Connecting large scale climate services to the local context? Look out of the window

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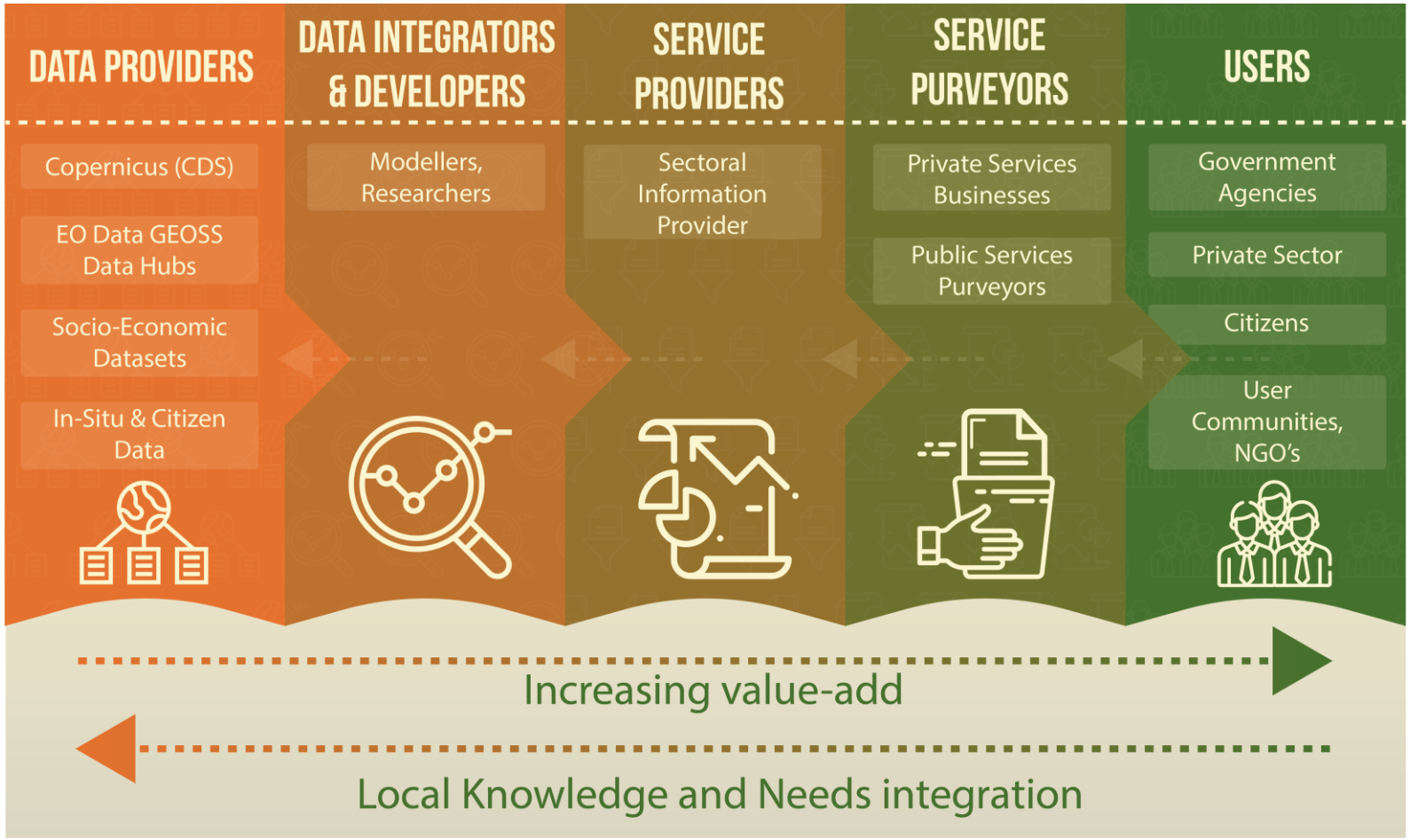
Windows

UK weather: Heavy rain and thunderstorms forecast this weekend – but with highs of 22C



Climate Services Value Chain

Value proposition – better decisions for:
Floods
Droughts
Heatwaves
Water Resources
Sectoral Information Provision

Do better forecasts and data in climate services lead to better decisions?

How can climate services best connect with local knowldge, user perceptions & needs?

At what space and time scales can connections be made? Local needs to global data sets?

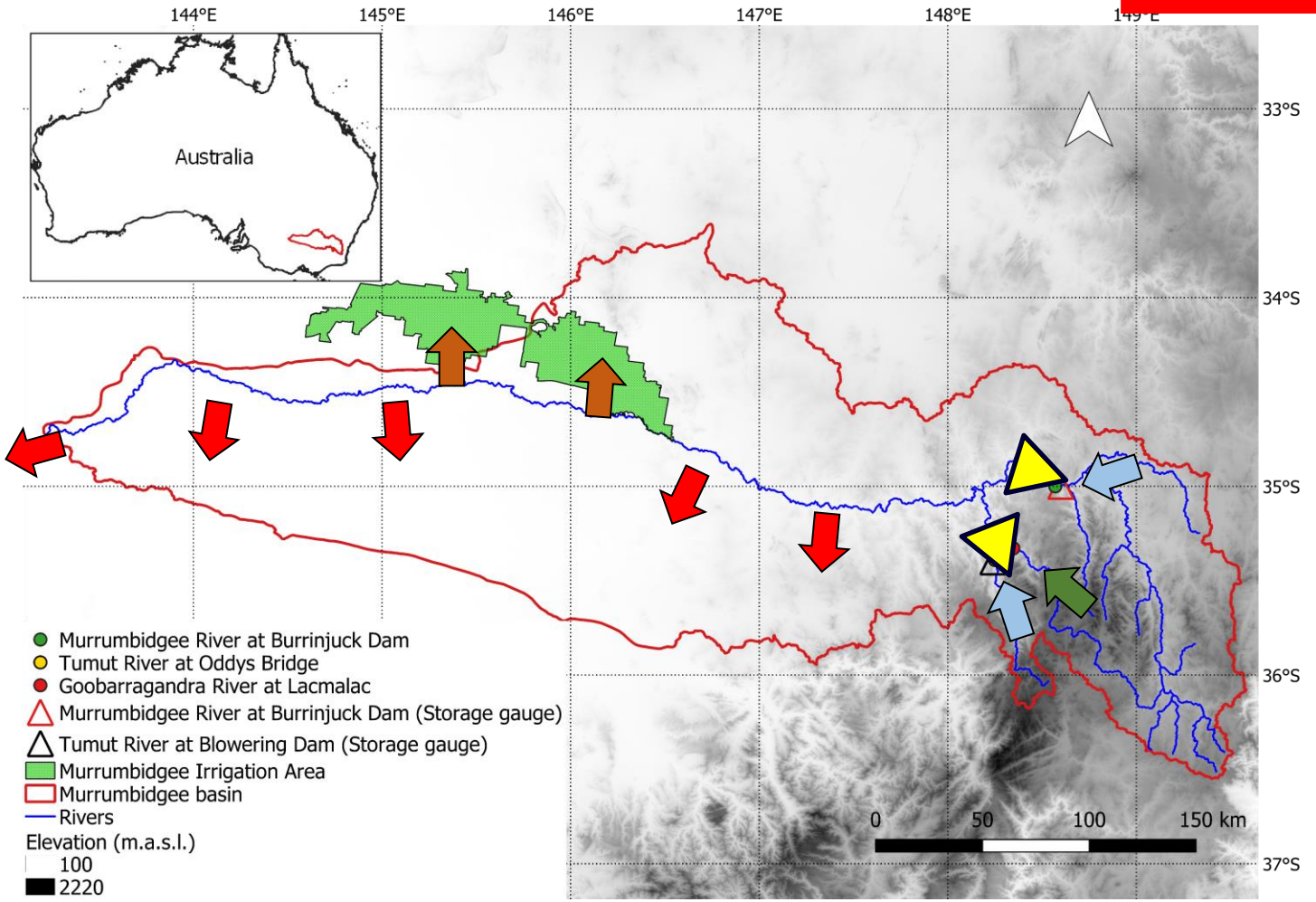
Water allocation for irrigation
Murrumbidgee Basin, Australia

