



**FEED THE FUTURE**

The U.S. Government's Global Hunger & Food Security Initiative

# Using Satellite Data as a Climate Adaptation Strategy to Enhance Food Security

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**Presenters: Walter E Baethgen, Molly E Brown, and Faisal Mueen Qamer**

**Moderator: Barbara Goldoftas**



**AGRILINKS**

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# Walter E Baethgen



Walter E. Baethgen is Senior Research Scientist and Director of the Regional and Sectoral Research program in the International Research Institute for Climate and Society (IRI) at The Earth Institute, Columbia University, and he served as Acting Director of the Agriculture and Food Security Center. He has established regional programs that aim to improve climate risk assessment and risk management in agriculture, health, water resources, and natural ecosystems. In 2020 he became the Vice-president of the Board of Directors of the Uruguayan National Agricultural Research Institute (INIA). Baethgen was an author in IPCC's Second, Third and Fourth Assessment Reports, and he was a member of the IPCC team that received the Nobel Peace Prize in 2007. He obtained his PhD and M.Sc. degrees in Crop and Soil Environmental Sciences from Virginia Polytechnic Institute and State University, and his B.Sc. in Agricultural Engineering from the University of Uruguay.

**AGRILINKS**

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# Molly E Brown



Molly E Brown is Research Professor in the Department of Geographical Sciences at the University of Maryland and the Chief Science Officer of 6th Grain Corporation, a digital agriculture company based in the United States. Molly has two decades of experience in interdisciplinary research using satellite remote sensing data and models with socio-economic and demographic information to better understand drivers of food security. She has worked on conflict, climate, and agricultural development impacts on communities in Africa and Asia, with a focus on improving decision-making at a variety of scales. She has a bachelor's of science in biology and environmental studies from Tufts University, and a master's and PhD in geography from the University of Maryland College Park.

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# Faisal Mueen Qamer



Faisal Mueen Qamer is Remote Sensing Specialist at the International Centre for Integrated Mountain Development (ICIMOD). He leads the food security and climate services related work at ICIMOD. He is responsible for framing geospatial information-based approaches to support decision-making process in the agriculture sector, and he contributes to capacity-building through close engagement with local, national, and international partners. His work spans across ICIMOD's eight regional member countries, with special focus on Afghanistan, Bangladesh, Nepal, and Pakistan.



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# Climate Services for Agriculture

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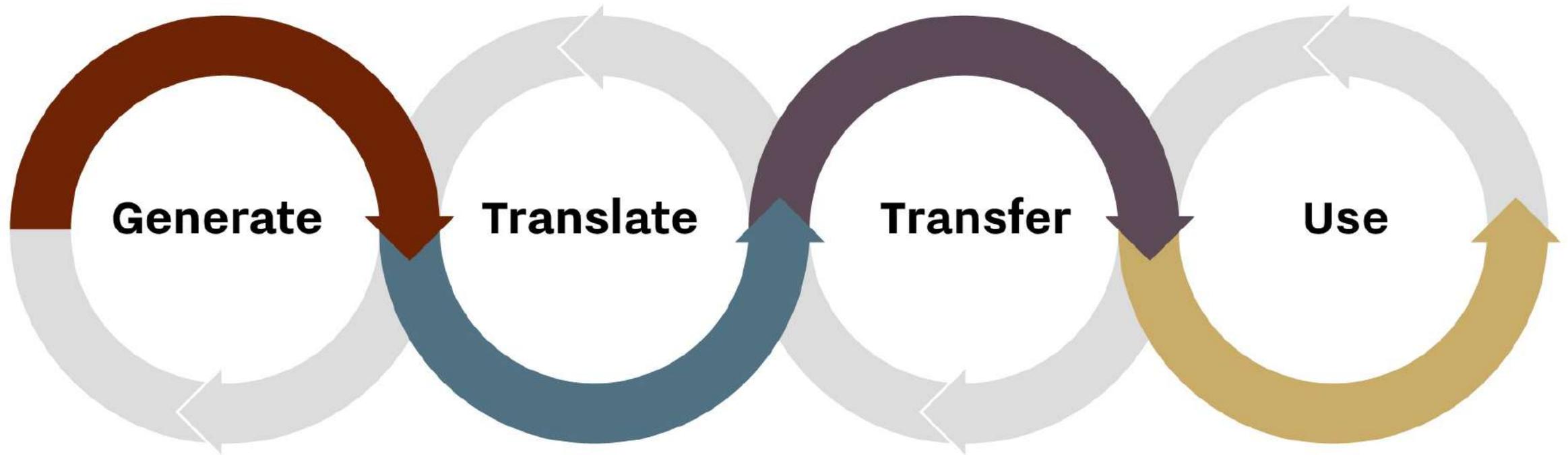
**Walter E. Baethgen**  
**IRI, Climate School, Columbia University**



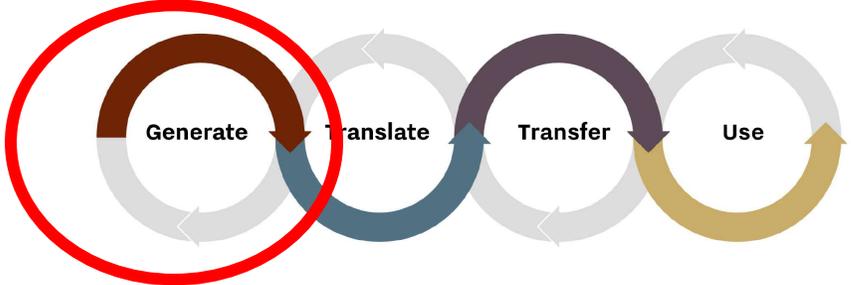
**AGRILINKS**

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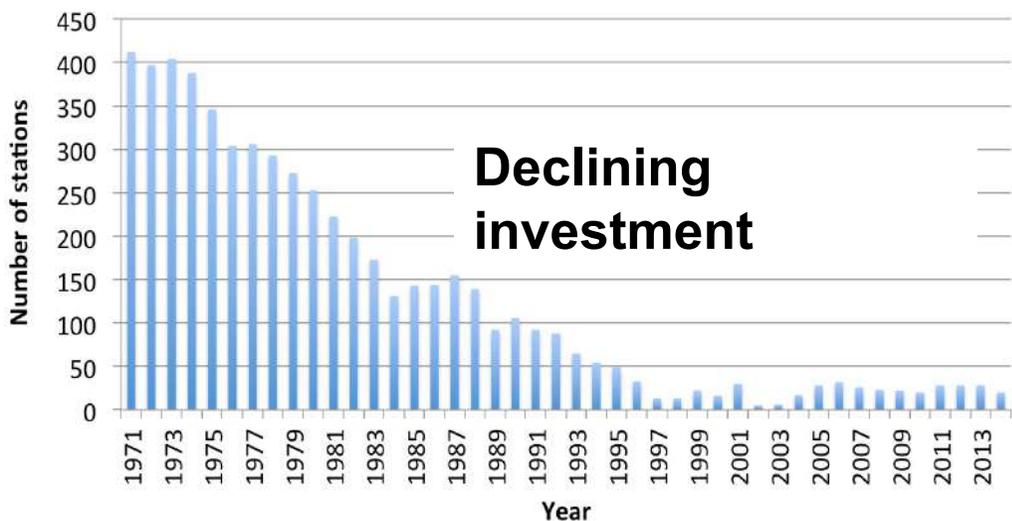
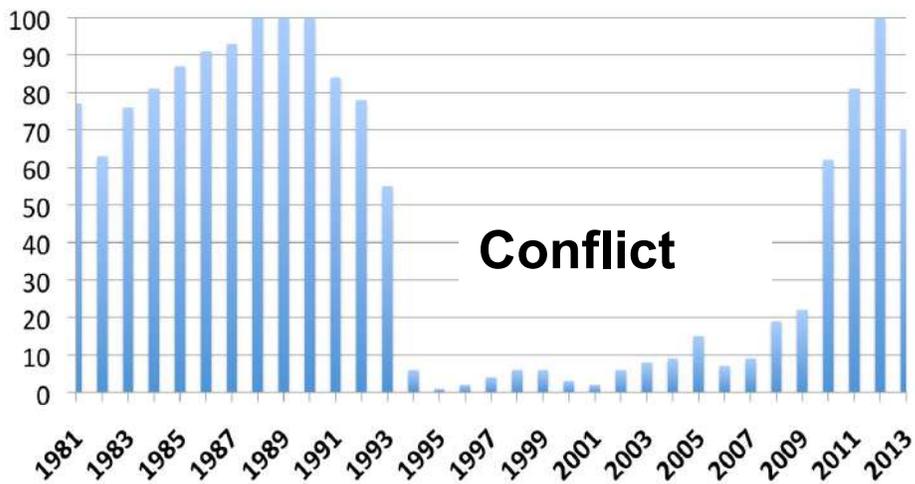
# THE FOUR PILLARS OF CLIMATE SERVICES



