Introduction to the W-E-F Nexus Project

Richard Lawford

4th Regional WEF Nexus Workshop

Hilton, Pietermaritzburg, South Africa

November 21, 2016

What is Future Earth

Ten-year Research Initiative

RESEARCH

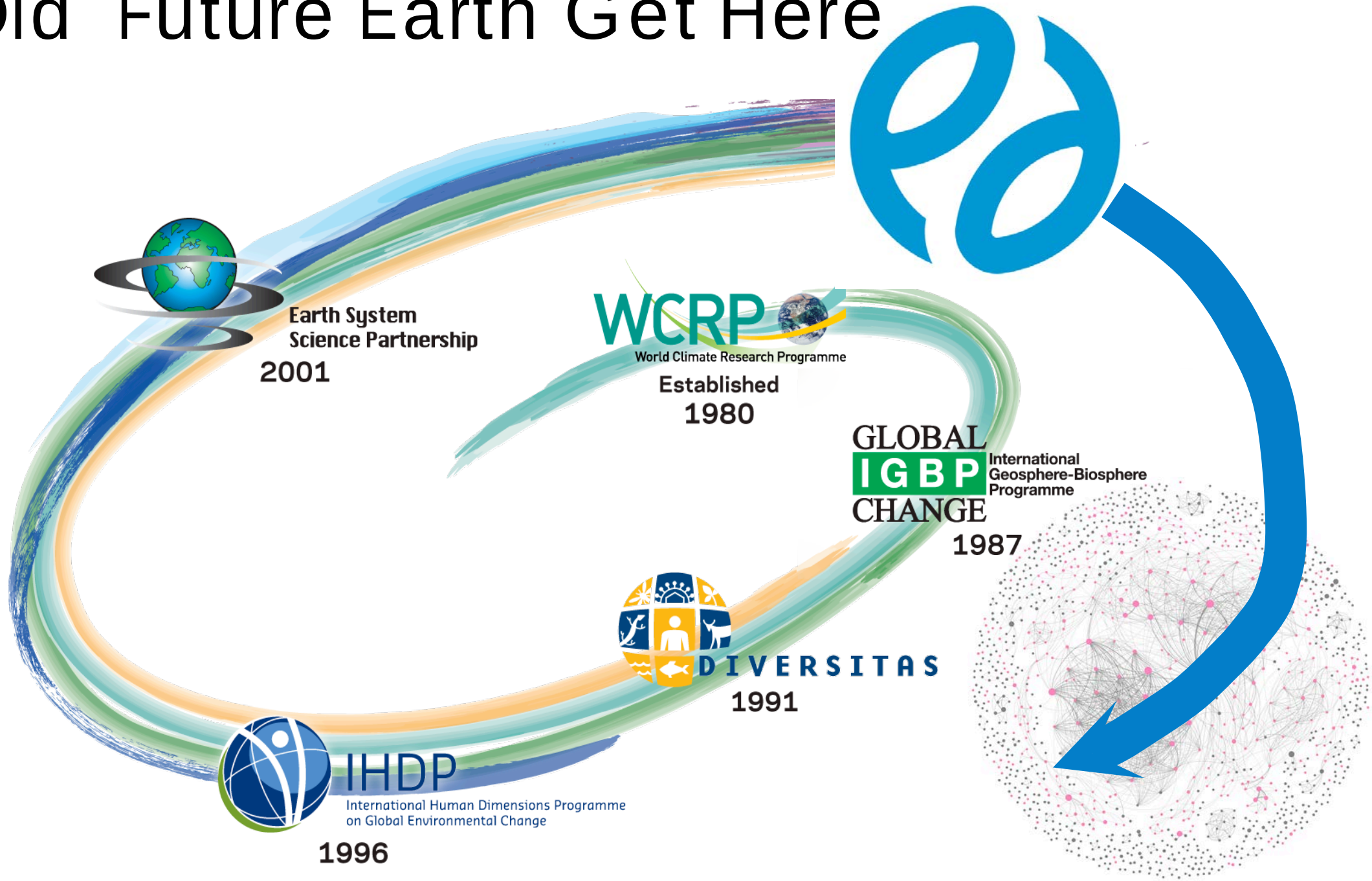
Generate new knowledge through international fundamental and interdisciplinary research coordination

SOLUTIONS

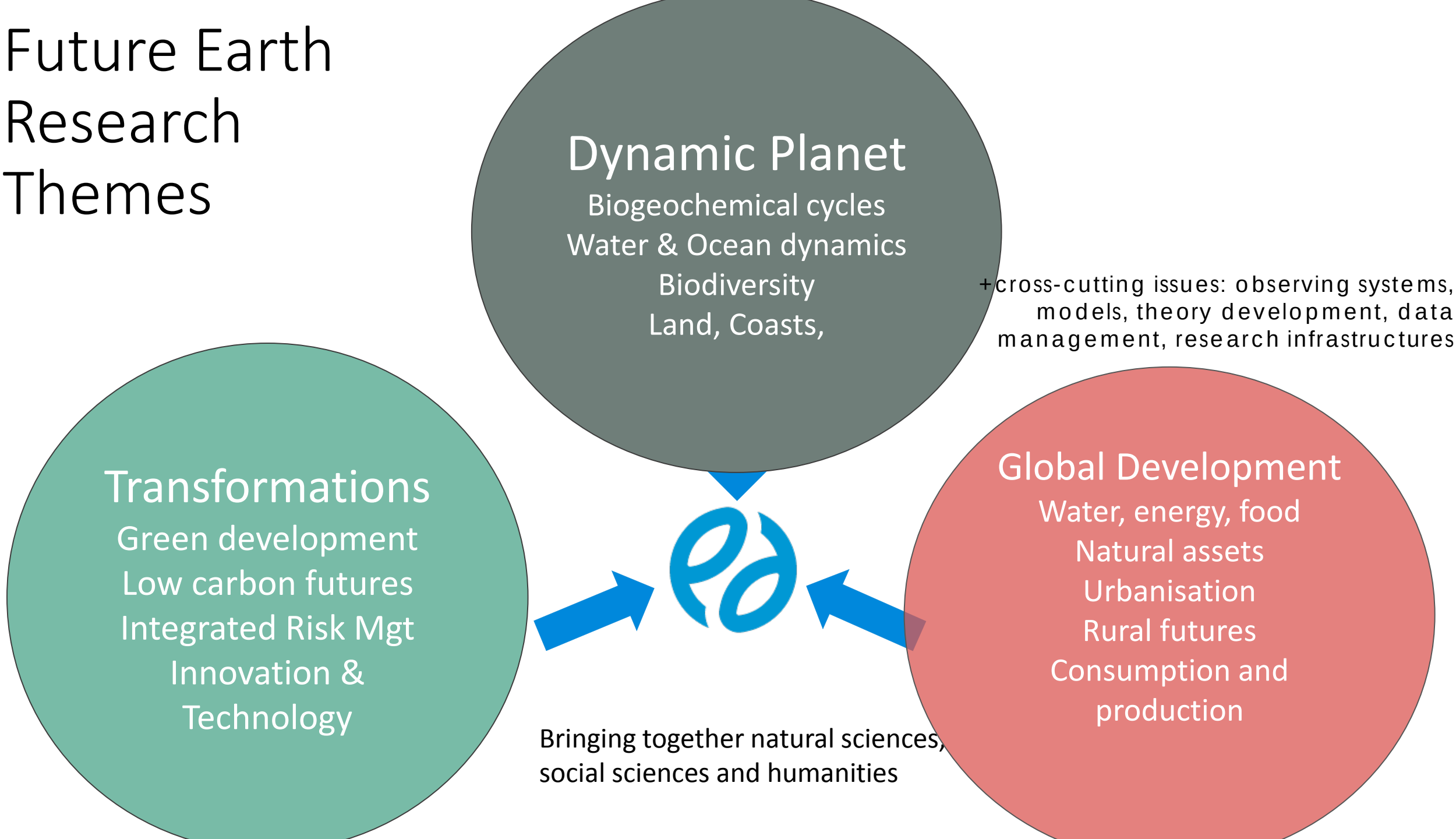
Catalyze transformation through a solutions agenda and greater societal engagement