Flash Flood Warning
Karonga District, Northern Malawi

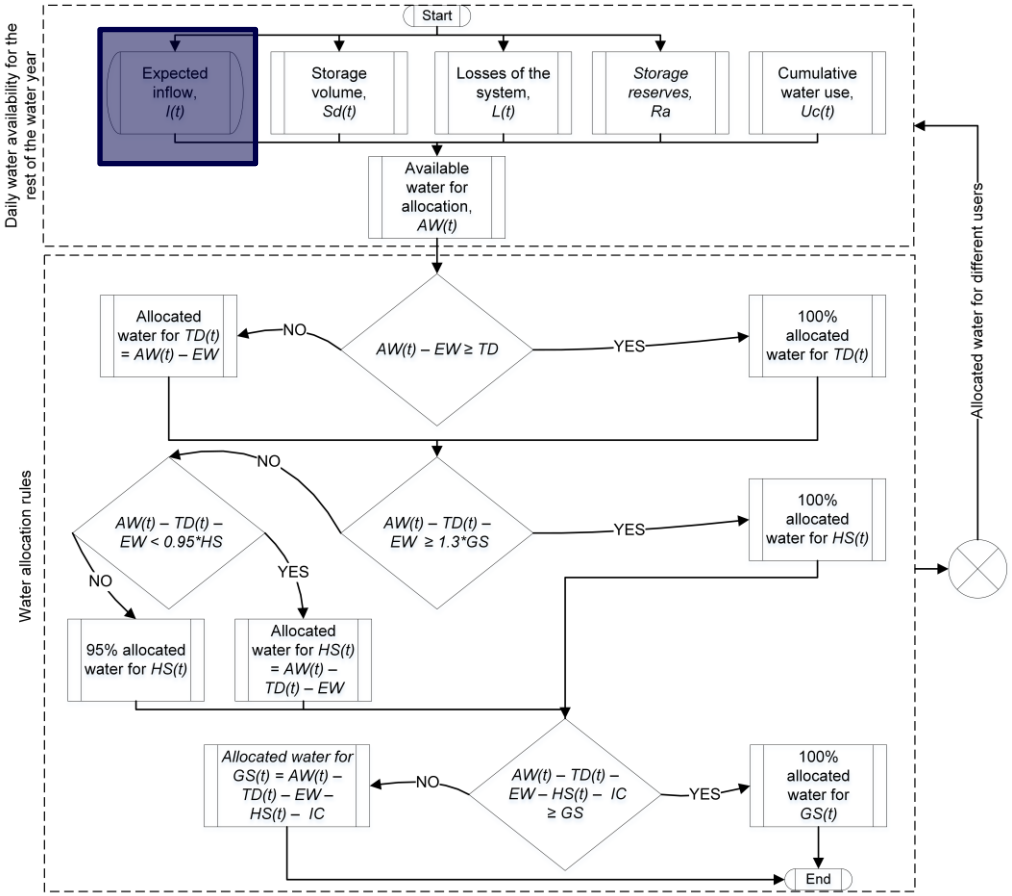
Rain-fed (Maize) Farming
Salima & Mangochi District,
Southern Malawi (*)

(*) Photo Tonderayi Mukeredzi/IRIN (https://www.thenewhumanitarian.org/);

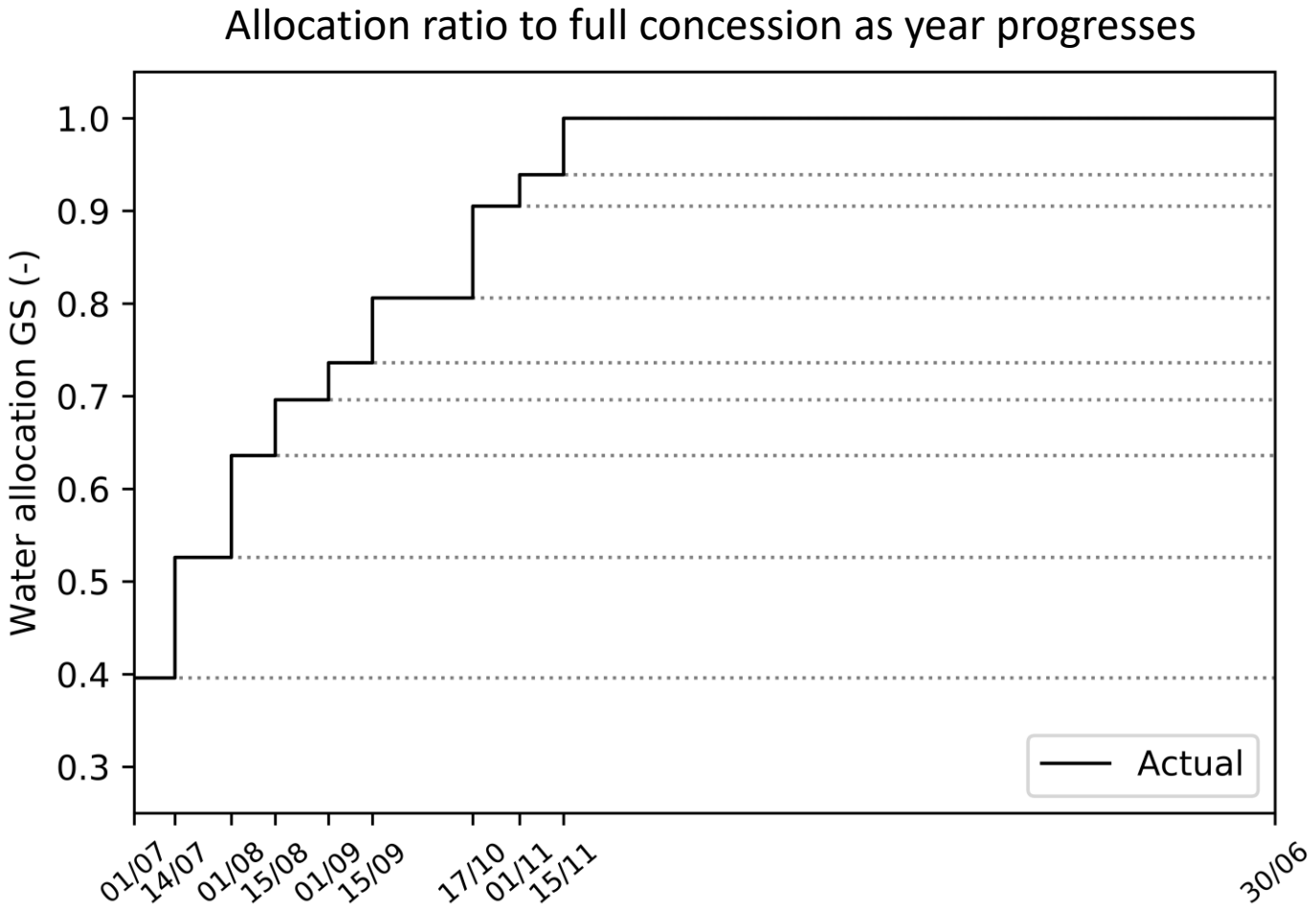
Available water for consumptive use = **Water available in the storages** + **Annual releases by Snowy Hydro Limited into Blowering Dam** + Seasonal forecast of natural inflows into storages - **Volume required to run the river (End of system flows, transmission and evaporation losses.), carryover, ENV need**