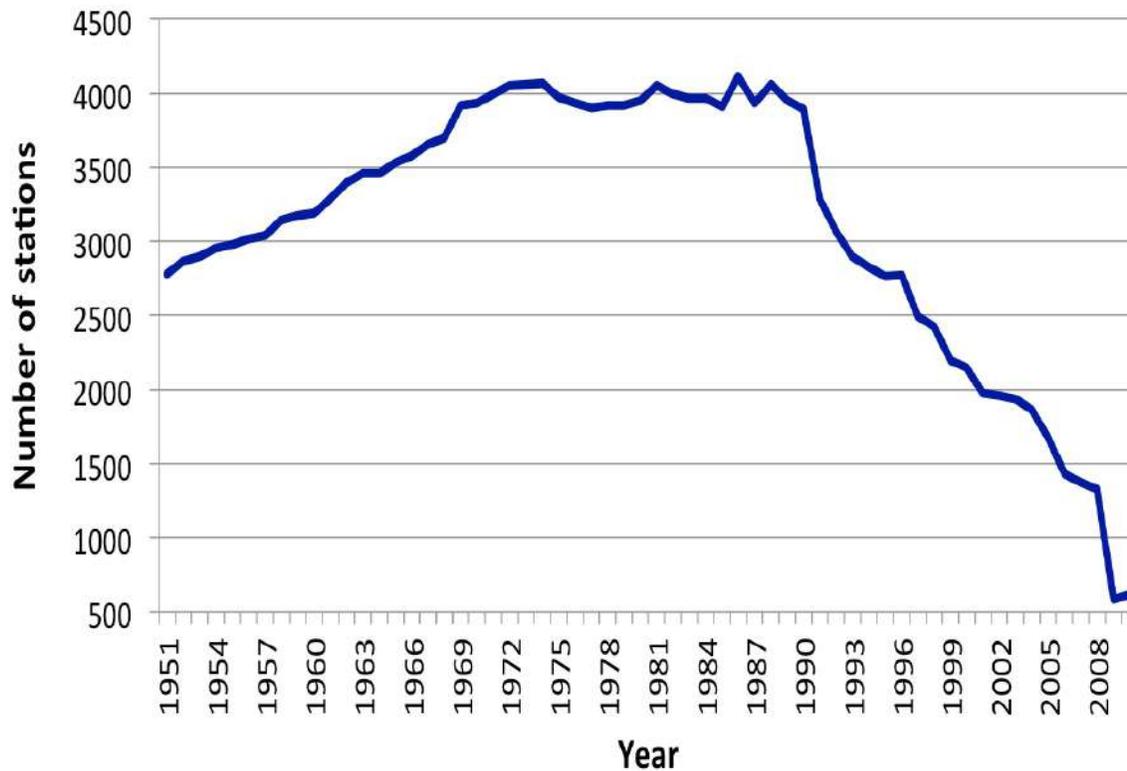
**AGRILINKS**



# Challenge: Data Poverty



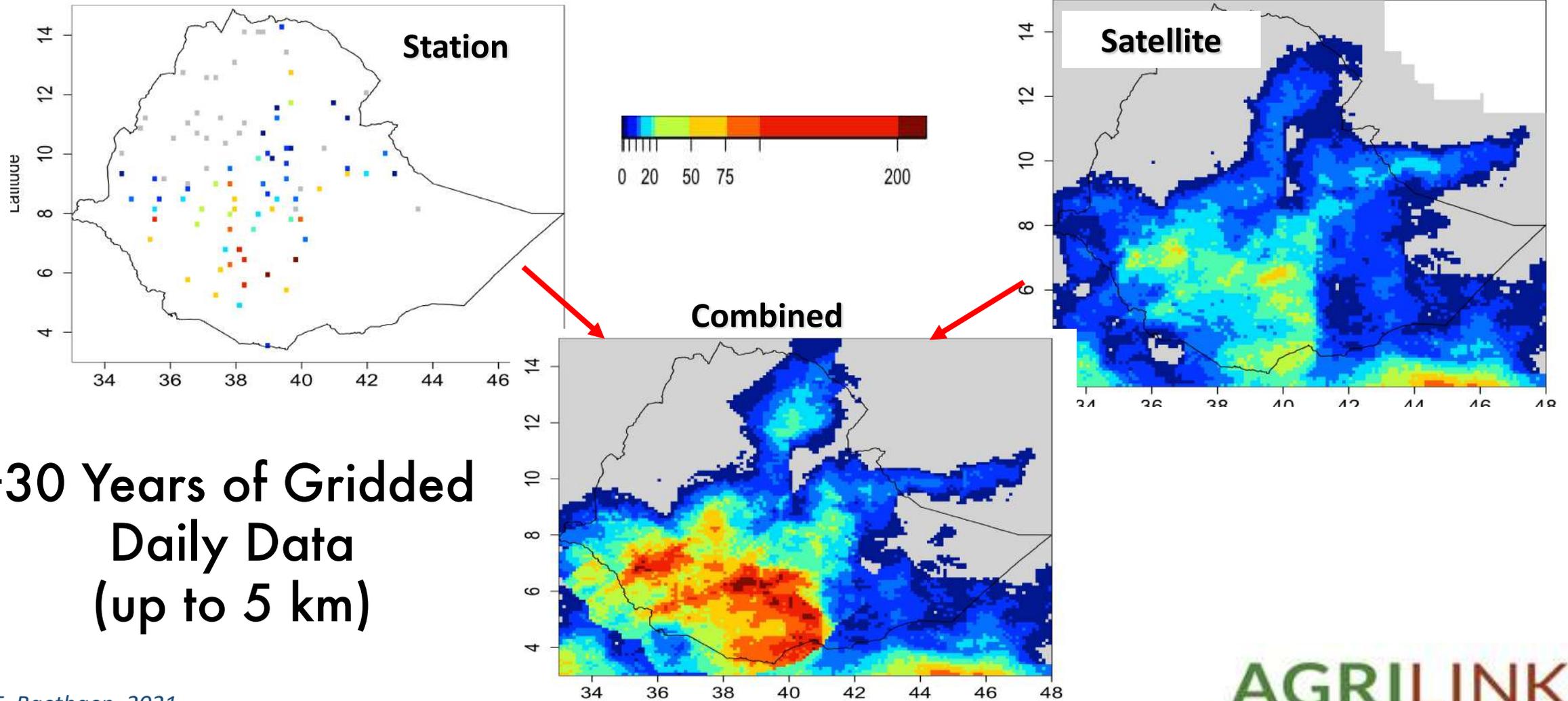
Number of stations whose data were reported to GPCC



Average number of African stations used in the available Global Dataset

# Solution

Support countries to generate spatially and temporally complete climate data



**+30 Years of Gridded  
Daily Data  
(up to 5 km)**

Generate what Climate Information?

## Vegetation Status per Month (Satellite Info)

# Learn from the Past

Consider 20-30 years

For example:

Frequency of months/years with:

Low Rainfall (Droughts)

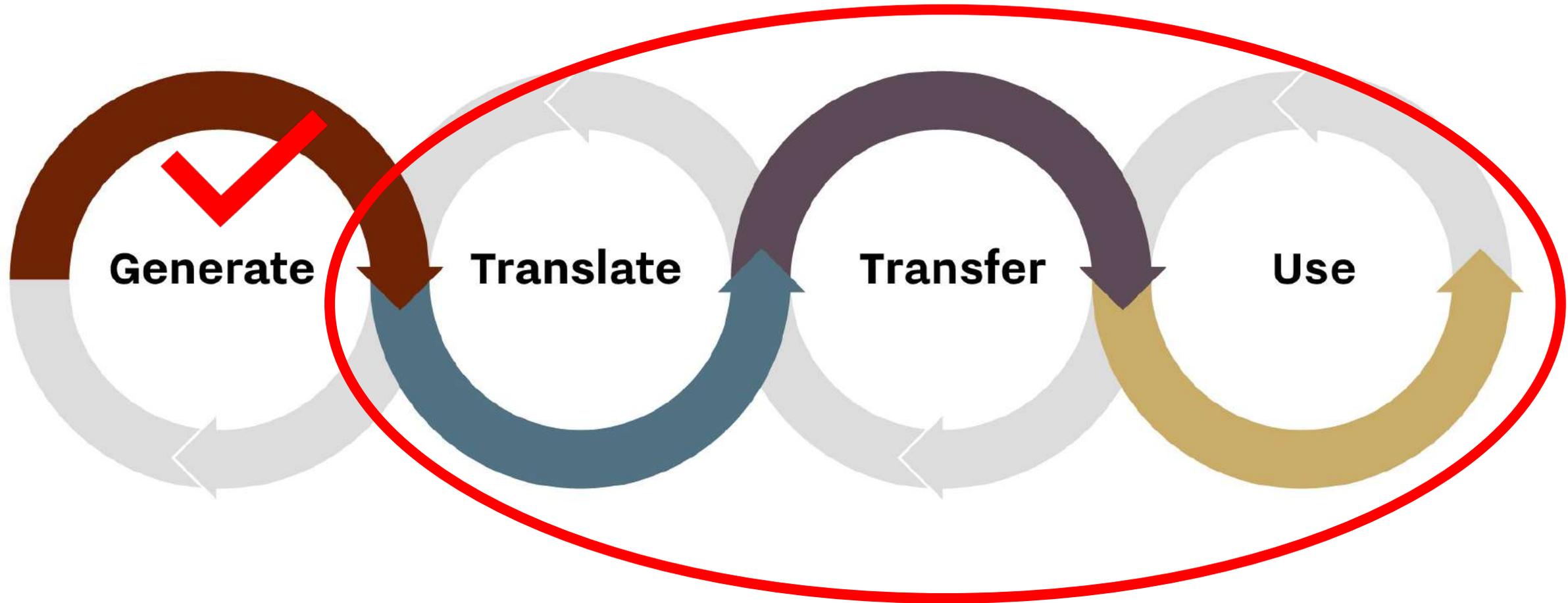
What Interventions worked best?

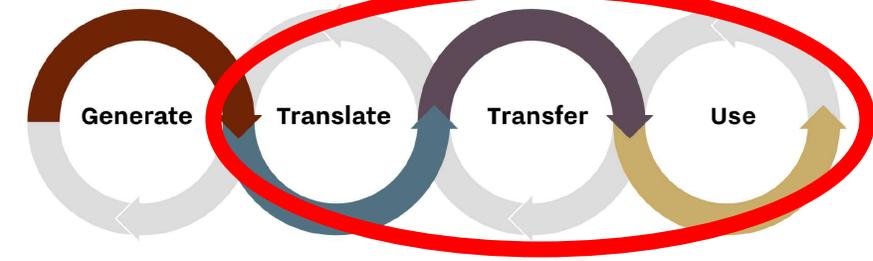
Which ones did not work?

Use as Proxy for  
Index Insurance



# THE FOUR PILLARS OF CLIMATE SERVICES





## Use Relevant Climate Information to Assist Policies

Example: Declaring an Official Emergency (Drought)

Typical Situation:

- Last minute look for Financial Resources
- Inefficient, Ineffective (often: Corruption)
- Not Objective, Subject to Criticism

**IRI Approach: Develop an Objective Tool**

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# Uruguay Drought in 2015:

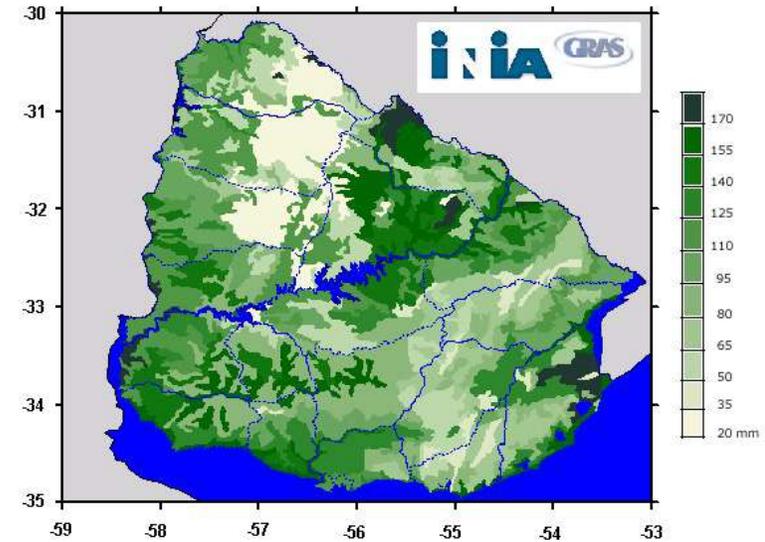
Provided information to  
Ministry of Agriculture

Soil Water Content every 10 days  
(Translate "Climate into Agronomy")

