Earth Observation for Water Management

International trends & developments

How to promote earth observation applications?

How to get funding?

Capacity building

0. Introduction

Mark Noort, consultant, project manager

HCP international:
consulting, marketing of earth observation

Coordinator GEONetCab:
project for promotion & capacity building of earth observation applications

Earth observation applications

- On the verge of reaching new user communities
- These new user communities need to be involved
- Weakest link / last mile aspects are important
- Marketing needed: promotion & capacity building

Life cycle of products & services

Initialization

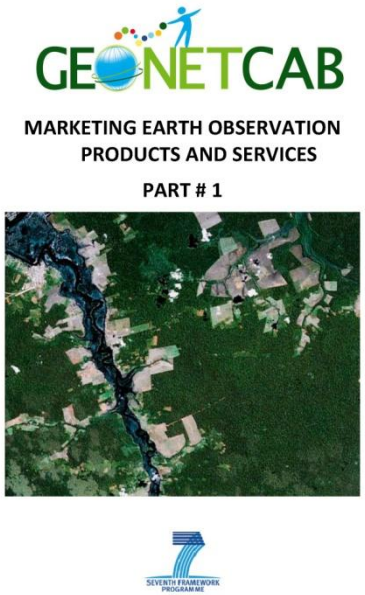
System analysis & design

Rapid prototyping

System development

Implementation

Post-implementation



Assessment of business & funding opportunities

- Categories of water management products & services
- Life cycle phase of product or service
- Regional context, level of technological & economic development
- Optimum marketing mix

1. International trends & developments in water management

Decision making

"We can only manage what we measure"

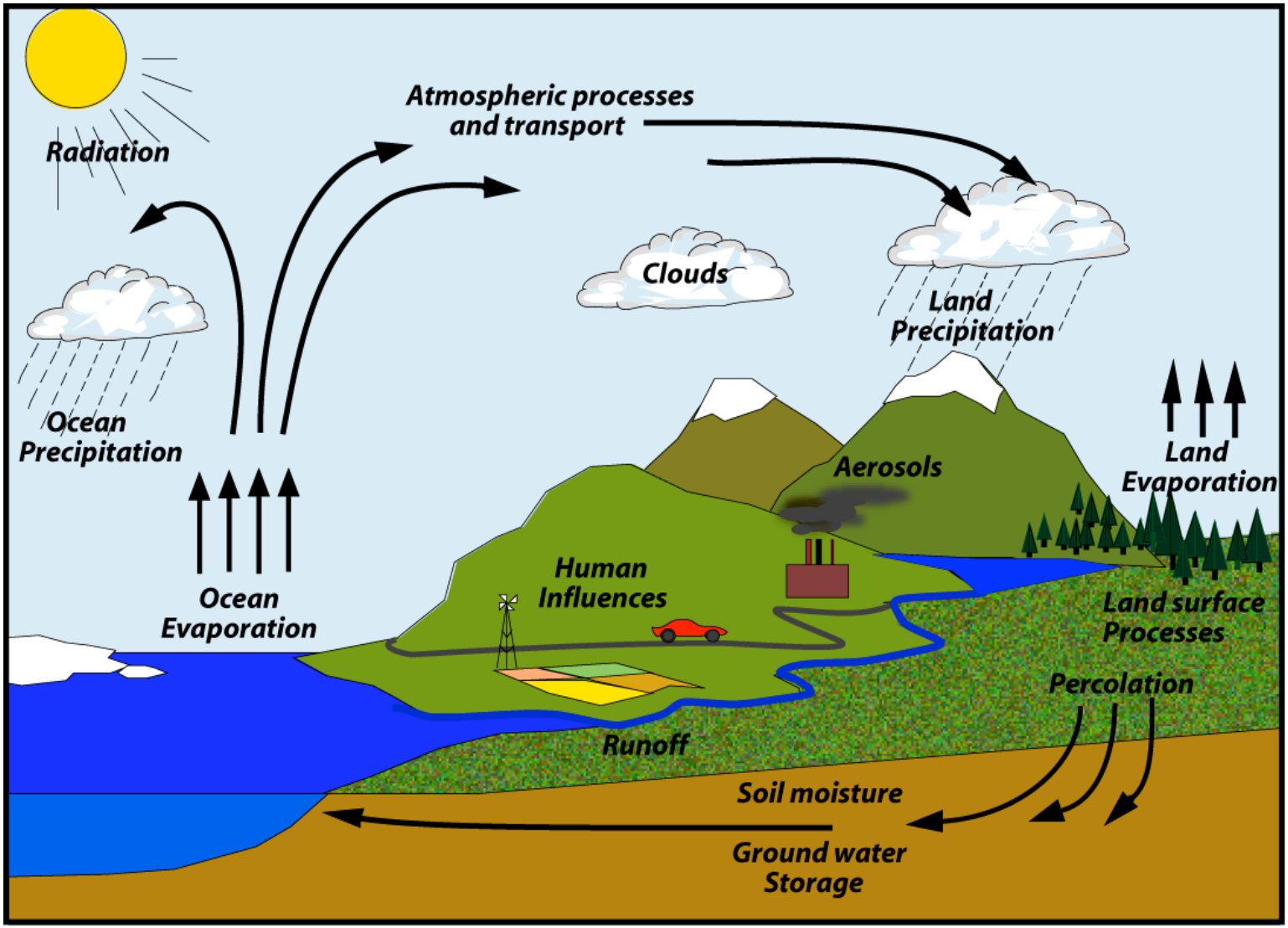
Water cycle: water resources availability and quality for