Water Allocation Policy (simplified)



Kaune et al., 2020



NSW Office of Water

What do they want to know?
Availability to end of Season

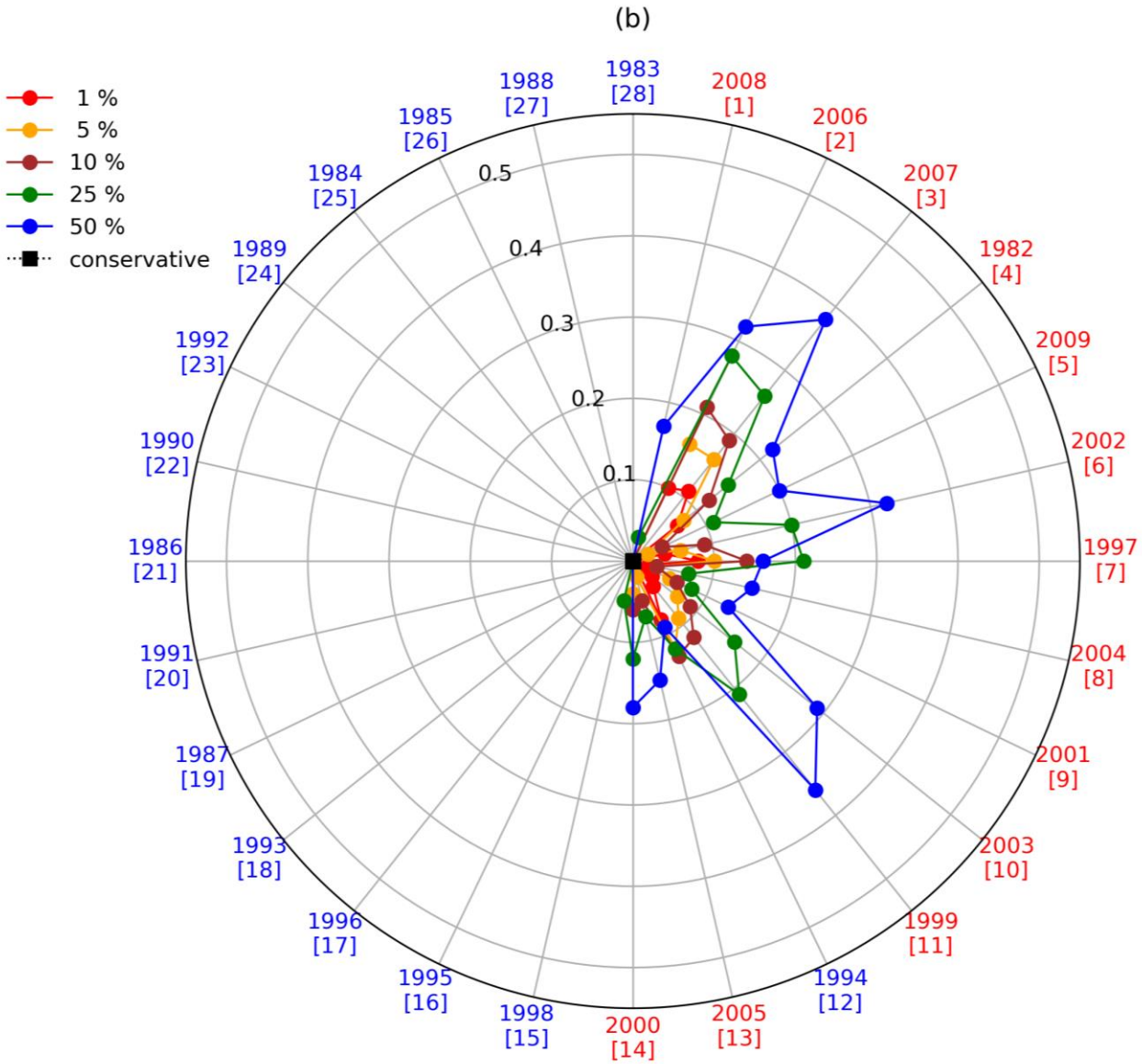
What are they worried about?
Downward revision of allocation due to less water than expected

General Security Farmers (Annual crops)

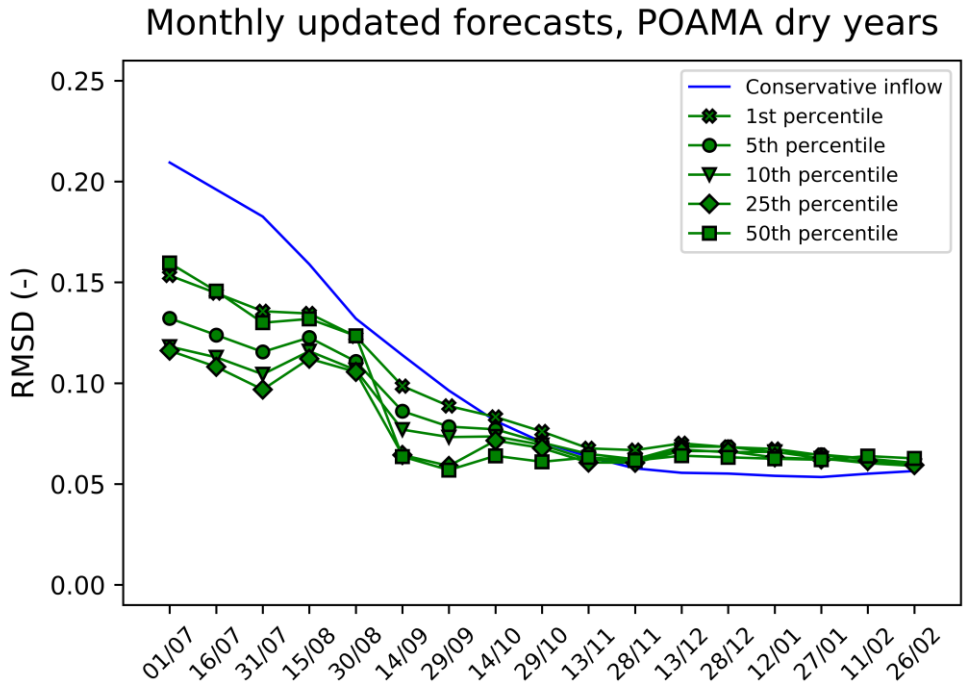
What do they want to know?
Water allocated to them as early as possible

What do they really not like?
Incosistent allocation, especially downward revision of allocation