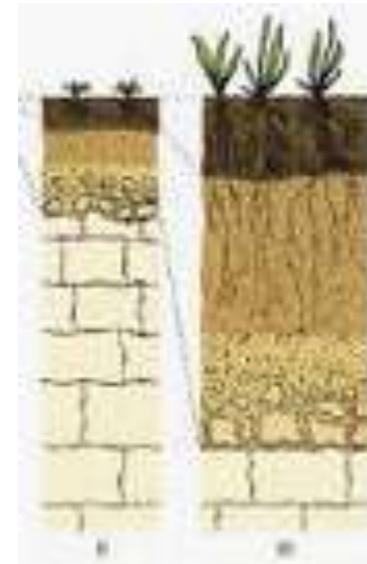
Soil Water Balance per Soil Type

## Soil Types:

Darker = Higher Water Storing Capacity



Soil Water Holding Capacity



Soil Characteristics  
Soil Depth



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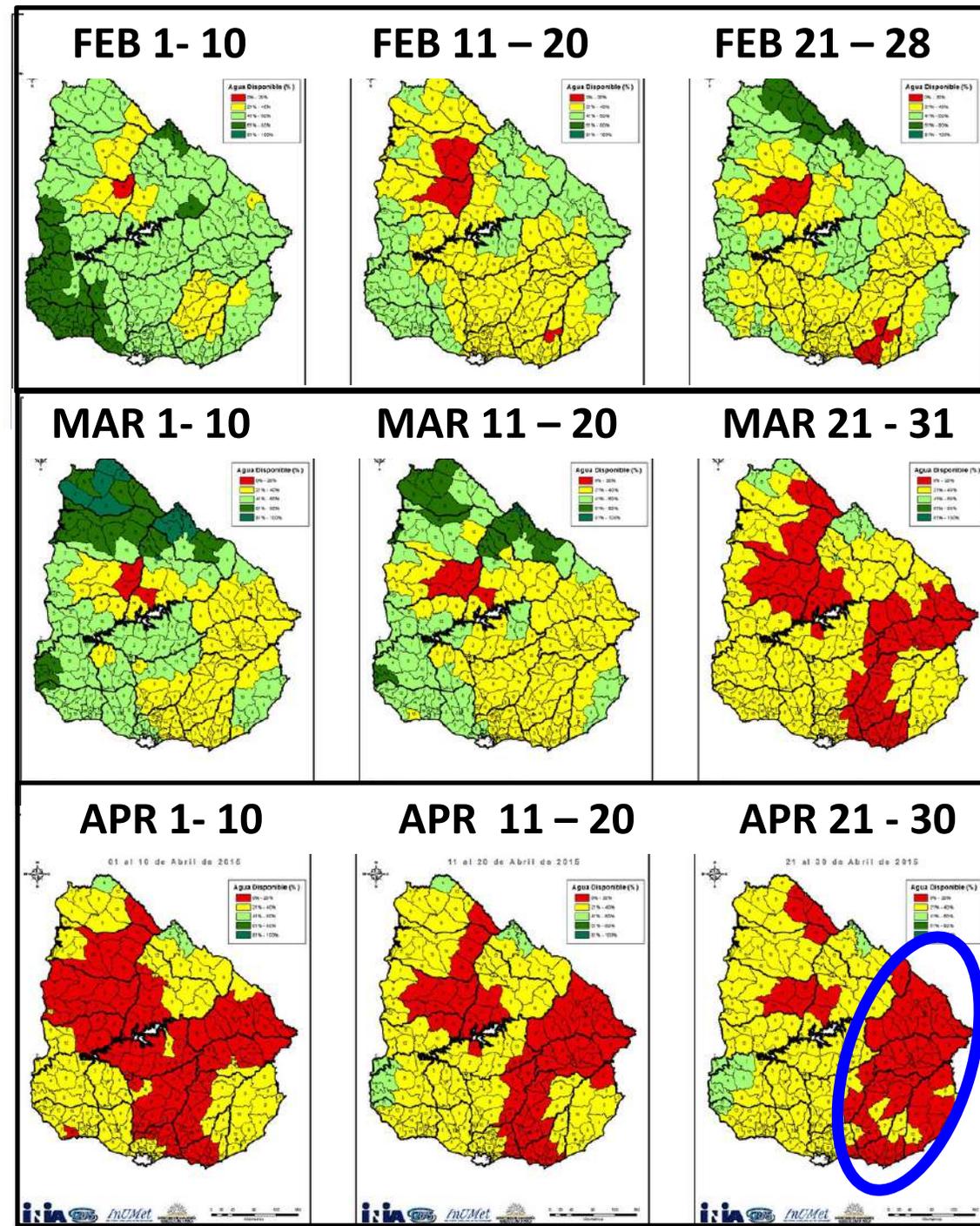
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**BUT: Decisions are made per  
Administrative Unit (county / district)**

**5 May:**  
Ministry declared  
Emergency in  
4 Eastern provinces

-Special Credit for feed  
-Prioritize response



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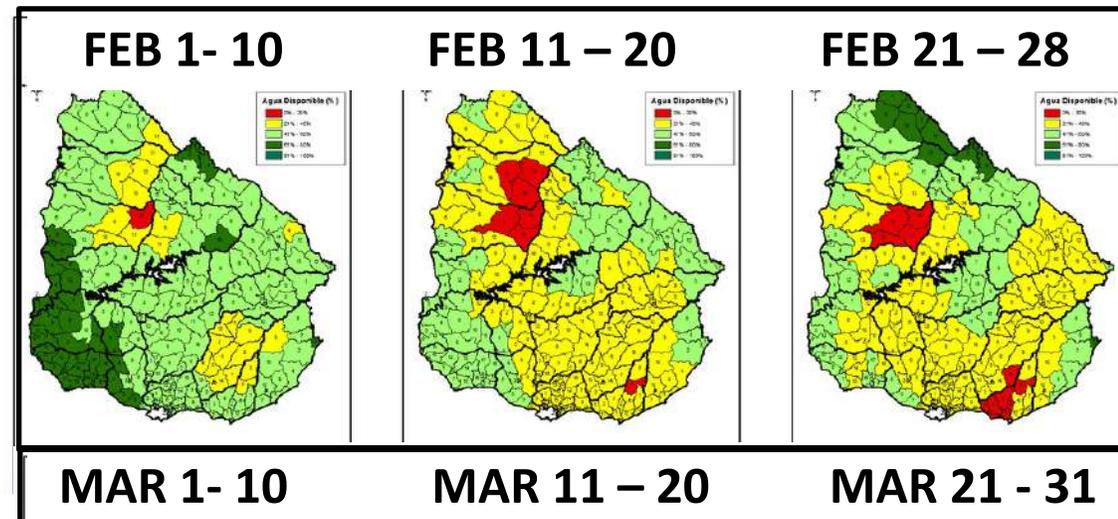
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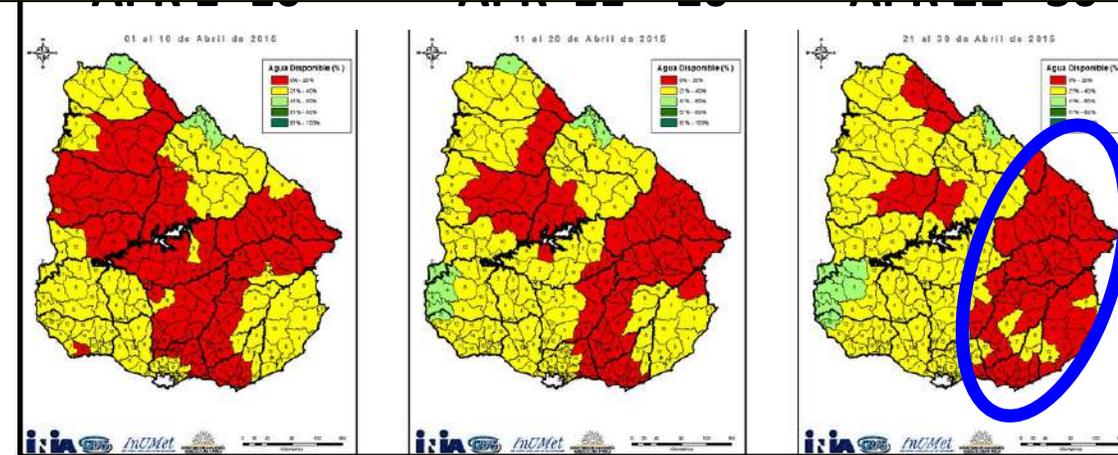
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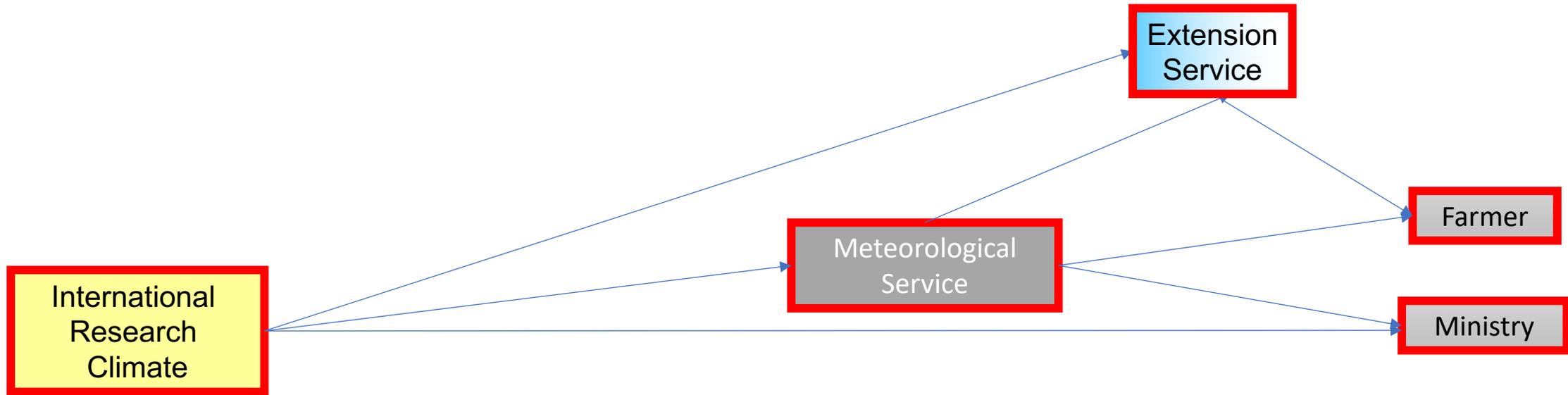
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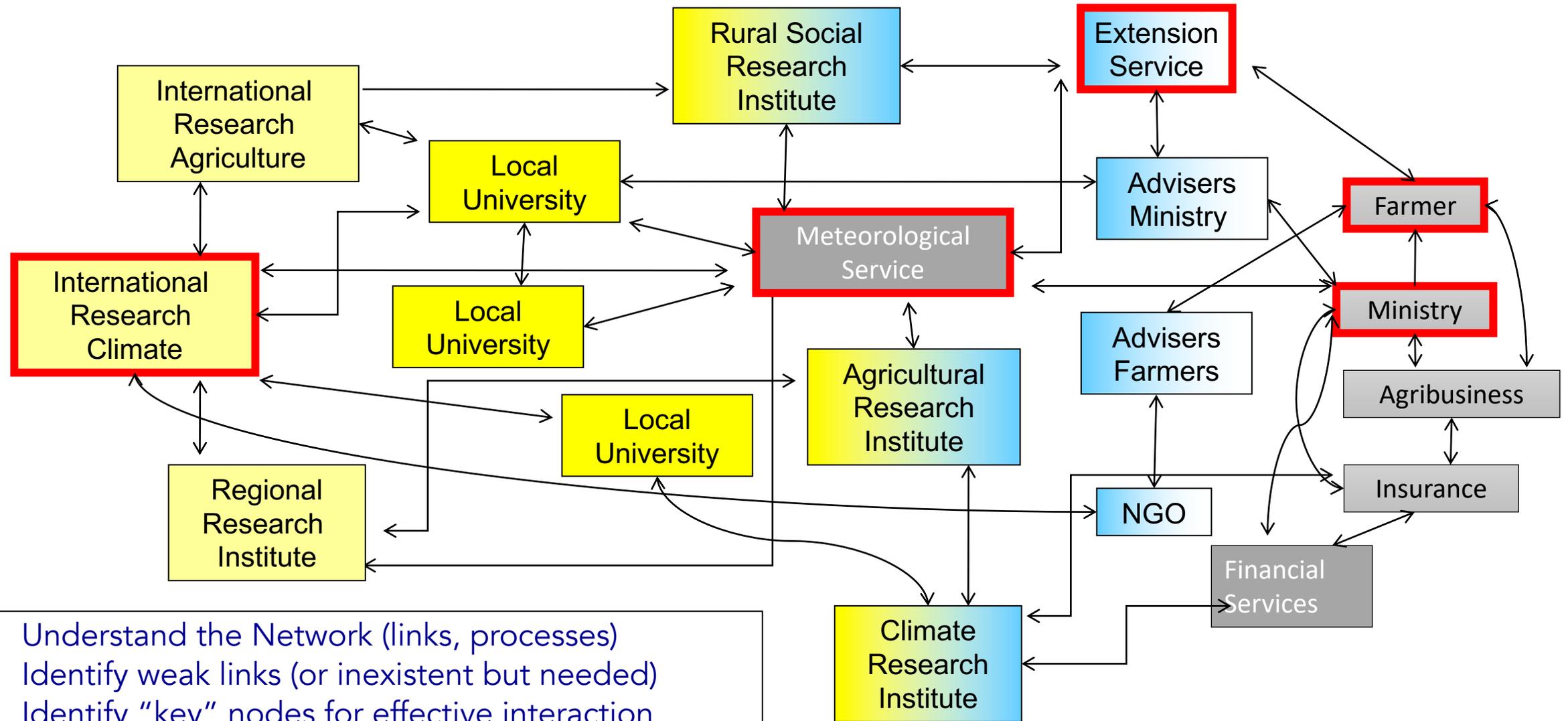
**Used again in 2018 and 2020  
(Established as Policy)**