Research for global sustainability

How Did Future Earth Get Here



Future Earth Research Themes

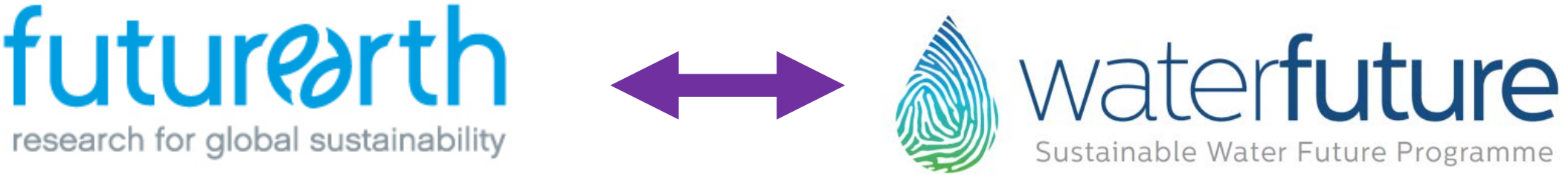


Knowledge Action Networks

1. Sustainable Development Goals
2. Transformations to Sustainability
3. Food, Energy, Water Nexus
4. Health & Environment
5. Natural Assets
6. Cities
7. Oceans
8. New Technologies
9. Sustainable Finance

Sustainable Water Future Programme

A solutions-oriented legacy of GWSP



Towards reality based and multi-scale knowledge-to-action water agenda

Expand the focus on fundamental global water system research to one that co-produces actionable scientific knowledge

Moves beyond problem identification and description to finding solutions for the world's water problems

SWFP: An international coordination mechanism for integrative research on Global Water

- Provides an international coordination for integrative research on global water system and current and future changes
- Promotes the adoption of science-based evidence into the implementation and monitoring of goals for SDGs
- Implements the state the art synthesis studies of knowledge about water system that can inform risk assessment of water system
- Capacity building of the next generation of water scientists and practitioners in water research
- Stimulates innovation in water institutions with a balance of technical and governance based solutions

Themes of SWFP

Global State of Water

Knowledge concerning the global state of water

Assessing risk to humans and the global water system through appropriate risk related metrics.

Governance of Transformation

Dynamic society-nature interface and interactions at and across different scales

Addressing institutional landscapes, actor networks, multi-dimensional valuation of water and its service

Water as a Global Agent

W-E-F nexus, the water-carbon link and interfaces with water and health, as well as water and biodiversity issues.

Water as an agent transmitting global change effects and its critical role in the development agenda

Water Solution Lab Network

- Address Broad SDGs Agenda
- Achieve multiple objectives simultaneously
- Connects science to policy makers
- Benefit private small and medium enterprise
- Reduce transaction cost, increase confidence and transparency

In late 2014 a Belmont Forum proposal on the WEF was funded. Leads for the project are Prof. Claudia Pahl-Wostl and Richard Lawford

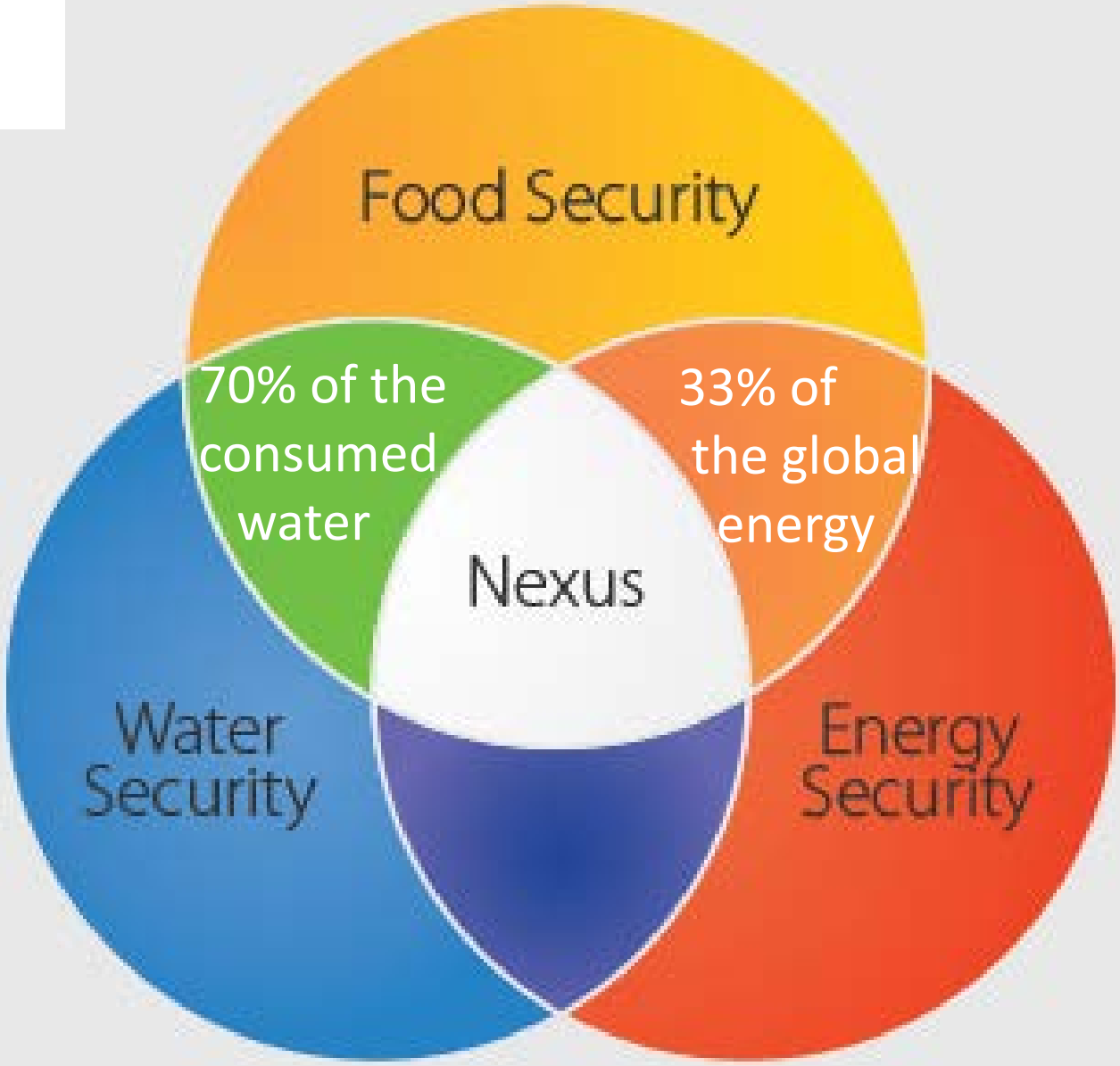
Goal: to explore the use of **integrated information** and **improved governance** for enhancing the **sustainability of the Water-Energy-Food (W-E-F) Nexus**.

The process involves holding four regional workshops in different parts of the world to address different geographical issues and different priorities and ways of managing the nexus

What do we mean by the Nexus?
There are many Nexus combinations.

Why choose the WEF combination?