Kaune et al., 2020



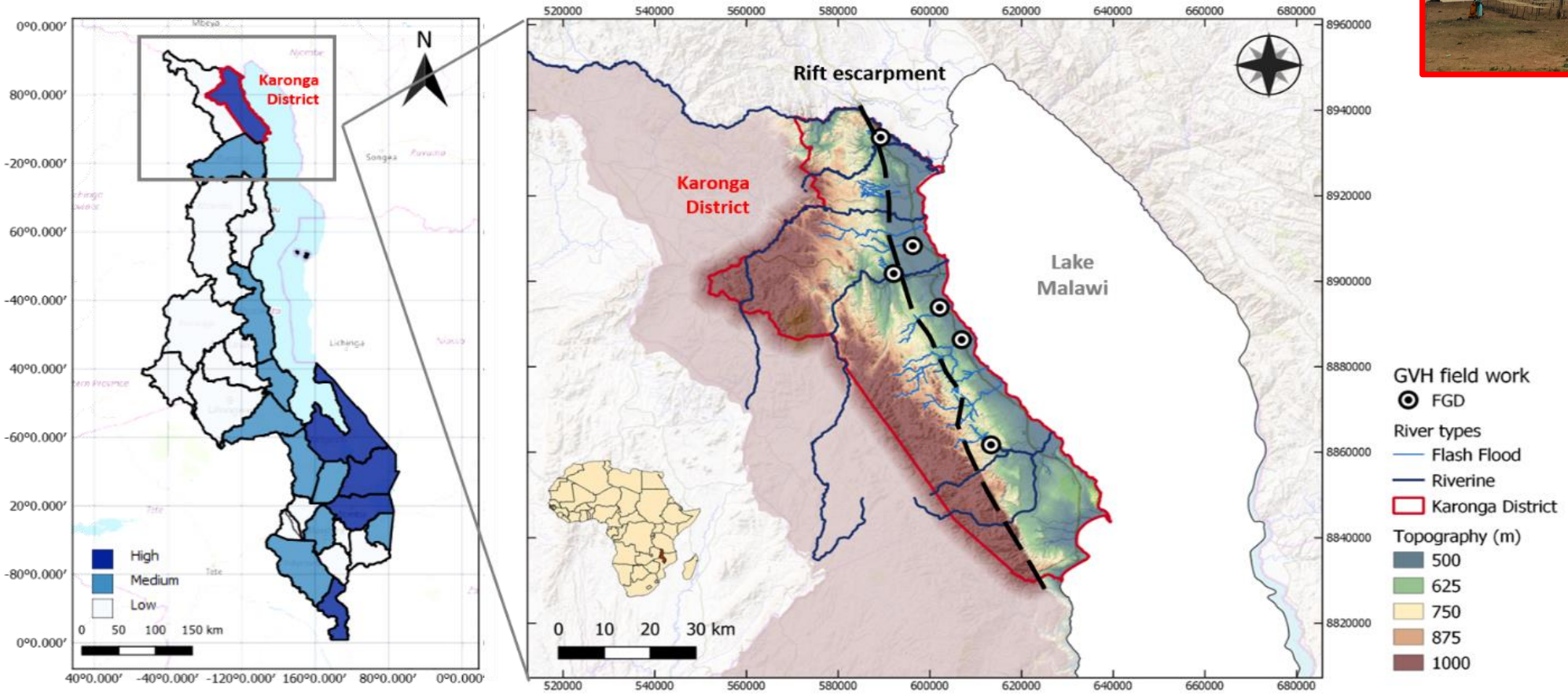
Inconsistency of allocation – downward revisions



What did we learn?

- Informing water availability with seasonal forecasts does lead to better (earlier) decision on allocation
- But… in dry years there may be downward revisions of allocation – is this politically acceptable?
- Trade-off of risk between water allocator and water user (farmer). Who carries what risk?
- Different perspective of looking at quality of seasonal forecast. Verification on volumetric forecast to end of season

Kaune et al., 2020



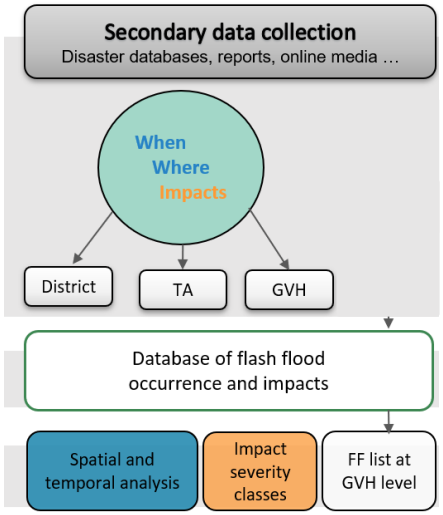
Frequency of occurrence of floods
DoDMA (ICA 2015)

Building common knowledge of flash flooding

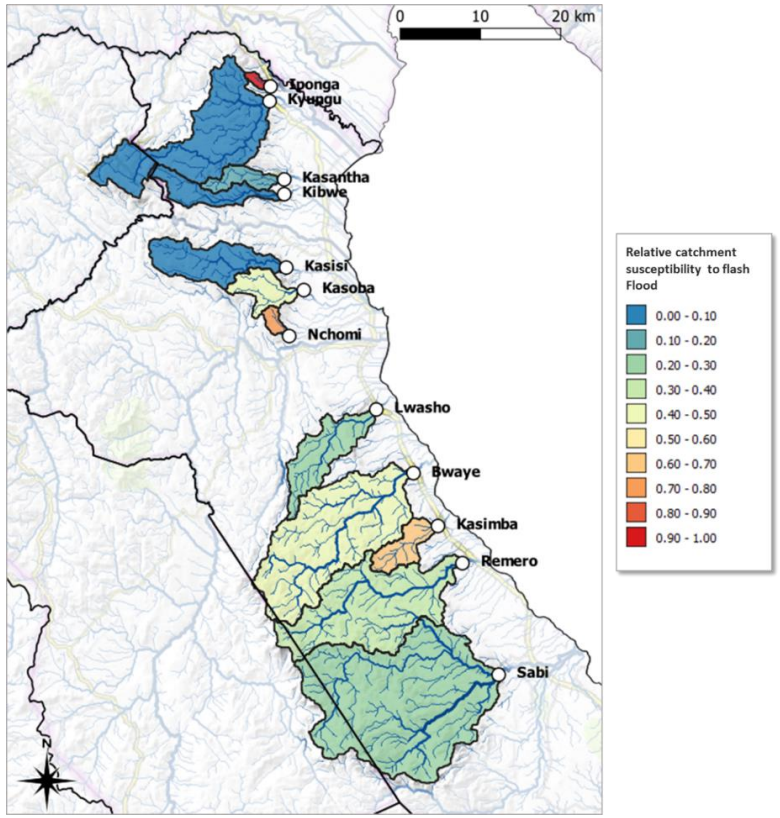
Transect walks

Focus Group Discussions

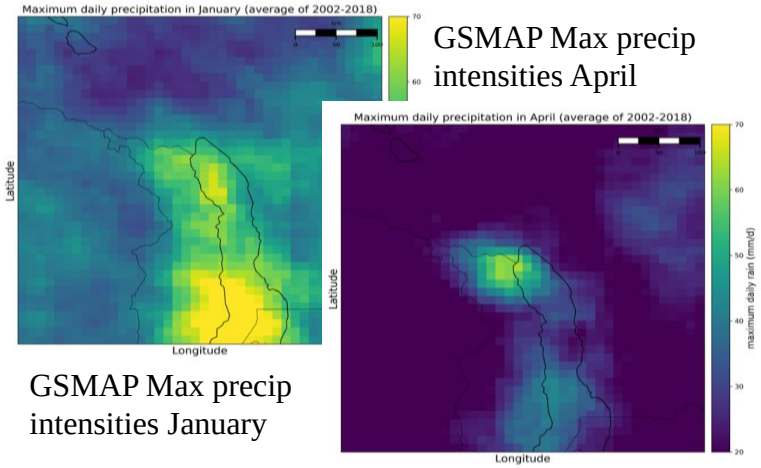
Community drawing



Mapping flash-flood susceptibility based on scientific data



Identifying hydro-meteorological conditions associated with flash flooding



GSMAP Max precip intensities April

GSMAP Max precip intensities January

ECMWF CDS

Wind Speed & Direction
Temperature & Humidity
Convective available potential energy
Soil Moisture