# TRANSFER

# Linear Model : "Knowledge" flows to reach "End User"



- Understand the Network (links, processes)
- Identify weak links (or inexistent but needed)
- Identify "key" nodes for effective interaction

**Requires Robust Research (Social Sciences)**

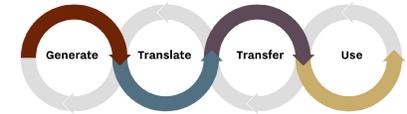


Up to here: Climate or Climate-related Information  
Very Useful but: Not Enough to Inform Decisions / Policies

No Decisions / Policies are based on “One Dimension”

- Climate
- Prices and Costs
- Farm characteristics
- Policies in Place
- Personal preferences
- Many possible others...

**Need to Integrate Information**



Translate / Transfer / Use

# Decision Support Systems (Extension / Advisers: "Integrators")



Provide Quantitative Information  
to Farmers and Policy Makers to  
Assess Risks, Inform Decisions



# Final Comments

Climate Services : **Generation, Translation, Transfer and Use**

**Generate:** Data Poverty, Trust

**Translate:** Sector Relevant, Participatory Approach

**Transfer:** Integrate Climate knowledge (prices, preferences, etc.)  
Need "Integrators" (people) and Decision Support Systems (tools)

**Use:** Identify Needs, Understand Networks, Develop Capacity to Use,  
Co-Produce



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# Thank you



COLUMBIA CLIMATE SCHOOL  
INTERNATIONAL RESEARCH INSTITUTE  
FOR CLIMATE AND SOCIETY

**Walter E. Baethgen**

Senior Research Scientist  
Director, Regional and Sectoral Research

Columbia University, New York



**USAID**  
FROM THE AMERICAN PEOPLE

**AGRILINKS**

A vibrant market stall filled with fresh produce. In the foreground, there are large piles of green okra, cucumbers, and purple cherry tomatoes. Behind them are several large, round cabbages. To the right, a wooden bowl is filled with red and green chili peppers. The background shows more market activity with various other vegetables and people. The overall scene is bright and colorful, representing a bustling agricultural market.

# Microinsurance for Agriculture

Molly E Brown, PhD  
University of Maryland  
6<sup>th</sup> Grain Corporation



# Microinsurance for Small Farmers

- Microinsurance is the protection of low-income people against specific perils in exchange for regular premium payment proportionate to the likelihood and cost of the risks involved.
- Microinsurance targets low-income farmers, and usually differs from regular insurance in terms of
  - types of risks covered
  - types of delivery channels
  - premiums level and
  - documentation requirements for each claim



# Types of Agriculture Insurance

## **Indemnity products**

- Named-peril crop insurance (e.g. hail, flood, frost)
- Multi-peril crop insurance (MPCI) (yield guarantee – requires submission of yield history and management plan before season starts)
- Accident and mortality livestock insurance

## **Index-based products**

- *Weather index insurance* using ground-based or remotely sensed measures of weather variables
- Area yield index insurance using ground measurement
- Index insurance using remote sensing to monitor cropping or pasture conditions



# Index Insurance for smallholders

- Smallholder farmers
  - Want hybrid seeds, fertilizers, other inputs
  - Understand how to increase yields
  - But face risk, have severe difficulties obtaining inputs
- Risk of 1 bad year out of 5 prevents them from being productive in 4 good years
- Agricultural insurance allows farmers to utilize technologies, get loans and increase productivity without risking their investment
- The index innovation
  - Insures the weather, not crop
  - Trigger uses a threshold of **remote sensing of rainfall or vegetation**
  - Only partial protection (basis risk), should not oversell
  - Cheap, easy to implement, good incentives





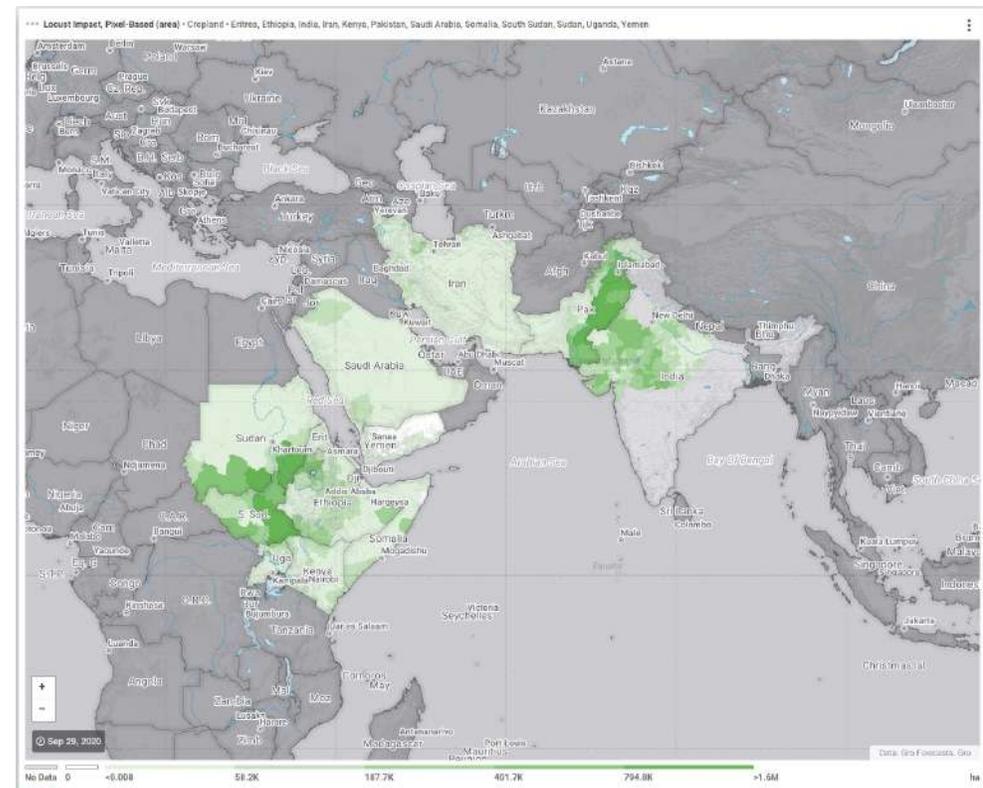
# Examples of Index Insurance using RS Rainfall

- Ethiopia R4 Weather Index Insurance is based on satellite-derived rainfall data
- We use CHIRPS satellite-derived rainfall data
  - Uses geostationary and polar orbiting temperature data from satellites
  - 5km resolution, 1981-2016
  - Uses dense network of all available station data
- We add to rainfall vegetation data to capture the impact of disease and pest threats



# Adding vegetation to index insurance

- Reductions in vegetation vigor due to locusts, fall armyworm and other pests are observable from satellite remote sensing
  - Gro's 2020 Desert Locust Impact Model, Pixel-Level estimates the cropland area impacted by locusts in each district of 11 countries.
  - The model compares this season's change in NDVI to the average historical change in order to identify the pixels affected by locusts.
  - By aggregating the areas of individual affected pixels, we arrive at a bottom-up, rather than top-down, estimate, which more accurately assesses crop areas.
  - The map on the right shows cropland impacted by locusts at the district level. Darker green indicates greater area affected.





