



RESEARCH
PROGRAM ON
Water, Land and
Ecosystems

The CGIAR Research Program on Water, Land and Ecosystems (WLE)

Led by IWMI



The challenges facing our global food production systems

Food security . . . Exploitation of resources . . .

 **Science & Space**

SEARCH Search TIME

GOING GREEN

Feeding the Planet Without Destroying It

By Bryan Walsh | Tuesday, May 22, 2012

Like 25 Tweet 98 +1 47

Climate change is the environmental problem that obsesses us, the one that's the focus of high-flying international summits and hardcore national politics. But it's not the only environmental problem — and it's not even the biggest one. That happens to be the crisis in agriculture and land use, the subject of what Jon Foley — the head of the University of Minnesota's Institute on the Environment — calls the "other inconvenient truth." Put simply, the act of feeding 7 billion plus human beings already puts more stress on the planet than any other single activity — and with both population and global wealth continuing to grow, we're going to need to figure out a way to produce more food without further damaging the environment. Otherwise we may end up running out of both food and the planet.



TREVOR SNAPP / BLOOMBERG VIA GETTY IMAGES

A farm worker inspects wheat ears before harvesting on a large scale wheat farm in Timau, near Nanyuki, Kenya

It's important to understand just how massive global agriculture's footprint really is. First there's simply the land: 6.2 million sq. mi (16 million sq. km) are currently used to grow crops — an amount of land about equal to that of South America — while 11.6 million sq. mi (30 million sq. km) has been set aside for pastureland, an area equivalent to the entire African continent. Altogether that's more than 40% of the dry land on the planet. We use 60 times more land to grow and raise food than we do to live on. Farming takes half the world's available freshwater, much of which is used for irrigation. And all that activity — plus the deforestation and degradation that tends to go hand in hand with farming — helps make agriculture the single biggest source of manmade greenhouse gases, more than industry or transport or electricity generation. "We are running out of everything," says Foley. "We are running out of planet."

 **World**

SEARCH Search TIME

WORLD

What If the World's Soil Runs Out?

By World Economic Forum | Dec. 14, 2012 | 17 Comments

Share Like 3.7k +1 138 Share 56

This is a "what if" interview from the World Economic Forum's Risk Response Network. To view the rest of the series, [click here](#).

It's a strange notion, but some experts fear the world, at its current pace of consumption, is running out of useable topsoil. The World Economic Forum, in collaboration with TIME, talked to University of Sydney professor John Crawford on the seismic implications soil erosion and degradation may have in the decades to come.



GETTY IMAGES

Is soil really in danger of running out?

pour most of our water straight onto the ground. If soil is not fit for purpose, that water will be wasted, because it washes right through degraded soil and past the root system. Given the enormous potential for conflict over water in the next 20-30 years, you don't want to exacerbate things by continuing to damage the soil, which is exactly what's happening now.

(MORE: [Feeding the Planet Without Destroying It](#))

How does soil erosion happen?

Soil is a living material: if you hold a handful of soil, there will be more microorganisms in there than the number of people who have ever lived on the planet. These microbes recycle organic material, which underpins the cycle of life on

The challenges *change . . . climatic, demographic, economic*



ANDHRA PRADESH

Over 270 killed in India floods

October 05, 2009 | By Harmeet Shah Singh CNN

Share Twitter

Recommend

The number of dead in devastating floods triggered by torrential rains in India has risen to at least 271, and about a million people have fled their homes, officials said Monday.

At least 192 people have died in the southern state of Karnataka, its disaster-management secretary H.V. Parshwanath told CNN.

More than 450,000 people there have been housed in 1,330 relief camps as authorities completed rescue operations in most of the flooded zones in the state, he said.

"The focus is now mainly on relief," Parshwanath said, adding that rain Karnataka.

In neighboring Andhra Pradesh, authorities put the death toll at 51. So evacuated to safety, with more half of them now sheltering in relief car commissioner of the state's disaster-monitoring department.

India has deployed the military to help with relief and rescue in Karnat

More than a dozen teams of naval divers have been sent to the two fi defense ministry said.

Air force planes and helicopters have also been dropping food packet

The military has been able to rescue 1,336 people so far, it added.

Flood waters were now receding in two of the five worst hit districts of official Kumar said.



An aerial view of a district in North Ka

THE WALL STREET JOURNAL.

U.S. EDITION Thursday, October 1, 2009

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Asia China Hong Kong Japan India SE Asia Europe U.K. Russia Middle East Africa

INDIA NEWS | October 1, 2009

India's Drought Is Worst Since 1972

By VIBHUTI AGARWAL

India's meteorological department declared the country's four-month monsoon season had ended, leaving behind what it said was the country's worst drought in decades, with rains 23% below normal.



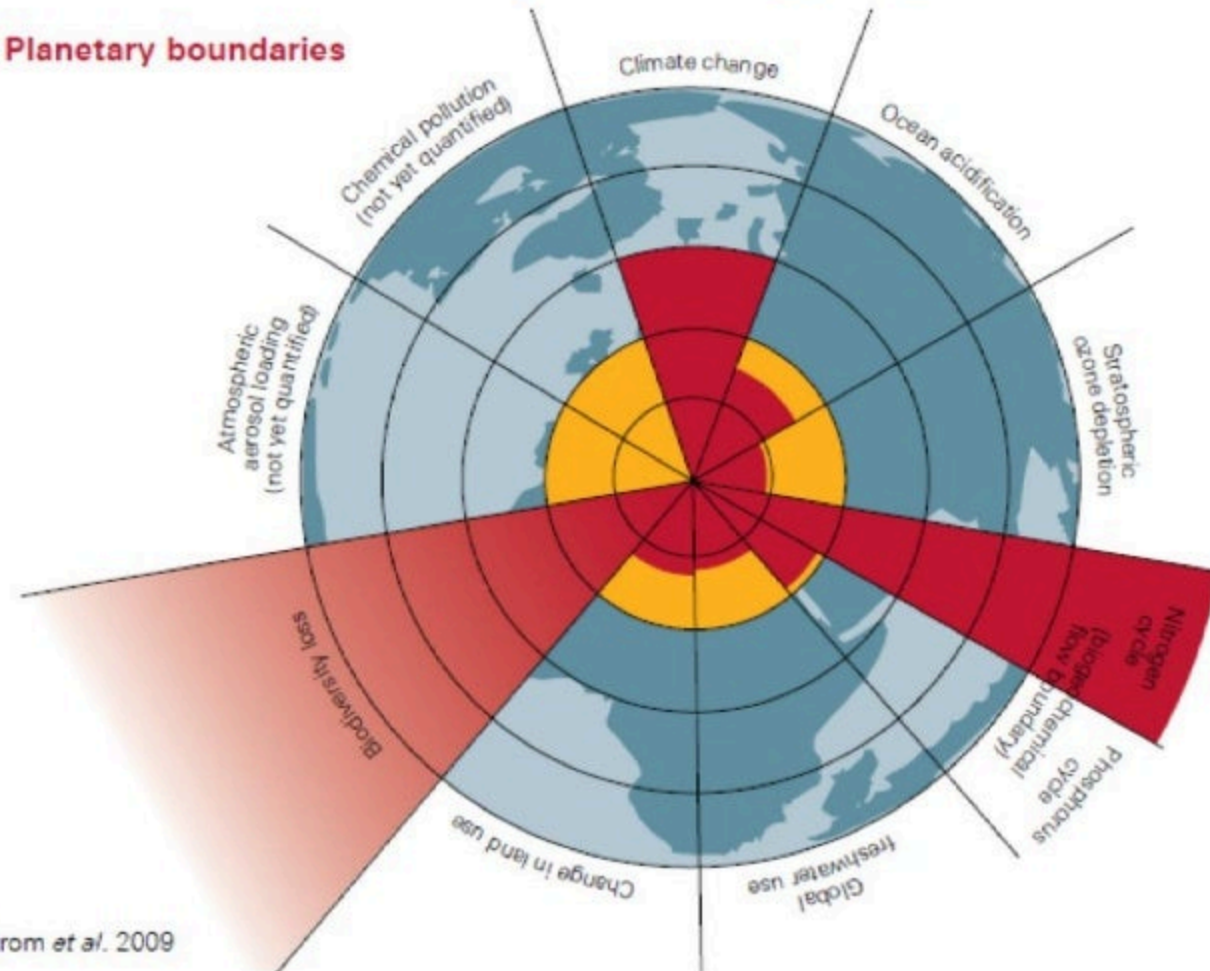
Enlarge Image

Many economists forecast that gross domestic product will expand about 6% this year, but the weak monsoon already has sent food prices skyrocketing and is expected to stoke inflation.

"The monsoon this year has left the country with the worst drought since 1972," said Awadhesh Kumar, the

We have exceeded three of the nine Planetary boundaries – danger of greater risks and uncertainty emerging.

Figure 4.2: Planetary boundaries



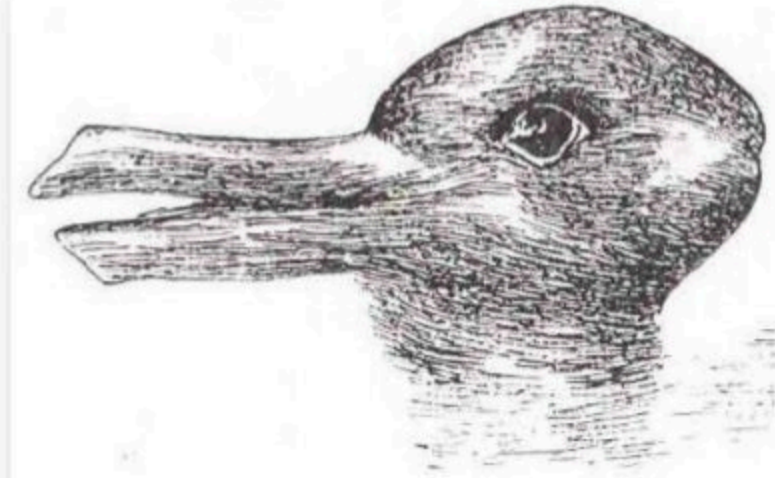
Agriculture is the dominant contributing factor and the solution.

The paradigm shift that WLE seeks – sustainable intensification that places people and nature upfront

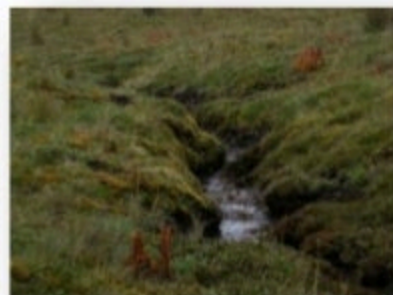
The *status quo*: **ecosystems and natural capital are wholly owned subsidiaries of our agricultural production systems.**

The paradigm shift: **agricultural production systems are a wholly owned subsidiary of the ecosystems and natural capital they are dependent upon.**

Agricultural production will be sustained provided we do not over-allocate or destroy ecosystems, associated services and natural capital.