- Economic development
- Green economy
- Poverty reduction
- Community empowerment
- Risk management

"Advances in Earth observation for water cycle science"

(Fernandez-Prieto, van Oevelen, Su, Wagner)

- Complex process mainly driven by solar radiation
- Evaporation of water from open water and wet soil surfaces controlled by energy, water availability and near-surface atmospheric conditions (air temperature, humidity, wind speed) + transpiration controlled by vegetation
- Results in water vapor in the atmosphere -> cloud formation
- Cloud condensation nuclei + atmospheric state allows for condensation, clouds formed and globally distributed by winds
- Precipitation clouds, water to the Earth's surface, accumulates in rivers, lakes, oceans
- Surface water infiltrates in soil, moistening soil layers and accumulating as groundwater, replenishing aquifers
- Aquifers store water, provide water for human activities or discharge it naturally to the surface or to oceans



Global Energy and Water Cycle Experiment

GEWEX WCRP

"Advances in Earth observation for water cycle science"

(Fernandez-Prieto, van Oevelen, Su, Wagner)

What is needed from a science perspective?

- Accurate and continuous observation of the long-term dynamics of the different key variables governing the energy and water cycle processes from global to local scale -> increase understanding of components of the water cycle (spatial, temporal) and characterize the processes and interactions between the terrestrial and atmospheric aspects of the energy and water cycle (to assess influence on climate variability and predictability)
- For decision making: global synoptic information on water resources availability and quality for water governance, management and planning (+ adaptation to climate change)
- Earth observation complemented with in-situ observations for vailidation, calibration and development of EO-derived products.

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Africa Water Atlas

Modeling of Africa's surface water systems (water balance data), identifying:

- "hotspots": tenuous food security situation
- "hopespots": potential for rainwater harvesting
- "water towers": areas with upstream water surplus

