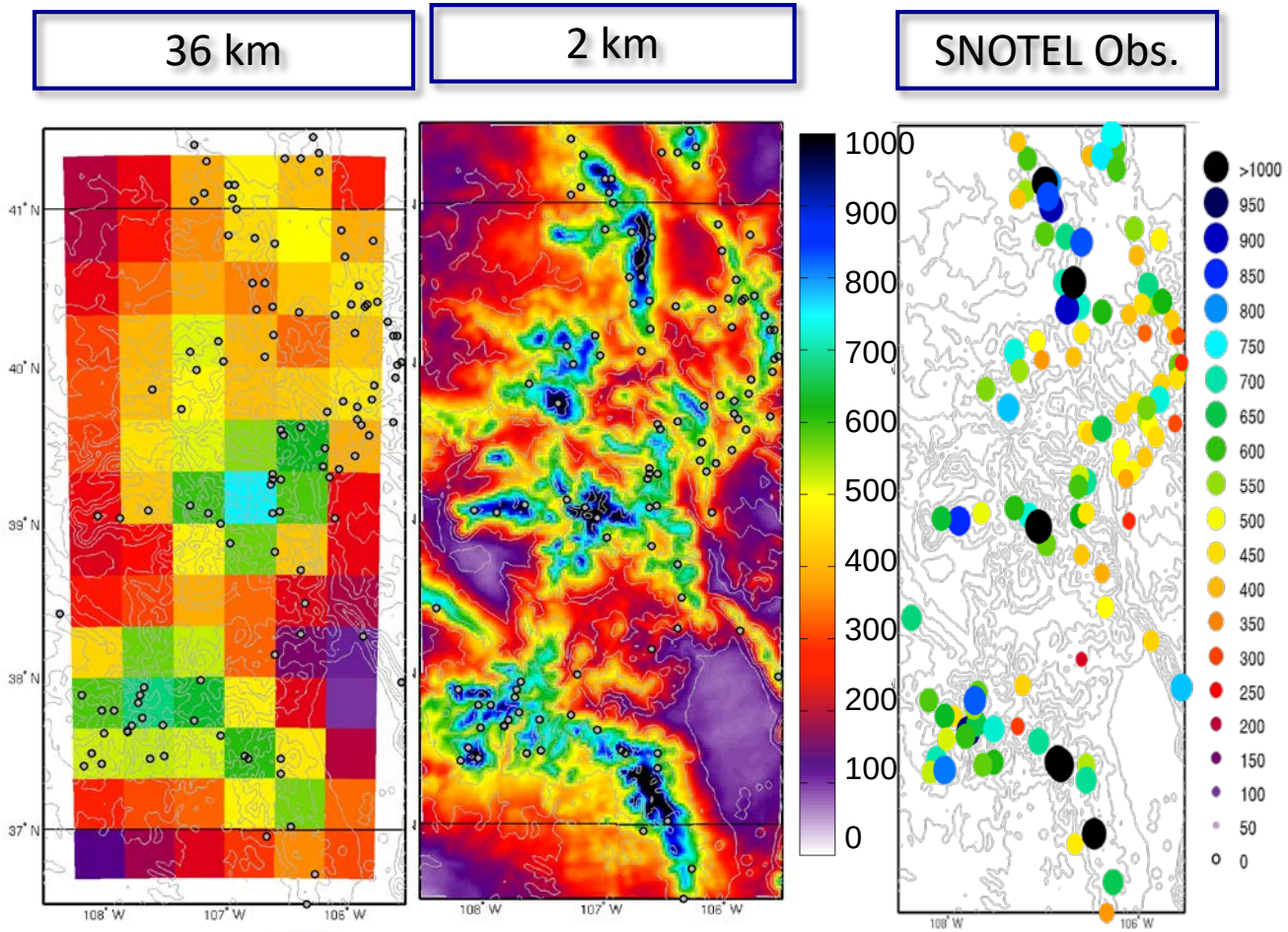
A Regional Hydroclimate Project for the Rocky Mountains

integrate ongoing research activities in Canada and the USA

- **Understanding the impacts of climate variability and change on water availability across the river basins of the Rocky Mountains**
- **Research needs:**
- ***Observational synthesis*:**
  - *Coordinated multi-scale field and remote sensing campaigns to quantify cross-scale controls on regional hydroclimatic processes*
  - *Understanding of key processes and compilation of data to test model hypotheses*
- ***Modeling synthesis*:**
  - *Controlled comparison of different modeling approaches*
  - *Improved model physics parameterization development for integrated water cycle projections*

GEWEX

WRF model able to reproduce the amount and spatial distribution of snowfall and snowpack over a winter season over the Colorado Headwaters at spatial resolutions less than 6 km



SNOTEL Precip gauge

6-mo. Total Precipitation (mm) Comparison
1 Nov. 2007-1 May 2008

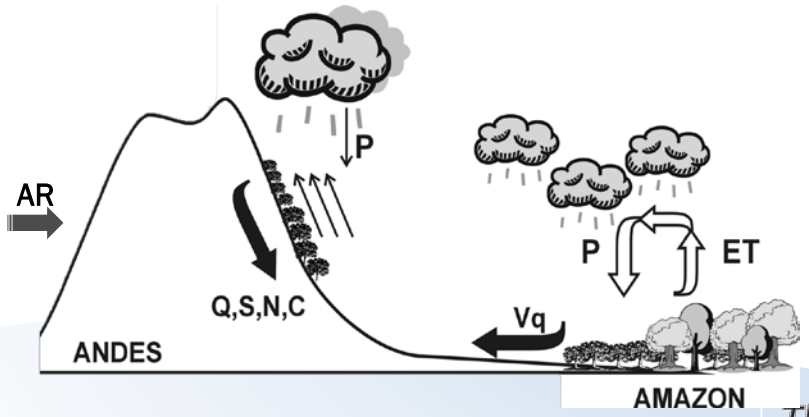
Ikeda et al, 2010, Rasmussen et al. 2011

