

living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE
OF OUR PLANET FROM SPACE



Satellite and Station Data for Meteo Services

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25/05/2022

WFP is increasingly working with National Meteorological Services through initiatives driven by WFP Country Offices.

These initiatives are focused in enhancing NMS capacity to generate timely Early Warning and Seasonal Monitoring information, improve its provision of climate services and support to AA/FbF initiatives.

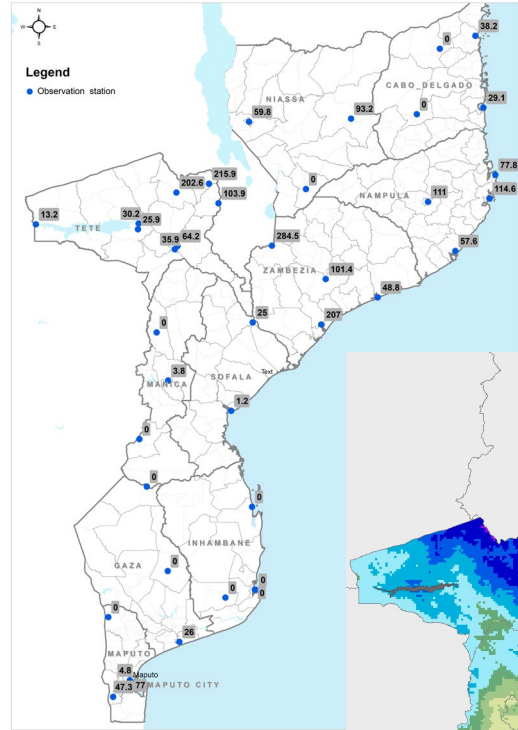
WFP Climate and EO unit frequently provides the technical support to these initiatives. As such, it developed a package of support to NMS to improve their status as a service provider to national stakeholders.

This support package includes:

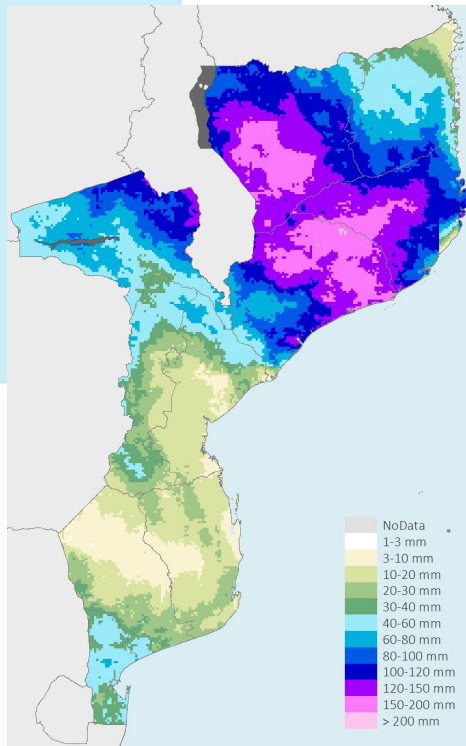
- Development of enhanced agro-meteorological products based on blending station and EO data. Improve internal station data flows and assimilation, increase the number of active real time stations (including AWS)
- Provision of access to real time Earth Observation data and indicators suitable for early warning and seasonal monitoring work
- Recovery of old climate records, upgrade of climatological database (WMO/UKMet support)
- Support multi-stakeholder Technical Working Groups and NMS leadership in key areas of responsibility