Benefit sharing mechanisms in the Andes Fuquene, Colombia



Annual net income:
US\$ 2,183/ha



Conservation agriculture and
paramo restoration supported by revolving fund

Revolving fund credit:
+180 farmers /year

Potato cropping,
grazing pressure,
degradation of *paramo*

S



Annual net income:
US\$ 1,870/ha

Our vision:

*A world in which **agriculture thrives** within **vibrant ecosystems**, where communities have **higher incomes**, **improved food security** and the ability to **continuously improve** their lives*

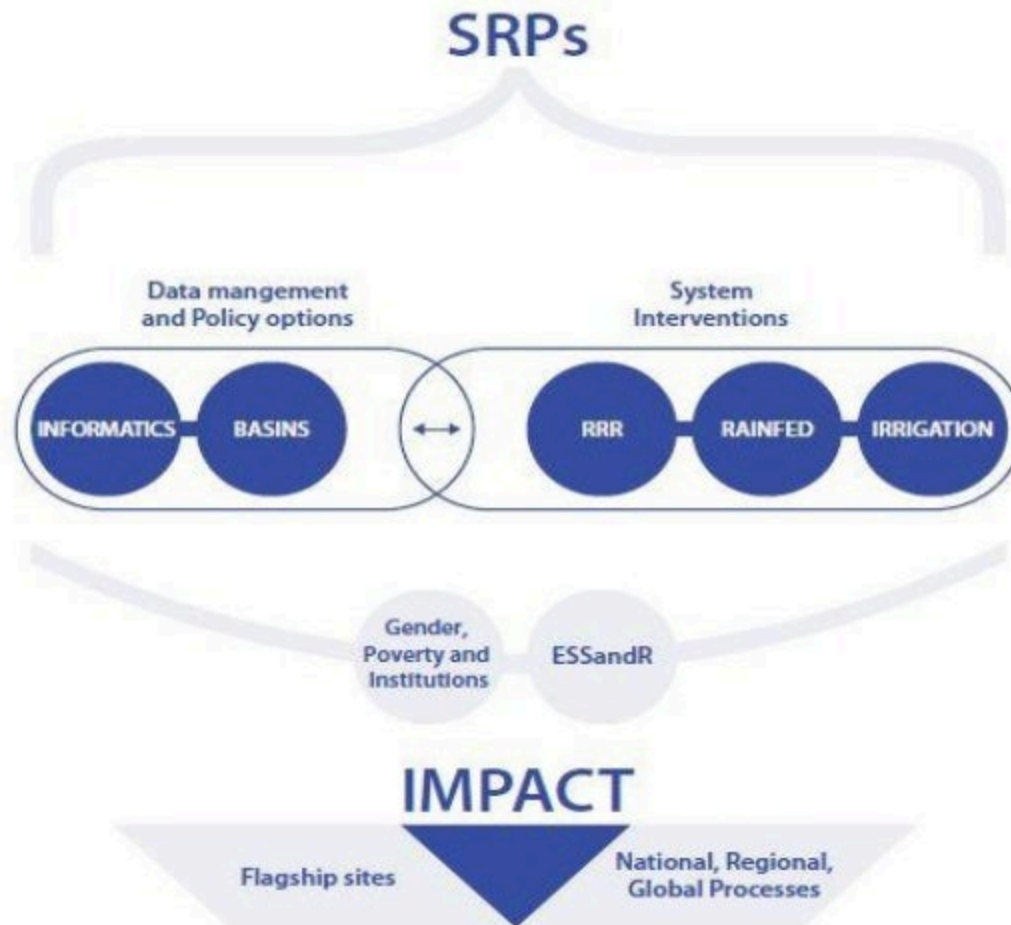


The Game Changers

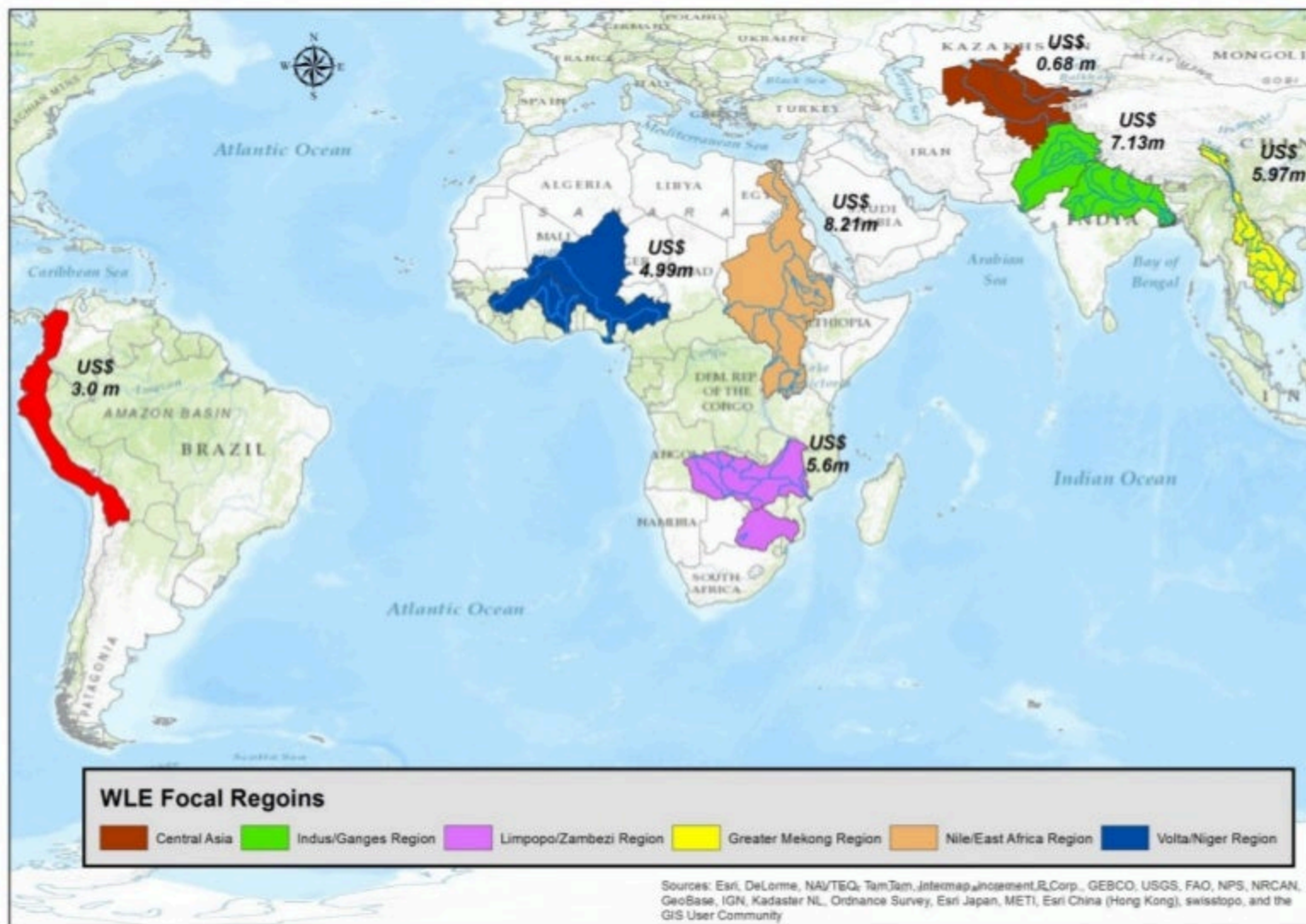
- What if smallholder farmers in the Eastern Gangetic Plain were able to grow crops all year round?
- What if we could prevent degradation and restore degraded lands?
- What if wastes and used water could have a second life in agriculture?
- What if excess water during floods could be stored in natural and man made systems and used during droughts?
- What if women had equal access to land, water and ecosystem services?



The Water, Land and Ecosystem Program



... with **targeted interventions** in 6 - 7 focal regions.



1. Irrigated farming systems



Irrigated Systems SRP



Solutions:

- Enhancing success of Irrigation in sub-Saharan Africa (SSA).
- Revitalizing public irrigation systems.
- Water management in the Eastern Gangetic Basin.
- Combating and convalescing irrigation induced salinity at field and regional scales.

Photo: Tom Van Cakenberghe/IWMI

2. Rainfed farming systems



Rainfed Systems SRP

Solutions:

- Reducing land degradation in rainfed landscapes.
- Sustaining productive landscapes by increasing biodiversity.
- Reducing risk and tackling productivity/environment challenges in farming landscapes.

Photo: Aklica Bahri/IWMI

3. Resource recovery and reuse



Resource, Recovery and Reuse SRP

Solutions:

- Business opportunities for resource recovery and reuse.
- Safe wastewater and excreta reuse.
- Efficient water and land management in peri-urban areas.



Photo: Andreea Silverman/IWMI

4. River basins



Basins SRP

Solutions:

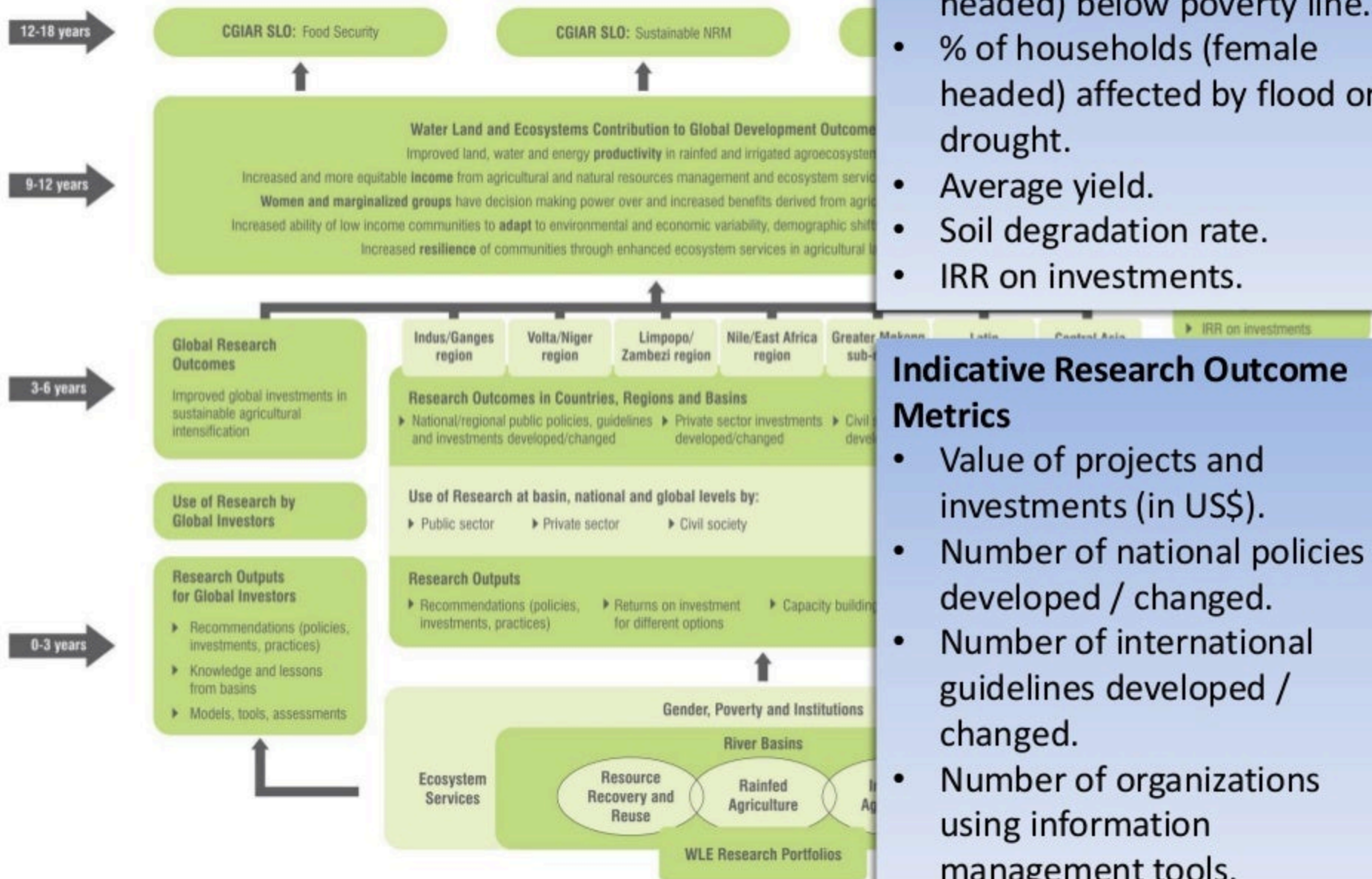
- Managing water resources' variability and re-thinking storage in basins.
- Resource allocation and sharing for the benefit of all
- Water and energy for food (WE₄FOOD).
- Water data and accounting in basins.



WLE IDOs

- Improved land, water and energy **productivity** in rainfed and irrigated agro-ecosystems.
- Increased and more equitable **income** from agricultural and natural resources management and ecosystem services in rural and peri-urban areas.
- **Women** and marginalized groups have decision making power over and increased benefits derived from agriculture and natural resources.
- Increased ability of low income communities to **adapt** to environmental and economic variability, demographic shifts, shocks and long term changes.
- Increased **resilience** of communities through enhanced ecosystem services in agricultural landscapes.

WATER LAND AND ECOSYSTEMS PROGRAM - LEVEL Results Str



- ### Indicative Impact Metrics
- % of household (female headed) below poverty line.
 - % of households (female headed) affected by flood or drought.
 - Average yield.
 - Soil degradation rate.
 - IRR on investments.

- ### Indicative Research Outcome Metrics
- Value of projects and investments (in US\$).
 - Number of national policies developed / changed.
 - Number of international guidelines developed / changed.
 - Number of organizations using information management tools.



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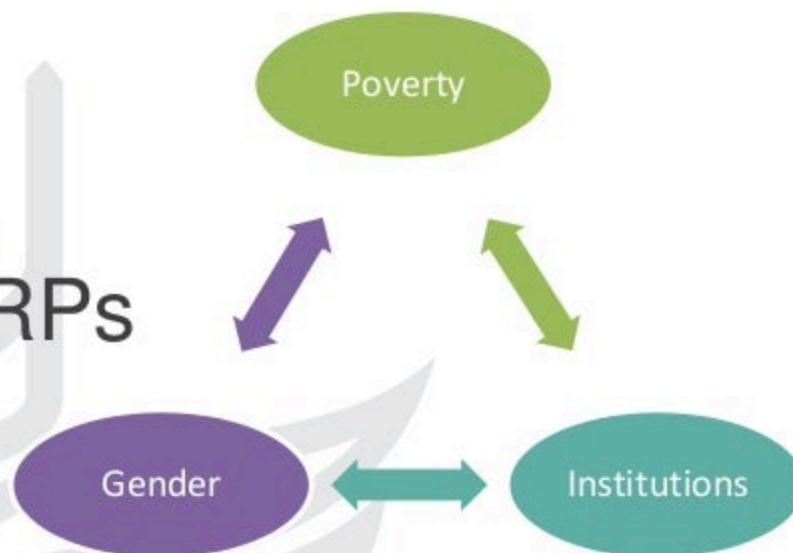
A photograph of a family of five standing in a field of tall green plants, likely corn. The father is on the left, wearing a green and white striped shirt. The mother is on the right, wearing a blue top and a yellow and black patterned skirt. They are surrounded by four children. The background shows a hazy landscape with hills and a cloudy sky.

Gender, Poverty and Institutions

How?

Content and structure

- Equity triangle
- Gender integration in SRPs and gender specific



Architecture:

- Embedded: not just one approach
- Budget - working towards full accounting
- Voting member of the management committee
- Growing with partners

What?

Towards:

- More equitable access to water, land and ecosystems services.
- Improved decision making - inclusion in resource management

Research questions:

- The African farmer and her husband: Feminization of agriculture
- Mother and earth: Replenishing and fostering agriculture

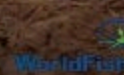
Develop:

Investable options for women



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Ecosystem Services and Resilience



Ecosystem Conservation as a result of poverty alleviation



Ecosystem Conservation as **means to** **poverty alleviation**



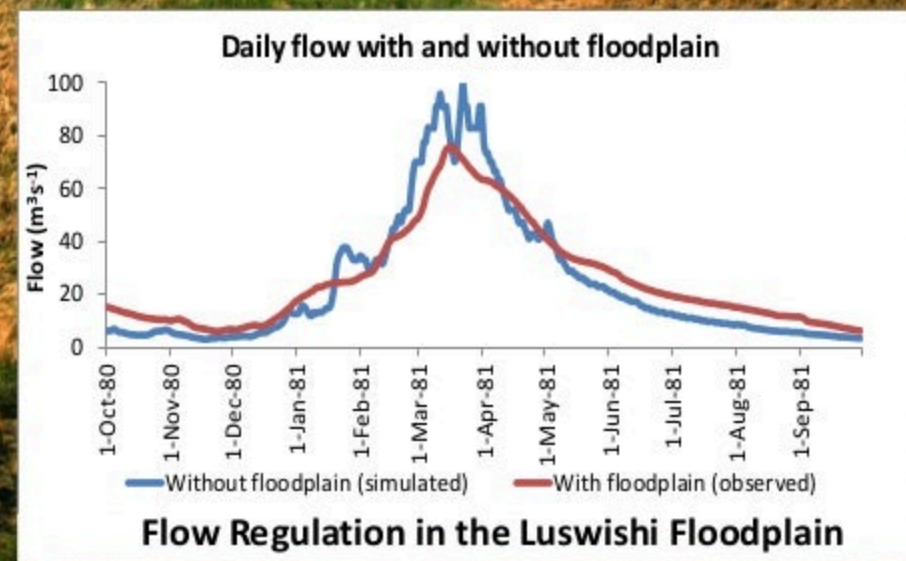
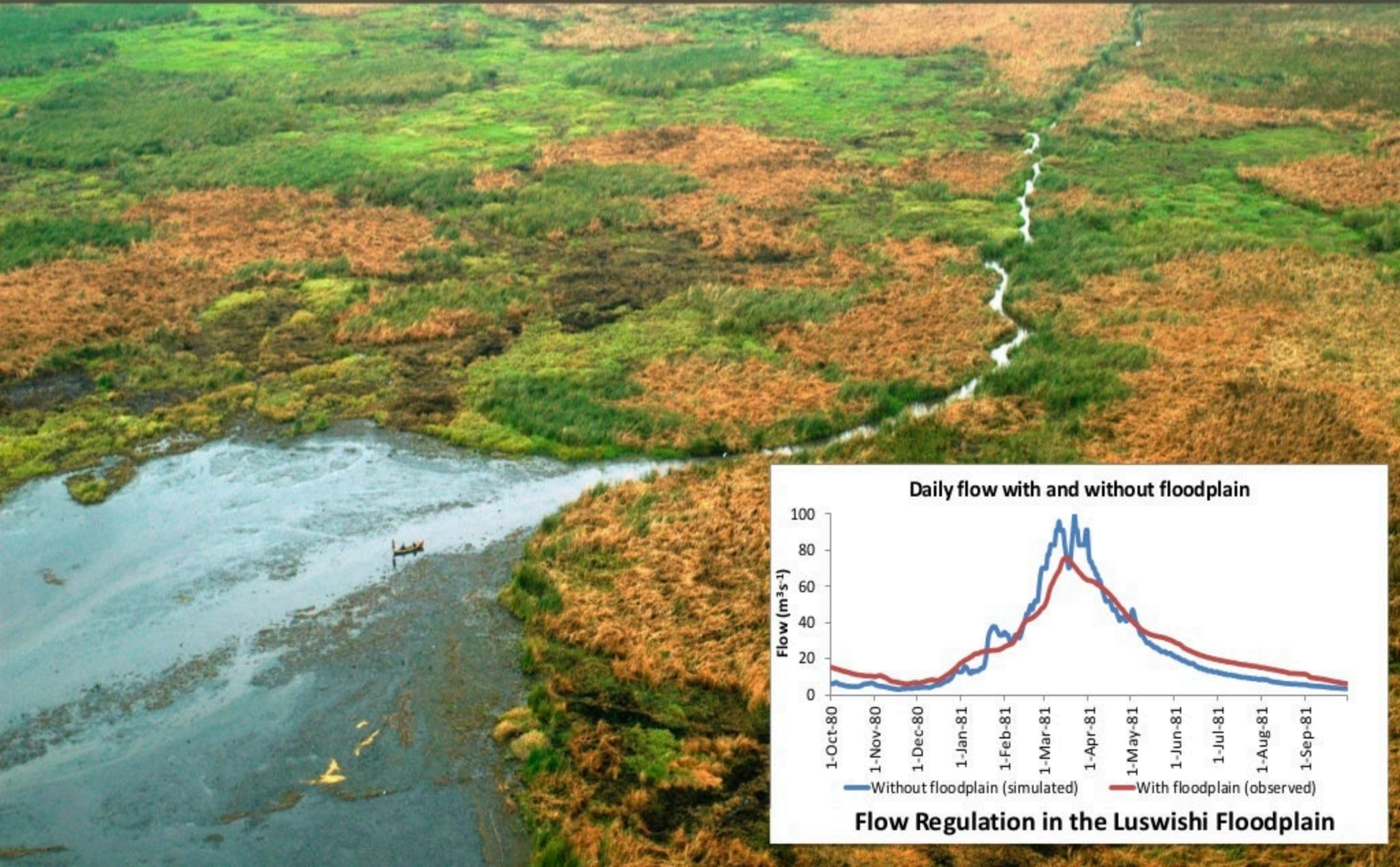
Principles