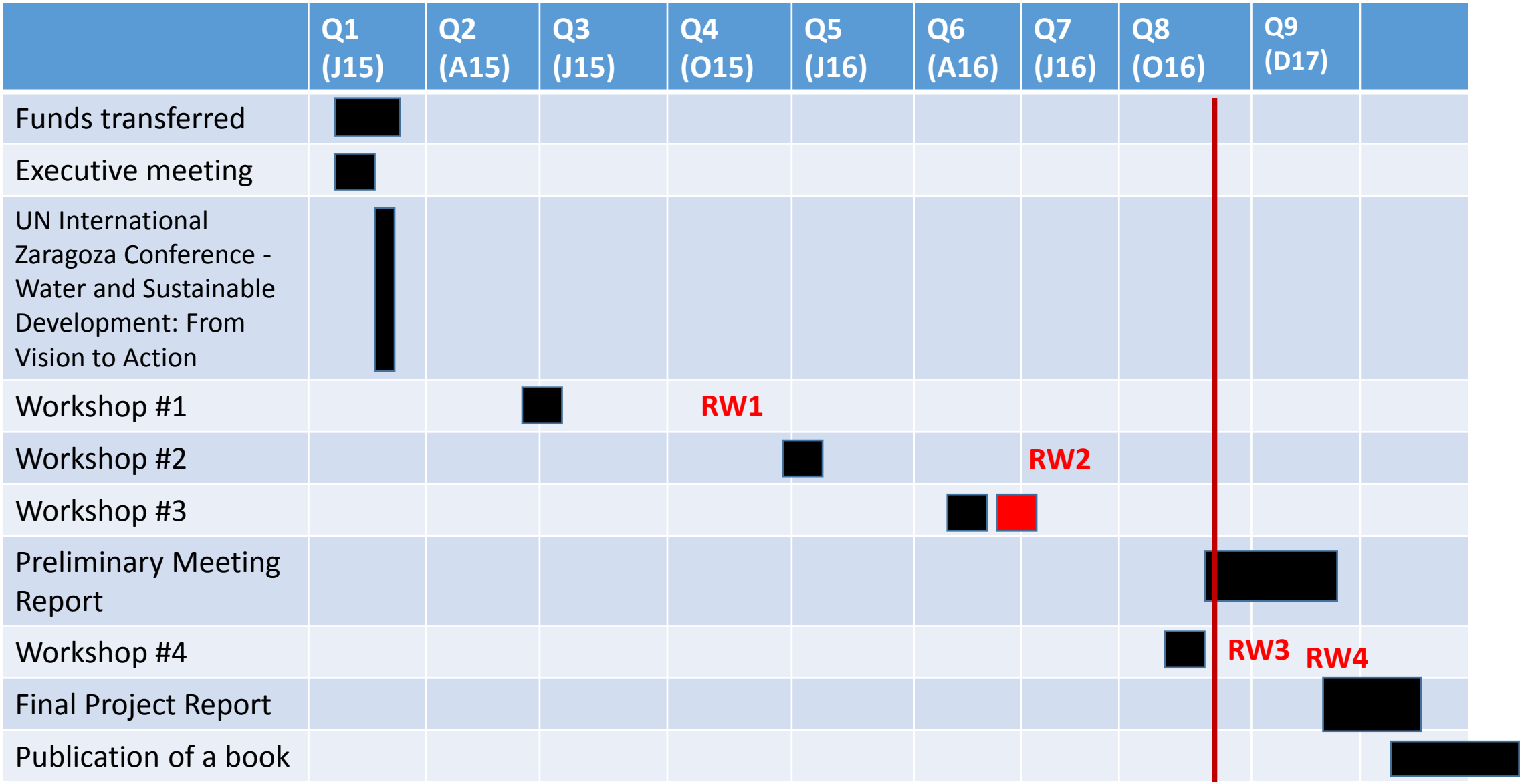
- Name recognition in policy circles (World Economic Forum has identified it as one of the 3 greatest risks to the world economy),
- It has strong links to the SDGs (three fundamental targets that permeate the SDGs.)
- It has a clientele at both national and international levels.



Overall deliverables from the 2-year project:

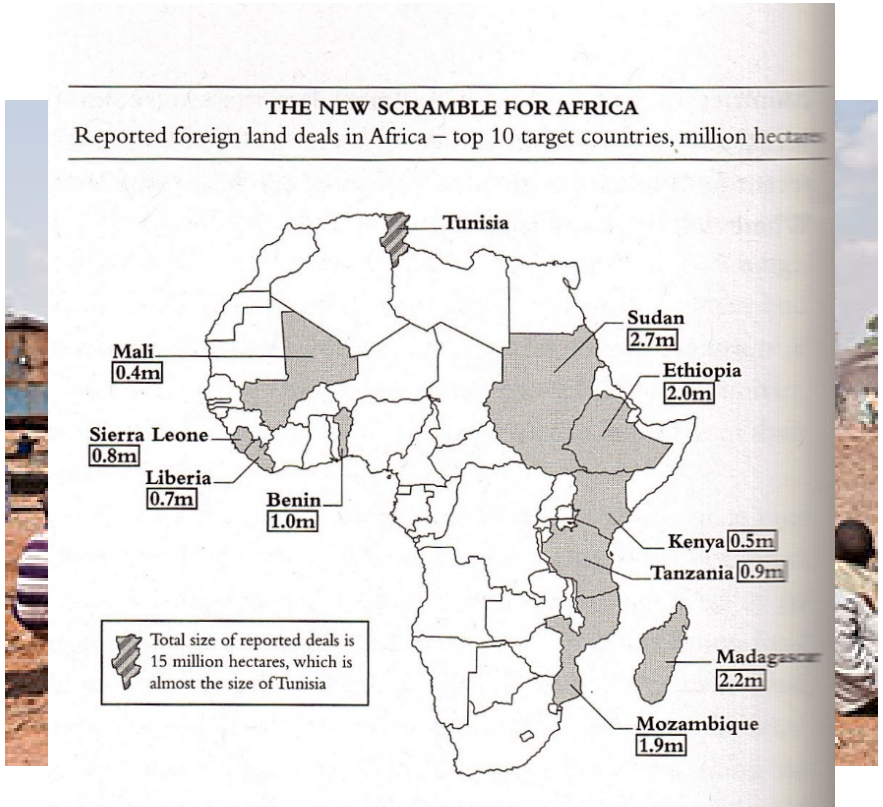
- a set of research questions,
- a programme outline,
- a global community of experts,
- Inventory of tools and techniques for using observations, and knowledge from the physical and social sciences to address the problems of the WEF with solutions-oriented research.

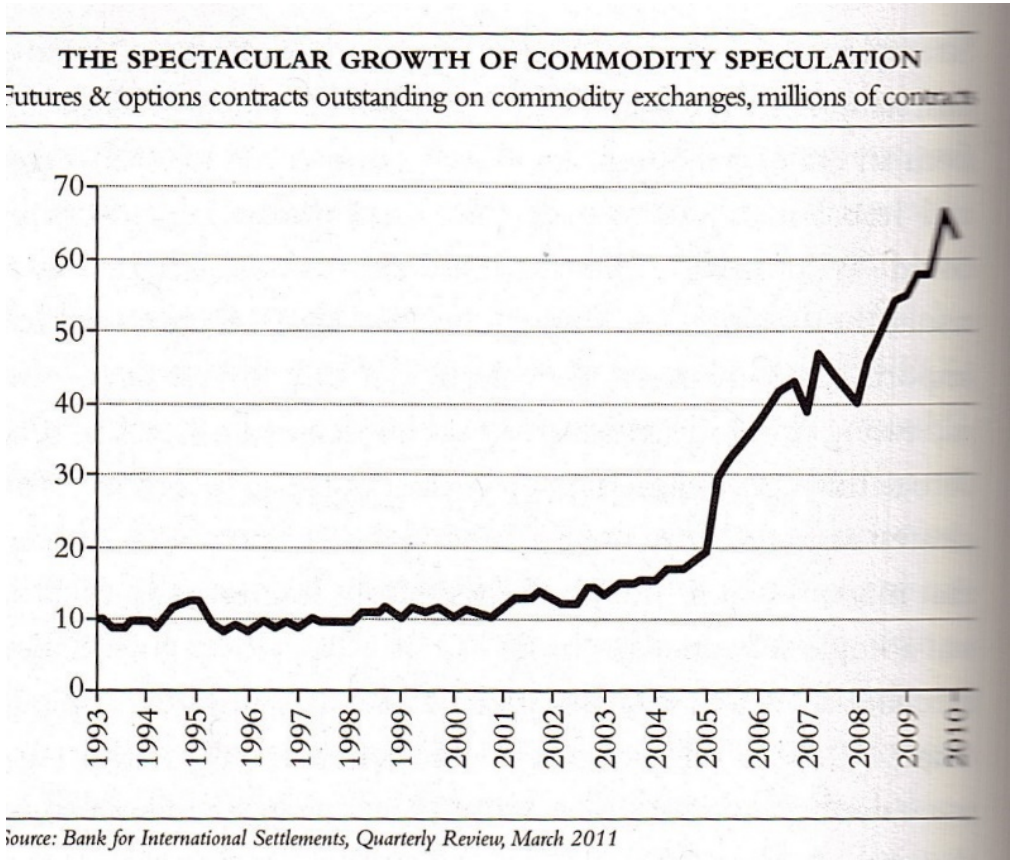
Hypothesis: The needs for science, governance, technology, observations, and information systems can be effectively identified by study of the current structure and plans of the energy and food industries and water services. Furthermore, the science community has, or can develop, the tools, data and expertise to meet these needs.