UNEP

USGS science for a changing world

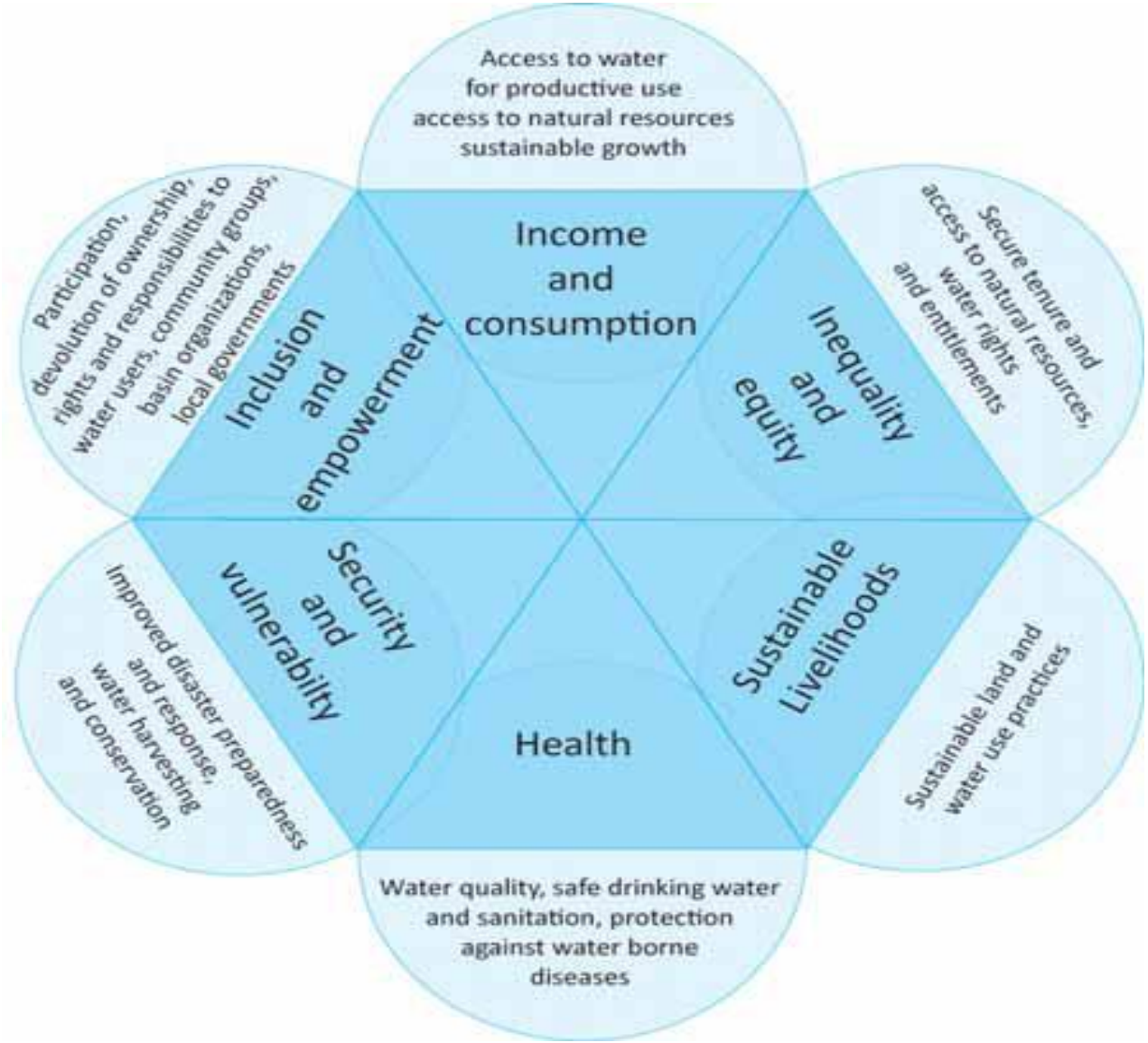
Africa Water Atlas

Key Facts:

- Millions of people in Africa suffer water shortages throughout the year
- Water scarcity is not simply due to geography: population growth, poor planning and poverty are significant factors
- Most urban population growth has taken place in peri-urban slum neighbourhoods, overwhelming municipal water services
- 64% of people in Africa use improved drinking water sources (2010)
- Only 38% of Africa's population has access to improved sanitation facilities (2010)
- Increases in access to improved drinking water sources and sanitation facilities are not keeping pace with population growth

Africa Water Atlas

Linkages between poverty water and the environment



Africa Water Atlas

Action:

- Provide safe drinking water + ensure access to adequate sanitation
- Foster cooperation in transboundary water basins
- Provide water for food security
- Develop hydropower to enhance energy security
- Meet growing water demand
- Prevent land degradation and water pollution
- Manage water under global climate change
- Enhance capacity to address water challenges

Earth observation contribution to action

- Increase insight in and visibility of available resources
- Analysis of historical and future use for planning and decision making
- Mapping of informal settlements, infrastructure and resources
- Analysis for more efficient use of water resources
- Hydropower: assessment of resources, planning & monitoring
- Instrument for community empowerment ->

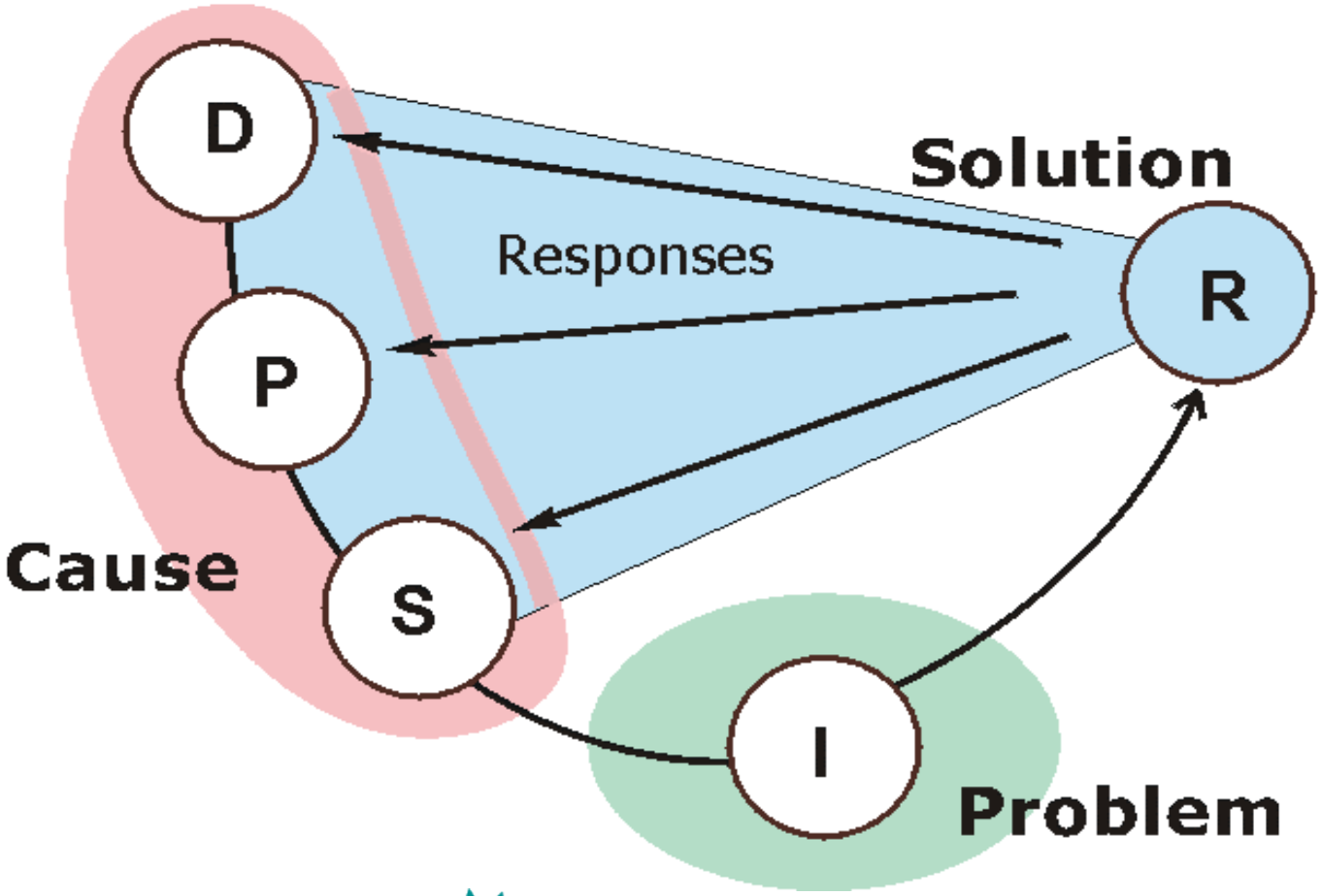
example – Human sensor webs: challenges for monitoring