- **People** are fundamental
- **Human and Natural** systems are tightly coupled.
- **Ecological processes** in the portfolio of options.
- **Multifunctionality:** Complex Adaptive Systems
- **Resilience:** shocks will occur.
- Recognize we might have to modify ecosystems
- **Large scale:** basin as maximum extent (CPR)

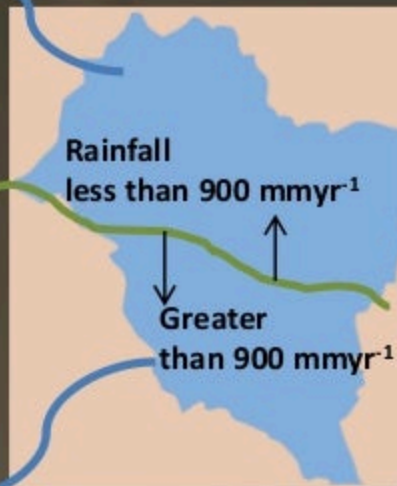
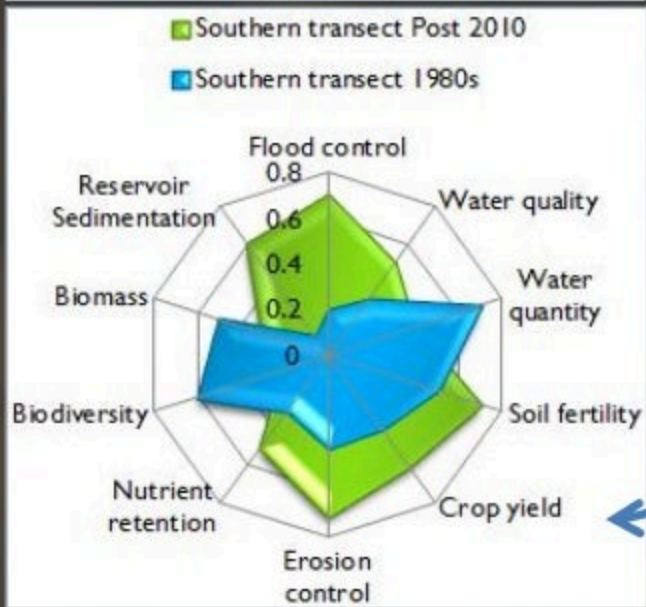
CGIAR

Understanding how ecosystems affect livelihoods

M. McCartney (IMWI)



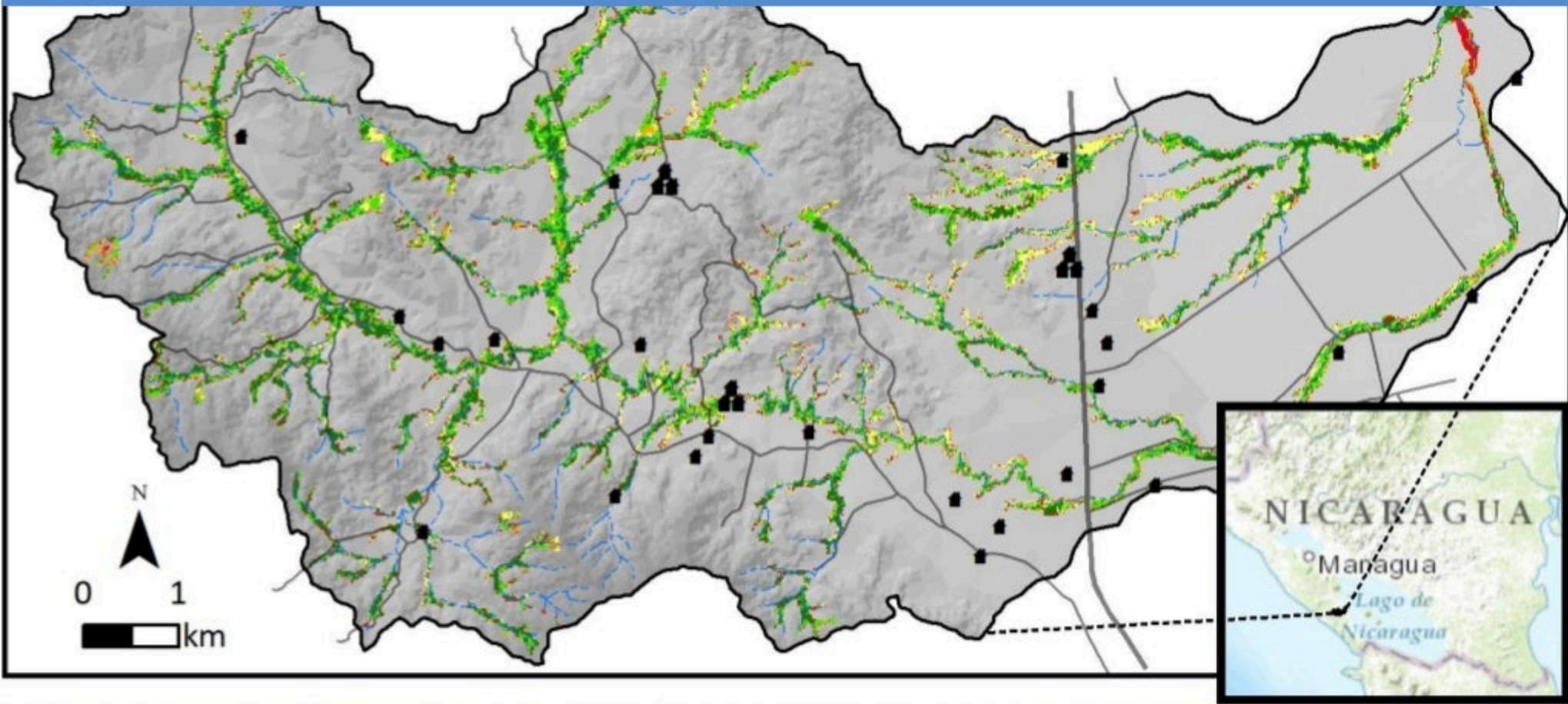
Ecosystem Services by whom and for whom?



F. Kizito (CIAT)



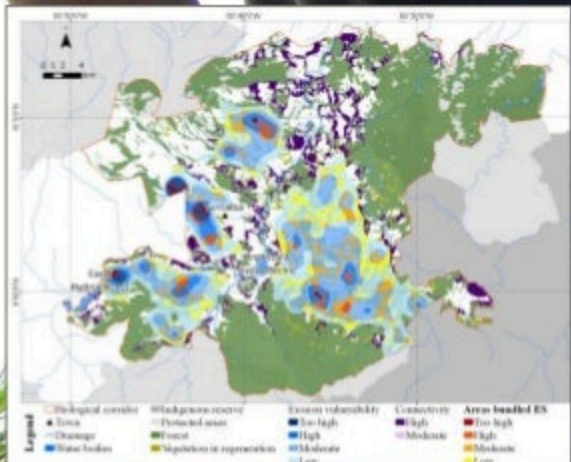
Facilitating intervention decisions: what and where?



Recognizing the value of Ecosystem Services Provided by Farming Communities



MI FINCA PARTICIPA EN EL
MANEJO DE LA CUENCA DEL
RIO REVENTAZÓN
ICE



My farm participates in the Management of the Reventazon River Watershed (ICE)



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Information



Information for Decision Making

Strategic objectives

- Systematically identify what information will improve productivity, reduce risks and improve lives the most.
- Build stakeholder capacity in how to design and implement cost-effective measurement and information systems that target critical uncertainties in development decisions.



"My job is to make decisions. Your job is to make them good decisions."

Background

Review of the Evidence on Indicators, Metrics and Monitoring Systems



<http://www.dfid.gov.uk/R4D/Output/192446/Default.aspx>

Process

- *103 monitoring initiatives screened.*
- *24 initiatives evaluated against 34 criteria*
- *Monitoring experience in other fields: public health, industry and public services.*

- **Investments in monitoring systems have had little impact on decision making**

“Land resource monitoring in Australia has never provided the right information for decision making” (Neil McKenzie, Chief CSIRO).