Q1 (J15)
Q2 (A15)
Q3 (J15)
Q4 (O15)
Q5 (J16)
Q6 (A16)
Q7 (J16)
Q8 (O16)
Q9 (D17)
Funds transferred
Executive meeting
UN International Zaragoza Conference - Water and Sustainable Development: From Vision to Action
Workshop #1
RW1
Workshop #2
RW2
Workshop #3
Preliminary Meeting Report
Workshop #4
RW3
RW4
Final Project Report
Publication of a book

Trends that could affect the future:

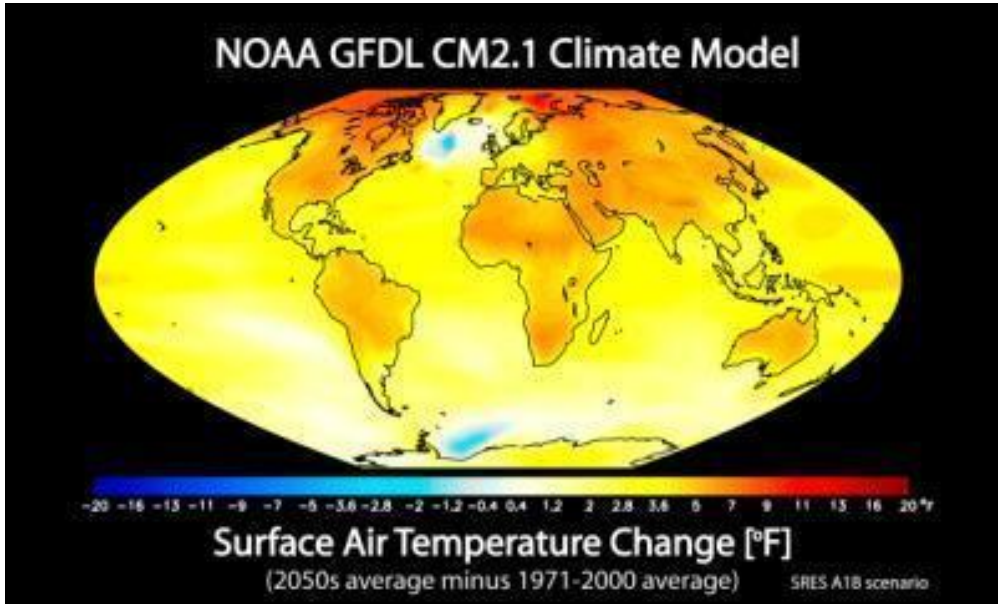
1) International commodity traders are playing a bigger role in the food system. Speculation is also becoming a significant factor in food prices.





2) Is the current development path for the WEF Nexus Africa best suited to meeting the needs of African people?

3) Climate change impacts of the WEF are increasing and must be addressed



4) Water continues to be under stress with the greater demands for irrigation, depletion of aquifers and the pollution of surface waters.

Workshop #1

Location: Washington, DC, USA
Dates: June 1-3, 2015
Partner(s): Texas A&M University (75 participants)

Outcomes:
- Efforts underway to develop a US WEF Community of Practice
- US NSF may incorporate some workshop findings into its upcoming call for proposals.

Recommendations (Examples only):
- Undertake case studies to define the interconnectivity of W-E-F systems. In this regard, a suite of comparative case studies should be carried out with an emphasis on governance issues.
- Develop a shared platform with both national and international components for data needed by the three communities.

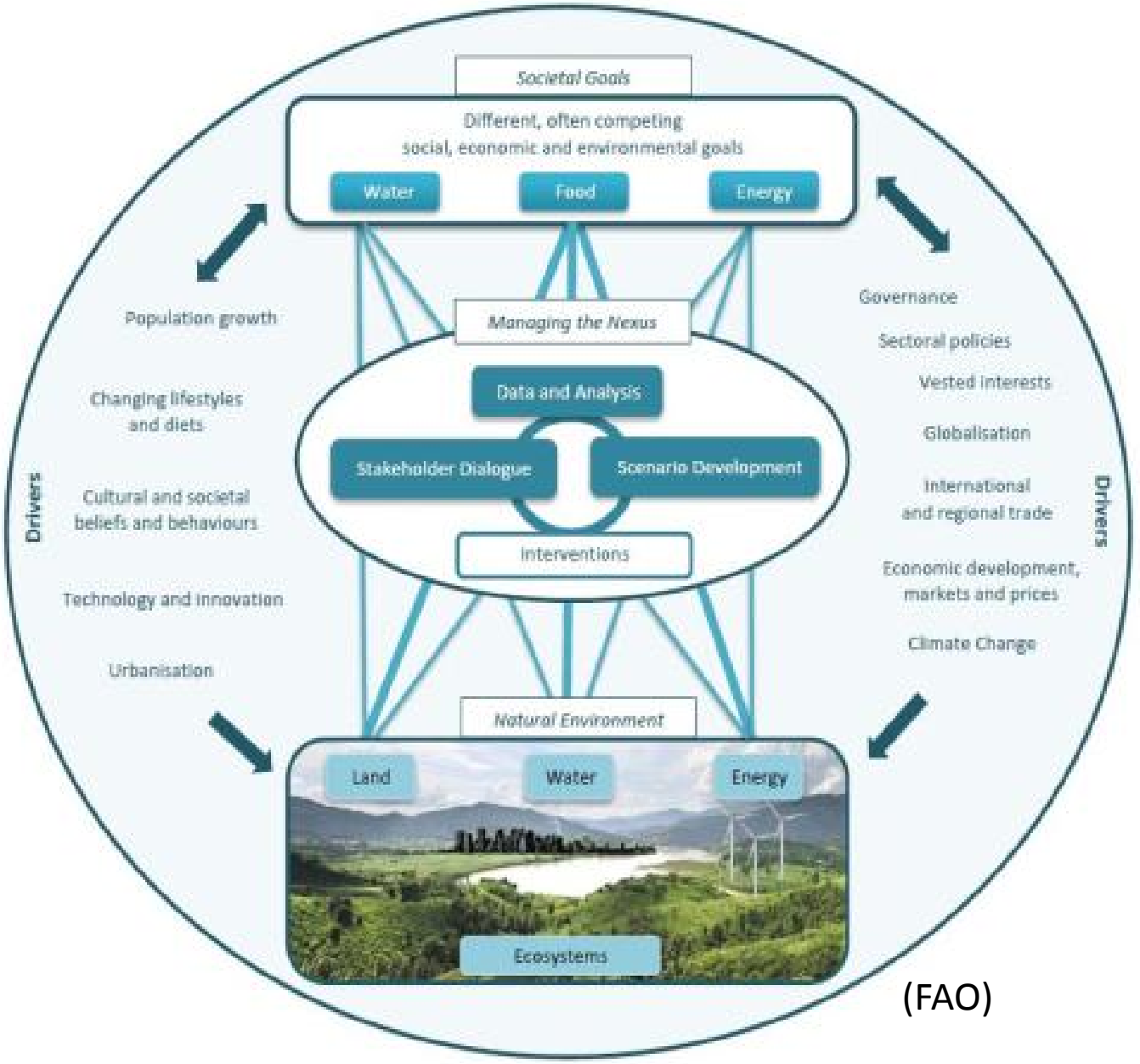
Insights from Future Earth/TAMUS Workshop in Washington DC

Better observations need to be turned into relevant information accompanied by tools to use the information

Better Governance

Values and Goals

Factual Knowledge	High Consensus	Low Consensus
High Consensus	**Structured Problems**	?
Low Consensus		**„Messy“ Problems**



(FAO)

Workshop #2

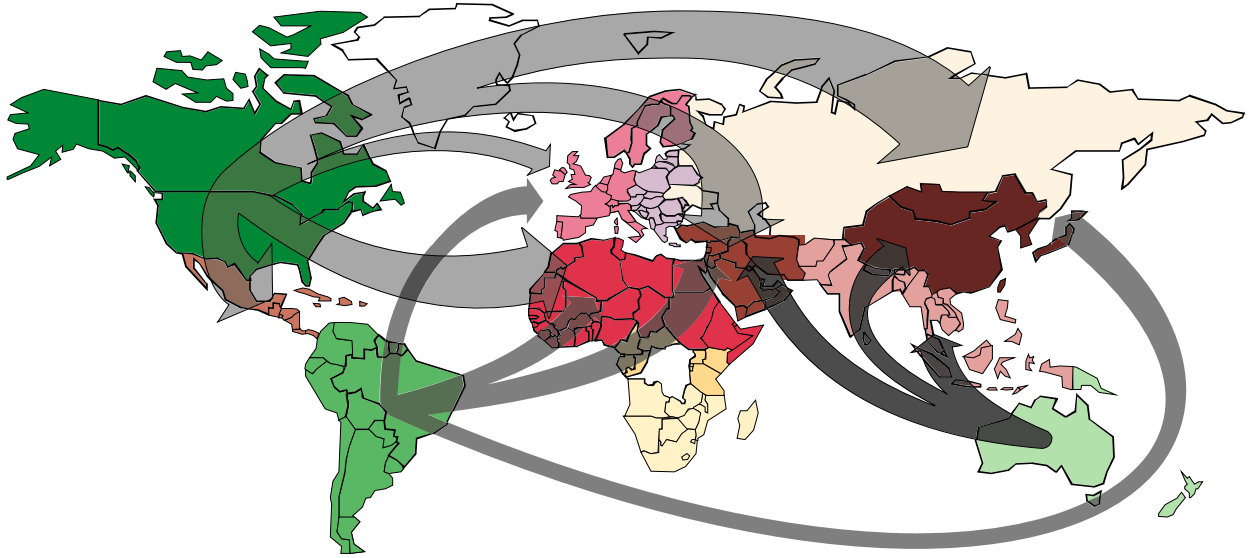
Location: Karlsruhe, Germany
Dates: November 2015
Partner(s): Fraunhofer Institute (~45 participants)

Outcomes:
- Better understanding of European issues: particularly in the energy area.
- Confirmed the need for a German workshop on the WEF

Recommendations: (illustrations only)
- As SWFP develops its regional structure it should seek opportunities for WEF studies and testbeds
- Related WEF policy experiments should be inventoried
- Funding should be sought for comparative case studies
- SWFP should contribute to the World Water Development Report in the area of the WEF.