# Designing a commercial index insurance product

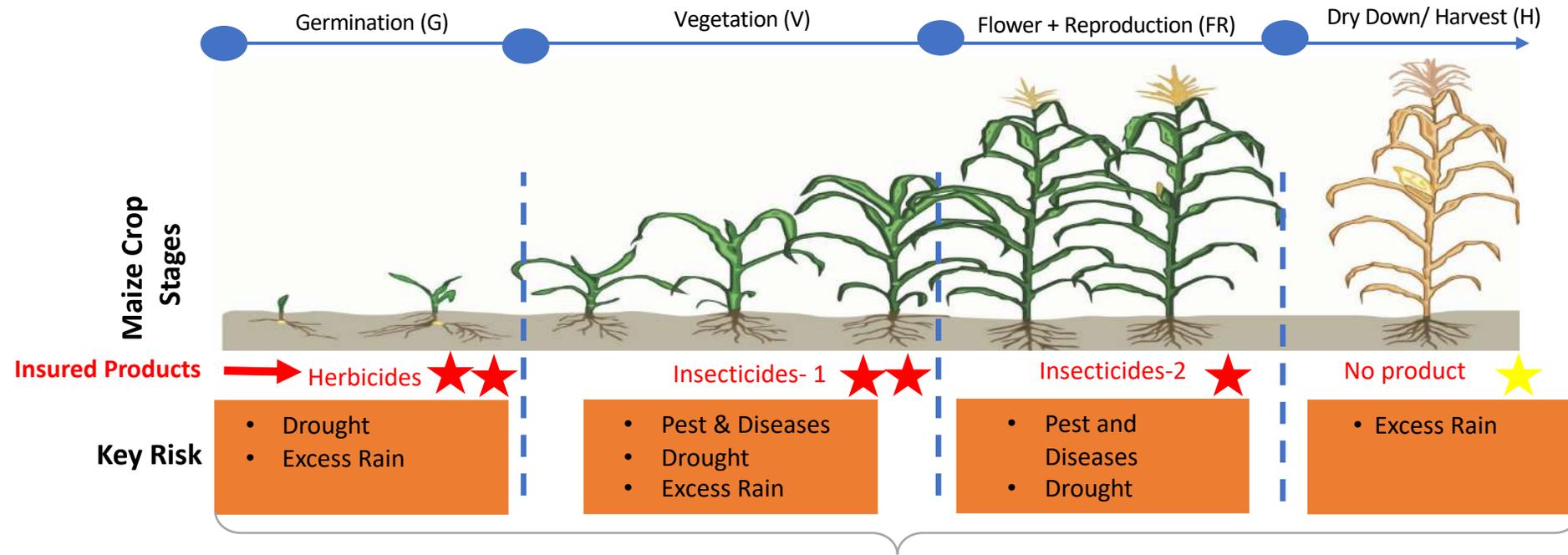
- Designing the system from research to payment of claims
- Objective is to reduce the ‘basis risk’ or the lack of relationship between the yield loss experienced by the farmer and the payout
- Designing the product includes deciding:
  - Premium rates and rate of subsidy
  - Timing and of payouts – at emergence, at peak vegetative stage, at harvest
  - Threshold payment by district and crop
  - Exact values of triggers (rainfall and vegetation)
  - Provisions to carry forward rainfall from phase to phase.
  - Crop durations were split into two to five distinctive phases depending on each crop

# Example: Macro Resilience Insurance pilot

- Design to bundle insurance with agricultural inputs and distributed through Syngenta inputs distribution infrastructure
- Dual trigger insurance program, piloted in Zambia/Zimbabwe
- Index Insurance will be included in every product purchased in region
- Payouts will be
  - Reimbursement of product value, or
  - Replacement of product
- Currently in the promotion and enrollment



# Insurance Product prototype - Design

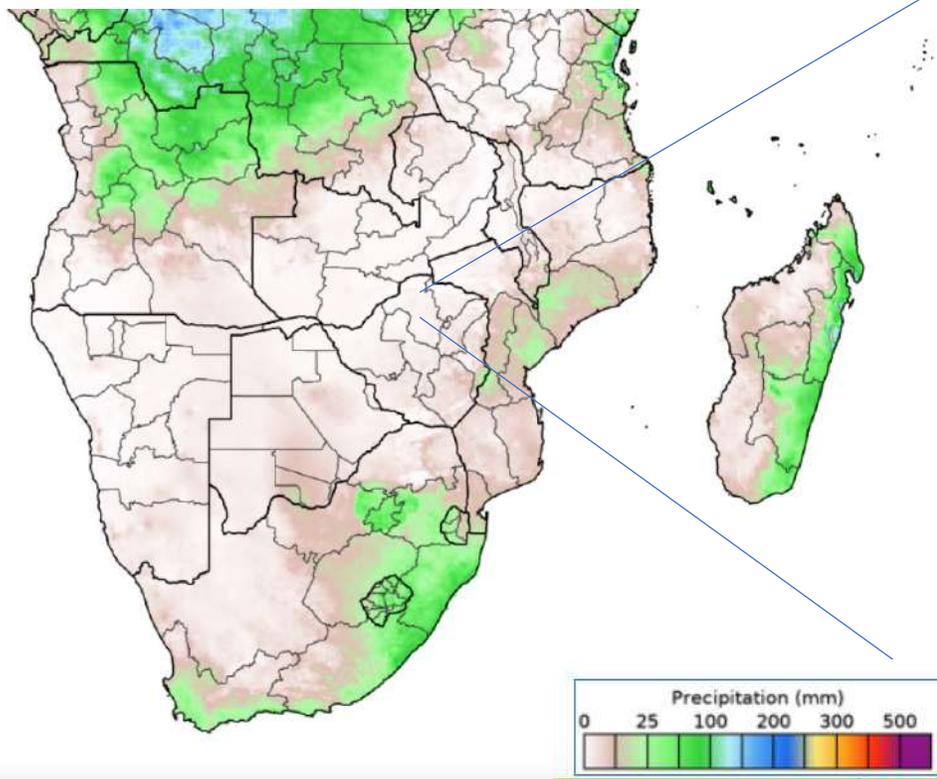


## HYBRID INDEX (Combining of two index solutions)

### Product

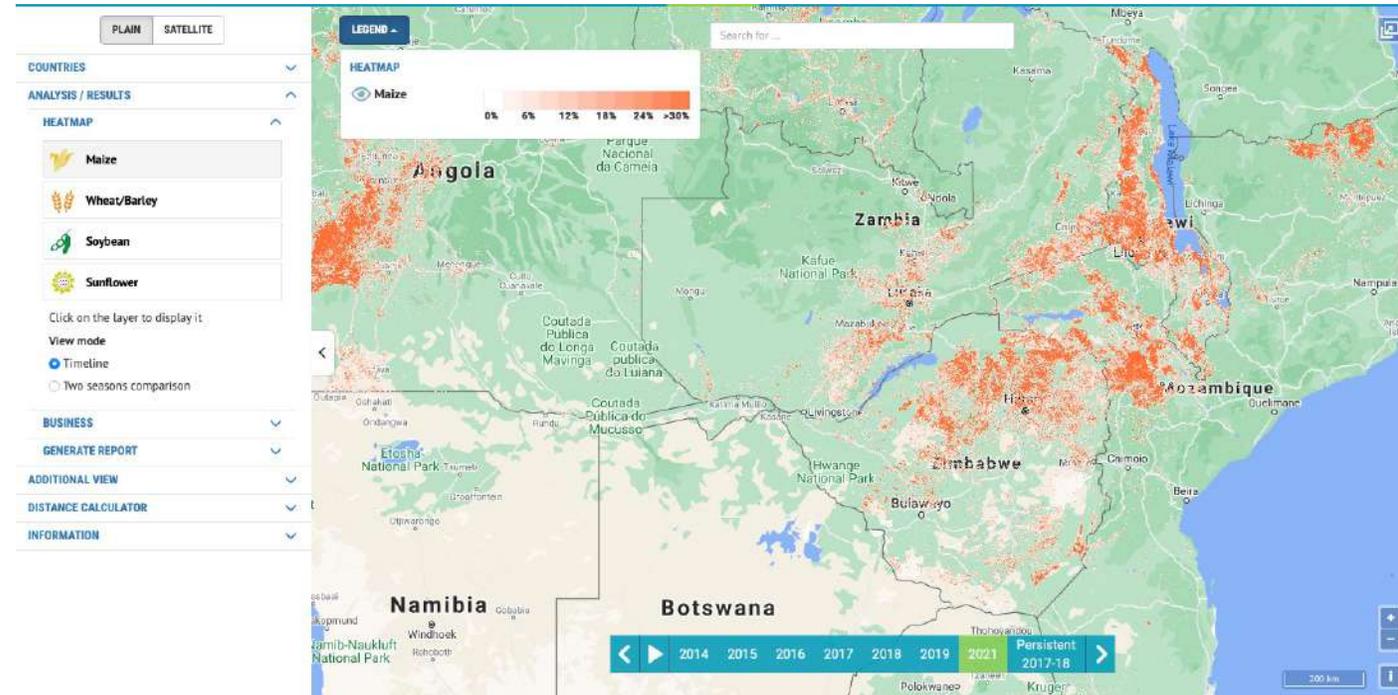
- Normalized Difference Vegetative Index (NDVI)- is an indicator of a plant's health. It's calculated by comparing the values of absorption and reflection of red and infrared light (Consider partnership with Six Grain)
- Weather Index Insurance (WII)- Rainfall Index product based on Arc 2 or Chirps 5 data provided by SFSA AIS  
*Note: Unit of measurement will be based on the lowest administrative boundary or clustered units based on homogeneous weather patterns*

# Rainfall data products - CHIRPS



# NDVI data products - MODIS

- 1) Download MODIS 500 m daily surface reflectance data from Aqua and Terra.
- 2) Derive NDVI from the daily MODIS data for pixels with  $>10\%$  maize from a cropped area map from 2021.
- 3) Compose the daily NDVI for every 10 days to calculate the average NDVI.
- 4) Save the 10-day NDVI images in GeoTIFF files.