Water resources across Europe — confronting water scarcity and drought

EEA Report No 2/2009

- DPSIR: framework used for water resources management
- Water exploitation index (ration of annual total water abstraction to available long-term freshwater resources)
- Action: water pricing, drought management plans, water efficiency and conservation, raising awareness, tackling illegal water use, alternative supplies, desalination
- Information requirements: river basin scale water balances based on the UN system of environmental economic accounting for water (SEEAW, 2007) & WISE (water information system for Europe)

DPSIR framework: driving force, pressure, state, impact, response



European Environment Agency

Back to decision making

"Make Information Relevant to Managers"

Main messages given to managers:

1. It is definitely getting warmer
2. Though we expect that the hydrological cycle will be enhanced due to more energy in the atmosphere, we really don't know how precipitation patterns will be affected.

Managers are liable to respond with:
"I need more information before I will invest in adaptive activities – I don't know how to respond to this much uncertainty"

Reference: Managing Drought: A Roadmap for Change in the United States

Back to decision making (2)

"Make Information Relevant to Managers"

Reframe the information in terms of combining the effect of temperature and demand:

1. Increased human demands for water for human, agricultural and the environment, among other sectors
2. Impacts on supply (increased evaporation from reservoirs, increased consumption by plants, decreased snowpack, etc.)
3. If it does rain more in a warmer climate, it is likely to rain harder than more often

Reference: Managing Drought: A Roadmap for Change in the United States

Back to decision making (3)

"Make Information Relevant to Managers"

Then the message to managers becomes: "though we don't know much about whether total precipitation will increase or decrease, the implication of global warming for water management are likely a reduction in average supply availability and an increase in extreme events, including both droughts and floods"

Framed in terms of risk to managers' systems

Reference: Managing Drought: A Roadmap for Change in the United States

Back to decision making (4)

"Make Information Relevant to Managers"

Need for "integrated and adaptive decision support systems able to explicitly account for system uncertainty"

Incorporate institutional, political, and economic considerations into translating physical science findings into relevant information for specific types of decisions within specific sectors

Communication should be perceived by the users as:

- Salient (answering the right questions)
- Credible (coming from a trusted source)
- Legitimate (accurate)

Other references related to extreme events:

References on flooding can be found in the GEONetCab disaster management toolkit

More references on drought:

Drought monitoring and early warning:
concepts, progress and future challenges

The national drought information system implementation plan *a pathway for national resilience*

Agriculture and Agri-Food Canada's Drought Monitoring and Information System

Methodologies for:

"we can only manage what we measure"

Water registers *(as key to fair distribution of access to water)*

Water and ecosystem capital *(water as natural capital, linked to economy and well-being (UN SEEAW 2007, NAMEA))*

Water scarcity and vulnerability indices *(per capita, renewal vs withdrawal, etc.)*

Water footprint assessment *(amount of water consumed per unit of product)*

Life cycle assessment *(benchmarking for industries)*

Water stewardship (quantify corporate water monitoring)

Key observations for:

"we can only manage what we measure"

- Over the past 50 years global freshwater withdrawals have tripled
- A quarter of freshwater use exceeds accessible supplies
- By 2030 nearly 3.9 billion people will live under conditions of severe water stress (OECD)
- By 2030 global demand for water will be 40% higher than it is today
- Open data access and optimal data availability are of cardinal importance

Different levels for:

"we can only manage what we measure"

- **User level**: price and technology play a key role (creating awareness, charging prices based on full marginal costs, stimulating water saving technology
- **Catchment or river basin level**: choice on how to allocate the available water resources to the different sectors of the economy (depends on the value of water in its alternative uses)
- **International trade**: water as a global resource (overall efficiency)

