



International Water
Management Institute

APPLYING ANALYTICAL AND MONITORING TOOLS TO IMPROVE CLIMATE CHANGE ADAPTATION IN THE AGRICULTURAL SECTOR

7th Nile Basin Development Forum
Webinar CS6

Abdulkarim H Seid, IWMI

21 September 2023

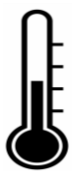
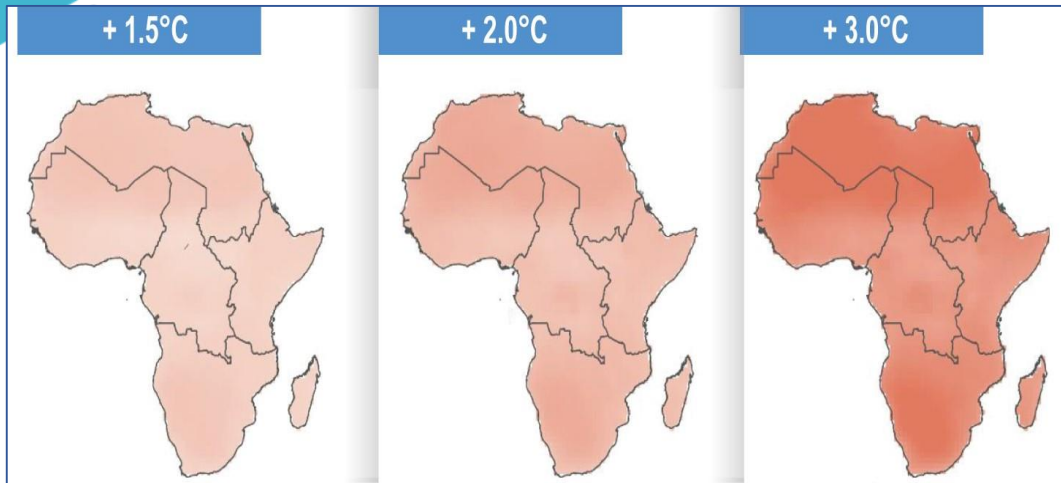
Innovative water solutions for sustainable development