Active in: Mozambique, Namibia, Zimbabwe, Sri Lanka, Cuba

Blending Station and Satellite Data



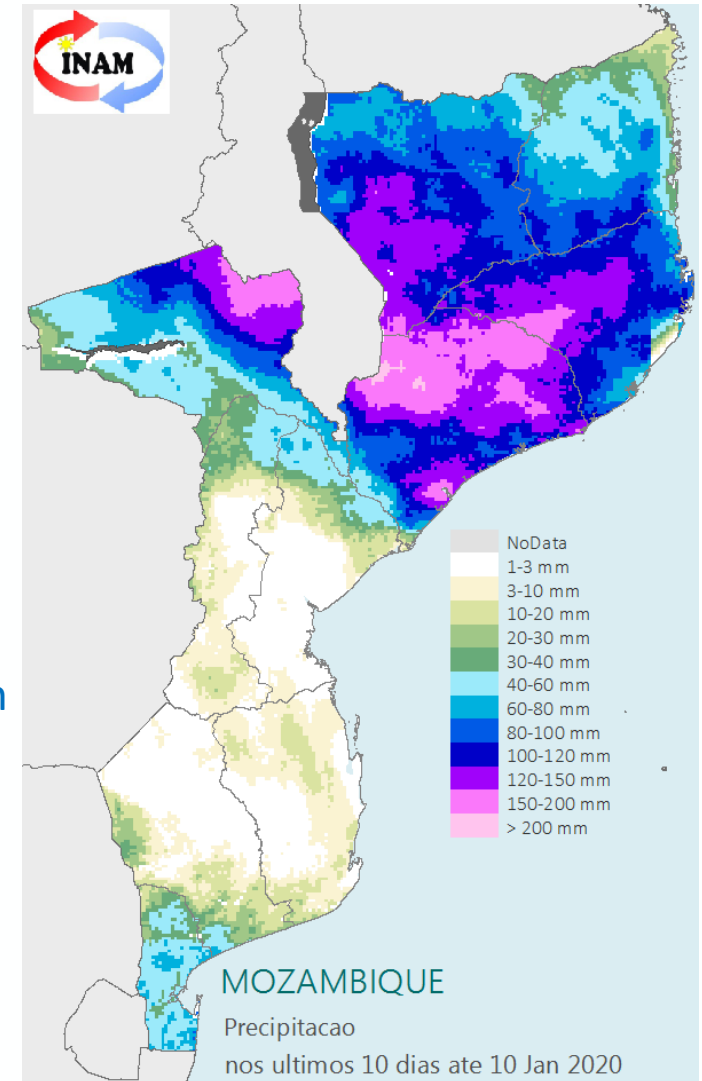
Station Data:
Point Coverage
Locally Accurate



Satellite:
Full spatial Coverage
High Resolution
Less Accurate

Blended:

- Improved Accuracy
- Full country cover
- Reduced conditional bias
- Better representation of extremes