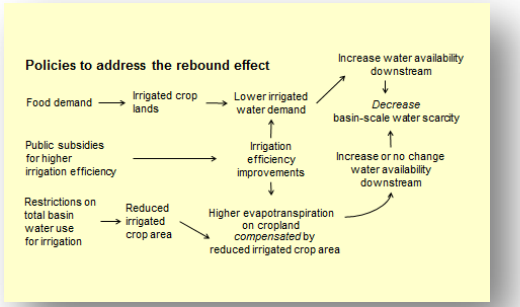
Workshop 2: Analysis Frameworks:

Assessment of virtual water flows as a means of assessing trade influences on the WEF.

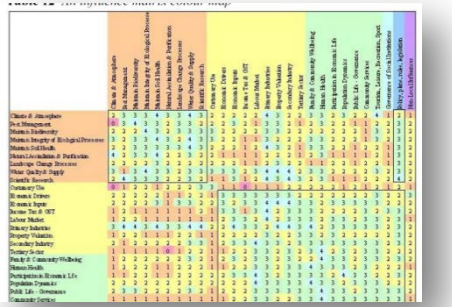


Livelihood Framework (Biggs)

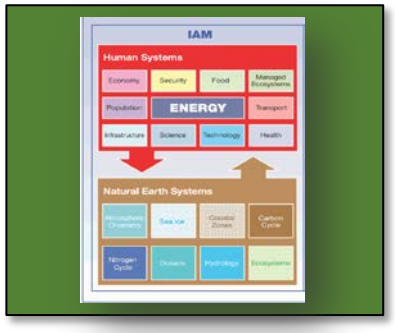
General systems approach to the W-E-F Nexus (Alcamo)



Systems mapping



Cross impact analysis



Modelling and scenario analysis

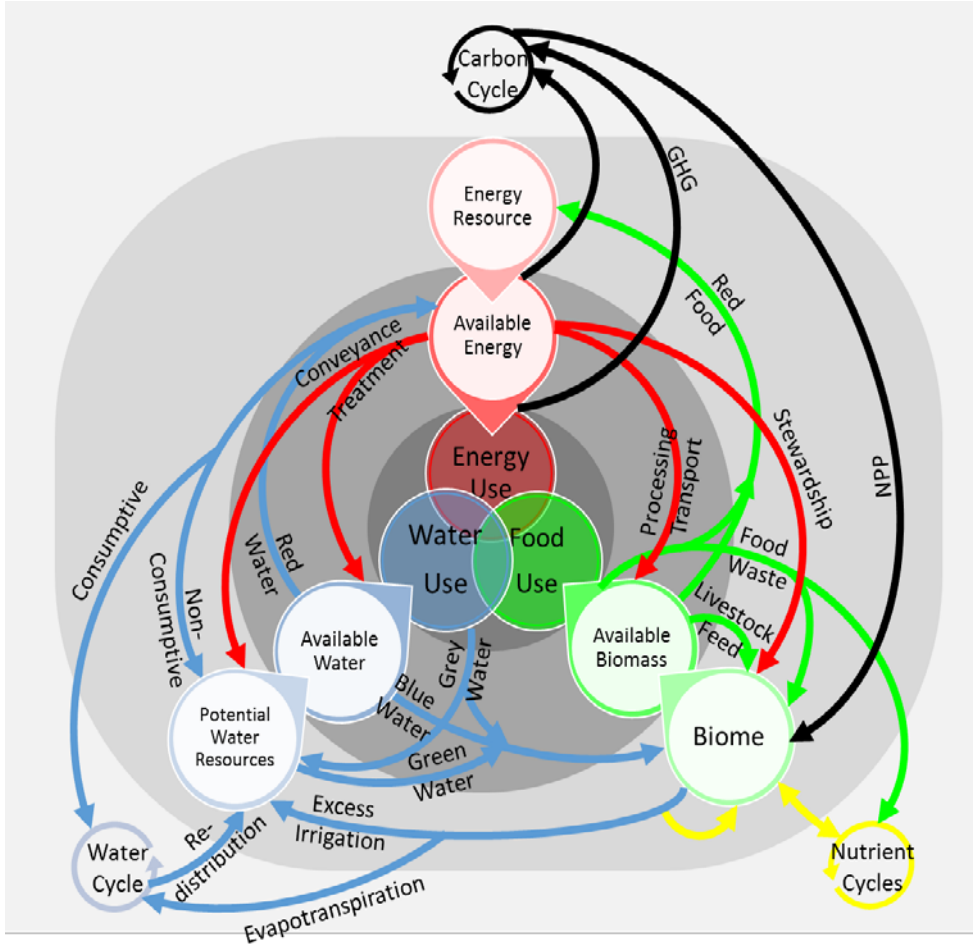
Workshop #3

Location: Kyoto, Japan
Dates: November 2015
Partner(s): Research Institute for Humanities and Nature (~50 participants)

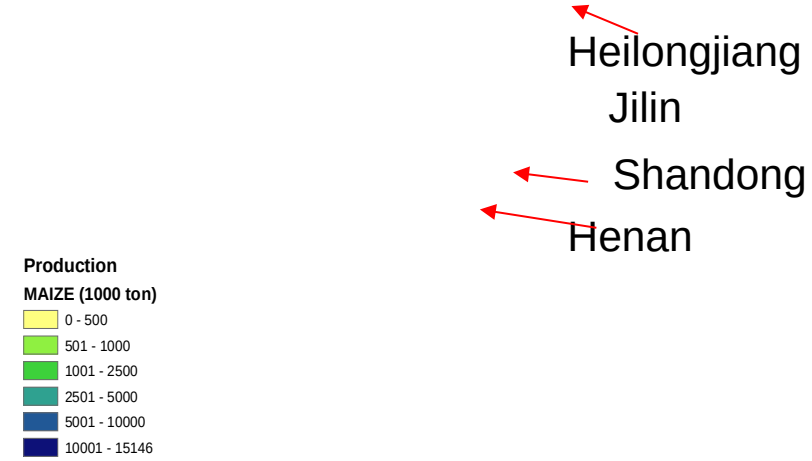
Outcomes:
- Better understanding of Asian issues: particularly aquatic foods.
- Identified some tangible initiatives for applications of EO to WEF Nexus problems

Recommendations: (illustrations only)
- Followup work should be done in the Mekong River Basin.
- Other projects in Asia should built on on-going work
- Aquaculture should be further developed as a possible theme
- Work should be undertaken to more rigorously define the Nexus and to develop a taxonomy of terms
- An activity should be developed in support of the Future Earth KAN

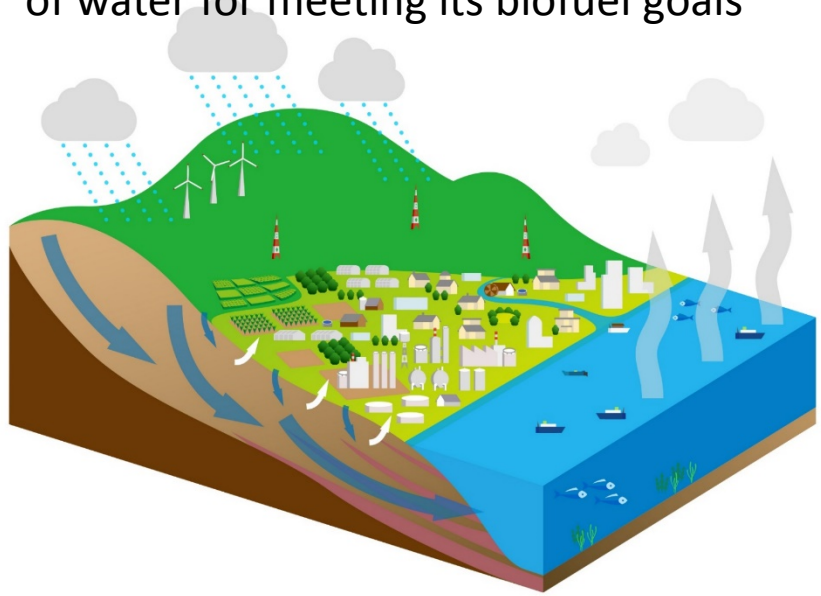
Workshop #3:



Addressing the WEF Nexus will require a clearer understanding of the nomenclature and taxonomy



Asian WEF Nexus Issues: China and the lack of water for meeting its biofuel goals



Subterrainian water flows: factor in aquaculuture

Workshop #4

Location: , Pietermaritzburg, South Africa,
Dates: November 21-23, 2016
Partner(s): Water Research Commission, University of Kwazulu-Natal

Priority Themes:

- Obtain information that would allow the WEF community to understand African issues and propose tools that could be used for solutions on a regional scale
- Assess the ability of the WEF Nexus to address SDG needs for understanding, solutions and monitoring
- Assess the degree to which the SDG goals and targets provide opportunities for new integrated management of the WEF Nexus.

