Forecast-based Financing for Food Security Interventions in Africa

Case Studies in Djibouti, Ethiopia, Lesotho, Madagascar and Niger

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Forecast based Financing Collaboration

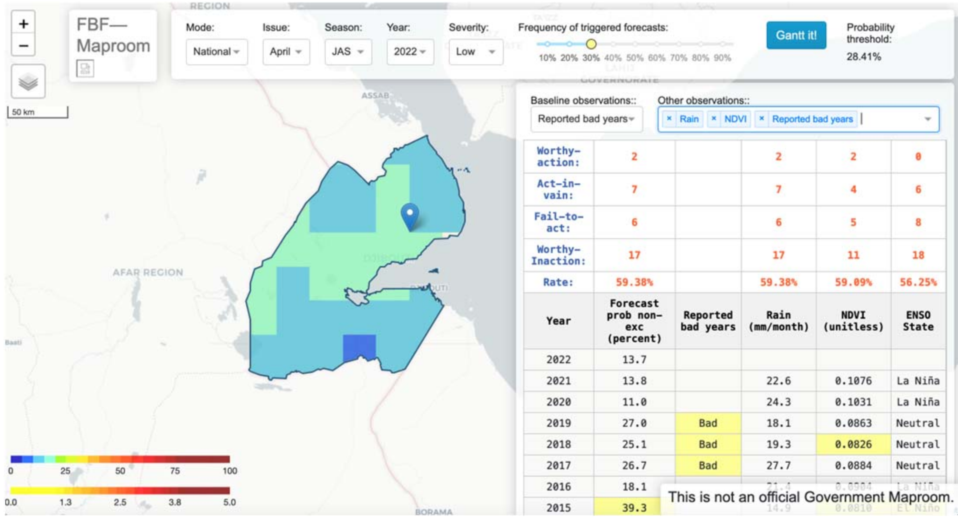
- Collaboration between IRI, WFP, UN OCHA and meteorological services in Djibouti, Ethiopia, Lesotho, Madagascar and Niger, as well as regional climate centers in East, West and Southern Africa
- Purpose: to develop a forecast-based approach to the deployment of humanitarian aid in vulnerable food-insecure regions
- Economies with large populations subsisting on rainfed agriculture=> food insecurity is especially connected to droughts
- Seasonal forecast distribution enables the calculation of the probability of rainfall below a chosen threshold for humanitarian interventions
- Tool facilitates intercomparison between forecast, El Nino state, observations and survey based assessment of bad impact years
- Future work may involve other vulnerability metrics (IPC)
- Trade off between forecast skill and timing
- The World Food Programme has been involved in Forecast Based Financing and agricultural index insurance in a variety of contexts through initiatives like WFP R4 https://www.wfp.org/r4-rural-resilience-initiative and FbF for Anticipatory Action https://www.wfp.org/publications/forecast-based-financing-fbf-anticipatory-actions-food-security-2019.