Bucherie et al, 2021

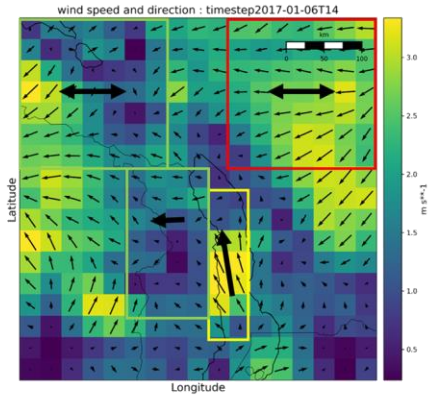
What the people were saying ⟺ What the data were saying

Hydro-meteorological Knowledge

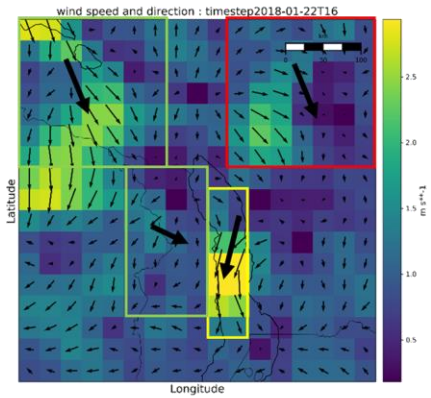
Precipitation	Short and intense precipitation events are indicated as the main trigger of flash floods for all communities.	The analysis of high resolution GSMaP precipitation during flash flood events confirms that daily maximum hourly rainfall rates are the most important indicator explaining historical flash flood events.
Temperature	An increase of temperature is experienced before flash flood events	Daily Temperatures from ERA5 do not reveal any specific increase before FF events. However, a rise in humidity is observed in ERA5 data before flash flood events, potentially linked to an increase in ambient temperature.
Soil Moisture	The higher soil water saturation in the flat plain along Lake Malawi in April is responsible for an increased flood duration.	ERA5 volumetric soil water data confirm higher values during the late wet season and in the North.
Wind	Change in wind direction and strength associated with flash flooding. Some communities reported strong winds from the lake as a precondition to flash floods.	ERA5 wind data reveals two different regimes at the beginning and at the end of the wet season, with higher instability during the early wet season potentially linked to LK observation.
Storms	Localised storms, with rotating black clouds and thunder are described as conditions associated with flash floods.	ERA5 CAPE and Relative Humidity are good indicators of the susceptibility of convective events developing. These show promising signals of FF potential during the early wet season.

January FF events

Pattern for FF affecting the North

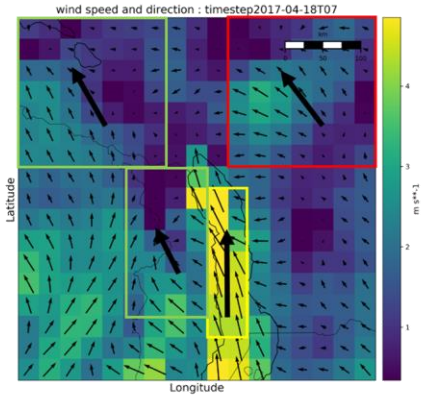


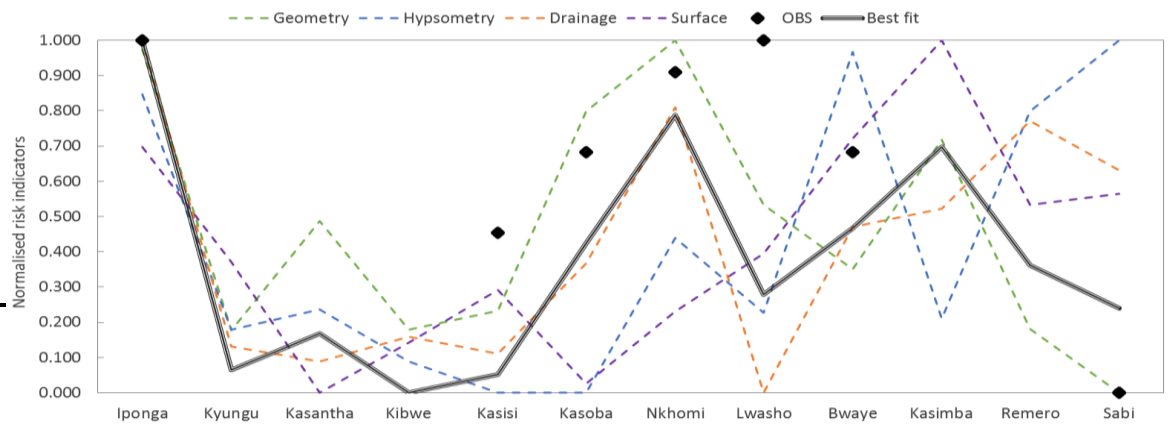
Pattern for FF affecting the South



April FF events

FF affecting the North only





Bucherie et al, 2021

Using common knowledge as a predictor of flash flooding

Common knowledge and catalogue of historical flash flood events

Most predictive Hydro-meteorological indicators

Time-series

Statistical extreme statistics

Rainfall indicators

- The maximum hourly rainfall during event
- Antecedent rainfall at the end of the wet season

Large scale antecedent meteorological indicators

RH, CAPE and Wind for the early wet season.

- 1 day RH
- 3 days CAPE
- Wind as a condition for spatial distribution of events

Predictive Skill at Catchment Level not great!
Better at District Level – still not the best! High FAR

Towards people-centred early warning

What did we learn?