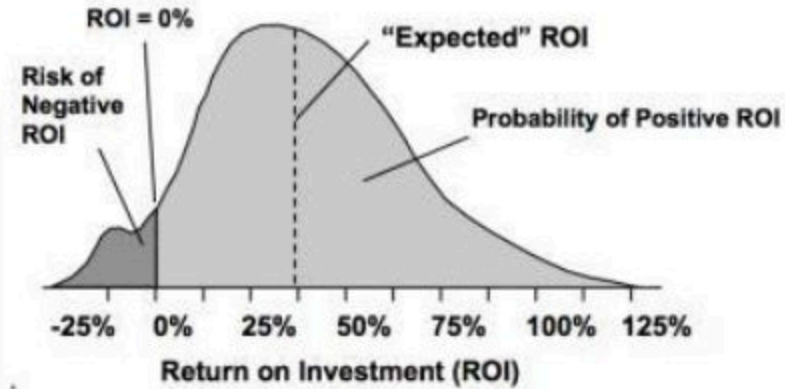
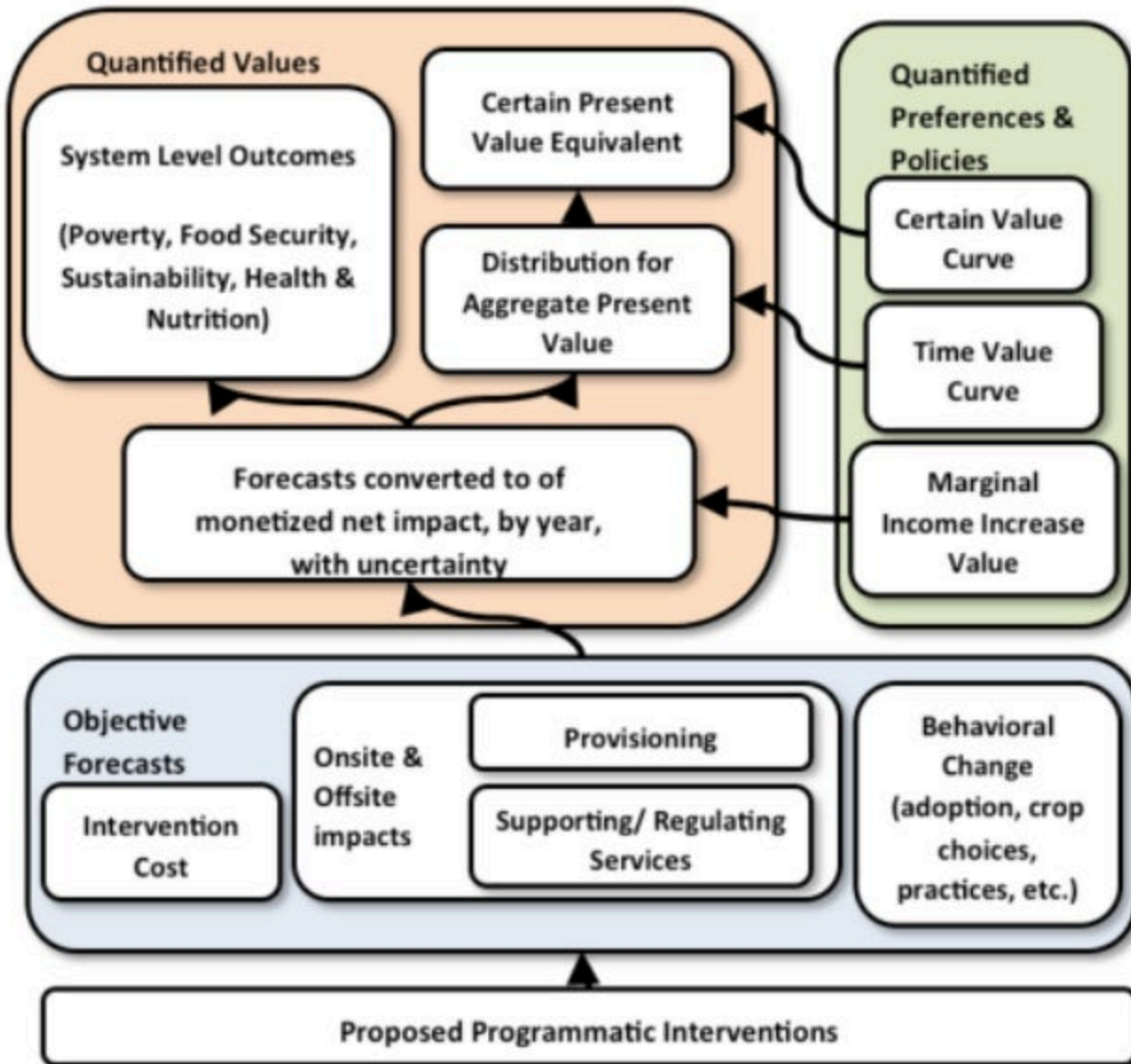
A Survey and Analysis of the Data Requirements for Stakeholders in African Agriculture

Contra-Indicator	Count	Percentage
Decision Awareness: Listed at least some real decisions when asked	75/110	68%
Needs/Uncertainty Alignment: There was at least some similarity between a stated need for data and variables believed to be uncertain	40/110	36%
Needs/Uncertainty/Effort Alignment: There was at least some similarity between a stated need for data, variables believed to be uncertain, <u>and</u> what they spent their time gathering	17/110	15%
Decision Alignment: demonstrated Decision Awareness <i>and</i> demonstrated Needs/Uncertainty/Effort Alignment	11/110	10%

- Poor alignment between perceived needs, perceived uncertainty, data gathering efforts, and actual decisions
- Measurement inversion – most effort spent where no information value

Decisions-under-uncertainty analytic framework

Intervention Decision Model



Value of Information Analysis

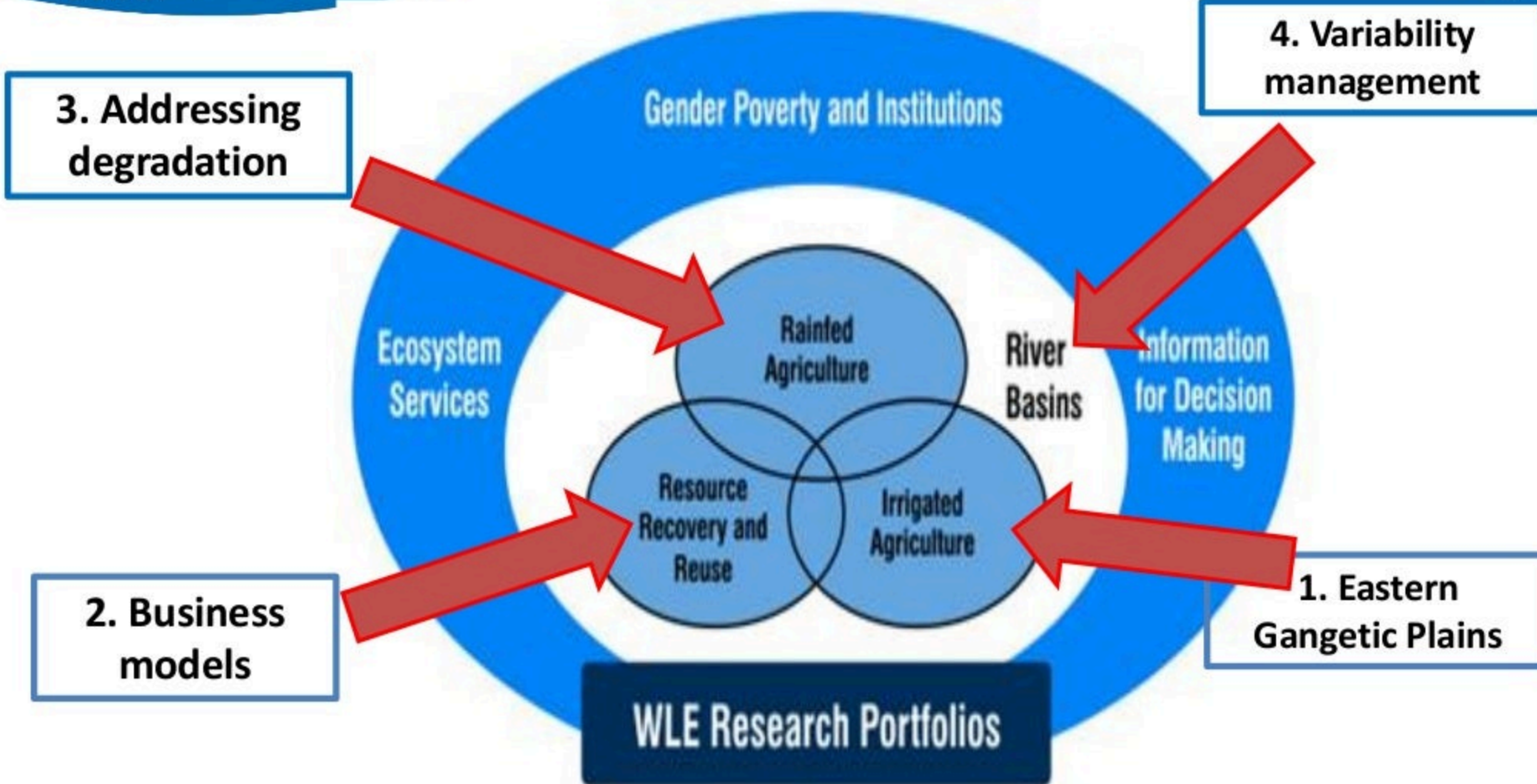



- 6 Intervention cases in progress with WLE teams: Rainfed, Irrigation, Basins, Agrobiodiversity, Reuse, PES

Outcomes

- Information products target key uncertainties in stakeholder decision dilemmas
- Stakeholder decisions use best available evidence to increase reduce risks, increase security and improve lives
- Decision tools and stakeholder capacity to:
 - Prioritize and improve interventions considering uncertainty
 - Efficiently measure the impact of interventions on development outcomes
 - Quantify the value of the research itself.
- Applications across WLE + other CRPs (CCAFS, Humid, Drylands, A4NH, Wheat) + CGIAR





A photograph of a rural landscape in the Eastern Gangetic Plain. A narrow canal or irrigation channel flows through the center of the frame. On the left bank, there are several tall palm trees and a small house with a red roof. On the right bank, there are green fields and a person standing near the water. In the middle of the canal, a person is sitting in a small boat. The sky is blue with some white clouds. The text "What if smallholder farmers in the Eastern Gangetic Plain were able to grow crops all year round?" is overlaid in white on the image.

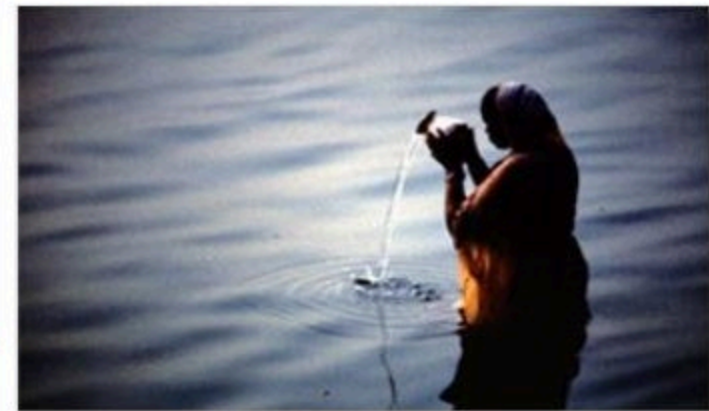
What if smallholder farmers in the Eastern Gangetic Plain were able to grow crops all year round?

Eastern Gangetic Plains



A region rich in Culture, Physiography and Wild life, and where water, sunshine and fertile soils are in abundance, is also the home to the poorest of the poor!

WLE, CCAFS, CSIRO, USQ, NUS
NARS & NGOs in Bangladesh, India, Nepal
Budget: 10 M USD



Why?

- 💧 A highly variable hydrology
- 💧 Prone to drought and flood

Southern
four months



after Don Blackmore

• **Is there a way out?**

YES

Run the Ganges Water Machine

- Sustainably use groundwater during summer and winter seasons.

- **Rains and floods shall fill them up**

Productivity increased
Droughts mitigated
Floods moderated.