Food aid from WFP/PAM

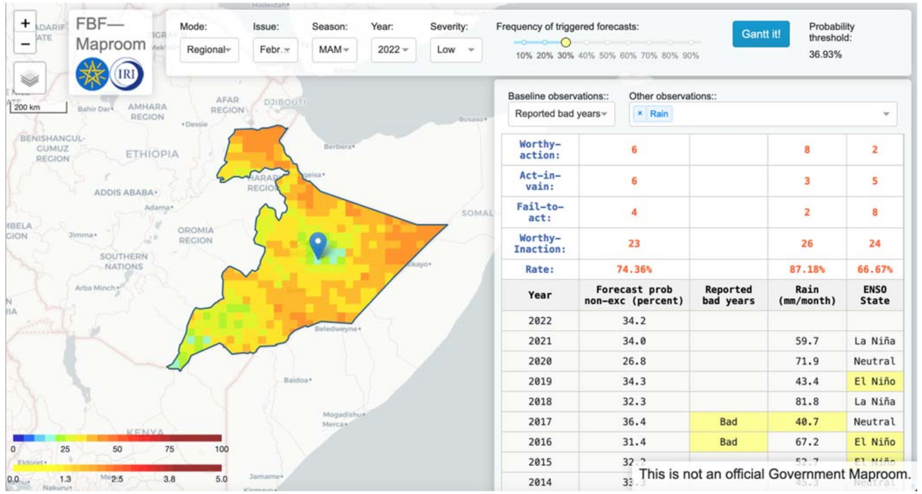
FbF Tool/Interface

- [Wikipage https://wiki.iri.columbia.edu/index.php?n=FbF.FbF](https://wiki.iri.columbia.edu/index.php?n=FbF.FbF)
- [Djibouti http://iridl.ldeo.columbia.edu/fbfmaproom2/djibouti](http://iridl.ldeo.columbia.edu/fbfmaproom2/djibouti)
- [Ethiopia http://iridl.ldeo.columbia.edu/fbfmaproom2/ethiopia](http://iridl.ldeo.columbia.edu/fbfmaproom2/ethiopia)
- [Lesotho http://devi.iri.columbia.edu:8059/fbfmaproom/lesotho](http://devi.iri.columbia.edu:8059/fbfmaproom/lesotho)
- [Madagascar http://iridl.ldeo.columbia.edu/fbfmaproom2/madagascar](http://iridl.ldeo.columbia.edu/fbfmaproom2/madagascar)
- [Niger http://iridl.ldeo.columbia.edu/fbfmaproom2/niger](http://iridl.ldeo.columbia.edu/fbfmaproom2/niger)
- Enables user to see farmer reported bad years, rain rank, ENSO state and forecast probability with respect to user selected thresholds
- Slidable thresholds enable users to make more targeted decisions
- Value plotted in forecast column is the forecast probability of non-exceedance
- For a 35% trigger, the forecasts that have the empirically 35% highest chance of drought are the ones that trigger
- Probability threshold (upper right) always a bit larger than selection threshold
- Impact analysis for bad years based on farmer and pastoral reports/surveys of bad outcomes (number of villages in food deficit and severity of shortfall)
- Gantt charts for specific actions