Food · Climate · Growth

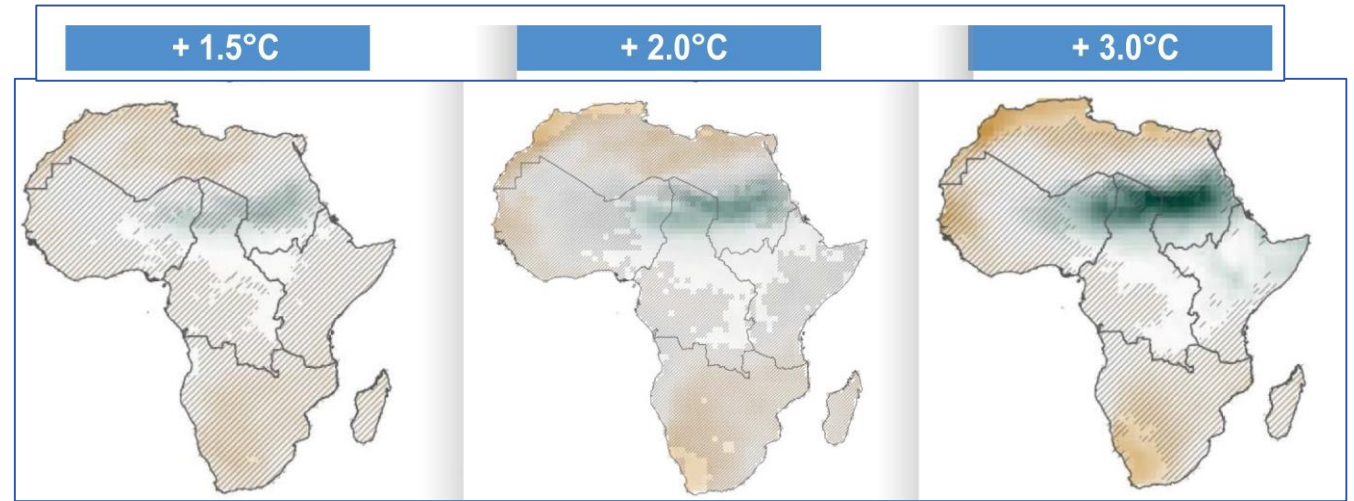
Outline

- Climate change and water in East Africa: quick overview
- Key implications for agriculture sector
- Monitoring for climate change adaptation in agriculture: What to monitor and why
- Cases studies of applying analytic and monitoring tools:
- Key steps/actions are needed to scale the limited, research focused experiences so far and mainstream them into operational workflows of governments.

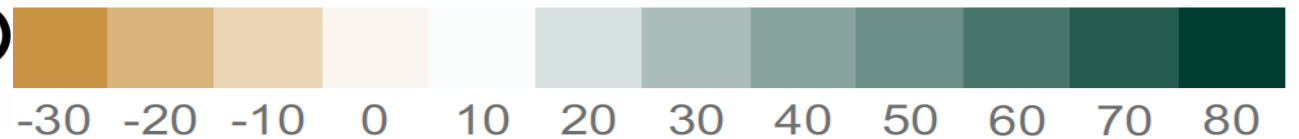
Projected changes (relative to 1995 – 2014 average)



Mean temperature change (°C)



Mean annual precipitation change (%)



- Increase of 0.6°C, 1.1°C and 2.1°C at GWL of 1.5 °C, 2 °C, and 3 °C, respectively

- *low confidence* in projected mean rainfall change for long rainy seasons.
- No significant mean annual rainfall trend projected for rest of East Africa. *Agreement on the sign of change is low,*
- Heavy rainfall events are projected to increase over the region at global warming of 2°C and higher (high

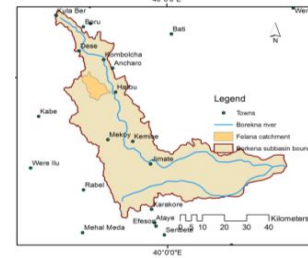
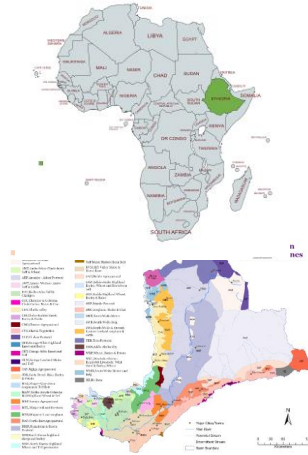
Magnitude, and Direction of change and level of confidence

Key implications of climate change for agriculture sector (IPCC 2022)

- Observed trends: Reduction in agricultural productivity growth has been reduced by 34% since 1961 due to climate change, more than any other region.
- Projection: Shortening growing seasons and increasing water stress (high confidence).
- Global warming above 2°C will result in yield reductions for staple crops across most of Africa compared to 2005 yields.
- Climate change poses a significant threat to African marine and freshwater fisheries (high confidence).
- Under 1.7°C global warming, reduced fish harvests could leave 1.2–70 million people in Africa vulnerable to iron deficiencies, up to 188 million for vitamin A deficiencies, and 285 million for vitamin B12 and omega-3 fatty acids by mid-century. {ES-Ch9; 9.4; 9.8}

Monitoring for climate change adaptation in agriculture: What to monitor and why

National and continental



What to monitor:

- Agricultural water use
- Water productivity
- Crop water stress?
- Irrigation water use efficiency
- ..

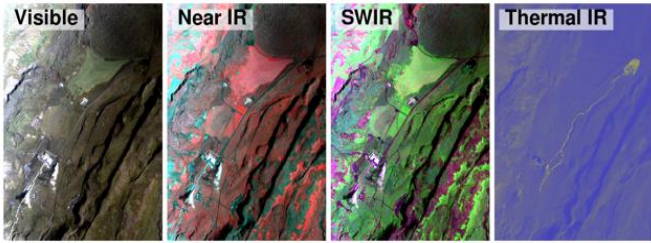
Analytic tools

- Water availability assessment
- Crop selection and cropping calendar
- Crop yield forecast
- Strategic decisions on land use planning ..