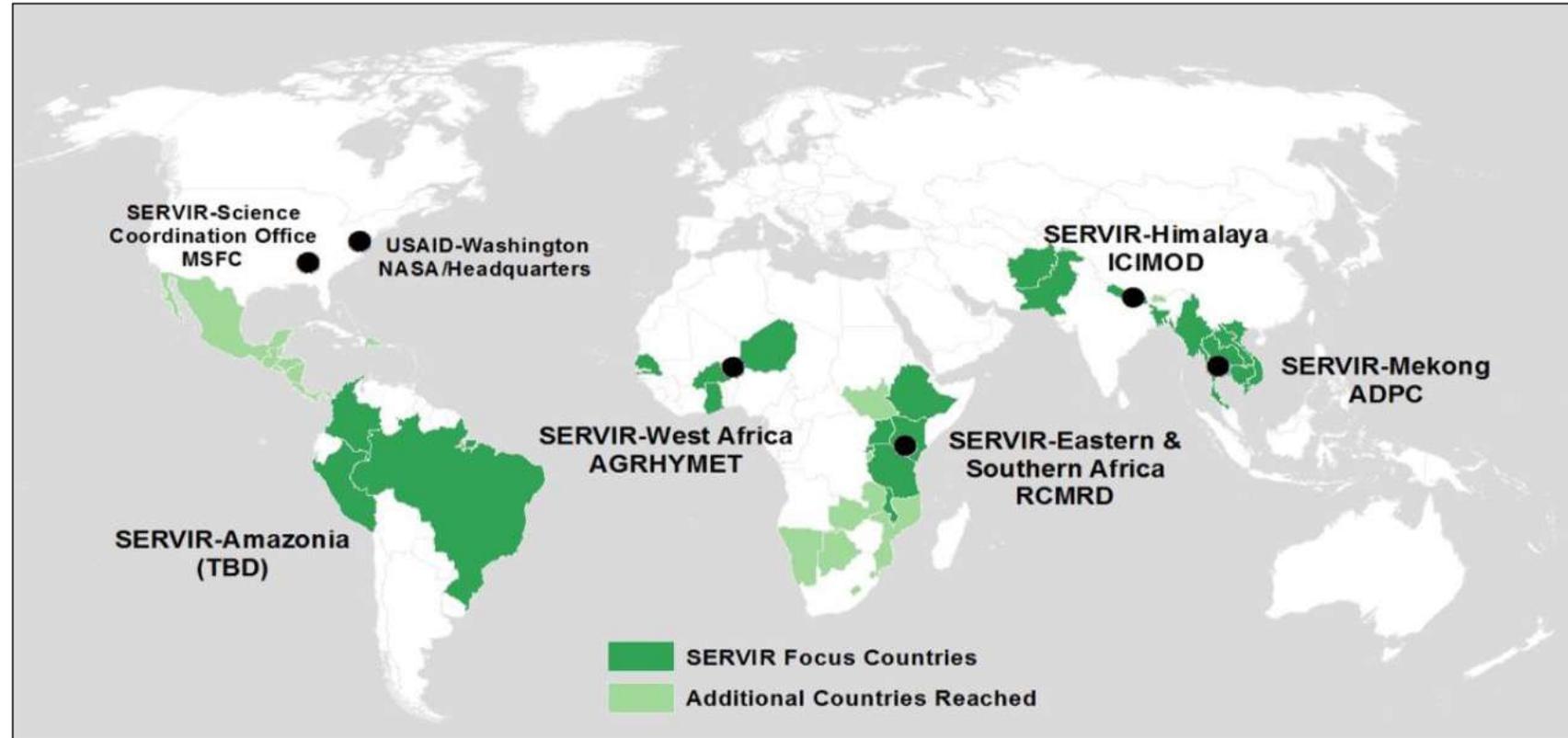
# Conclusions and next steps

- Index insurance can reduce risk and increase grower profitability through the increased access to agricultural technologies
- Increasing productivity in good years by reducing financial risk in poor years
- Bundling insurance with high value agriculture inputs will support growers who are investing in hybrid seeds and modern management practices

# Mainstreaming Earth Observation (EO) for food security planning and policy formulation in the south Asia

# NASA SERVIR – Connecting Space to village

A joint initiative of USAID and NASA that partners with regional technical institutions around the world to get Earth observation information into the hands of decision-makers to improve development outcomes.



Food security & agriculture



Water & hydroclimatic disasters



Land use/land cover & ecosystems



Weather & climate

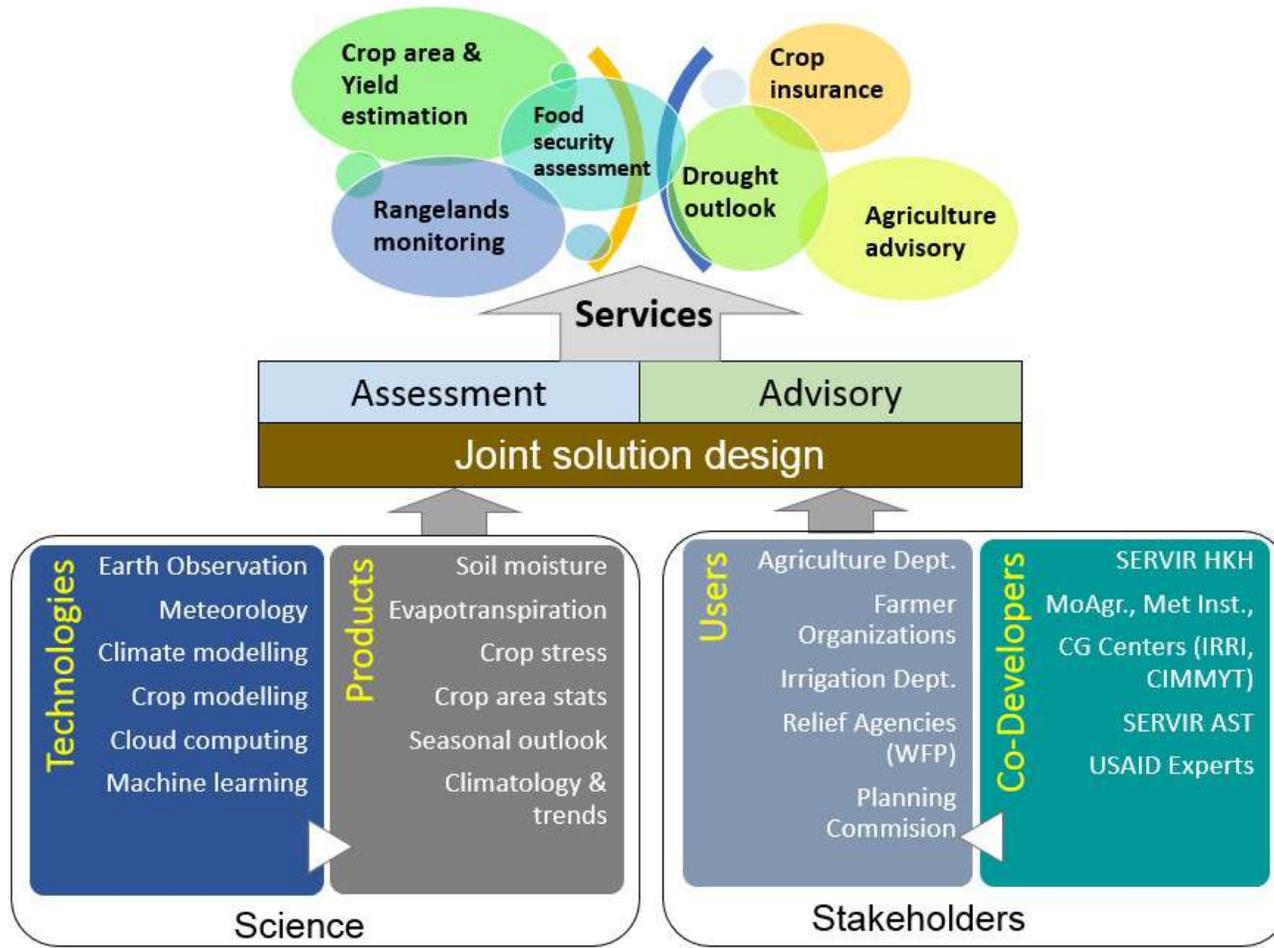


Air quality

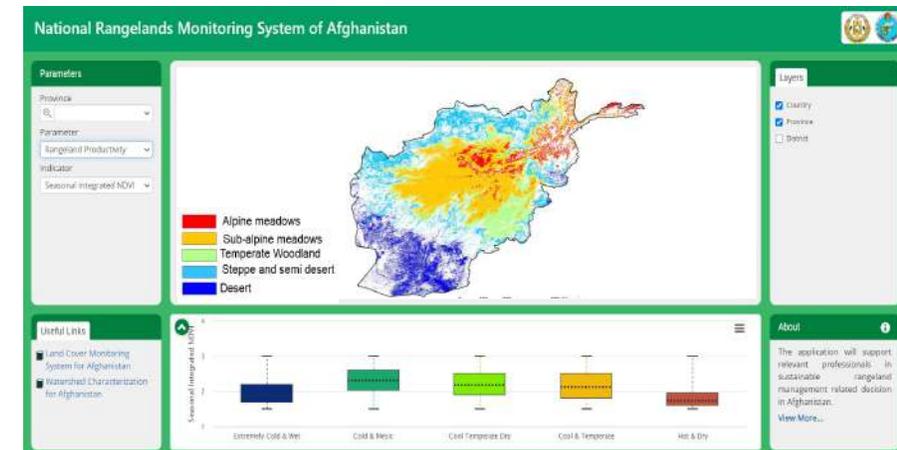
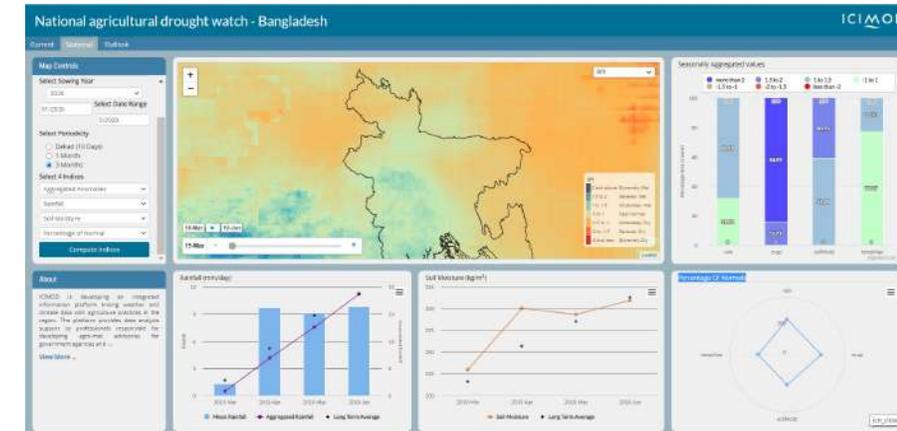
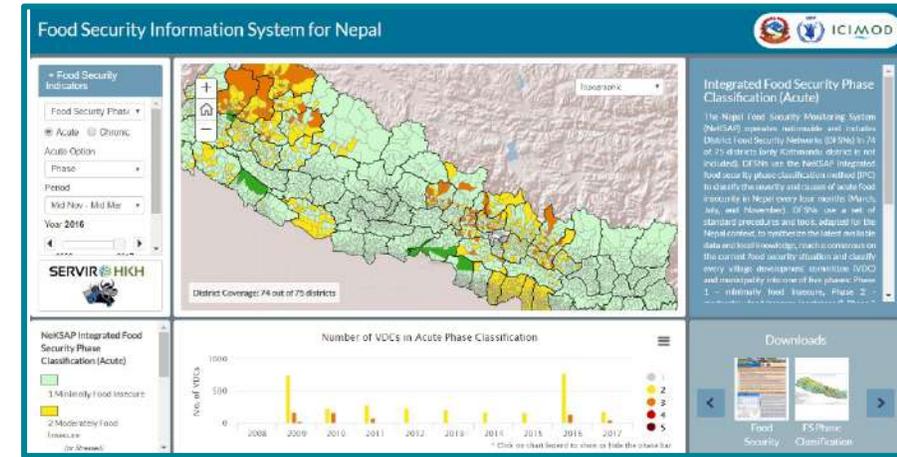