Djibouti

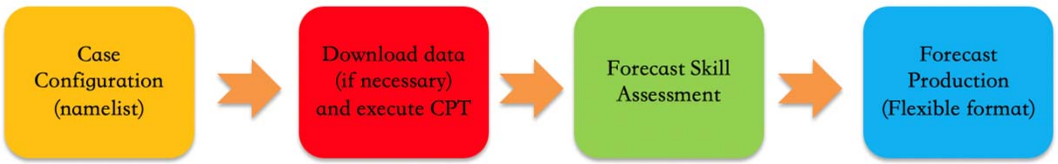


Ethiopia



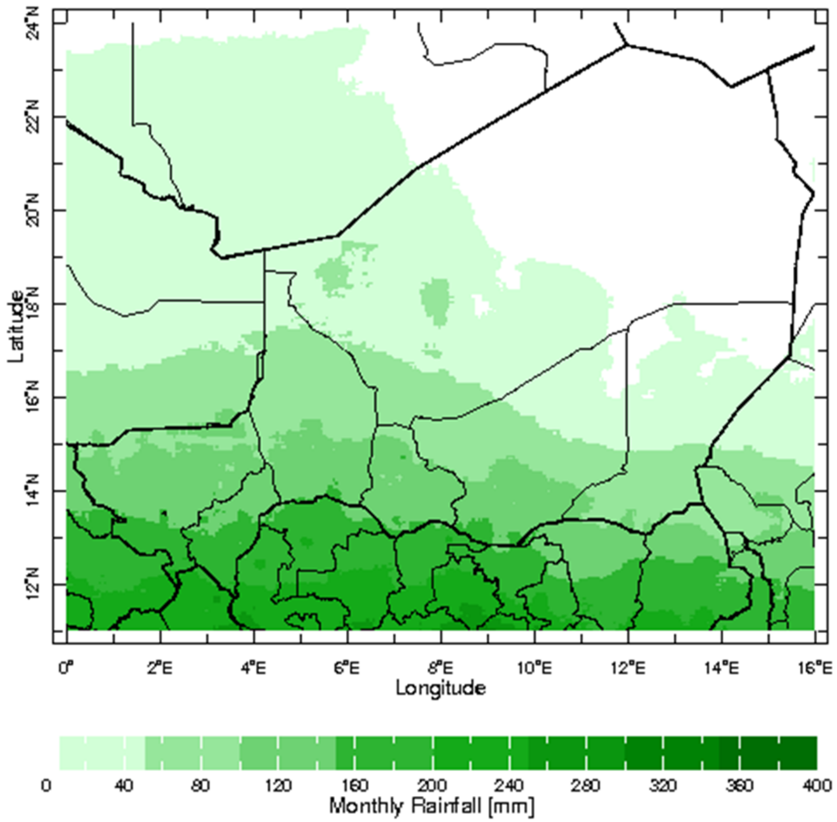
NextGen

- Our NextGen system (https://wiki.iri.columbia.edu/index.php?n=Climate.NextGen) is a systematic approach for creating, calibrating, and verifying multi-model climate forecasts
- Climate Predictability Tool (CPT) (https://iri.columbia.edu/our-expertise/climate/tools/cpt/) is the basis for our forecasting and uses Multiple Linear Regression (MLR), Principal Component Regression (PCR), Canonical Correlation Analysis (CCA) and/or Extended Logistic Regression (ELR) to make forecasts
- The Python based PyCPT interface makes performing large CPT tasks and making multi-model ensemble forecasts more efficient
- Case configuration
- Download from the IRI Data Library (IRIDL) http://iridl.ldeo.columbia.edu/
- Execute CPT analysis
- Evaluate forecast skill
- Calibration and ensemble for NextGen
- Forecast production



Observational data: CHIRPS and ENACTS

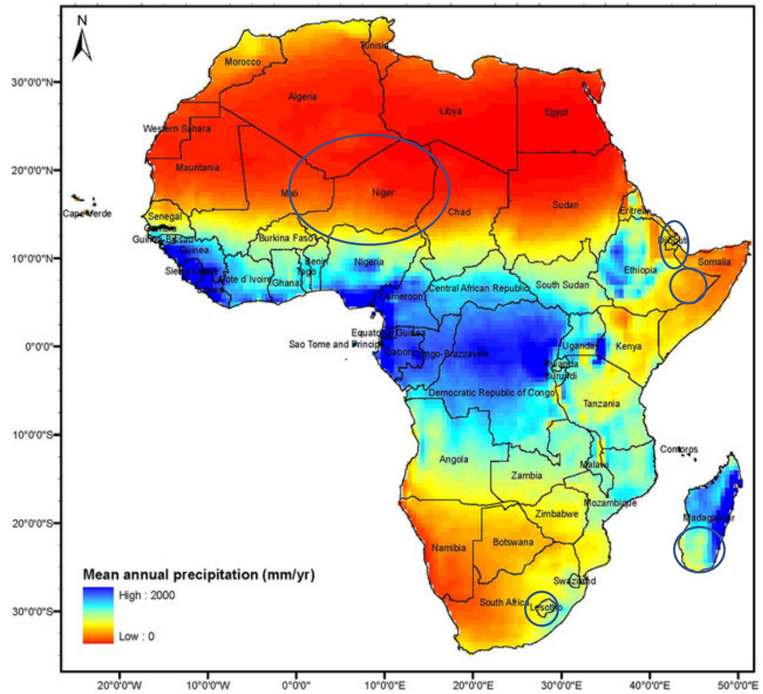
- For all components of this project, we are using merged satellite/station rainfall datasets at high resolution (0.05 degrees or finer)
- UCSB Climate Hazards Group InfraRed Precipitation estimate with Stations (CHIRPS) data
- IRI Enhancing NAtional ClimaTe Services (ENACTS) project (precipitation and temperature)
- ENACTS data include more meteorological stations than CHIRPS, is based on collaboration between IRI and NMS and is owned by the NMS (not public)
- CHIRPS has fewer stations, is not a collaborative arrangement, but is public
- https://iri.columbia.edu/resources/enacts/