Users	Examples of uses of DST and improved data
<ul style="list-style-type: none"> • Policy makers 	<ul style="list-style-type: none"> • Monitoring of efficacy of policy interventions • Decisions on allocation of resources
<ul style="list-style-type: none"> • Basin development office experts 	<ul style="list-style-type: none"> • Water allocation planning • Flood and drought risk mitigation
<ul style="list-style-type: none"> • District level experts at water, agricultural and irrigation offices 	<ul style="list-style-type: none"> • Catchment management plans • Water allocation schemes • Irrigation design and management • Improve extension services
<ul style="list-style-type: none"> • Development Agents • Community based organizations 	<ul style="list-style-type: none"> • Design and management of water harvesting structures • Cropping calendar decisions • Irrigation water management • Water productivity ...

Rethinking integrated monitoring and analytic tools: Preliminary conceptual architecture of data and decision support tools

Remote Sensing



Earth observation data



Other data sources
IoT; Big Data, Surveys

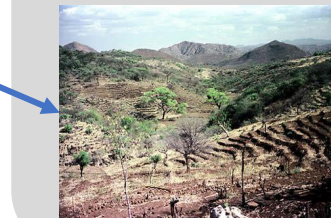
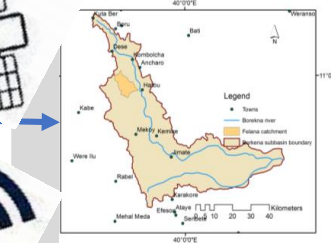
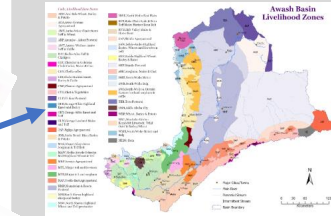
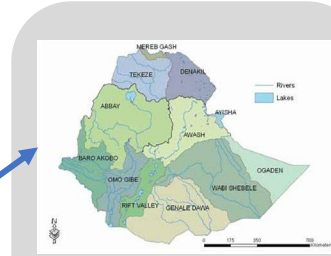
Ground-based data



Suite of tools; AI, ML
Interoperable DBs

Multiple scales

Multiple Users/users



Users

- Policy makers
- Basin development office experts
- District level experts at water, agricultural and irrigation offices
- Development Agents
- Community based organizations

Examples: 1) Monitoring water productivity in agriculture

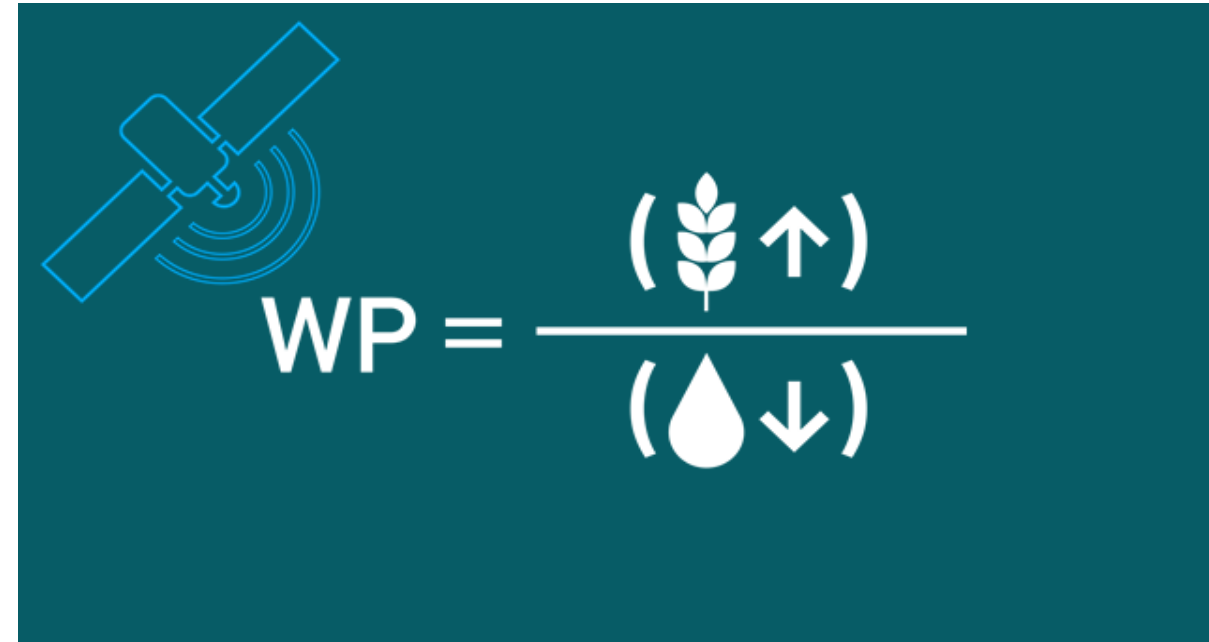
We need to produce more food with less water