We will work on the three pillars of Water Management

Availability | 224 BCM
water
managed to
minimize
temporal
variability



Access | Equitably
improved for
300 m
people



Achievements | Productivity
increased
from 2.5 t/ha
to improve
food security
and nutrition

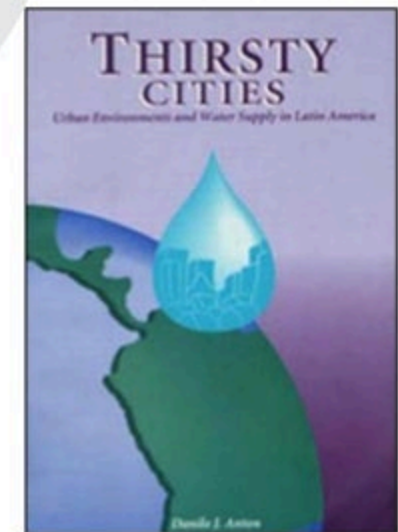
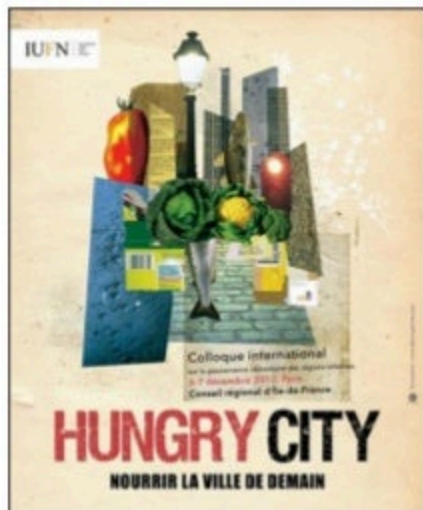
Putting EGP on the takeoff trajectory needs evidence based public policy shifts!!

- Access
- Ars
- Eco
-
-
-
-
- Micro

Research under the EGP shall create the required knowledge and public policy support for these big-ticket items.



What if wastes and used water could have a second life in agriculture and the renaissance is actually safe and viable?



Innovative RRR initiatives – to close water and nutrient cycles



Wastewater – Water (irrigation, aquaculture)



Agro-industrial waste - Energy



MSW, Faecal sludge - Nutrients (ag. production)



Reuse is not new . . .

- Technical knowledge is largely available.
- But hardly any project can recover costs or survives its subsidized pilot stage.
- RRR brings a paradigm shift into the sanitation-agriculture interface by studying and testing **Business Models** for RRR with due consideration of safety aspects and cultural perceptions.




Solutions

- ❑ Applying a business perspective to the recovery of nutrients, water and energy from domestic and agro-industrial waste streams.
- ❑ Analyzing existing successes across low-income countries for their set-up, history and business models.
- ❑ Testing most promising business models for replication and economic feasibility for city investment plans at largest possible scale.
- ❑ Addressing health concerns through the development of Sanitation Safety Plans with WHO.

Feasibility testing of business models in different cities

Current status:

- Existing Database of 150+ business cases across Asia, Africa and Latin America
- Selection of 60 cases for in-depth analysis
- Development of 20 business models
- Testing their feasibility in 10 cities

 Energy  Nutrient  Wastewater  Feasibility studies

0 2,050,000 4,100,000 8,200,000 Meters

Action research on reuse guidelines and policy recommendations.

Compost valorization trials (from faecal sludge to safe fertilizer pellets)

Monitoring Business Model Implementation through PPP.

Selected strategic partners:

eawag
aquatic research

Sandec
Water and Sanitation in
Developing Countries



AFRICAN DEVELOPMENT BANK GROUP
GROUPE DE LA BANQUE AFRICAINE
DE DEVELOPPEMENT

**BILL & MELINDA
GATES foundation**

Swiss TPH



**World Health
Organization**

International Partnerships

- **Technical expertise:**



- **Health risk mitigation:**



World Health
Organization

Swiss TPH



- **Business school curricula development:**

cewas

international centre for water management services



UNIVERSITY OF
CAMBRIDGE

- **National partners:** NARS, Min. Of Health, Private sector, ...

- **Donors:**



BILL & MELINDA
GATES *foundation*



AFRICAN DEVELOPMENT BANK GROUP
GROUPE DE LA BANQUE AFRICAINE
DE DEVELOPPEMENT



Take home messages

1. The RRR research portfolio targets private sector engagement, PPP, donors and business schools.
2. A team of economists, business developers, engineers and environmental scientists works closely together.
3. Analyzing business models and returns on investment are building blocks of the research program.
4. The program has so far received significant feedback and there are many avenues to apply the same business approach to other WLE research portfolios.

**What if we could prevent degradation
and restore degraded lands?**



Land Degradation is a Classic ‘Wicked Problem’

More than 95 million ha of arable land, or 75% of the total in SSA has degraded or highly degraded soil and farmers lose eight million tons of soil nutrients each year, estimated to be worth \$4 billion...

Now is an exciting time for renewed coordinated efforts towards a ‘land degradation neutral (or better!) world’

1. Advances in research

Social Science

CIRAD

IWMI, CPWF, CIAT, WRI



Inclusion of the people's voice within the scientific research framework at many scales



Wet season



Dry season

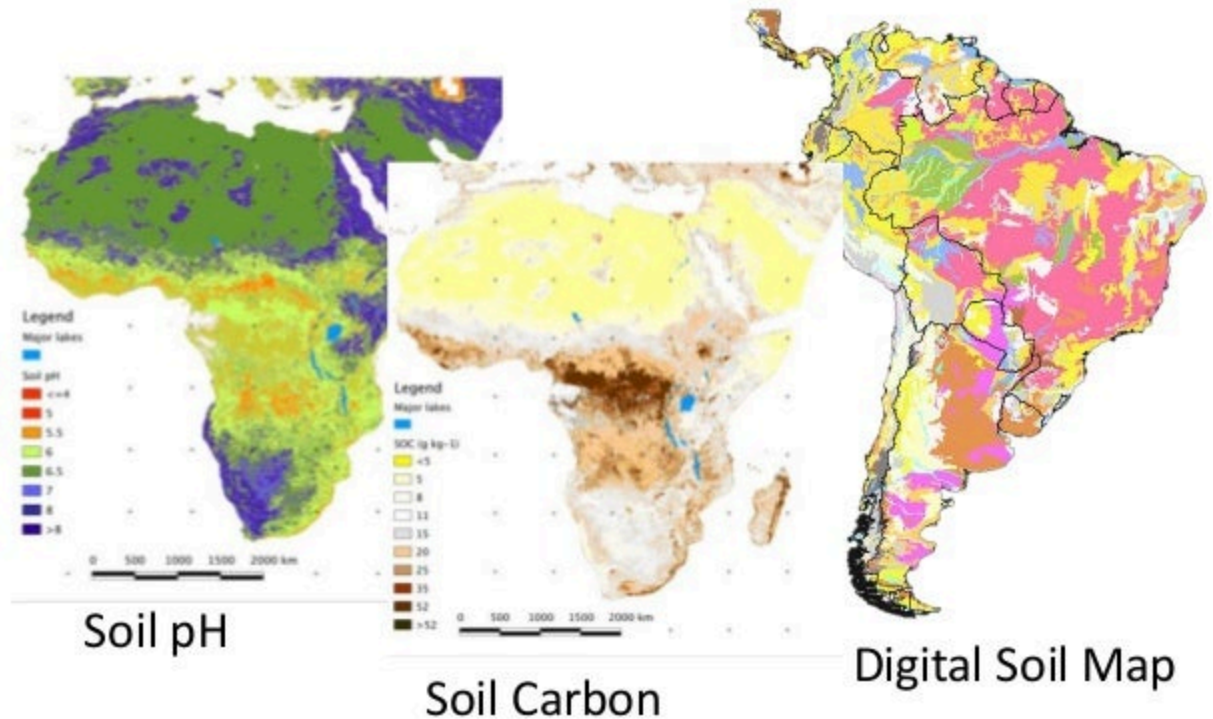
1. Advances in research

Soil Science RS/GIS

CIAT, ICRAF, CU, ISRIC, Purdue, FAO-GSP, countries in sub-Saharan Africa and Latin America



Diagnosing,
assessing and
mapping



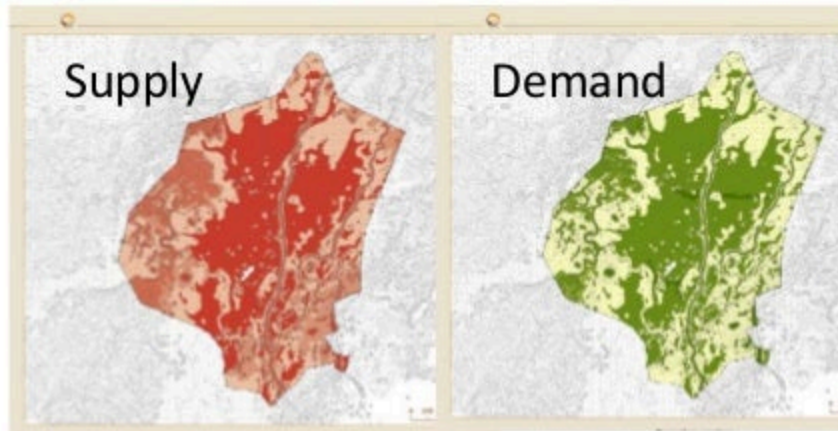
1. Advances in research

Ecosystem Services

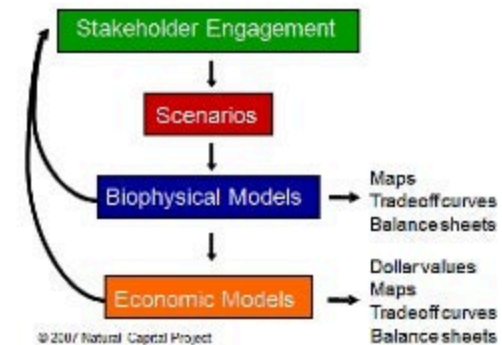
Trade-off Analysis

Environmental Economics

IFPRI, Bioversity, CIAT, IWMI, CPWF, ELD



InVEST Framework



Costs of Action vs. Cost of Inaction



A global initiative
for sustainable
land management

2. Alignment of global initiatives

- Rio+20 'The future we want' Land Degradation Neutral'
- UN Sustainable Development Goals
- FAO's Global Soil Partnership

3. Drivers of change as opportunities

- Public and Private Investment, CAADP and GrowAfrica
- Urbanization, feminization of agriculture
- Increased price of food
- Investments in hydropower and mining