# SERVIR HKH - Agriculture and Food Security



**Priory countries:** Afghanistan, Bangladesh, Nepal, Pakistan





# EO solutions for resilient agriculture and food security

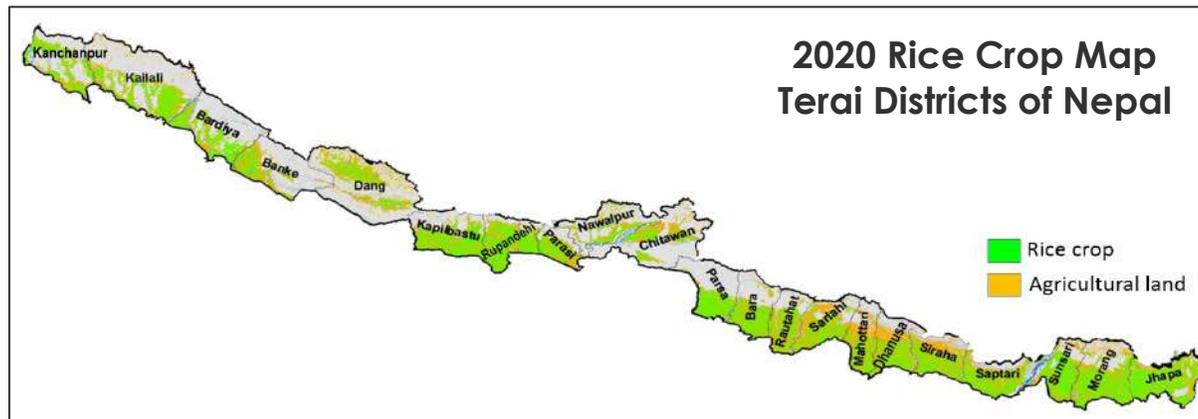
<b>Sustainability assessments for policy support and long-term planning (National planning commission)</b>	<b>Decision support tools (Nationally mandated institutions)</b>	<b>Advisory services (Local government)</b>	<b>Risk financing services (Multilateral development banks)</b>
Agricultural land use policies support in context of climate and water availability scenarios	In-season crop condition monitoring to support national food security planning process	ICT and advance climate information supported agricultural advisories	Forecast based action/financing (FbF)
Agro-ecological zonation  Niche crop zonation	Harnessing data-science for climate-risk preparedness of pastoral communities	(high value) Crop specific advisories	Crop insurance

# Strengthening in-season crop assessment to support federal and provincial agriculture planning and food security decision making in Nepal

- Co-development and customization of algorithms in local context
- Easy-to-use service design aligned with existing institutional function
- Institutional capacity building at all levels



**Sub-district estimates facilitated in efficient crop procurement during server COVID-19 situation of 2020**



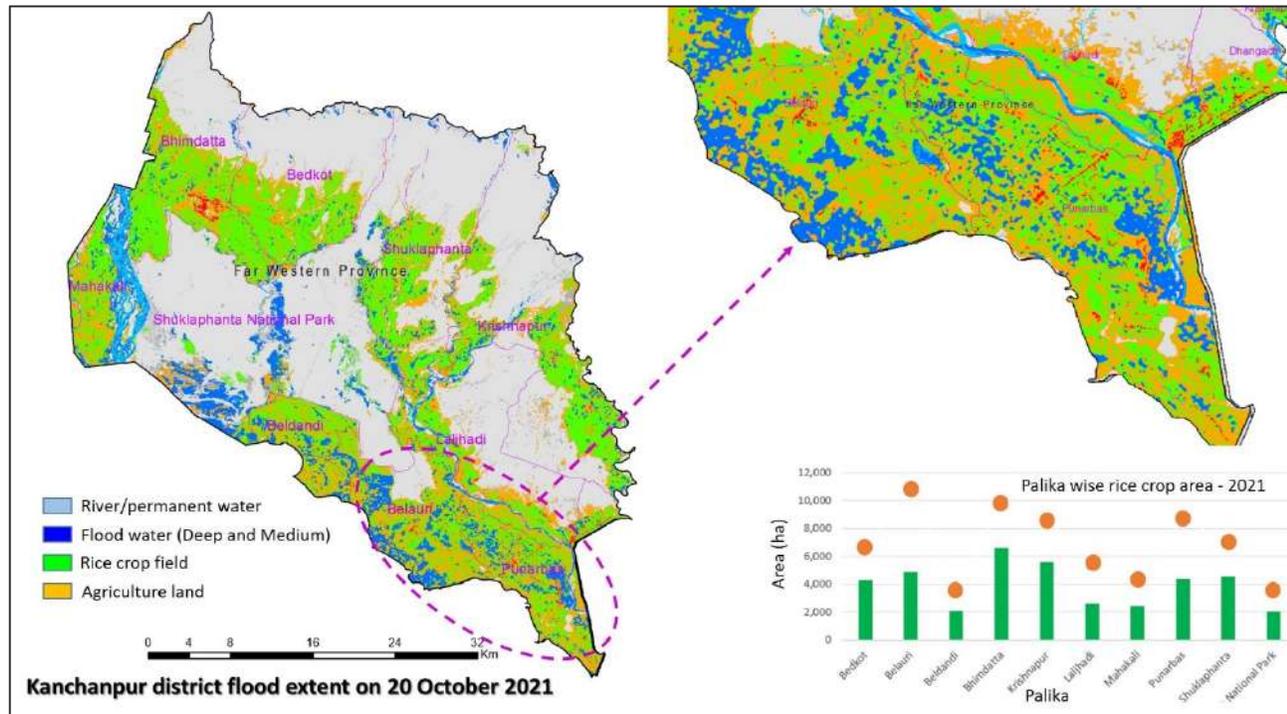
# Strengthening in-season crop assessment to support federal and provincial agriculture planning and food security decision making in Nepal

Published at : October 23, 2021 THE KATHMANDU POST

**MONEY**

## Paddy damage by freak rains estimated at Rs8.26 billion

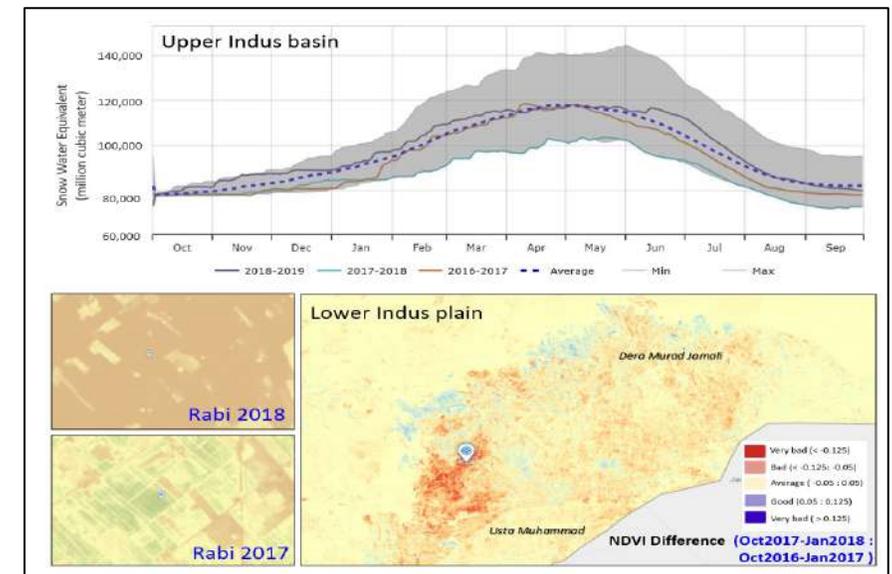
According to preliminary estimates by the agriculture ministry, 325,258 tonnes of ready-to-harvest paddy on 85,580 hectares have either submerged or swept away in seven provinces.



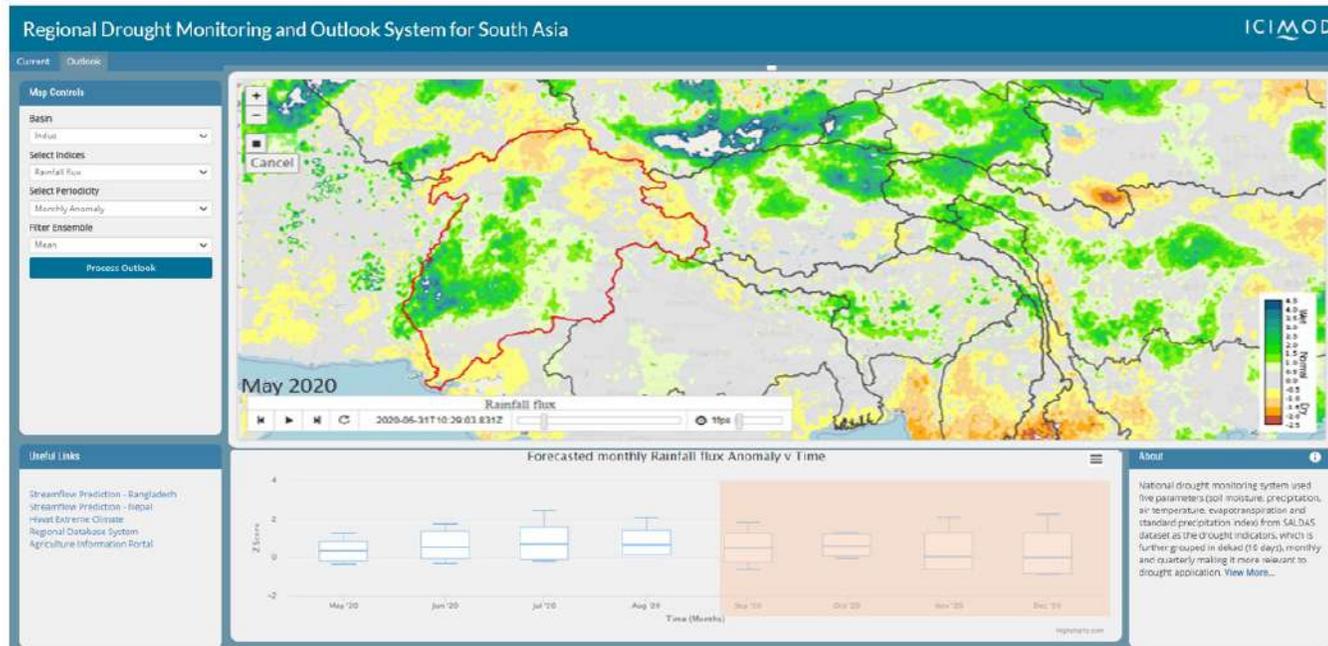
**Earth Observation data for rapid loss & damage assessment for aid assistance and farmer compensation**