JAS ENACTS 91-20 rainfall climatology, Niger

Seasonality and Predictability

- Djibouti
  - •Semi-arid to arid country in Horn of Africa with single rainfall season peaking in JAS
  - •Some ENSO and Indian Ocean Dipole influence (generally El Ninos and positive IOD tend to favor suppressed rains)
  - •Some risk of tropical cyclones from Gulf of Aden
  - •Some decadal variability (drier 1980s)
- Ethiopia
  - •Focus on Somali region – arid lowland region in Southeast with bimodal rains in MAM and OND
  - •Some ENSO and Indian Ocean Dipole influence (generally El Ninos and positive IOD tend to favor enhanced rains)
  - •Some risk of tropical cyclones from Gulf of Aden
- Lesotho
  - •Small country entirely encircled by South Africa in Drakensburg mountains – with single long rainy season ONDJFM
  - •Some ENSO and Indian Ocean Dipole influence (generally El Ninos and positive IOD tend to favor suppressed rains)
- Madagascar
  - •Island country off of Africa's SE coast – with single long rainy season ONDJFM.
  - •Focus on southern regions (Anosy, Androy, Atimo Andrefana and Atsimo Atsinanana) that tend to be drier than the rest of the country.
  - •Some ENSO and Indian Ocean Dipole influence (generally El Ninos and positive IOD tend to favor suppressed rains)
- Niger
  - •Country in central Sahel region with strong north-south rainfall gradient and single rainfall season in JJASO
  - •ENSO and Atlantic Ocean influence (both Pacific and Atlantic El Ninos tend to be associated with suppressed rainfall)
  - •Strong decadal variability – much drier in the 1980s than in the more recent times
  - •Strength of the monsoon modulated by Sahara heat low easterly waves and tropical jet stream

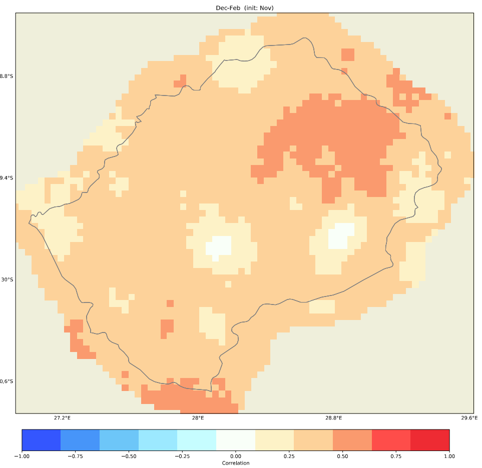


Based on ERAI rainfall data, from
Masih, Maskey, Mussa and Trambauer, 2014. A Review of Droughts on the African Continent: A Geospatial and Long-Term Perspective, Hydrology and Earth System Sciences, 18, 3635-3649.

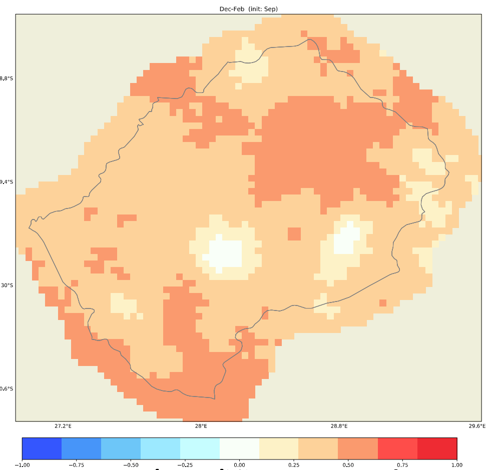
Forecast Skill at different lead times

- Available skill scores: Pearson, Spearman, RPSS, GROC, 2AFC, Ignorance, RocAbove and RocBelow
- Statistics are calculated for each model and for NextGen
- Spearman correlation shown here (red colors imply higher skill)
- Often, skill is best at short lead times
- However, this is not always the case when looking at gridded skill metrics
- In the maptool, skill is evaluated by percentage correct for triggering and non-triggering events
- sometimes a longer lead time forecast produces better matching with empirical farmer reported bad years (comparison on the right side is from the Niger page)

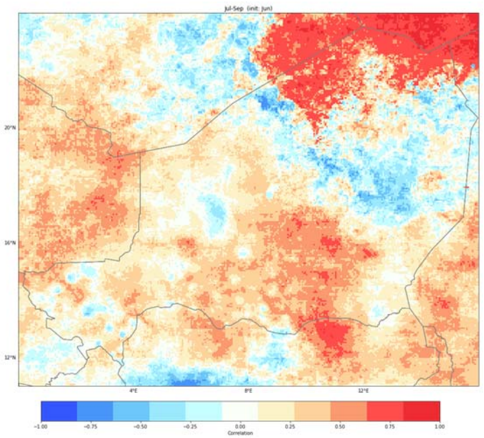
Lesotho (DJF) Nov. initial.