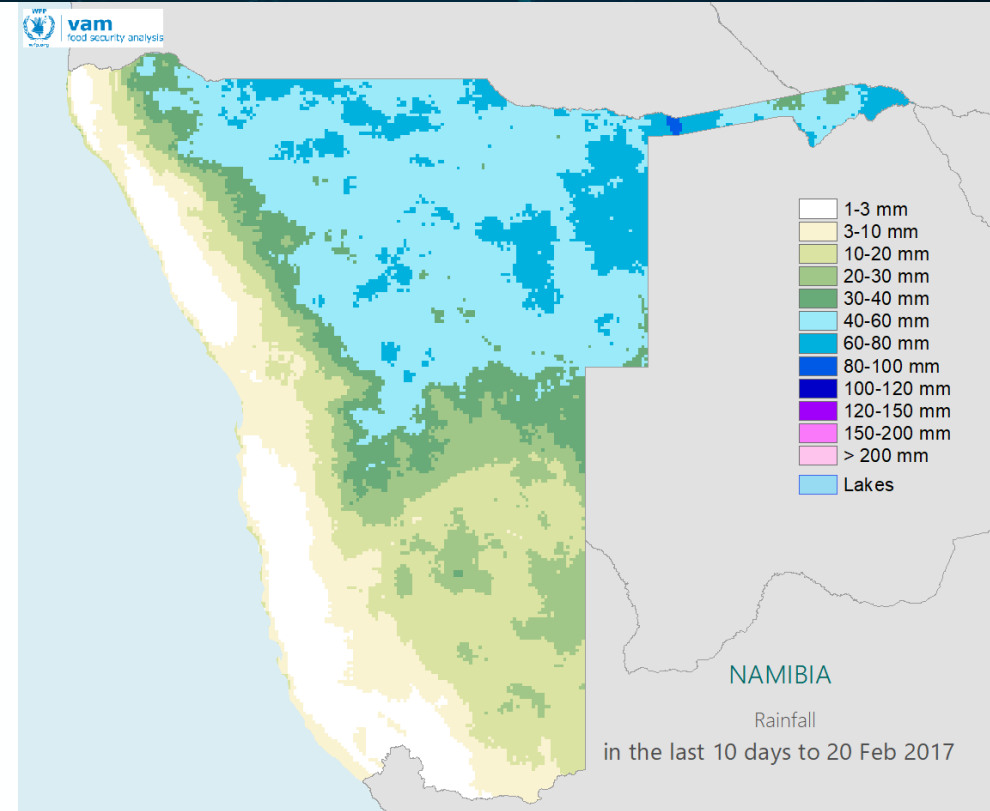
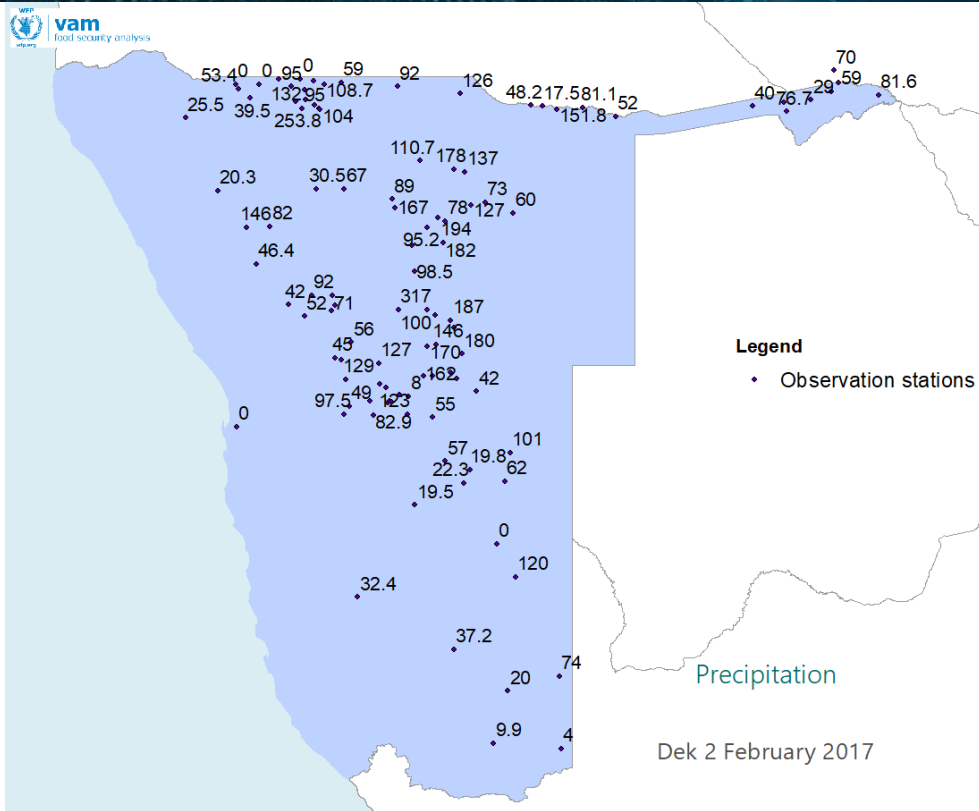
Blending is the combination of two estimates into a single value. We use a well known approach, where by the SRE is taken as a so called *first-guess* that is adjusted by observations from ground measurements of rainfall. The approach used is as follows:

$$BRE = SRE + f(SRE - OBS)$$

This means that we take the SRE and apply a correction **f** that is related to the differences between observations and the SRE.

f is derived from interpolation methods applied to the point differences between the SRE and the gauge rainfall (the SRE undergoes a bias correction).

Blending Approach



Ingredients (Original Data):

Rainfall from the NMS (left) and the CHIRP rainfall estimate (right) for February Dekad 2, 2017

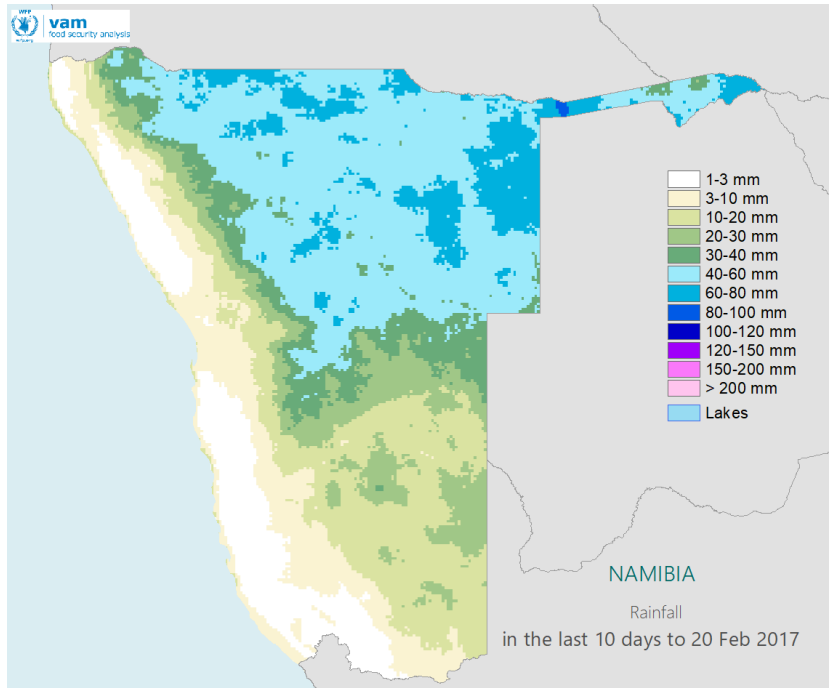
Note the very high rainfall values registered by the raingauges, some close to 200mm and the very high spatial variability of the rainfall data. In contrast the SRE values barely exceed 80mm