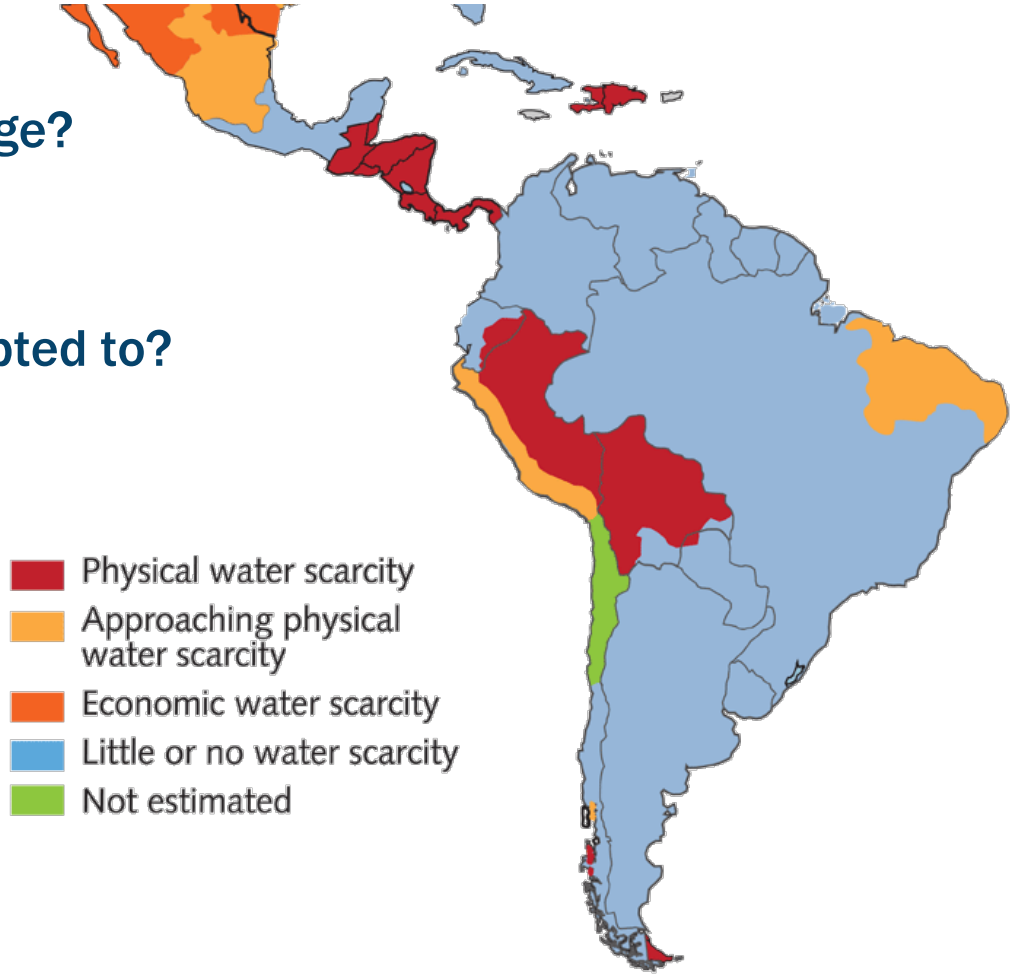
Transition to Convection Permitting Models

- "Climatically Available Water (P-E)" as we want both P and E at higher spatial (and temporal) resolutions
- Agronomy and the FAO in particular, are limiting themselves to "reference evaporation" without taking into account small scale processes which change water availability.
- Soil moisture availability is strongly driven by factors such as rainfall intensity which has been below our (GEWEX) radar screen for decades
- Most (Pot.) ET formulations used by agronomy are not very useful in a changing climate scenario
- Plenty of evidence that (sub)surface/atmosphere interactions occur at small(er) scales and will not be credible until we reach convection permitting models.
- ==> High resolution modeling but we should not limit it to just the atmospheric processes! It is the entire terrestrial/atmospheric system which needs to be treated at very high resolution.
- Many problems exist both terrestrial as well as atmospheric including: human dimension, LULC etc.

Water Scarcity in Latin-America

- How stable under climate change?
- How could it change?
- What is it that needs to be adapted to?
- What can be mitigated?





The Comprehensive Assessment of Water Management in Agriculture, FAO, 2007

Essential link to agricultural modeling

- The human dimension has many aspects. In this GC we focus on the food and water directly related aspects
- The link between water and agriculture is highly non-linear, how to model at weather and climate scales beyond the watershed (regional to global)
- Much more than just irrigation, ground water extraction and reservoir management!
- Linking convection-permitting models (high res < 4km) to agronomy/ag. models

Expected outcome of the GC

- Progress in land surface modeling with the explicit representation of water management.
- Enhance our knowledge of surface atmosphere interactions in managed environments.
- Build the capability to predict the “real system” at least at the regional scale for weather forecasting as well as climate research.
- Develop our capabilities to predict the water and nutrient fluxes to the oceans.
- Make climate sciences more relevant to hydrological and agronomic sciences in terms of processes and scales considered.

WCRP GC on Water and UN SDGs


Great Plains and
Central Valley
Pannonian Basin
SE Asia Rice and
Wheat Regions

Thank You

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MORE INFORMATION ON:

HTTP://WWW.GEWEX.ORG

Contact Us

Peter van Oevelen
Director
International GEWEX Project Office

gewex@gewex.org

+1 (240) 485-1855