Economic calculations of:

"we can only manage what we measure"

Calculating the monetary value of externalities and ecosystem resources and services that are currently unpriced

Decoupling concepts:

- Resource decoupling:
  reducing resource use per unit of economic activity
- Relative decoupling:
  resource use still increases but at a lower rate of economic growth
- Impact decoupling: *scale and character of resource use causes no negative environmental impact*
- Absolute decoupling:
  resource use declines irrespective of the growth rate of the economic driver

2. Steps to promote earth observation for water management

State-of-the-art

Earth observation is new technology.

Learn technical skills, but when back in professional practice, it has to be put to good use.

That involves ‘selling’ it.

How to do that?

To whom? Could be your own boss, local authorities, communities, etc.

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Categories of products and services

- Hydrologic information systems
- Soil moisture modelling
- Drought monitoring / early warning
- Monsoon monitoring / forecasting

Different levels of intervention for earth observation products & services

- Formalization axis *(technical products, such as DEM, terrain analysis, land use / land cover & change detection)*
- Axis of use *(processed information, for example for management of dams, water or hydro-erosion and flood risk zones)*
- Axis of facilitation *(products and services that directly facilitate decision making)*

From: Application of satellite remote sensing to support water resources management in Africa: results from the TIGER initiative

Steps for Earth observation supported water resource management

1. Land use and land cover mapping + change monitoring
2. Water abstraction estimate in respect of crop water demand estimates for irrigated areas
3. Refined land use / land cover mapping
4. Surface water bodies or water pools (location, extent, dynamics)
5. Digital elevation models and derived products
6. Estimates of basin-wide evapotranspiration and precipitation
7. Water and vegetation monitoring (entire aquifer)
8. Ground subsidence monitoring and its correlation with groundwater abstraction

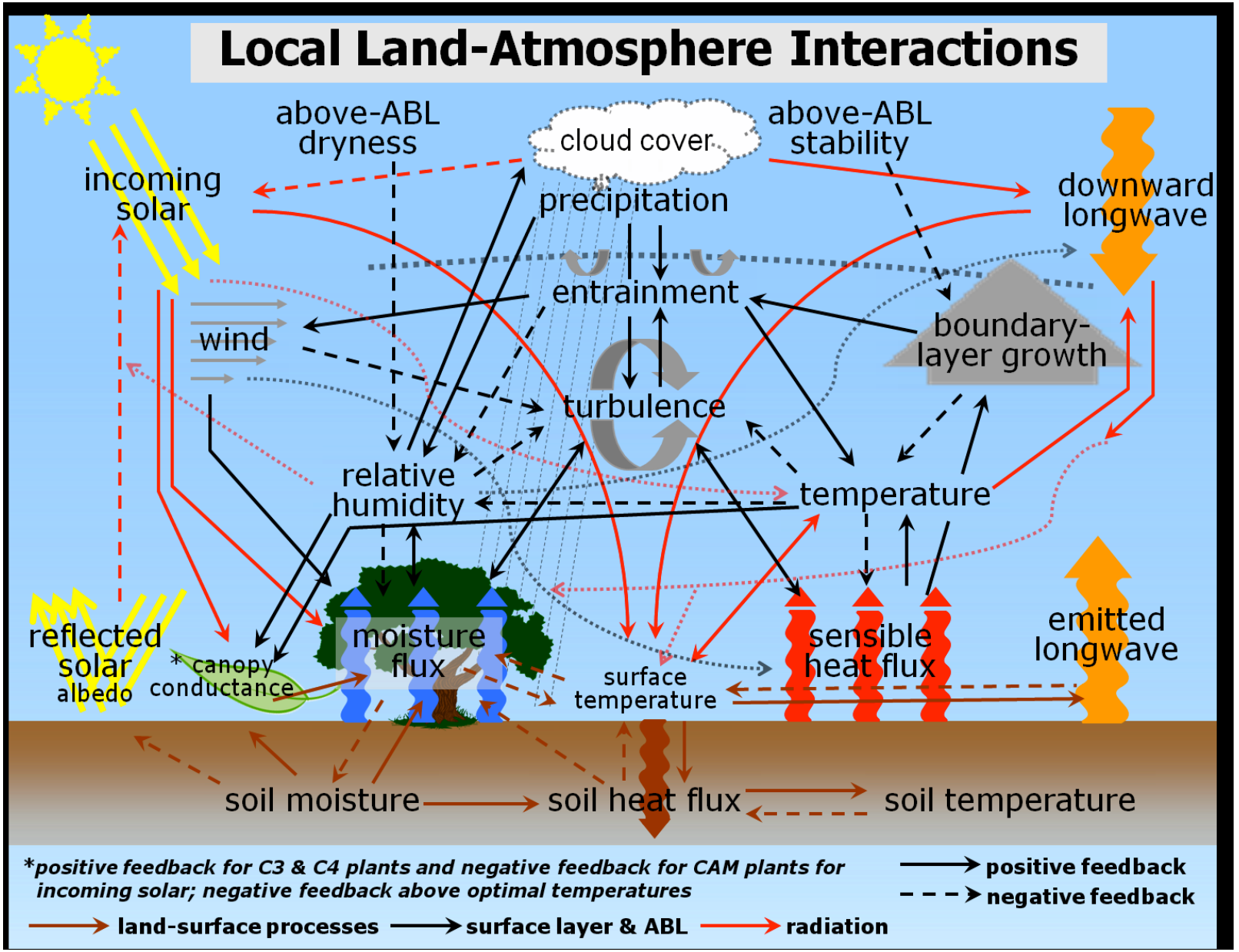
From: Application of satellite remote sensing to support water resources management in Africa: results from the TIGER initiative