Water productivity in agriculture measures the output (kg/ha) per unit of water consumed (m³/ha).

→ *requires the estimation of water productivity is essentially the simultaneous estimation of ETa and CY*

Other variables monitored:

- Actual ET
- T and E
- Rainfall
- Water Accounts


$$WP = \frac{(\text{Crop Yield } \uparrow)}{(\text{Water Consumption } \downarrow)}$$

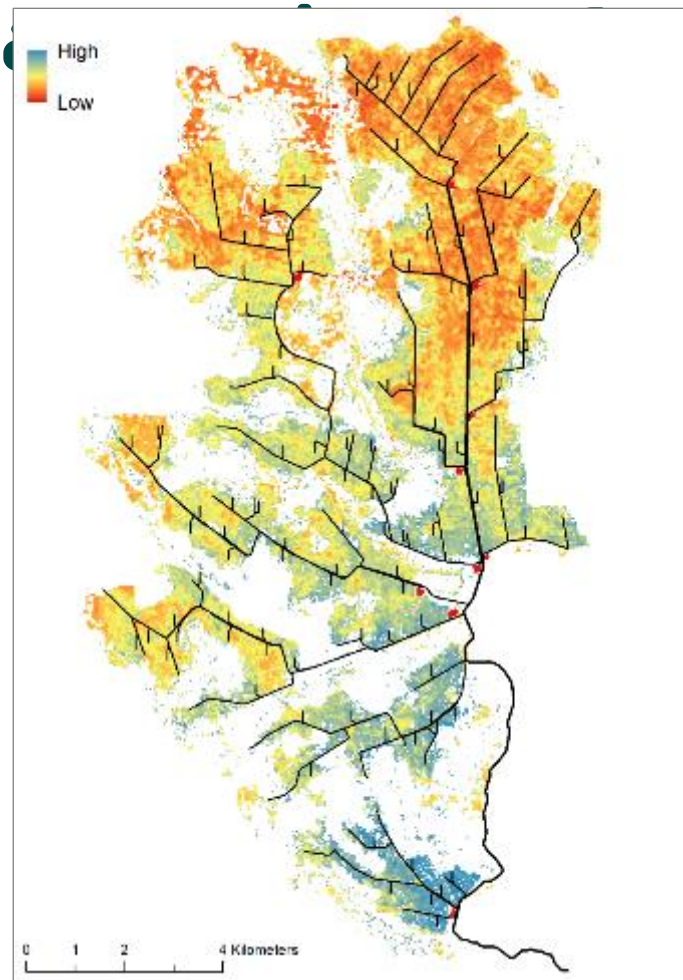
Examples: 1) Monitoring water productivity in agriculture (applying WaPOR data for agricultural water use and water productivity monitoring)

Assessing agricultural water use and interventions

Monitoring agriculture water use

Irrigation scheme performance assessment

Crop water productivity assessment



Crop water productivity (wheat)

Co-learning from head to tail:

- 6 irrigation blocks (head-mid-tail)
- Multi-actor learning alliance for 2 irrigation seasons:
 - Irrigators (647)
 - WUG, block and scheme leaders & development agents (230)
 - National research partner, students and data collectors (22)




What advanced data acquisition systems (Earth Observation) can offer in this task, experiences from use of WaPOR data in Ethiopia

On-going applications

- **Strengthening the Ethiopian Irrigation Management Information System:**
 - Agricultural water use assessment
 - Estimation of irrigation water use efficiency
 - Crop productivity

- **Understanding drivers of wheat productivity**




The screenshot shows the top navigation bar of the IMISET website. It includes the IMISET logo, a 'Home' button, and links for 'Irrigation report', 'Knowledge Management', and 'Map'. A 'Sign in' button is also visible on the right.

Irrigation management information system for Ethiopia (IMISET)

Irrigation Management Information System of Ethiopia (IMISET) is a national web-based information system on irrigated agriculture at national, regional, basin and sub-basin scales. The objective of IMISET is to support in monitoring of the performance and status of irrigated agriculture and making informed decisions and timely planning of appropriate measures by providing accurate and up-to-date information presented in a consistent and standard way. IMISET collects, analyzes and disseminates data and information on irrigated area, water use and production.

It keeps records and gives information on location, equipped and actual irrigated area, causes for any discrepancy typology, technology, crops/production, environmental and health effects due to irrigation, estimated net water use by source and irrigation water requirement, irrigation beneficiaries disaggregated by



Examples: 2) Monitoring water accounting

Agricultural Water Accounting:

How much water is flowing into the system

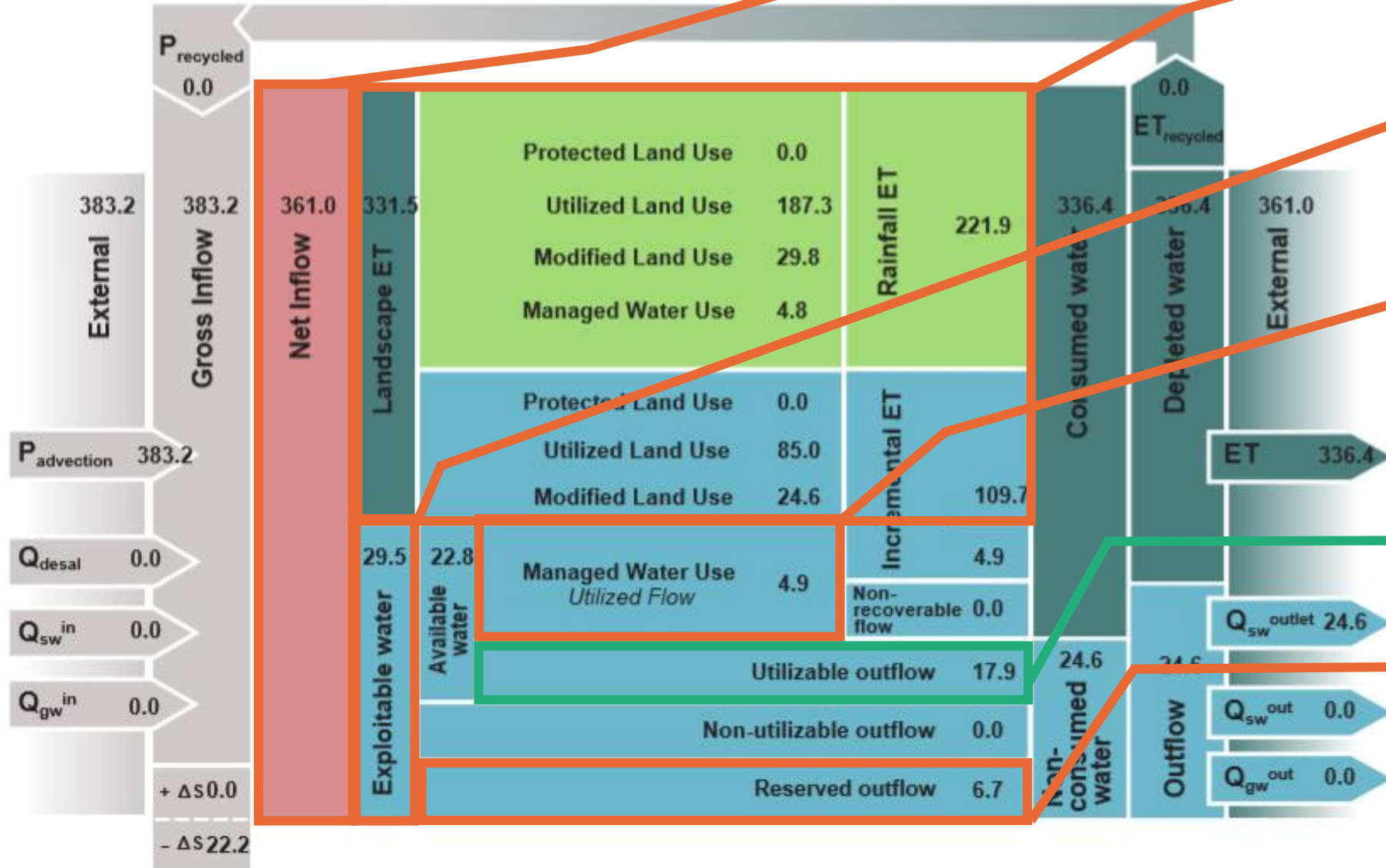
How much water is consumed through evapotranspiration