Organizing Committee members who are at this workshop

Anik Bhaduri
Graham Jewitt
Richard Lawford
Sabine Stuart-Hill

Logistics:
Susan Risko

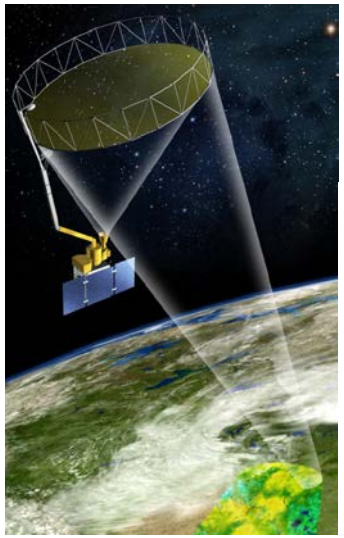
Missing People

Andree-Anne Boisvert

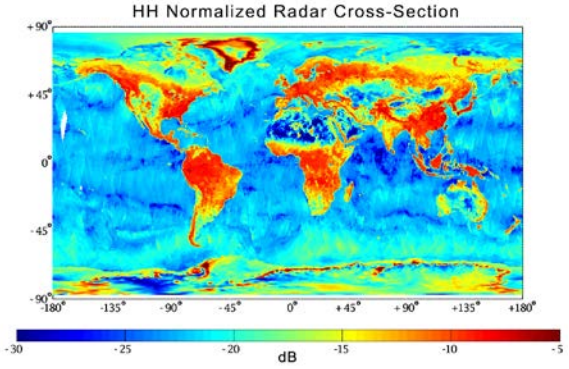
Earth observations can contribute to:

- A reliable basis for planning and design
- Timely assessments of resource requirements
- Advice for management and marketing decisions
- Estimates of the outputs from W-E-F activities
- Guidance for interventions in the W-E-F processes

Information for planning and design



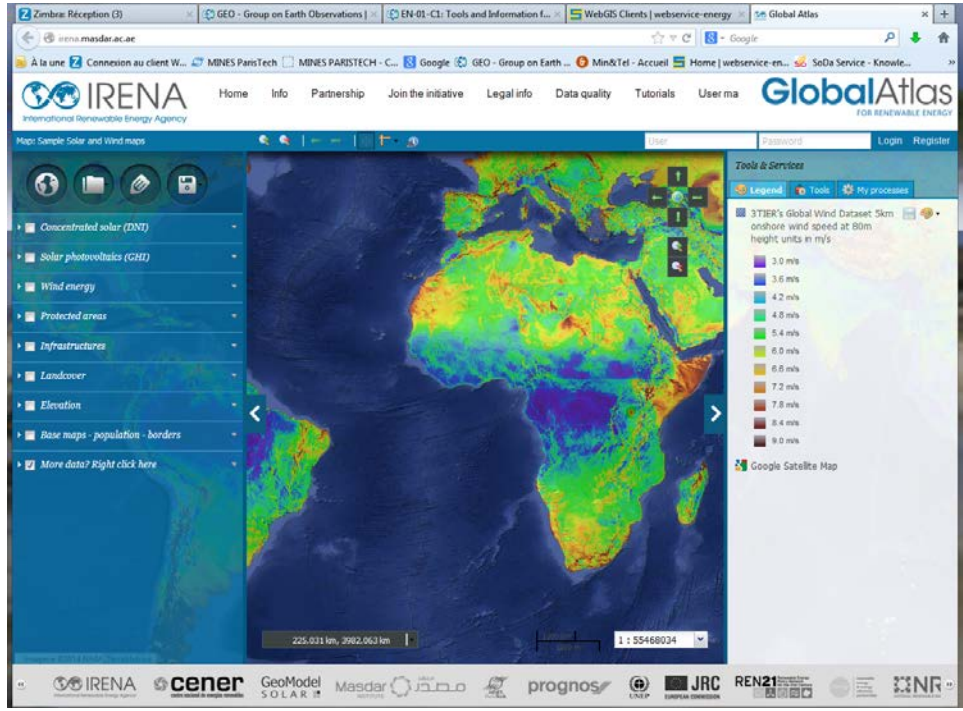
Soil moisture is useful for planning field operations and assessing potential crop productivity.



Water (Entin, Rodell)

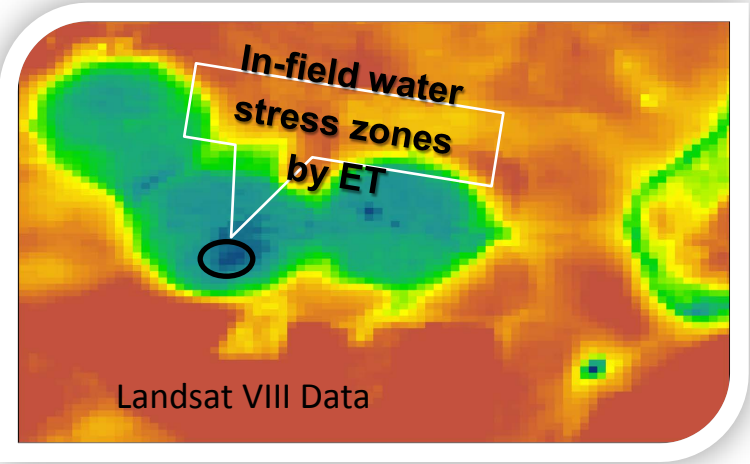
Food: Finding arable land for agricultural expansion is difficult in many areas without help from satellite data (G. Simpson)

Energy



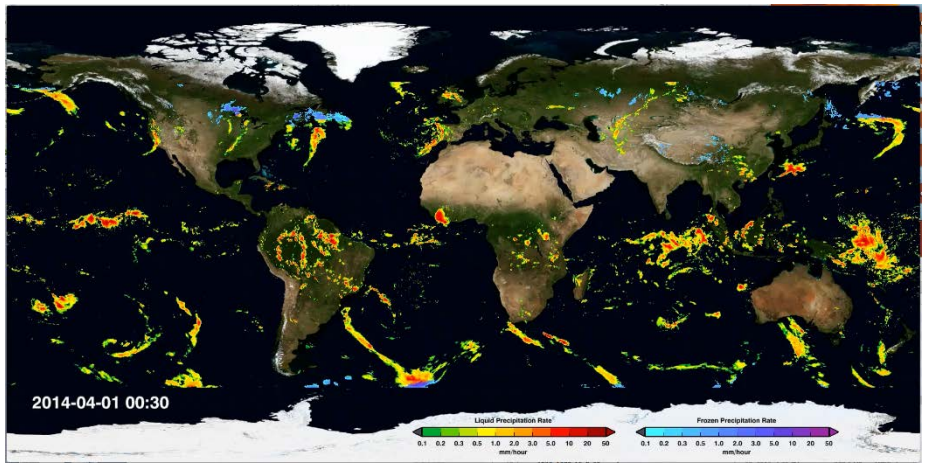
IRENA atlas for **renewable energy** provides information the is useful in siting energy providers based on satellite data.