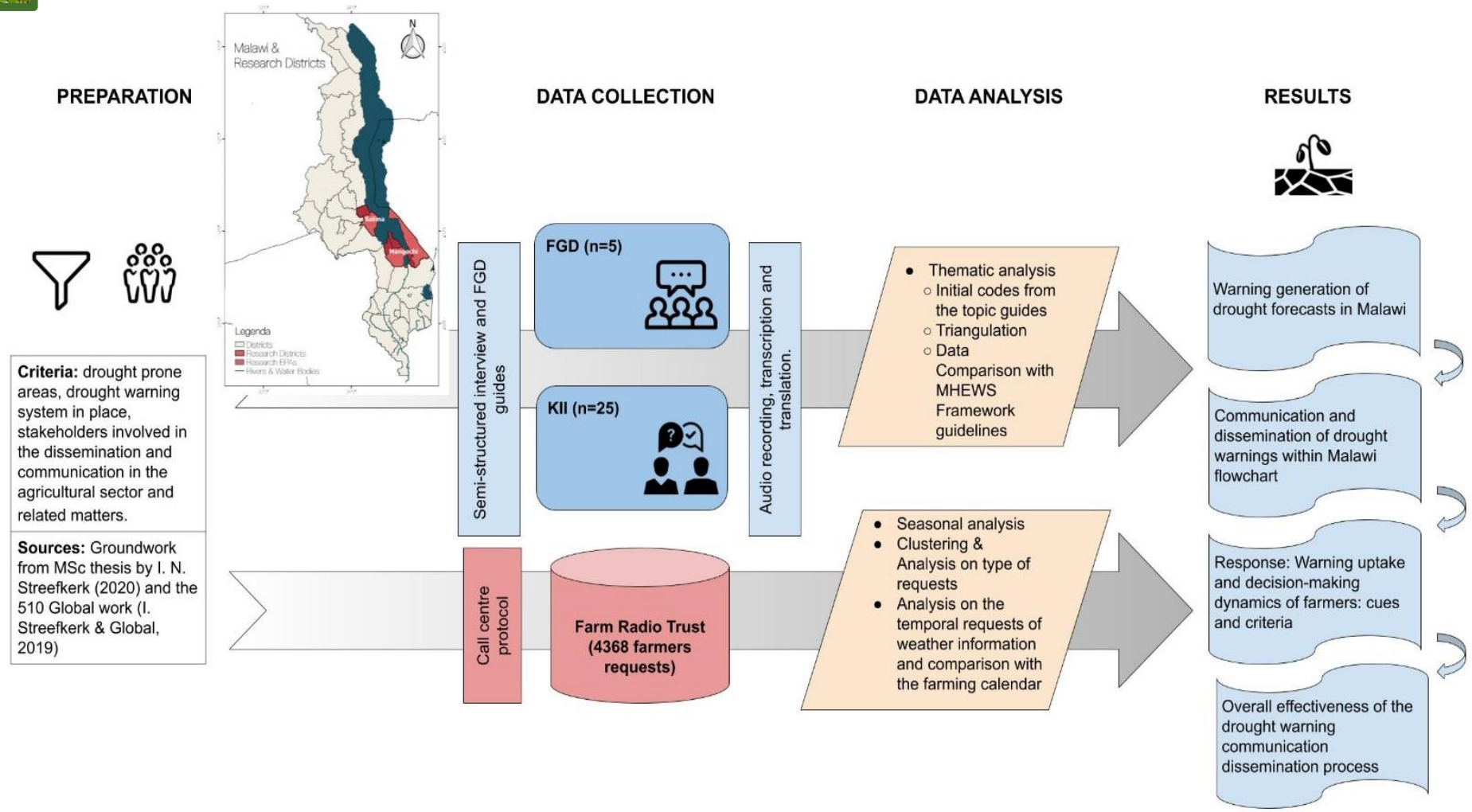
- Local people had a reasonably well developed understanding of where flash floods happen in the district, their impacts, and the signs that lead up to flash flood events
- Complementarity of local knowledge and scientific datasets – even with data from global models
- Still challenges in crossing the global-local scale divide – but approaching it from two ways may help

Where do we go from here?

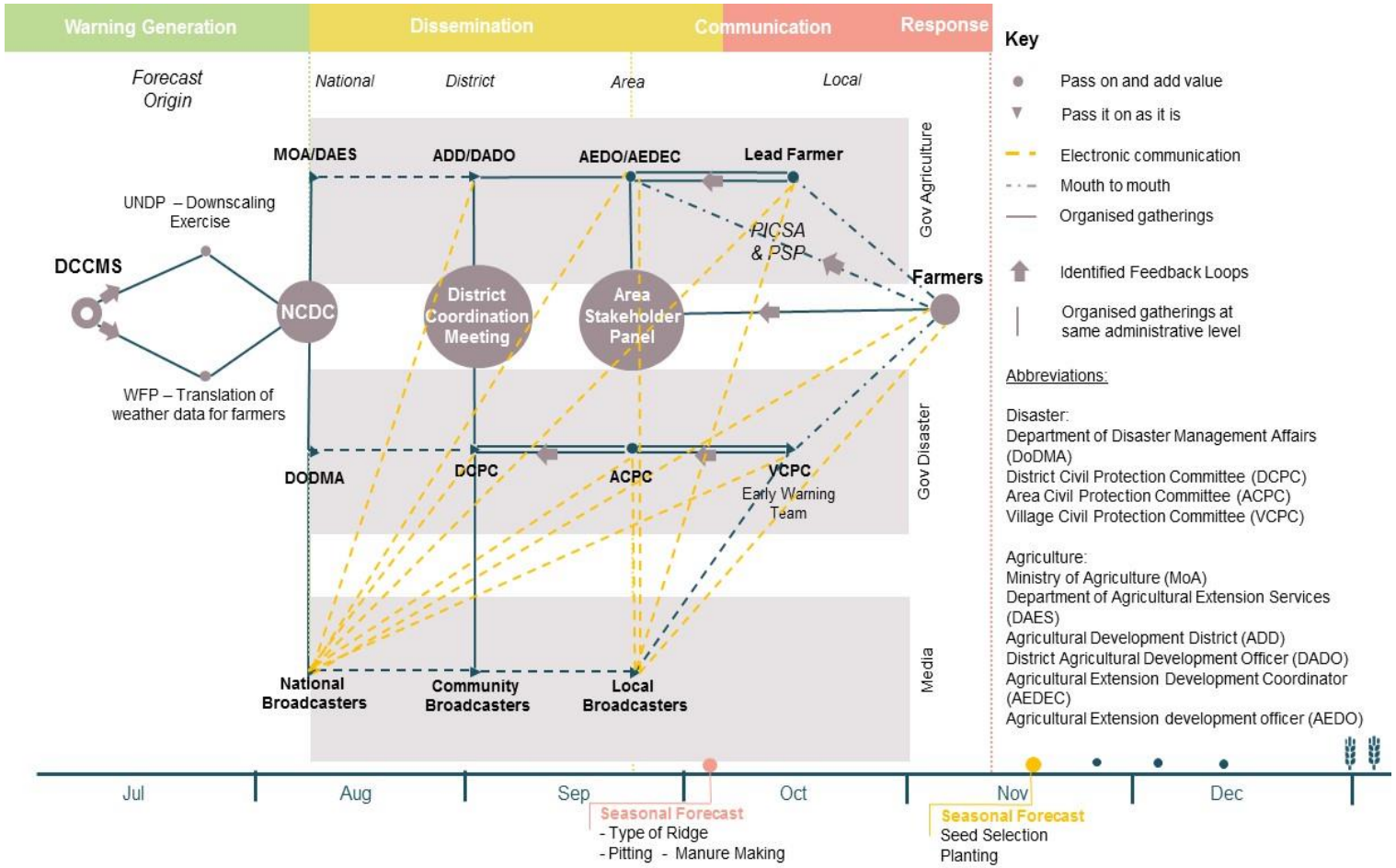
- People-centred warning: communication of science based warnings in the (visual) language people speak.
- Environmental cues an important motivator of action.