How much water is available to be exploited...

...of which, how much is already being utilized....

...and therefore, how much water is still available for allocation.

...and how much is reserved for downstream countries, environmental flows, etc. ...



External

Gross Inflow: 383.2

P_{recycled} : 0.0

$P_{\text{advection}}$: 383.2

Q_{desal} : 0.0

$Q_{\text{sw}}^{\text{in}}$: 0.0

$Q_{\text{gw}}^{\text{in}}$: 0.0

$+\Delta S$: 0.0

$-\Delta S$: 22.2

Examples: 3) Monitoring disaster risk

The case for value chain resilience

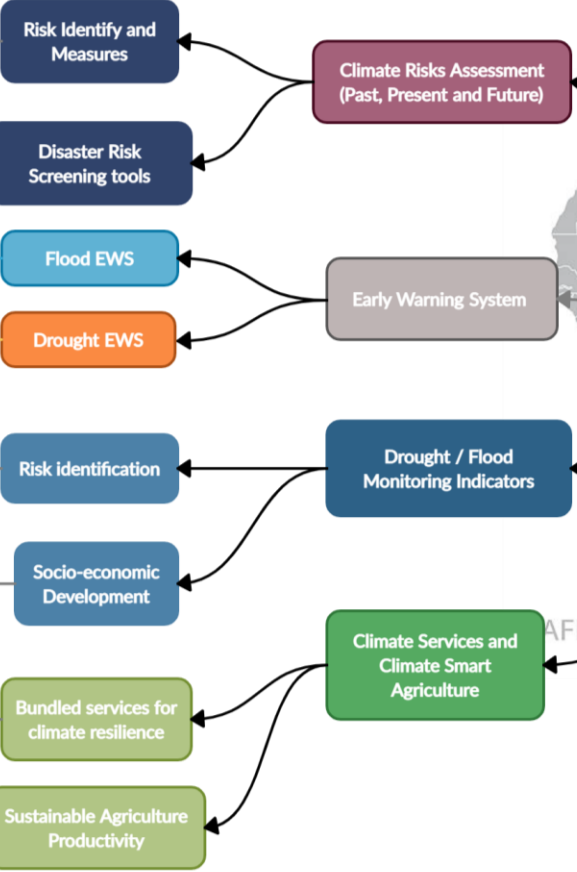
Resilience Applications

Policies & Governance
Climate & Sustainable finance
Basin toolkit
Vulnerability Analysis
Mapping
Sustainable GW Mng.
Green infrastructure