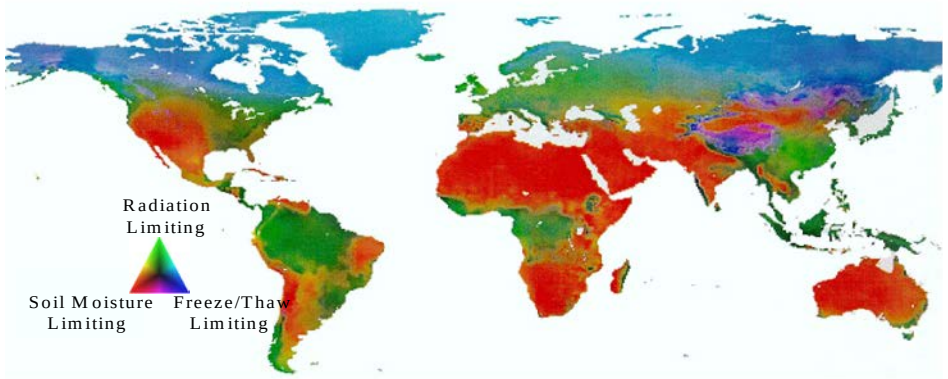
Information for assessing resource requirements



Evapotranspiration (ET) estimates provide assessments of the amount of irrigation required to meet crop needs.

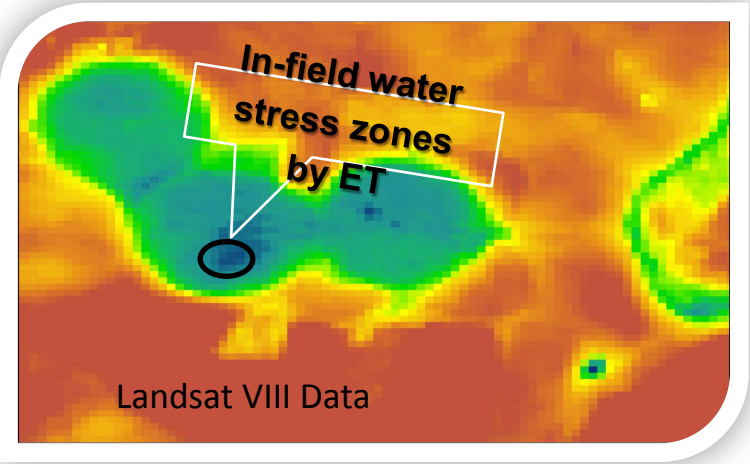
High resolution precipitation maps indicate how much water has been received, allowing the additional amount required for plant growth to be calculated.





Maps of the factors constraining ET can be derived from Earth observations to show the limiting factors for crop growth.

Information for assessing resource requirements



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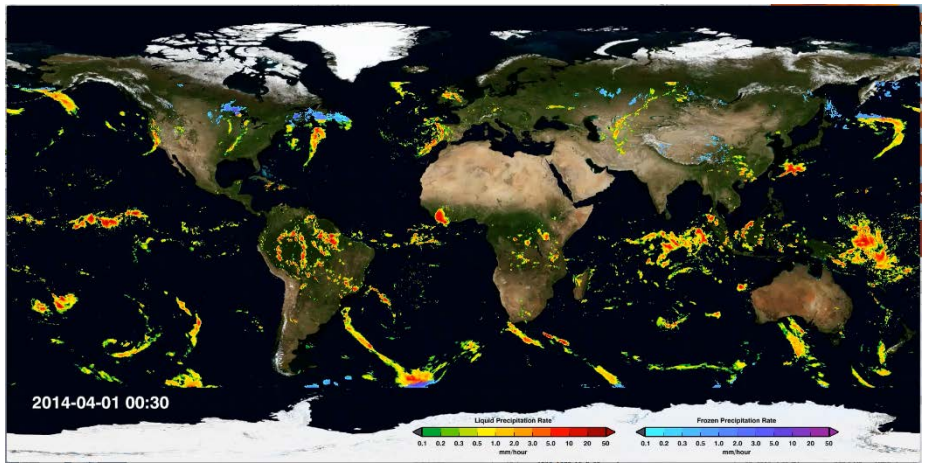
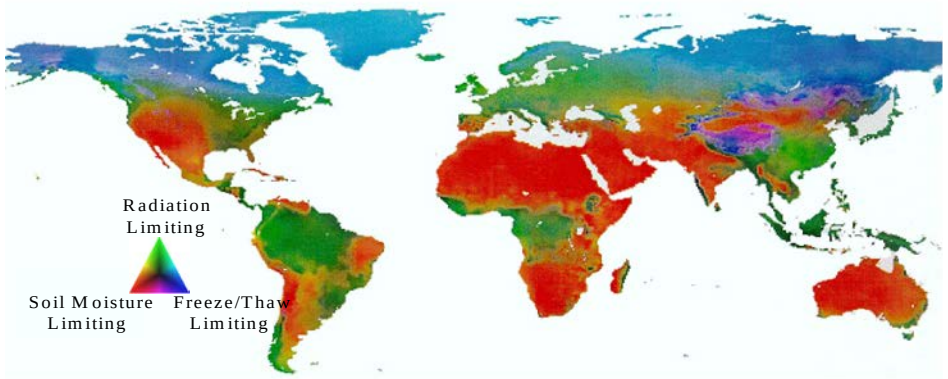
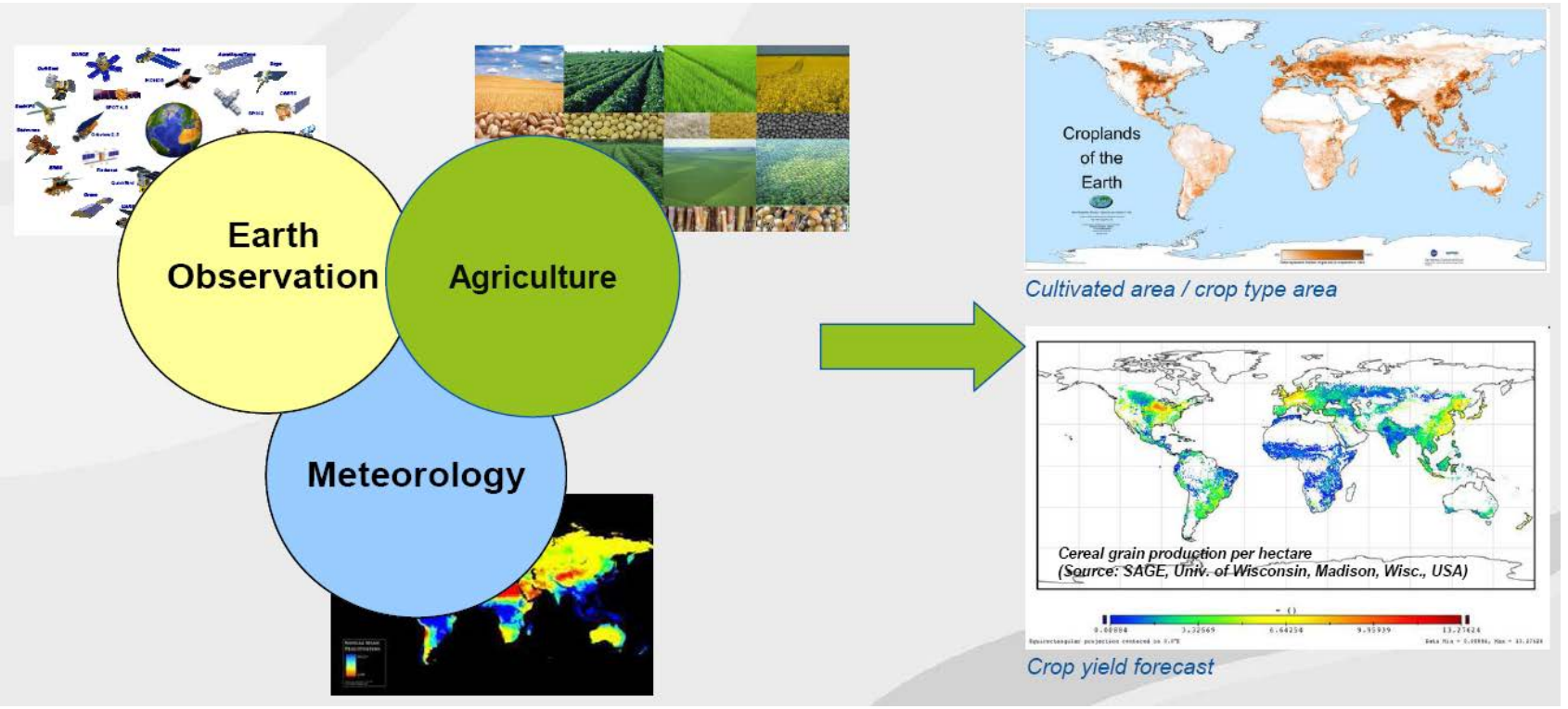




Maps of the factors constraining ET can be derived from Earth observations to show the limiting factors for crop growth.