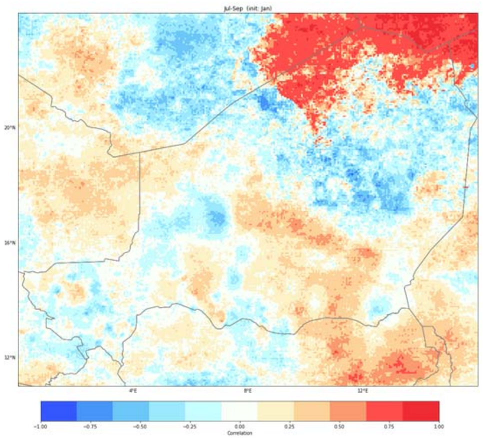
Lesotho (DJF) Sep. initial.



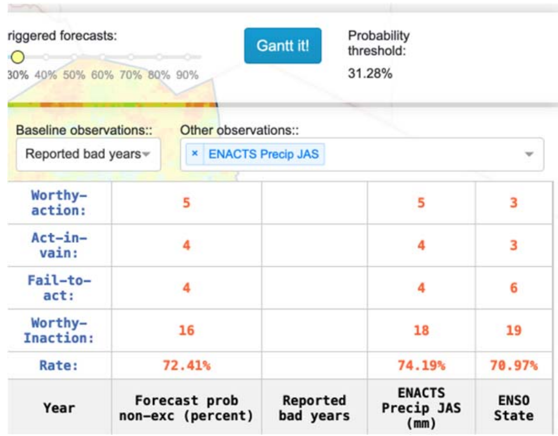
Niger (JAS) June initial.



Niger (JAS) Jan initial.

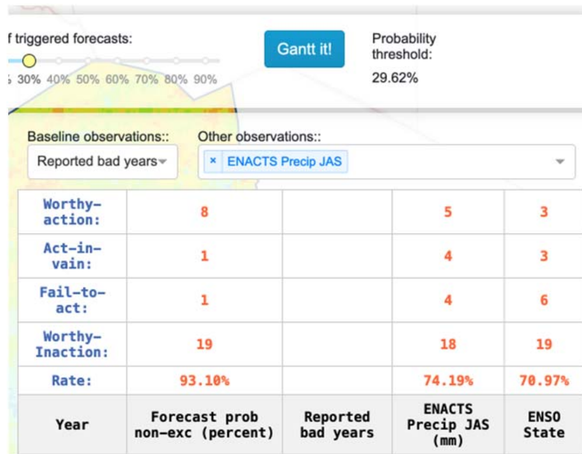


May initialization



Year	Forecast prob non-exc (percent)	Reported bad years	ENACTS Precip JAS (mm)	ENSO State
Worthy-action:	5		5	3
Act-in-vain:	4		4	3
Fail-to-act:	4		4	6
Worthy-Inaction:	16		18	19
Rate:	72.41%		74.19%	70.97%