Where to get the data from?

Global energy and water experiment (GEWEX) -> now:

Global and regional energy and water exchanges – *some considerations from* **"GEWEX Plans for 2013 and Beyond"**

- Prototype data management scheme for GEOSS
- Development of land data assimilation systems
- Decadal-long data records of land states for soil moisture
- Systems require inputs from some combination of in-situ meteorological networks, satellite observations and forecast model outputs
- Transfer research developments and demonstration applications to operational agencies and users



Global Energy and Water Cycle Experiment
GEWEX
WCRP

More references:

GEO Task US-09-01a: Critical Earth Observations Priorities - *Water Societal Benefit Area* *Overview of available and needed observations, overview of application areas and user types*

EUGENE Water Status Quo report (and final report)
Overview of state-of-the-art EO for water in Europe

WMO statement of guidance for hydrology
Overview of (international) organizations dealing with water
Overview of observation gaps: water use, evapotranspiration and soil moisture

WMO guide to hydrological practices
Part 1: from measurement to information
Part 2: management of water resources and application of hydrological practices

More references (2):

Remote sensing applications, National Remote Sensing Centre, India Chapter 6: water resources management & Chapter 8: groundwater
Overview of remote sensing applications and case studies in India

Water management by satellites; the unavoidable way forward
Visionary presentation from a Dutch SME: assessing spatial water productivity & water footprint

Spatial dimensions of land administration and users rights over groundwater: case study of Kerala, India vs. Coca Cola
Case study on how geo-information visualizes groundwater rights, water use and associated problems

Impacts of agricultural intensification through upscaling of suitable rainwater harvesting technologies in the upper Ewaso Ngiro North basin, Kenya *Article describing remote sensing applications for rainwater harvesting*

More references (3):

Evaluating nitrogen removal by vegetation uptake using satellite image time series in riparian catchments
Article on a pilot study in China on improving water quality by making use of natural vegetation

Summary of the 2nd GEOSS Africa water cycle symposium
Overview of available data and models in Africa

Update on the Integrated Global Water Cycle Observation (IGWCO) community of practice *Overview of activities of the GEO water community*