Land use planning
Infrastructure
Investment
Flood Insurance
Emergency Response

Drought hotspots
Drought proofing
Agriculture
Contingency plans
Watershed
Development
Drought Insurance

River basin planning
Disaster Risk Assessment
Resilient Water infrastructure
Drought proofing
Strategies with Water Accounting
Climate finance
Conflict and migration plans
Local development plans
Prioritize CSA investment and bundled solutions e.g. BICSA



Climate Change

Data, Algorithms and Models

Historical flood and drought records

Biophysical, Environmental and Socio-economic indicators

Hydrological model - Deltares
WFlow and FEWS

Model Calibration, Validation and Evaluation

Near real-time EO data access (Google and AWS)

Flood and Drought Indicators

Ready Analysis Data, Knowledge Products and Statistics

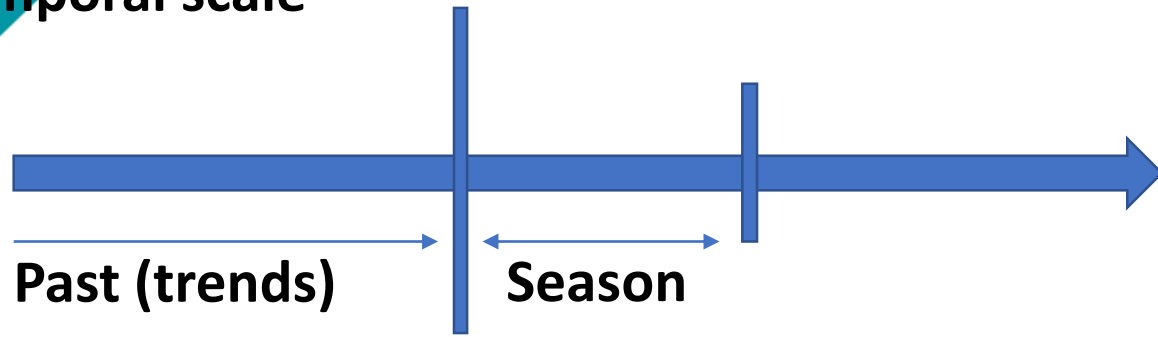
Data-Driven Decision Making, Visualization, Analytics

DIWASA Resilience Initiatives in advancing Climate Resilience Development to achieve SDG, NDCs, NAPA, SFDRR

Source: Amarnath et al. 2021

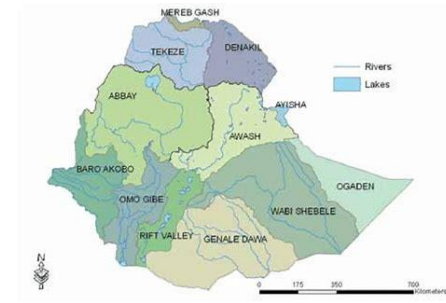
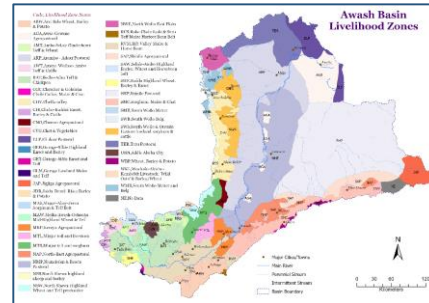
Key steps/actions are needed for scaling ...

Temporal scale



- Near real-time monitoring
- Seasonal prediction

Spatial scale



Farm/landscape

Catchment

Basin

National

Conclusion: key recommendations

1. Build the capability of relevant government agencies → move from research to operational application
2. Mainstream (embed) into workflows of relevant government agencies (MoA, MILL)
3. Leveraging government land consolidation programme to address challenge of spatial resolution
4. Awareness raising on the potential value addition of the EO based agricultural productivity
5. Expand private sector role: integrating agricultural water use and productivity in their advisory services
6. Learning landscapes/farms which serve as testing and validation grounds (through in-situ data collection). Integrate farmers as part of the R and D stakeholders.



International Water
Management Institute

Innovative water solutions for sustainable development

Food · Climate · Growth