# Earth Observation data supported drought early warning and impact evaluation

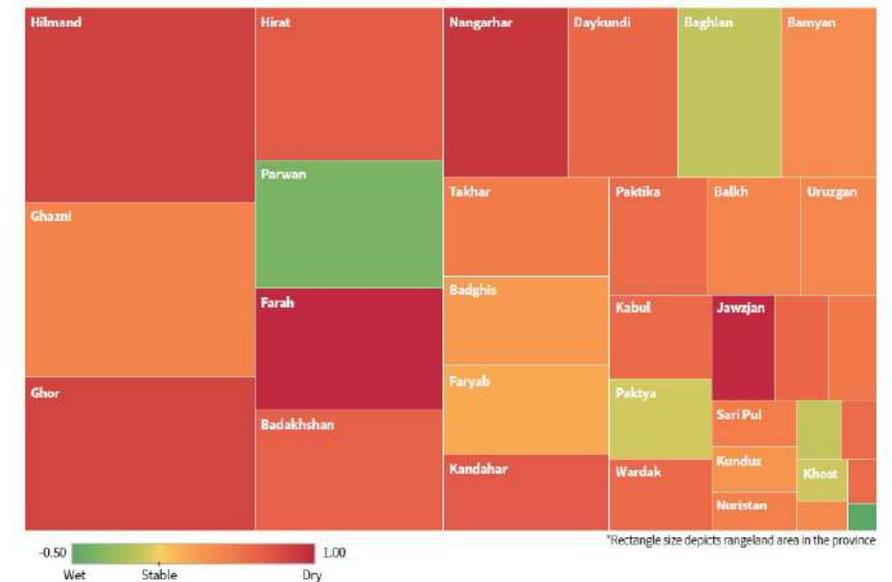
- Downscaling and calibration global system at regional scale in collaboration with national institutions
- Information service for decadal near real time assessment and 4-months seasonal outlook
- Promoting use (integration) of data products in the risk preparedness and aid assistance at national and local level



Earth observation data supported assessment of snow water equivalent (SWE) in the upper Indus basin and its impacts on downstream crops



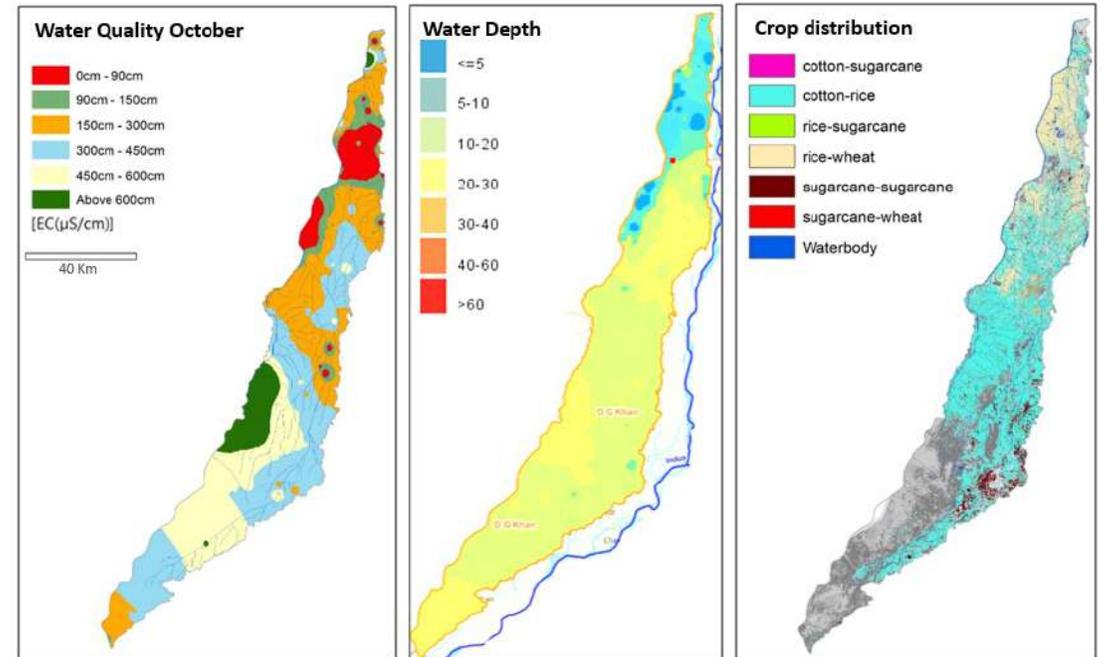
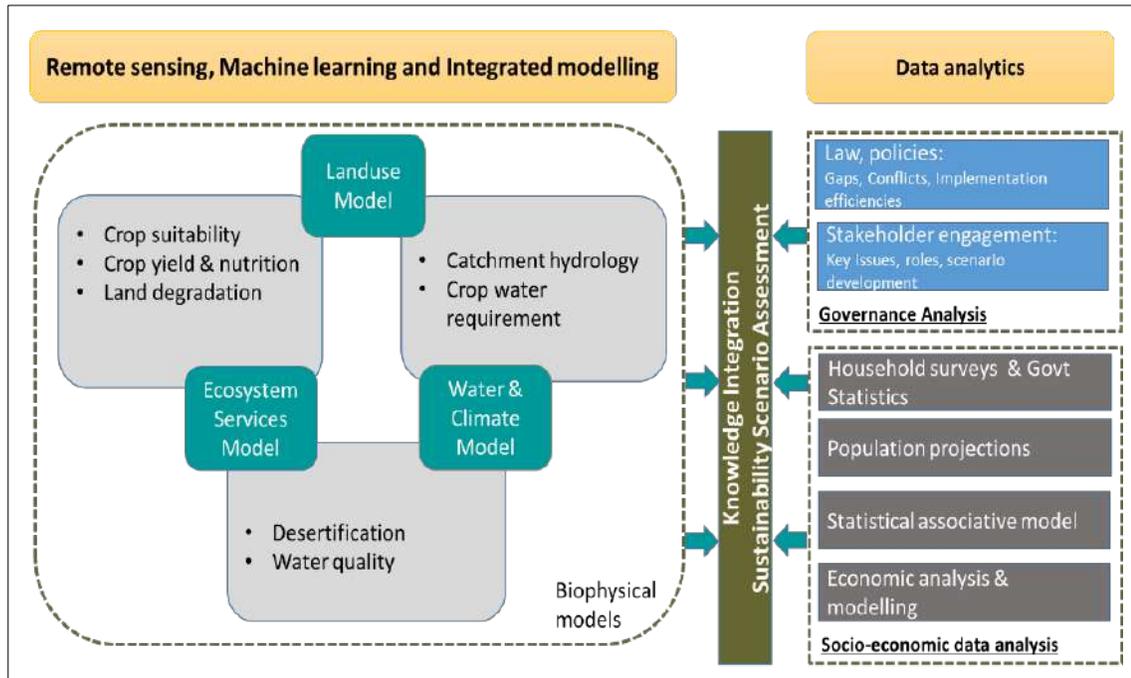
<http://tethys.icimod.org/apps/regionaldrought/outlook/>



Drought severity and the distribution of rangelands across the provinces of Afghanistan

# Strengthening sustainable agricultural practices and policy support through Earth observation data in Pakistan

- Sustainability assessment for current cropping practices in Pakistan
- Provision of EO derived agro-climatic data and inclusion of climate change scenarios in the planned crop zonation process
- Data exchange and dissemination platform



# Building on capacities for resilient future

- Continuing working with key national institutions on expanding users, enhancing service functions as per emerging needs to support the service adoption process.
- Working with multilateral development banks for designing earth observation data supported risk financing services
- Promoting use of data products and service for processes like Loss and Damage assessment
- Integration of climate risks and adaptive capacity assessments in the formulation agriculture land use policies



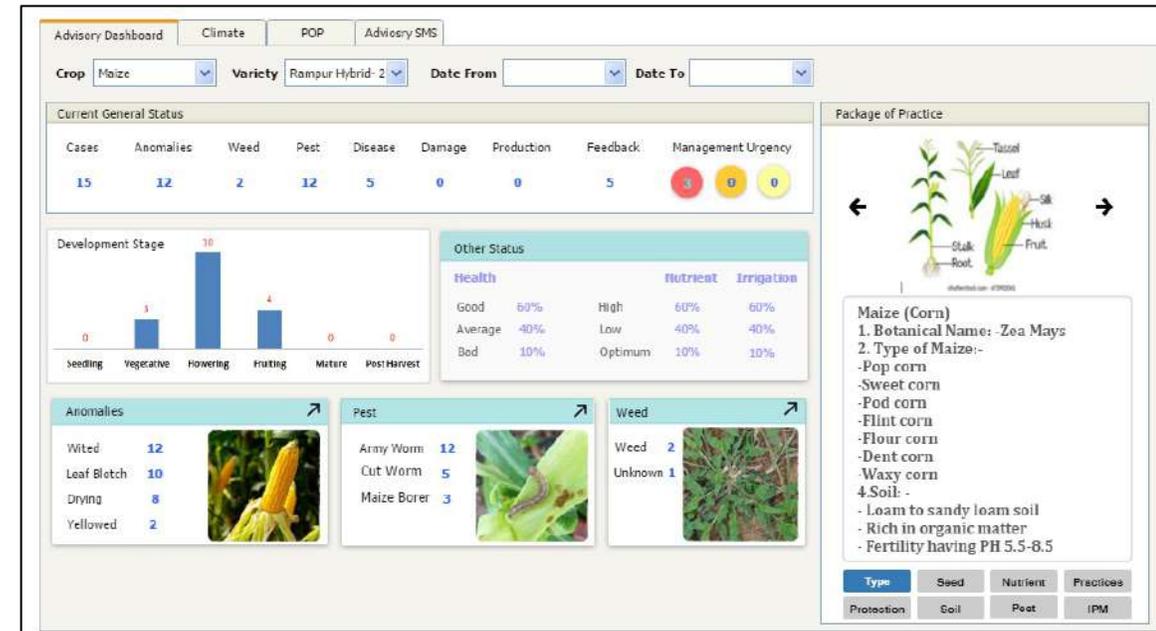
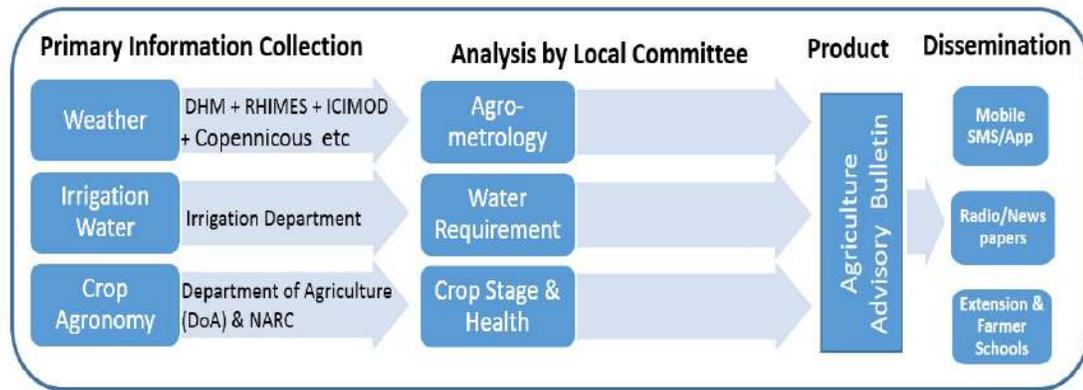


**Let's protect the  
pulse**

# Localizing agro-met advisories for resilient agriculture in Nepal

## Setting-up institutional and technological mechanism

1. Setting-up the institutional mechanism
2. Establishing ICT infrastructure for digital agriculture advisories
3. Agriculture advisory service design and delivery mechanism
4. Capacity building



# Q&A

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