Information for advice for management and marketing decisions

Food

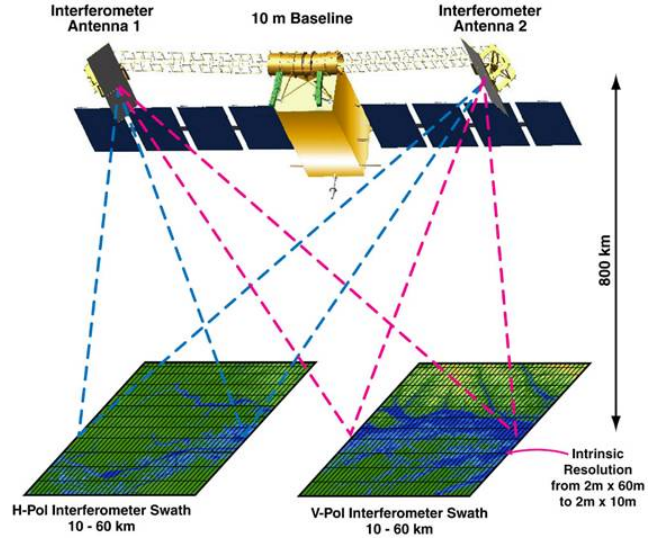


GEO Global Agricultural Modeling (GEOGLAM) provides a capability to forecast yields of different types of crops from satellite data.

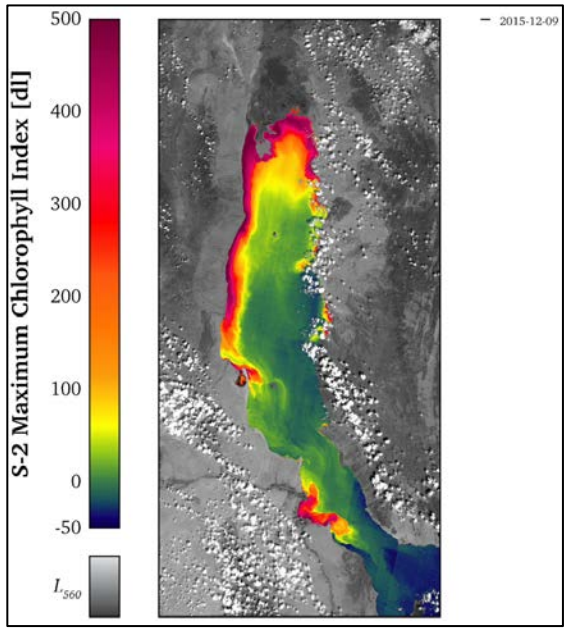
Energy/Water

Information for the Surface Water Mission Concept (SWOT) regarding estimated reservoir heights will be useful for planning forward contracts for hydropower production.

Interferometer Concept (JPL) (courtesy M. Jasinski)



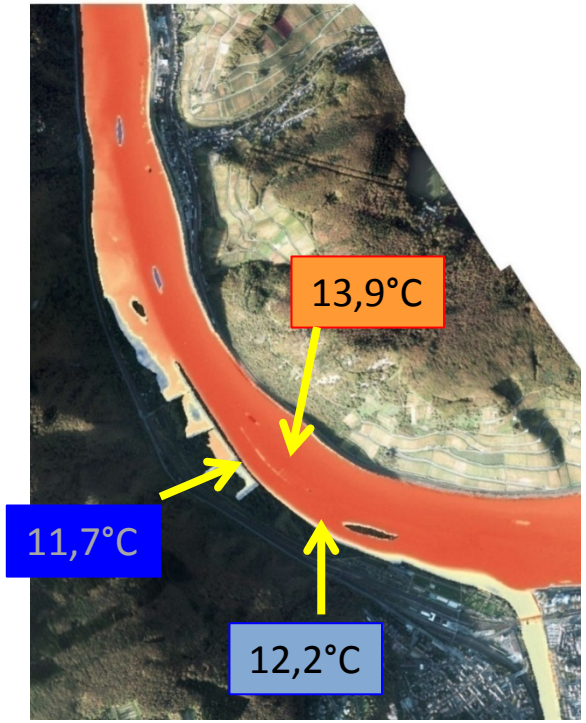
Information to assess the sustainability of the WEF and its impact on the environment



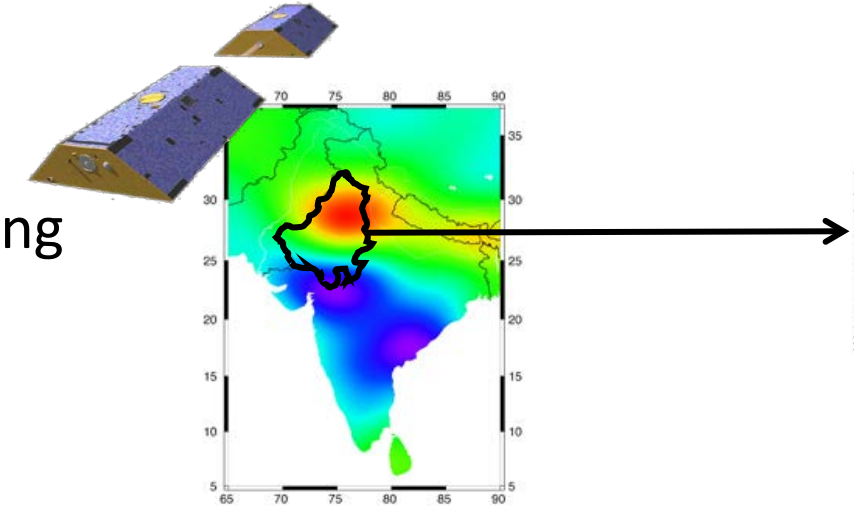
Sentinel-2: 10 m resolution

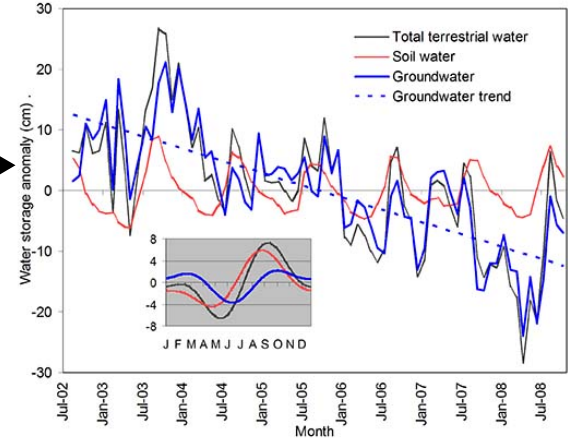
Monitoring the effects of fertilizer excesses on chlorophyll blooms observed on lakes and rivers by the Sentinel satellite (Christian Tottrup)

Aircraft monitoring of thermal emissions (at ~4 m) into the Rhine River (Björn Baschek)



Unsustainable groundwater depletion over northern India arising from withdrawals for irrigation (Rodell, Velicogna, and Famiglietti, *Nature*, 2009)





Water	Potential Data Sources
Source water for irrigation	FAO (AQUASTAT) Voluntary Statistic
Source water for fracking	No data sources
Water used for biofuel production and processing	No data source
Wastewater reclamation	FAO (AQUASTAT)
Water for food processing	FAO (AQUASTAT)
Decreased lake water quality from fertilizers and pesticides	Not monitored by country
Thermally polluted water from power plants and industry	Not monitored by country
Urban water demand	Not monitored

Table 1. Interactions of water with the food and energy sectors.

Energy	Data Sources
Wastewater treatment	FAO AQUASTAT?
Water used in biofuel production	Not monitored
Energy losses in transmission	Can be estimated
Urban demand for energy	Not monitored
Operations/transportation in the food sector	Not monitored
Energy used for irrigation	Not monitored
Energy in food processing	Not monitored
Energy for desalinisation	Not monitored

Table 2. Interactions of energy with the food and water sectors.

Food	Data Sources
Food used for biofuels	FAO AQUASTAT
Energy for irrigation pumping	FAO AQUASTAT
Water used in irrigation (including waste water)	No data source
Energy for food processing	No data source
Environment and health impacts	No data source
Fertilizer use	No data source
Urban food demand	No Known data source
Pesticide use	No known data source

Table 3. Interactions of food with the energy and water sectors.

Land	Data Source
Land covered by large hydropower and irrigation reservoirs	GWSP datasets
Land used for urban development	Satellite data
Land used for bioenergy production	
Arable land lost to soil degradation	No data source
Area of deforestation	N/A
Area purchased by large corporations and foreign national governments	No data source

Table 4. Interactions of land with the food, energy, and water sectors.