Bucherie et al, 2021

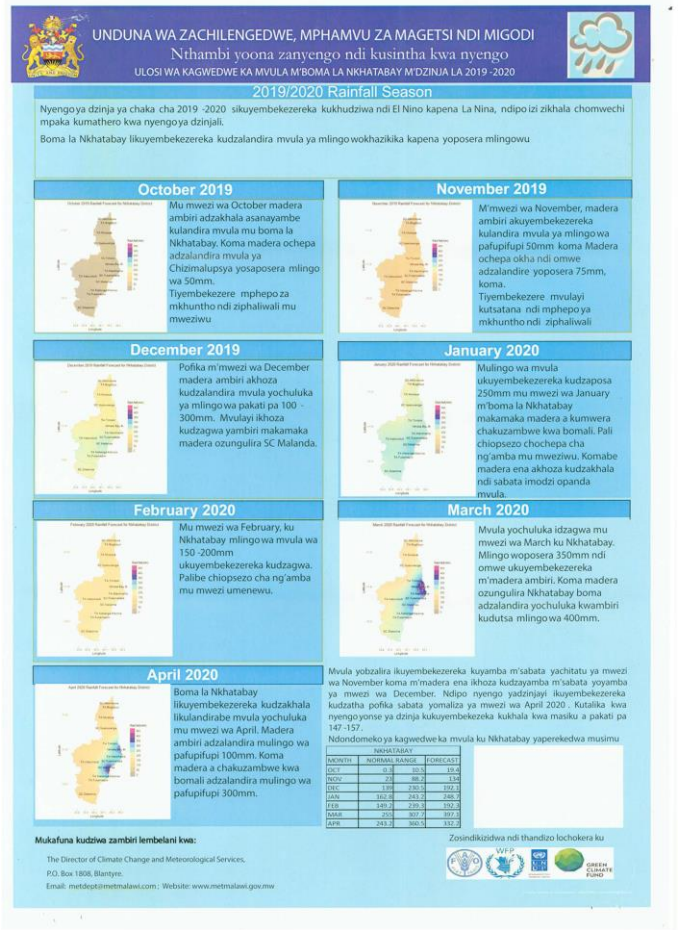
How are seasonal forecasts & drought warnings disseminated, communicated, and acted on? Who adds value? Is there feedback from local to regional to national level?



Source: Calvel et al., 2020



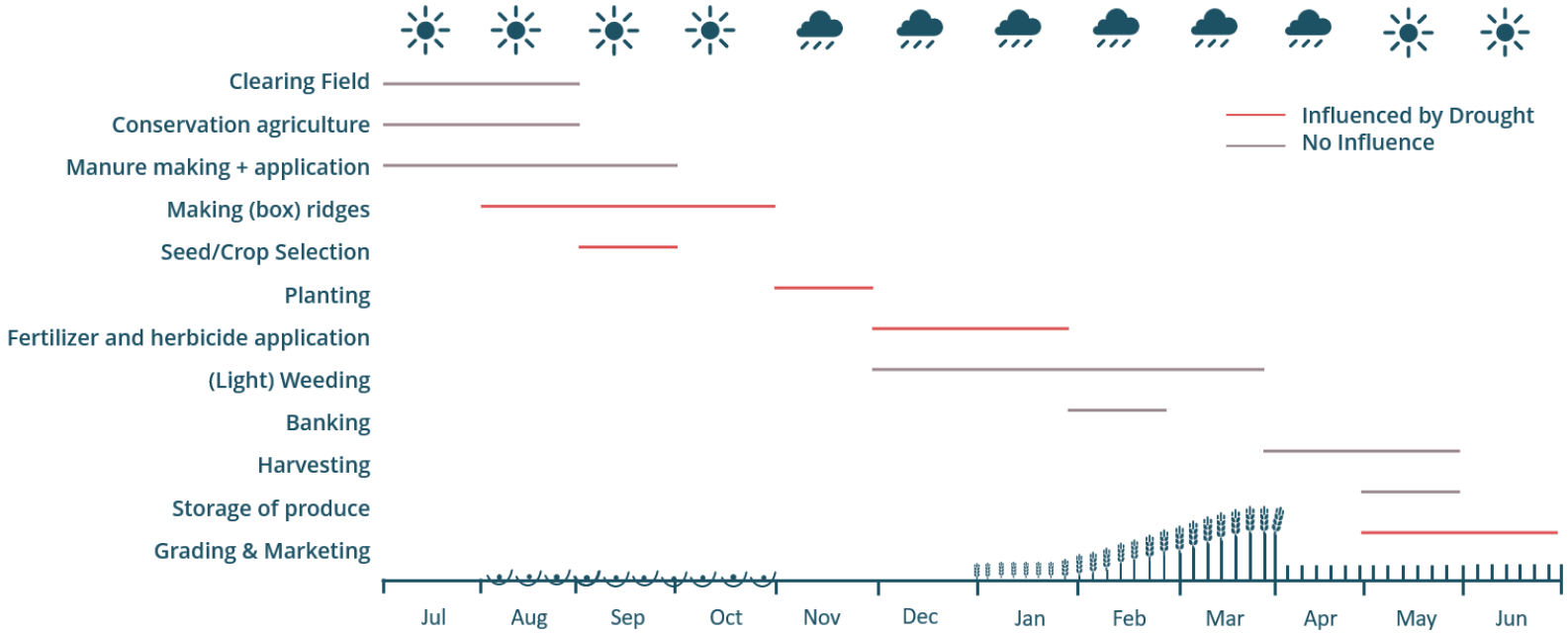
Flowchart representing the organisational set-up and the dissemination and communication processes in place for seasonal forecast and drought warnings (source: Calvel et al., 2020)



2018–2019 Seasonal forecast for Salima District (source: Calvel et al., 2020)

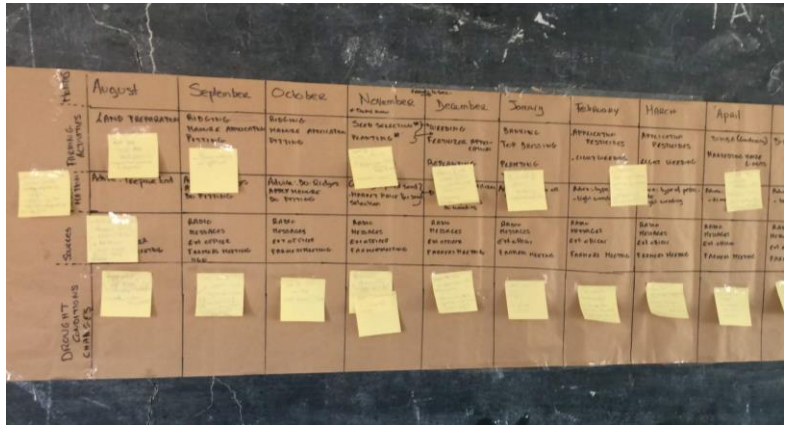
Calvel et al., 2020; Streefkerk et al., 2021; Mittal et al., 2020

Developing a seasonal calendar to understand agricultural practices



Agricultural Practices during the Season and the Influence of Drought (source: Streefkerk, 2021)

Developing seasonal calendar in a Focus Group Discussion Streefkerk, 2021)



Farming calendar built during focus group discussions with farmers (source: Calvel et al, 2020)