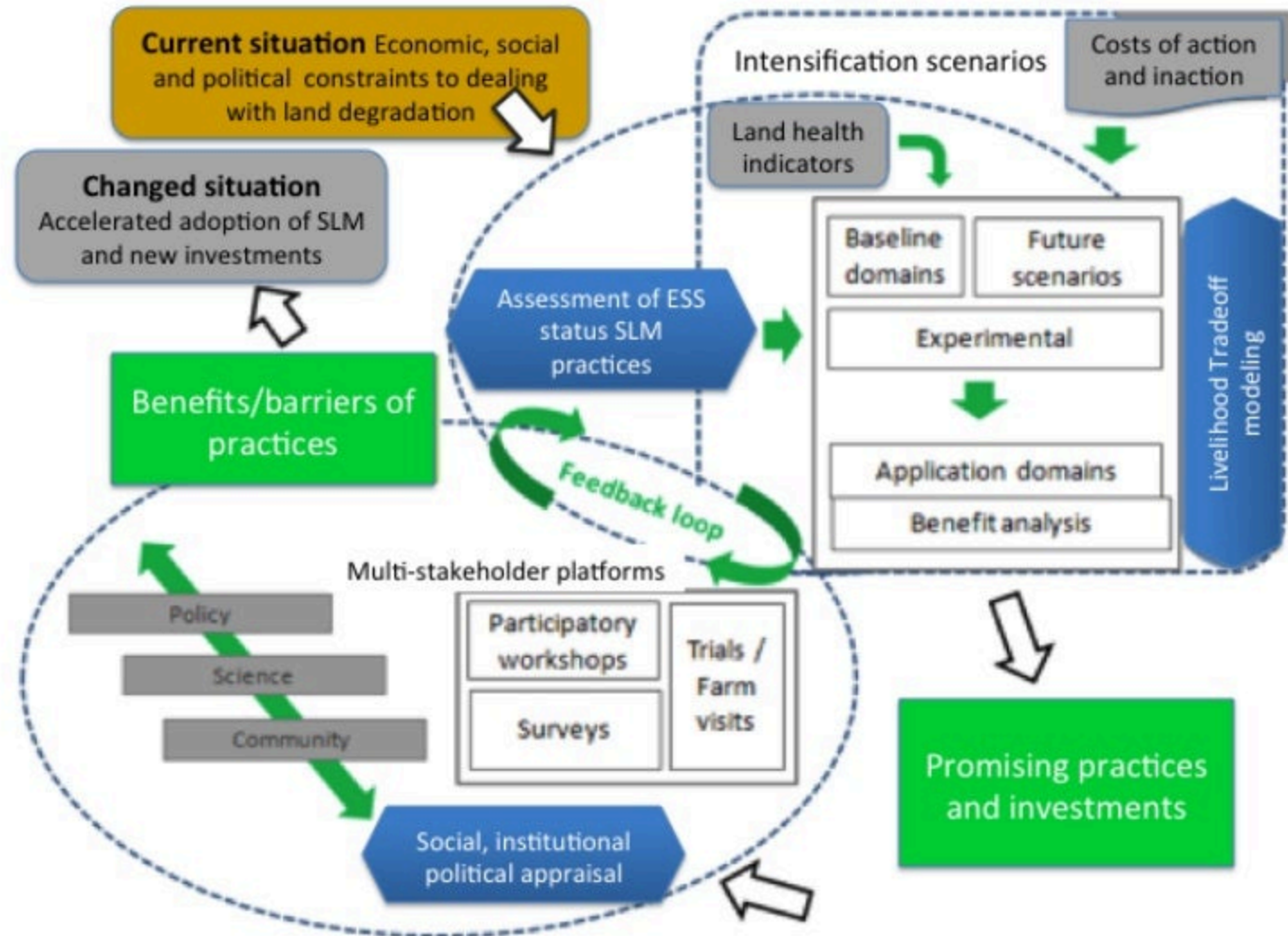
Study Landscapes in Focal Regions

+/-10 Study

Landscapes Tanzania, Malawi, Kenya, Ethiopia, Ghana, Burkina Faso, Niger, Lao PDR, Cambodia, Myanmar, Nicaragua, El Salvador

Building on CPWF and other Programs

Working with FTA, CCAFS, Humidtropics, Dryland Systems

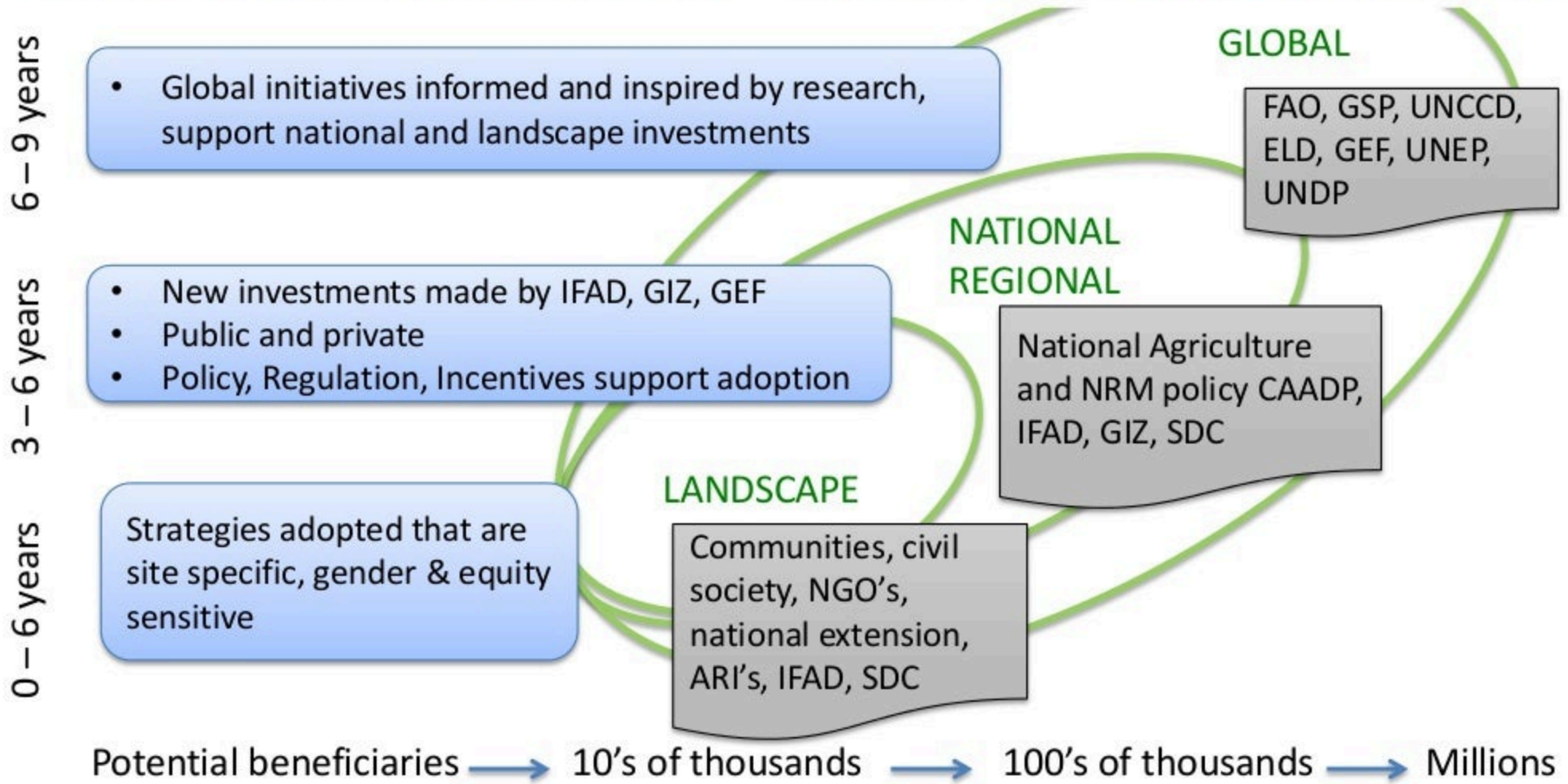


Research Outputs

- Assessments of land degradation, ecosystem services impacts and tradeoffs, and economic valuation of societal costs
- Evaluations of institutional and policy contexts and constraints that hinder sustainable practice and women's access to resources
- Co-created and spatially-explicit strategies to recuperate degraded lands, and manage landscapes for ecosystem services and equity
- Incentives designed for institutional change to support adoption
- Stakeholder engagement processes, adaptation of participatory tools
- National, local and NGO capacity built for soil and land assessment, ecosystems services evaluation, participatory approaches
- Engagement in international initiatives and conventions, FAO GSP, ELD, UNCCD, and conservation NGO's, TNC, CI, EAP, and the Future Earth Initiative.

Partnership for Outcomes

DELIVER RESEARCH OUTCOMES – impact multiplies through partners



Take home messages

- We have a global enabling environment for addressing land degradation – we want to make the local environment also enabling
- Part of the story is making the value proposition for the big investors – ‘costs of action vs. inaction’
- Partnership with, and support to, the ‘big players’ is how we propose to get to scale

What if floods could be stored in natural and man made systems and used during droughts?



Background & Suggested Metrics

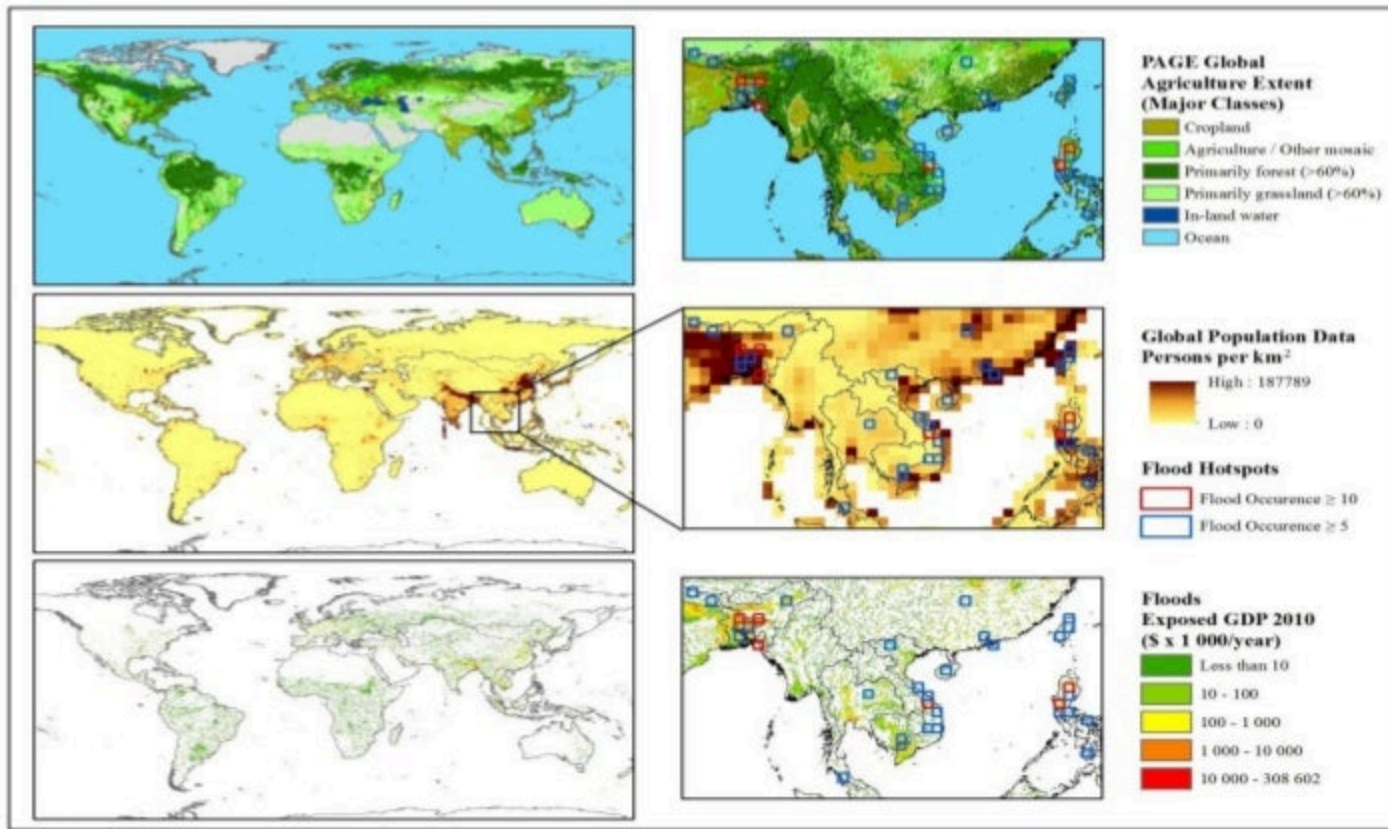
- Moving from a focus on water scarcity to an era of increased uncertainty and **water variability**
- Reducing **adverse impacts** of variability and improving positive outcomes can impact millions of lives
- Developing **science-based evidence** to develop understanding, options, tools **and policies** to reduce adverse and improve positive impacts of water variability