HARIMAU Radar-Profiler Network over the Indonesian Maritime Continent: A GEOSS Early Achievement for Hydrological Cycle and Disaster Prevention *Article describing the establishment of a network for monsoon forecasting and monitoring*

More references (4):

Global Runoff Data Centre report series hydrologic information – metadata
UML model of available catalogues

The current status of global river discharge monitoring and potential new technologies complementing traditional discharge measurements *Article on options for discharge monitoring by remote sensing, especially in remote areas*

Essential climate variable studies on: glacier, snow cover, groundwater, water level, river discharge *Description of available and needed information, including role of earth observation*

References on drought: see slide above (on extreme events)

More references (5):

SHARE: soil moisture for hydrological applications *Article on earth observation for soil moisture products*

Emerging technology analysis *Overview of application and possibilities of emerging technologies for earth observation related to water, weather and oceans*

Space research – a European journey *Overview of space-related research projects, including projects dedicated to GMES downstream services*

GLOWASIS user requirement study *Report on user requirements for the GMES global water scarcity information system*

Marketing of earth observation

Marketing of earth observation is difficult.

New technology, few big companies, lots of small ones.

Lots of reports describing the bottlenecks, like reliability, data access, data continuity, etc.

Means that relatively a lot of effort is needed to promote EO.

Points to keep in mind:

- Look for opportunities, where can you have most success in a short time: quick-wins.
- Target the right audience to start with: who would be interested and listen to you?
- Identify the problem that they are trying to solve: is it the same as yours?
- Learn to speak the same language. Example ‘evapotranspiration’: this is a term most managers do not understand and do not care about. Use terms related to water use, supply and demand instead.
- Look for examples from elsewhere (success stories): solutions that work and are affordable.

Be patient:
introduction of new technology
and / or applications takes time

3. How to get funding for your activities

Approach

- Share information on your subject (a thing you are doing) and think that is interesting for your contact, then look for the link. Could this solve a problem for your partner? Are adjustments necessary? Need other parties be involved? Take it from there.
- LEADS, LEADS, LEADS

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How?

- Establish your network.
- Look for opportunities.
- Write a good proposal.
- Promise much, but not too much.

Proposal outline

(more detailed version in separate document, see also www.geonetcab.eu)

1. Introduction / relevance
2. Objective(s)
3. Activities
4. Output
5. Management & evaluation
6. Risk assessment
7. Time schedule
8. Budget

Annexes

Other references

- Civicus: writing a funding proposal
- Michigan State University: guide for writing a funding proposal
- ESRI: writing a competitive GRANT application
- REC: project proposal writing

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Again:

- *SHARED PROBLEM*
- *SHARED LANGUAGE*
- *SHARED SOLUTION*

If all else fails, try to link with a more popular (and easy to understand) topic.

4. Capacity Building

General

Marketing is promotion + capacity building.

Especially for the introduction of new technologies capacity building is important at all levels.

Capacity building is the instrument to increase self-sufficiency and make solutions work.

Think of:

- Different instruments for different levels: workshops for decision makers and awareness raising, detailed technical training for professionals.
- Provide follow-up. Getting funding for good capacity building is difficult: everybody agrees that it is important, but nobody has time.
- Training is usually part of funding of big projects that are managed by big companies or ministries, as a consequence capacity building is forgotten (in the end).
- Aim at small budgets that are available without having to tender.

Examples & references

White paper on GEO capacity building and water resources in Africa

Dedicated programs, such as TIGER and DRAGON

Tiger capacity building facility: growing from projects to professional community (article by Vekerdy, et al.)

GEONetCab capacity building web www.geonetcab.eu

compilation of tutorials, references, open-source software, etc.

GEO Portal: www.earthobservations.org

Focal points: general appraisal of water resources, specialist information (such as improving on curve number method), historical analysis *(making use of free and open data): integration with other services*

More references

A Rough Google Earth Guide

MEASURE Evaluation Global Positioning System Toolkit (USAID)

Handbook of Research on Developments and Trends in Wireless Sensor Networks: From Principle to Practice

Further details:

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