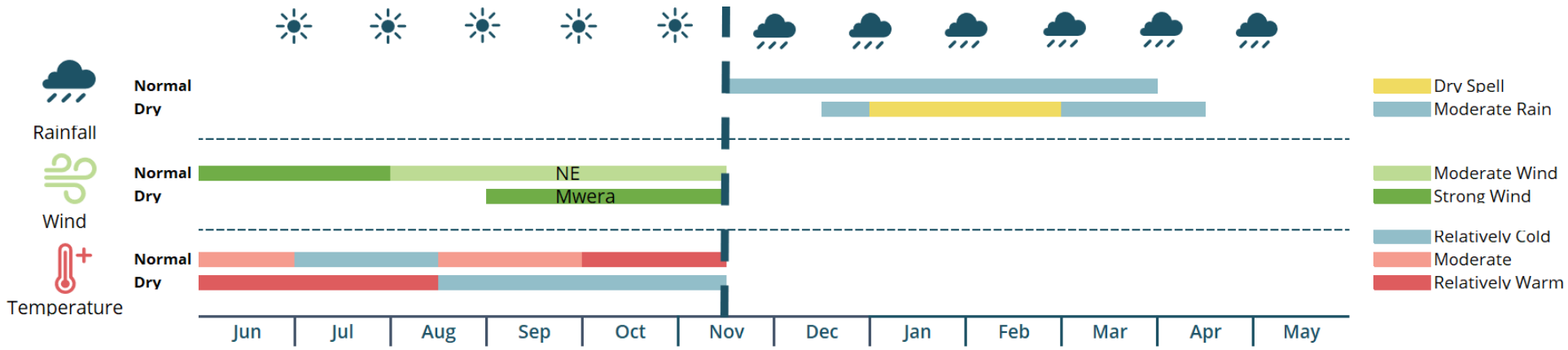
Calvel et al., 2020; Streefkerk et al., 2021; Mittal et al., 2020

FGD	What / When	Farming Activities	Criteria	Cues	Months
3	When	Land preparation	Dry conditions	Environmental cues: High heat (relative)	August
3	When			Environmental cues: Tree regeneration	August
3	When		After ceremonial activities	Traditional: Always in August	August
3	What	Ridging	Normal weather condition (normal ridging)	Advice: Seasonal forecast	September/ October
3	What	Ridging	Drought weather condition (box ridging)	Advice: Seasonal forecast	September/ October
3	When	Ridging	Dry conditions	Environmental cues: High heat (relative)	September/ October
3	When	Manure Making	Drought forecast	Advice: Seasonal forecast	October
3	When	Manure Application	Dry conditions	Environmental cues: Dust storm for signs of rainfall, High heat(relative) and Tree regeneration	October
3	When	Pitting	Drought forecast	Advice: Seasonal forecast	September/ October
3	When	Pitting	Dry conditions	Environmental cues: High heat (relative)	September/ October
3	What	Seed Selection	Drought forecast: Drought or Normal	Advice: Seasonal forecast	November/ December
3	What	Seed Selection	Best Quality (grading)	Advice and observations	November/ December
3	What	Seed Selection	Market prices	Advice	November/ December
3	When	Planting	Enough Rain (moist soil)	Environmental cues: High heat and Thunderstorms	November/ December
3	When	Weeding	Presence of weeds	Environmental cues: Bad weeds	December
3	What	Fertilizer app	What	Advice on what fertilizer to use	December
3	When	Fertilizer app	Soil moist and after planting	Environmental cues: Presence of moist	December
3	What	Replanting	Weather forecast	Advice on what to replant	December/ January
3	When	Replanting	Failure of seeds	Environmental cues	December/January
3	When	Replanting	Enough moisture content left	Advice on when to replant	December/January
3	When	Banking	After Planting and need for heavy rainfall	Advice on when to start banking (and how) & Environmental cues	January
3	When	Top dressing	Soil moist and after planting	Environmental cues and advice	January
3	When	Thinning	N/A	N/A	January
3	What	Application Pesticide	Type of pests	Advice on what to apply	February/March
3	When	Application Pesticide	Dry conditions	Environmental cues: No rainfall but need moist soil so during the dry spell 1-2 weeks	February/March
3	When	Light weeding	Presence of weeds	Environmental cues: After heavy rains	February/March
3	What	Dimba (gardening)	Weather forecast	Advice on what to plant for Dimba	April/May
3	When	Dimba (gardening)	Drought forecast	Advice on when to start Dimba	April/May
3	When	Harvesting	Dry conditions	Environmental cues: Dry and crops ready for harvesting	April
3	When/ To whom	Marketing (selling Products)	Market	Advice on when to start selling products, what they should keep for themselves and linking farmers with buyers	June/July

source: Calvel et al, 2020

Predictors – what meteorological observations (before the rainy season) do farmers make to predict dry conditions (during the rainy season) as part of their local knowledge to inform their decision-making?

Predictands – what weather conditions (during rainy season) do farmers perceive as dry to inform their decision-making?



Conditions before and in the rainy season during normal and dry conditions, according to farmers. NE = North Easterly winds. Mwera = strong South Easterly winds (Source: Streefkerk et al, 2021)

Findings Meteorological indicators informed by local knowledge and derived from global datasets show a better performance in forecasting locally relevant dry conditions in comparison to the currently used ENSO derived indices.

Relevant to contextualise information in communication of seasonal forecasts with farmers

Calvel et al., 2020; Streefkerk et al., 2021; Mittal et al., 2020

What did we learn?

Farmers seek, prepare, and respond to drought warning information mostly when it is provided as advice on agricultural practices, rather than as weather-related information.

Information provided found to be useful – but mainly where it relates to the criteria and environmental cues that farmers use to inform their decisions

Focusing on enhancing trust, improving information uptake and financial sustainability are key aspects & metrics for monitoring the effectiveness of early warning systems within the WMO MHEWS framework

Effective drought warning and seasonal forecasting/climate services requires in-depth understanding of the knowledge, perceptions and options available to recipients and what motivates them to act

Calvel et al., 2020; Streefkerk et al., 2021; Mittal et al., 2020

Connecting global to local modelling and forecasting

Going from information that is useful to information that is used requires in-depth understanding of knowledge, perceptions and options available to recipients and what motivates them to act

Acknowledge that decisions are made based on multiple knowledges – context and user specific

Connections can be made in two directions – from global to local but also from local to global

More work to do!

How do different scales in time and space, informed by local knowledge and (policy) needs influence how uncertainty is interpreted; bias correction strategies, and indicators we look at?

Can these connections harness the strength of community based warning systems by complementing the local knowledge and trust these embed and link to more scientific data at longer lead times?

Thank you

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References

Bucherie A, Werner, M, van den Homberg, M., Tembo, S. 2021. Flash Flood warning in context: combining local knowledge and large-scale hydro-meteorological patterns, Preprint nhess-2021-107, https://doi.org/10.5194/nhess-2021-107

Calvel A, Werner M, van den Homberg M, Cabrera Flamini A, Streefkerk I, Mittal N. Whitfield S. Langton Vanya C. Boyce C. 2020. Communication Structures and Decision Making Cues and Criteria to Support Effective Drought Warning in Central Malawi. Front. Clim. 2:578327. doi: 10.3389/fclim.2020.578327

Kaune A, Choudhury F, Werner, M, Bennett J. 2019. The benefit of using an ensemble of seasonal streamflow forecasts in water allocation decisions, *Hydrol. Earth Syst. Sci., 24, 3851–3870, 2020 https://doi.org/10.5194/hess-24-3851-2020*

Mittal, N, Pope, E, Whitfield, S. Bacon, J., Bruno Soares, M., Dougill, AJ, van den Homberg, M, Walker D. Langton Vanya, C. Tibu, A., Boyce C. 2020., Co-designing Indices for Tailored Seasonal Climate Forecasts in Malawi. Front. Clim., 13 January 2021 | https://doi.org/10.3389/fclim.2020.578553

Streefkerk, I., van den Homberg. M., Whitfield, S., Mittal, N., Pope, E., Werner, M., Winsemius, H., Comes, T., Ersten, M. 2021. Contextualising seasonal climate forecasts by integrating local knowledge on drought in Malawi. Submitted to *Climate Services*

New H2020 Project: I-CISK Innovating Climate Services through integration of Scientific and Local Knowldge; starting Nov 2021