Procedure:

- Bias correct CHIRP.
- Form residuals between CHIRP-BC and raingauge data
- Interpolate residuals into same grid as CHIRP data.
- Combine residual grid with CHIRP-BC to form a blended estimate

Interpolation:

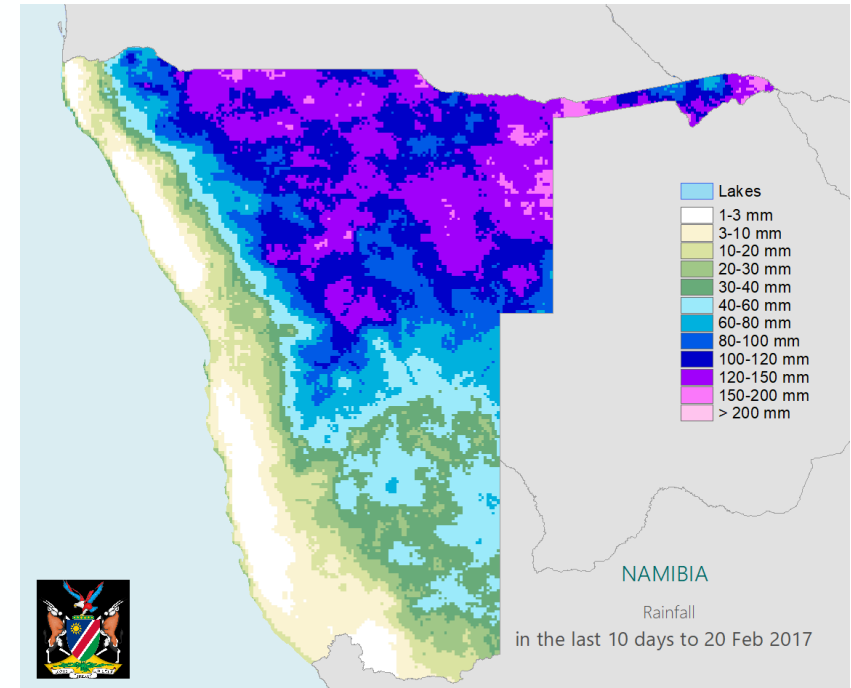
- Uses geo-statistical method (Kriging)
- Operational blending uses a pre-defined climatological variogram
- Setting up an operational blending process requires some historical data to define the climatological variogram(s)



* Bias Correction Factor =

$$BC = \frac{Gauge\ Avg + C}{CHIRP\ Avg + C}$$

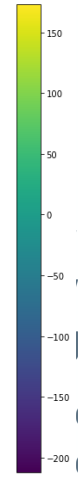
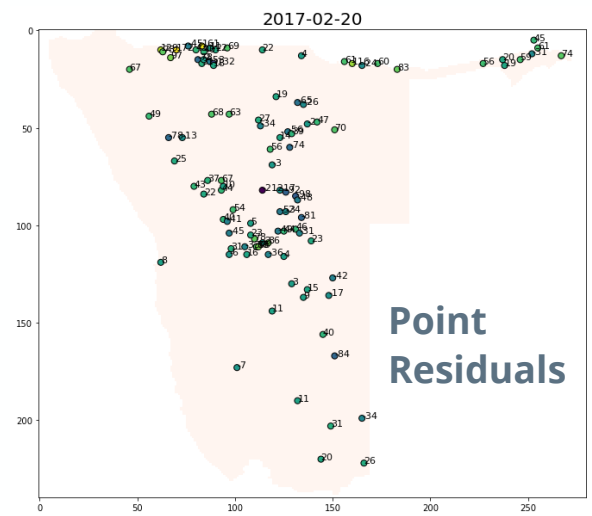
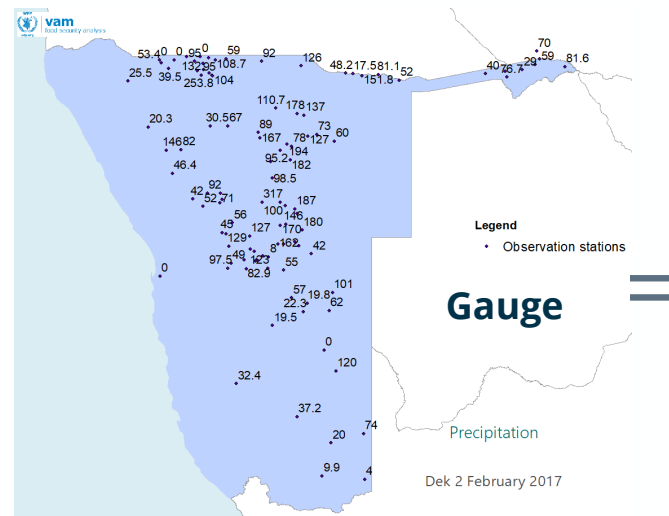
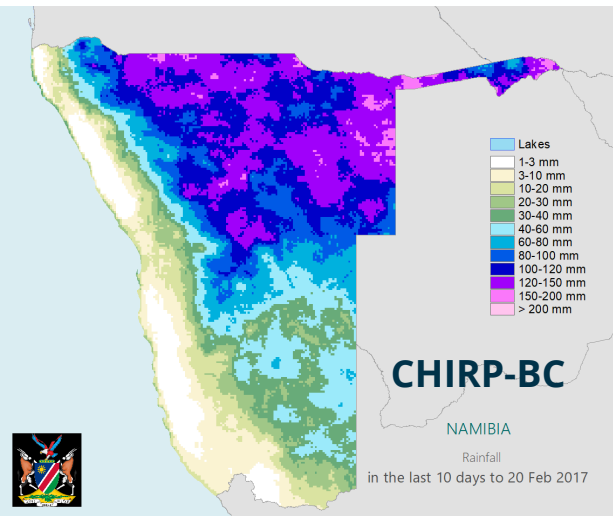
BC derived for each time step