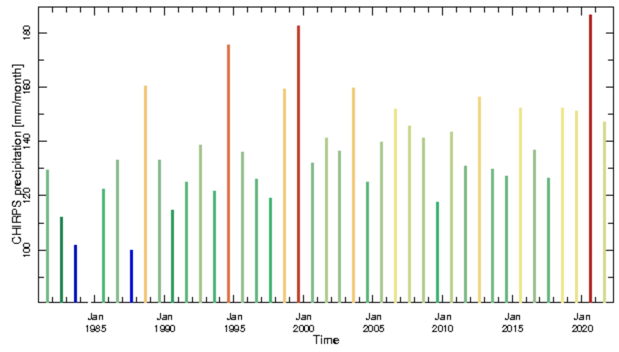
February initialization



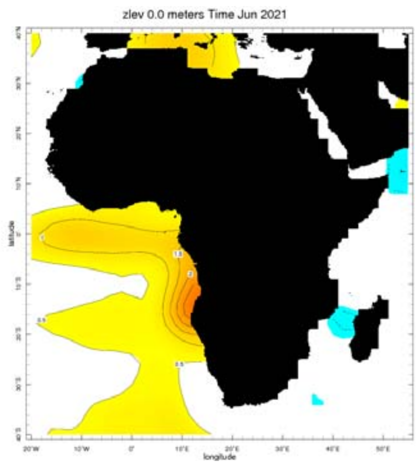
Year	Forecast prob non-exc (percent)	Reported bad years	ENACTS Precip JAS (mm)	ENSO State
Worthy-action:	8		5	3
Act-in-vain:	1		4	3
Fail-to-act:	1		4	6
Worthy-Inaction:	19		18	19
Rate:	93.10%		74.19%	70.97%

Case Study of Niger in 2021

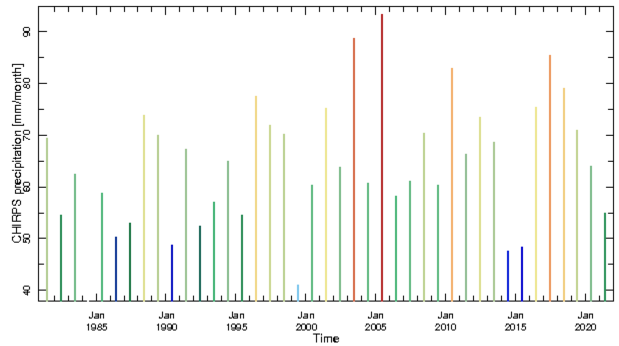
- This project started last year and the forecast for rainfall over Niger was generally normal to above normal for the JAS season
- The rainfall during JAS was measured from gridded-remotely sensed data was normal or above normal
- June rainfall (from gridded sources) was quite low
- Station-based rainfall by DMN showed below average rainfall for 2021 and a shorter season than normal (both delayed onset and early termination)
- "Atlantic Nino" that developed over the Gulf of Guinea in June 2021 may have suppressed early season rains
- Widespread food security impacts throughout the country in 2021 (over 5 million people affected out of 24 million total population)
- Ongoing and forthcoming work focused on making sure that 2021 would have "triggered"
- Future work to apply a dry mask to northern Niger, because very few stations north of 15 N
- Potential responses: quick response to monitoring June-July rainfall
- more collaborative work to define best rainfall source data and other monitoring variables