M&E indicators

1. Share of households affected by floods and droughts
2. Number of organizations using information and tools developed
3. Number of policies developed / changed

Flood Hotspots and Mapping

- Globally - 90 grid cells of 100 km with catastrophic flood occurrence > 5 , during 1900-2010; Damage analysis

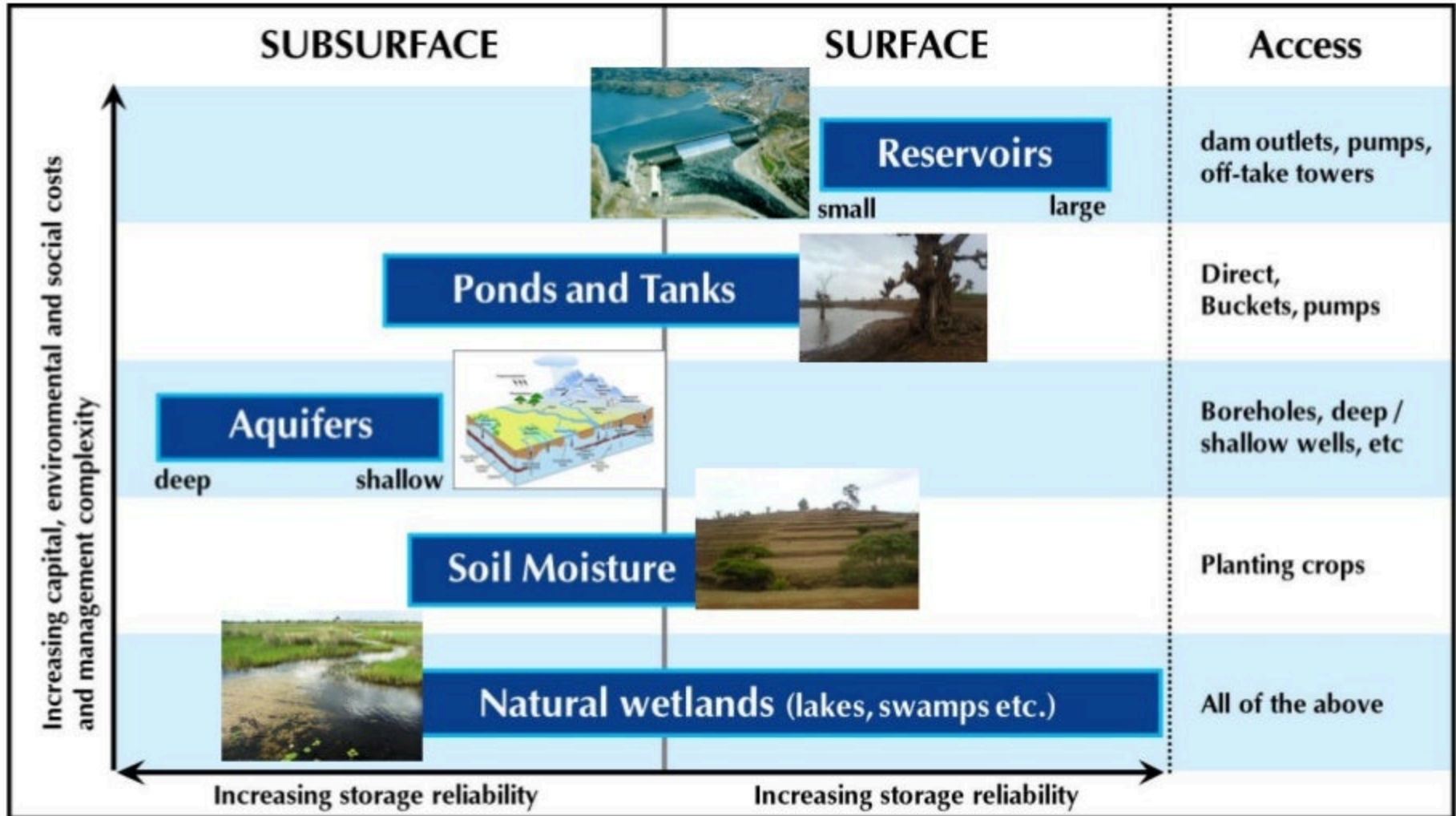


AGRICULTURE;
PAGE (2005)

POPULATION
CIESIN - 2010

FLOOD EXPOSED
GDP
WB, 2010

Water Storage Continuum



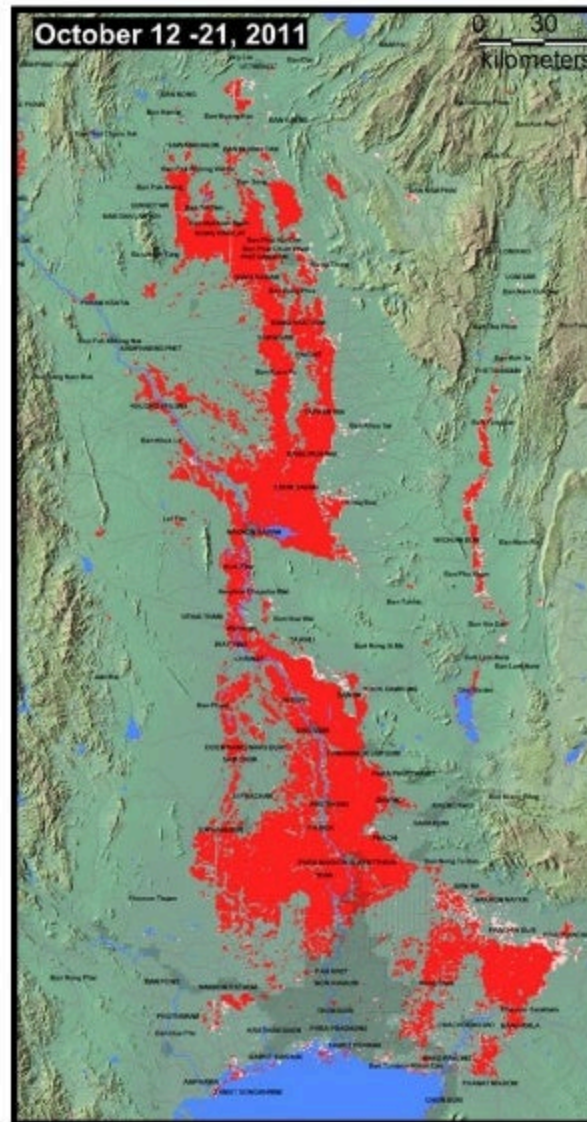
Conjunctive Flood and Drought Management

Chao Phraya basin, Thailand

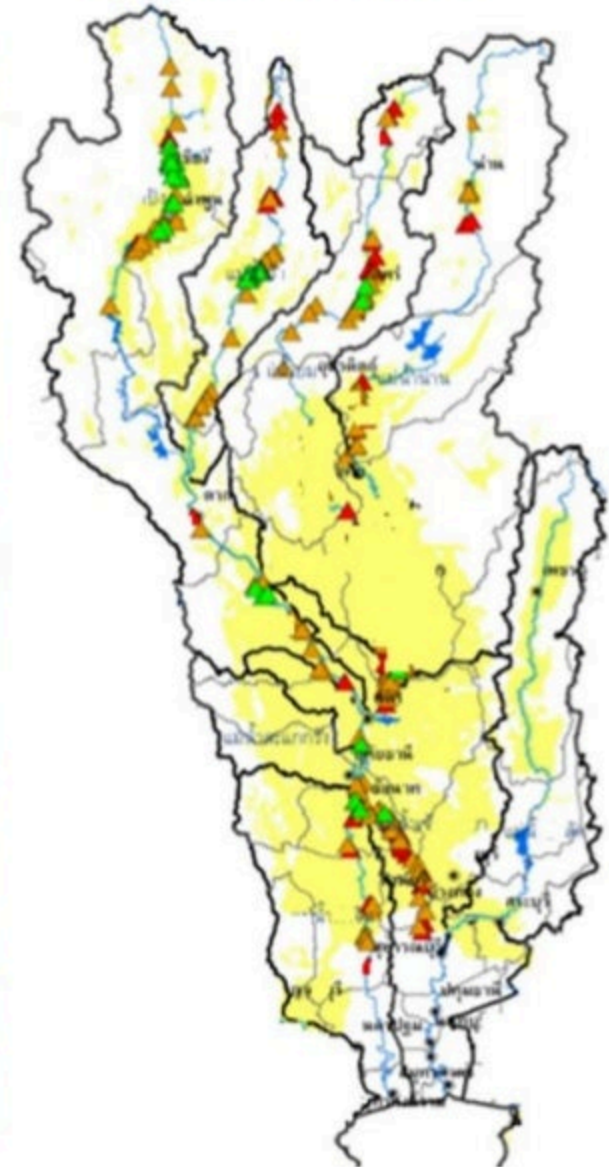
Land Use



Regular Flooding



Alluvium aquifers



Partnerships

- International Association of Hydrological Sciences, FAO, Global Water Systems Project, UNEP, International Union for Conservation of Nature, WWF, and many others.
- At national level—work with disaster management agencies (CSO & public), water and agricultural agencies, basin authorities
- Regional disaster management and basin organizations
- Private sector: insurance companies