Bias Correction

CHIRP rainfall is very biased (under-estimates), so for the interpolation of the residuals to work properly a first degree (mean value) bias correction is applied. C is a small value (1mm) to avoid division by 0 or tiny values.

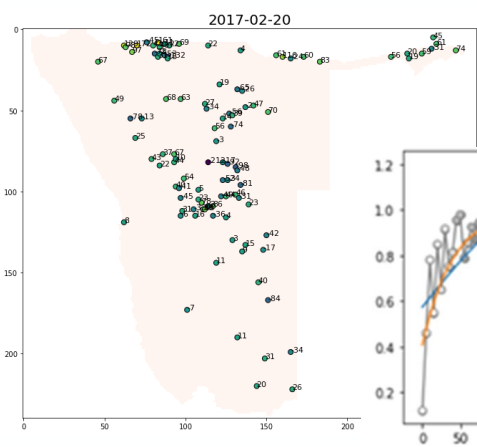
Blending Approach



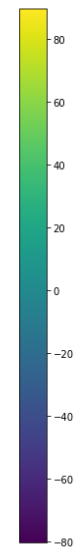
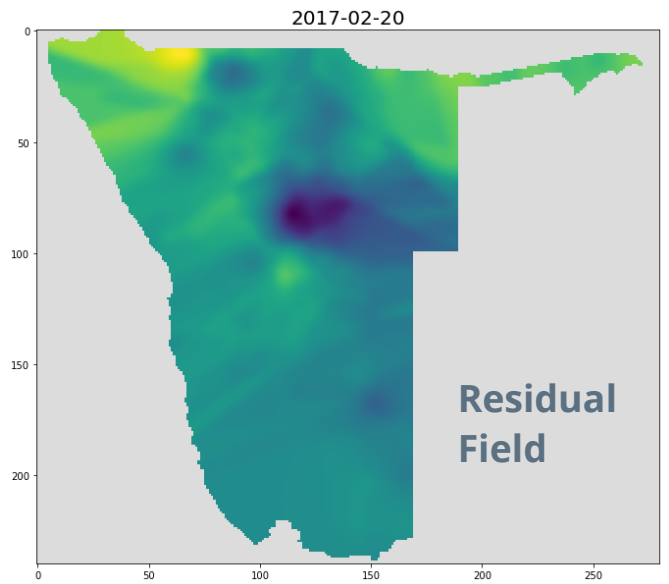
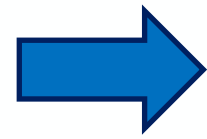
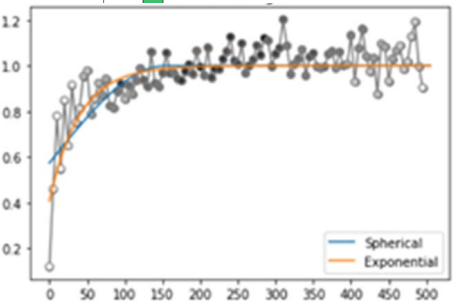
Characterizing Spatial Variability and Point Uncertainty

Residuals are formed between CHIRP-BC and gauge values and are derived for all time steps in the record.