JAS rainfall south of 15N



June 2021 SST anomaly

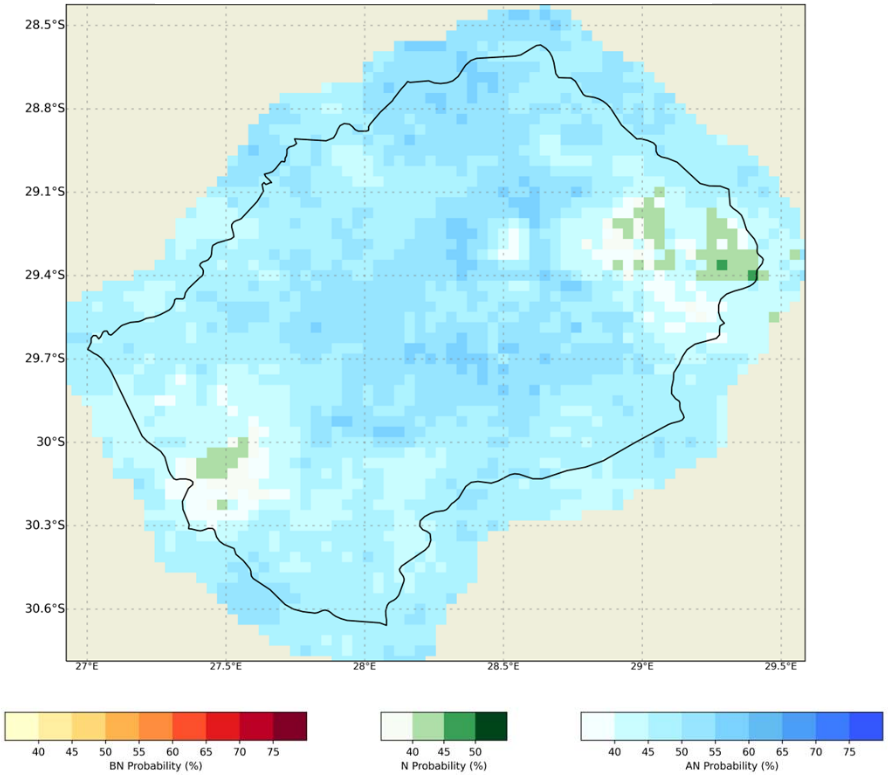


June rainfall south of 15N

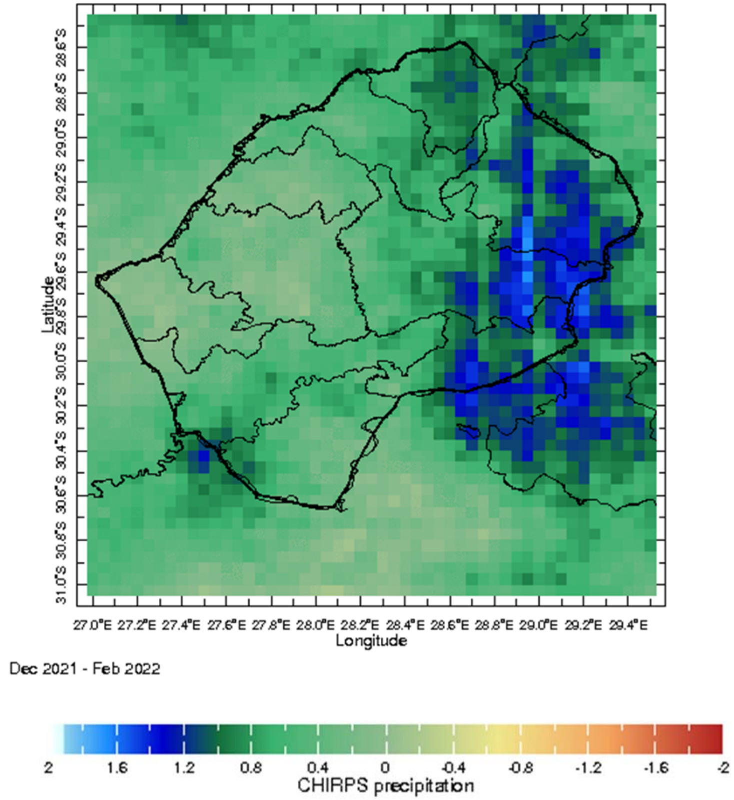
Forecasts vs. observations

Probabilistic Forecast Lesotho
DJF 2021-22 **Nov.** initialization

Probabilistic Forecast (Dominant tercile)