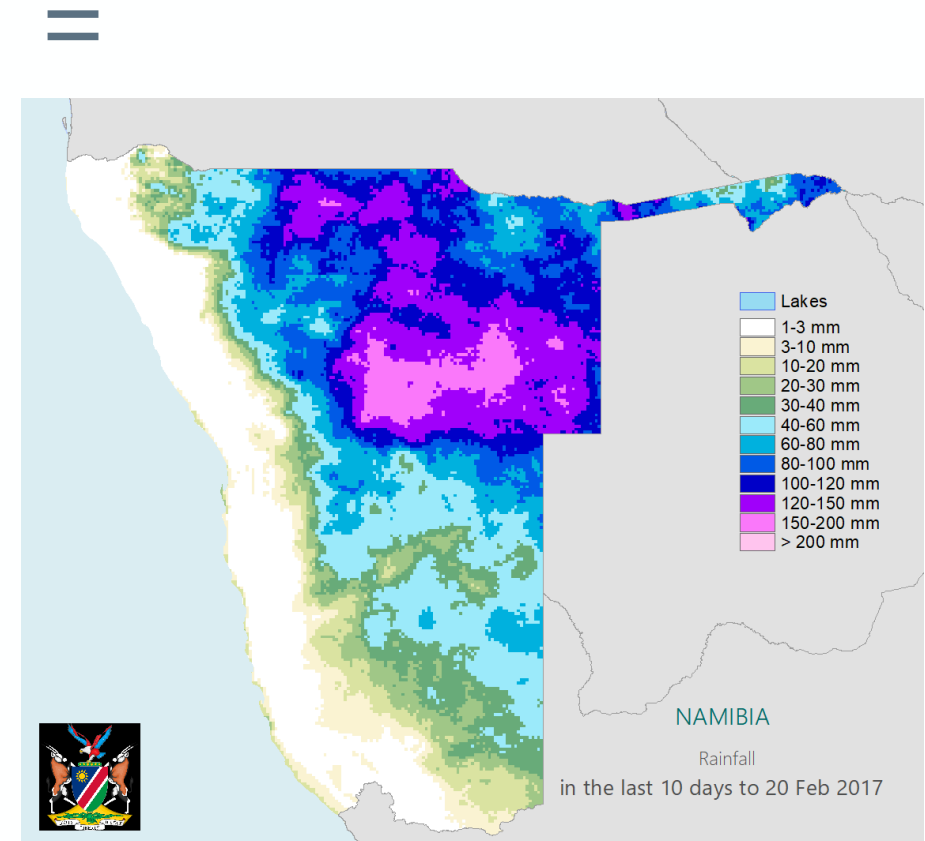
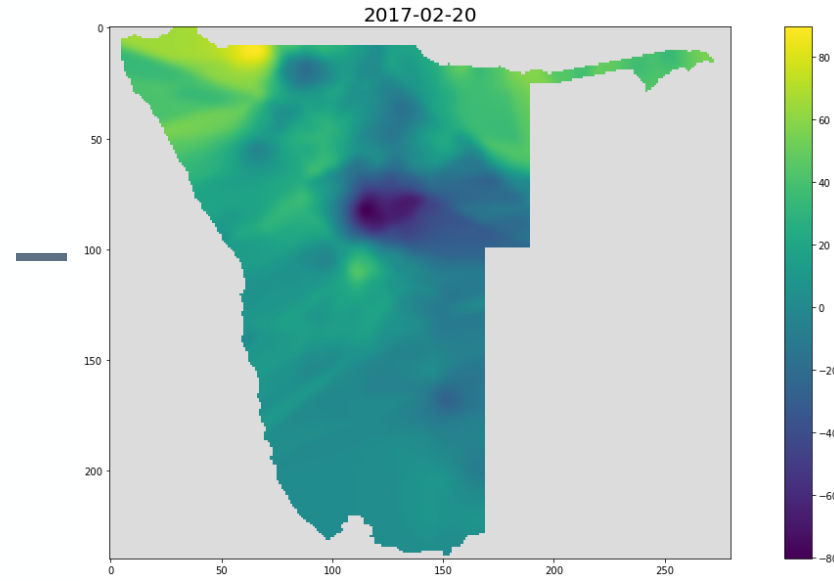
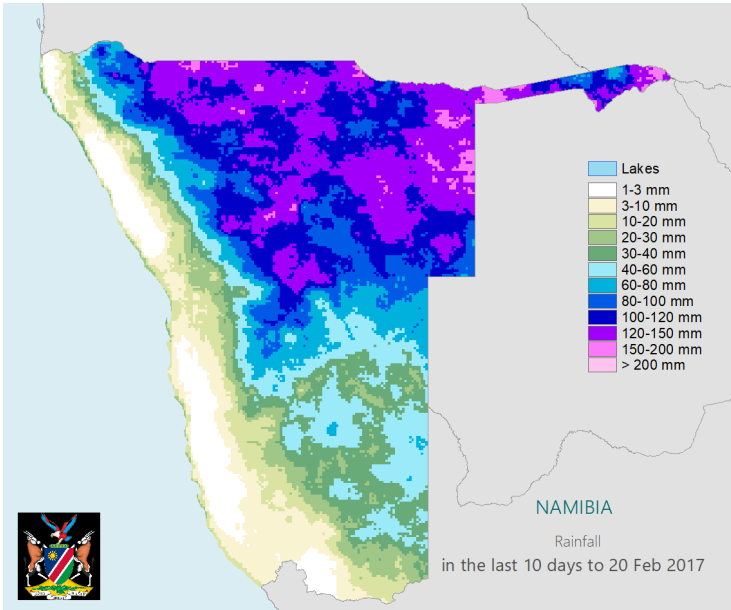
A mean variogram is prepared. This describes spatial variability and point uncertainty and is a key input to kriging interpolation.