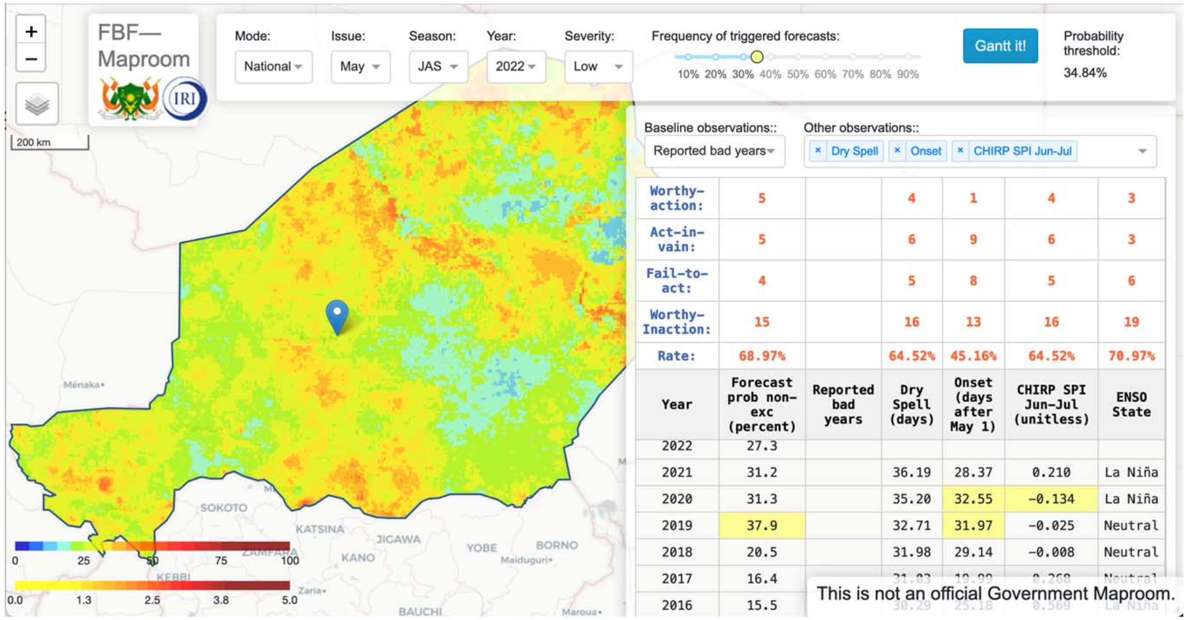
CHIRPS DJF 2021-22 rainfall standardized anomaly



- For each grid-point, there is a full forecast and historical distribution. Probabilities of non-exceedances of chosen thresholds are based on forecast distribution parameters.

Observational Indices under development

- In addition to the forecast indices that can trigger advance humanitarian action, there is also a need for observational or monitoring indices to trigger actions mid-season, especially if the forecast produces a false negative
- For Niger, we have added sub-seasonal rainfall totals (June, June-July, JAS, JJASO), standardized precipitation anomaly (SPI), maximum dry spell length and onset date as potential observational
- Other observational triggers under consideration: water requirement satisfaction index (WRSI) and normalized difference vegetation index (NDVI), station based SPI
- Flexible comparisons are possible between the observational, forecast and other datasets in the maptool



Impacts and Responses

- Severe drought causes or contributes to many predictable impacts including
  - Poor agricultural harvests
  - Poor yields and health of cattle
  - Adverse health impacts for both humans and animals
  - Conflicts over limited resources
  - Challenges in water management
- Range of humanitarian responses tailored to different needs and to different times in the season
  - Climate/agriculture early warning systems dissemination through local networks
  - Improved soil conservation and water retention practices
  - Prepositioning of medicine
  - Nutrition resources for infants
  - Cash transfers
  - Direct food aid

Collaboration and Research

- Ongoing multi-lateral partnerships between IRI, WFP, OCHA and national meteorological services and regional climate centers (AGRHYMET and ICPAC)
- Training in partner country meteorological services
- Interface to be improved/expanded on through collaboration with WFP by developing Gantt Charts and protocols for specific actions
- Interface to be evaluated over time by humanitarian partners and in country technical partners
- Multiple potential future collaborative research threads on climate side
  - Predictors: other models and/or reanalysis fields, winds, 2 meter temperature, modeled or observed SSTs
  - Predictands: different rainy day thresholds, dry day thresholds, onset date (rainfall, soil moisture or water balance definitions), season length, WRSI, NDVI
  - Monitoring tools for a range of early season triggers; rainfall, NDVI, SSTs, etc..

Additional Resources and Links

- Wikipage https://wiki.iri.columbia.edu/index.php?n=FbF.FbF
- IRI webpage iri.columbia.edu
- WFP publication on FbF https://www.wfp.org/publications/forecast-based-financing-fbf-anticipatory-actions-food-security-2019
- Ethiopia National Meteorological Agency http://www.ethiomet.gov.et/
- Lesotho Meteorological Services https://www.lesmet.org.ls/
- Meteo-Madagascar https://www.meteomadagascar.mg/
- DMN Niger http://www.meteo-niger.org/
- https://fist.iri.columbia.edu/publications/docs/Forecasts4Action/
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