Kriging



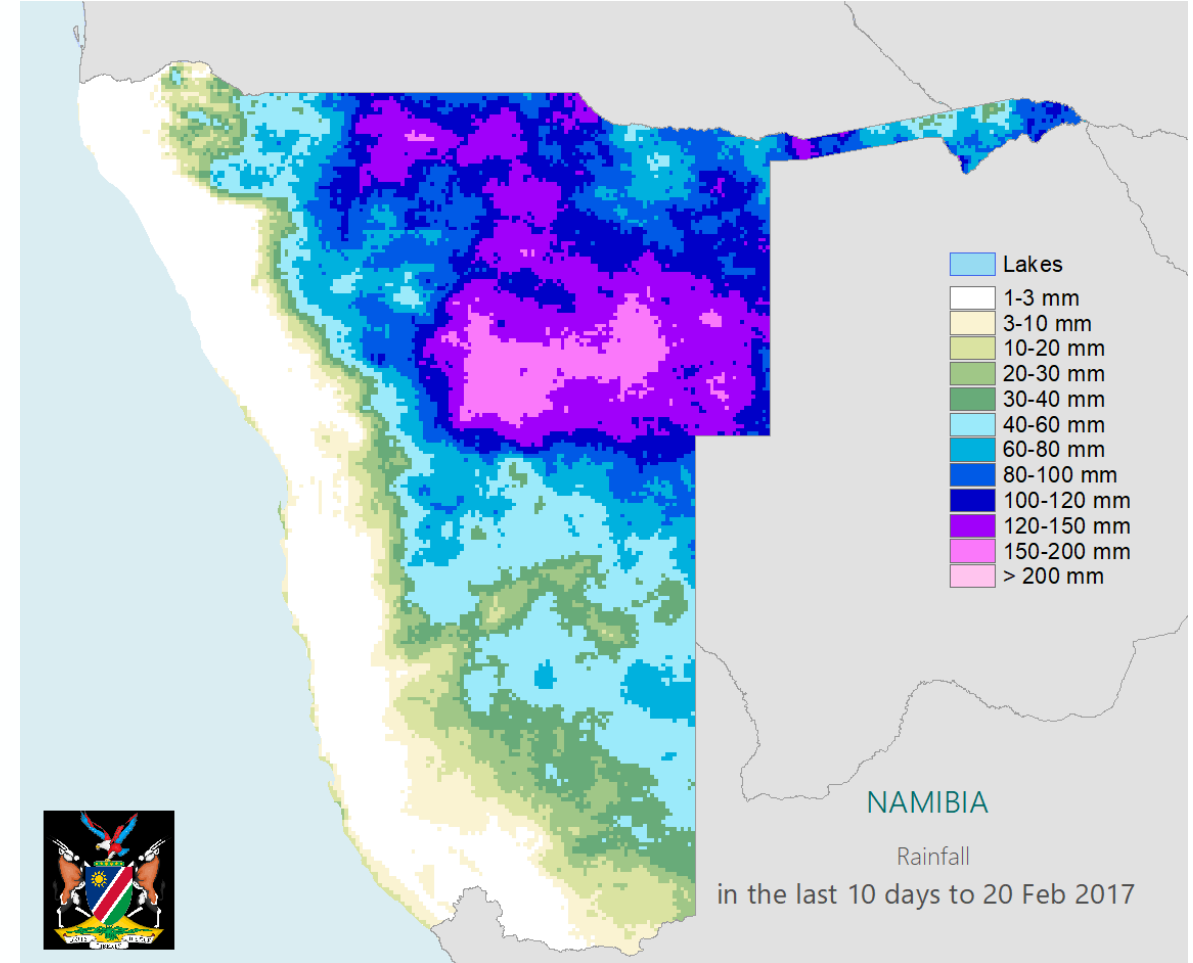
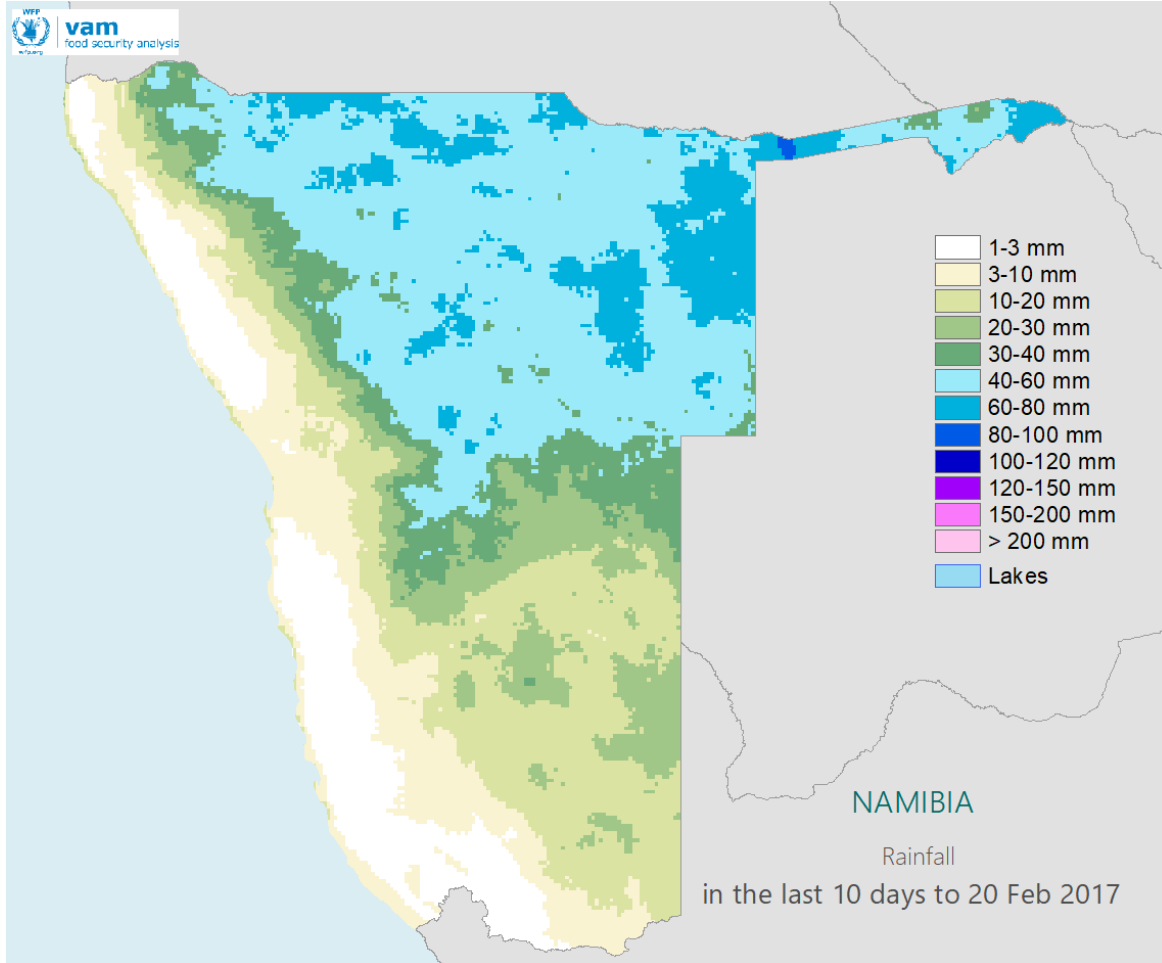
Blending Approach



Applying Residual Correction

Once the residual field is derived, a plain operation applies the correction

Blending Approach



From biased SRE to fully blended improved product

Geo-statistical Interpolation

Classic methodology, accounts for irregular distribution of gauges and adapts to the spatial variability of the variable being interpolated.

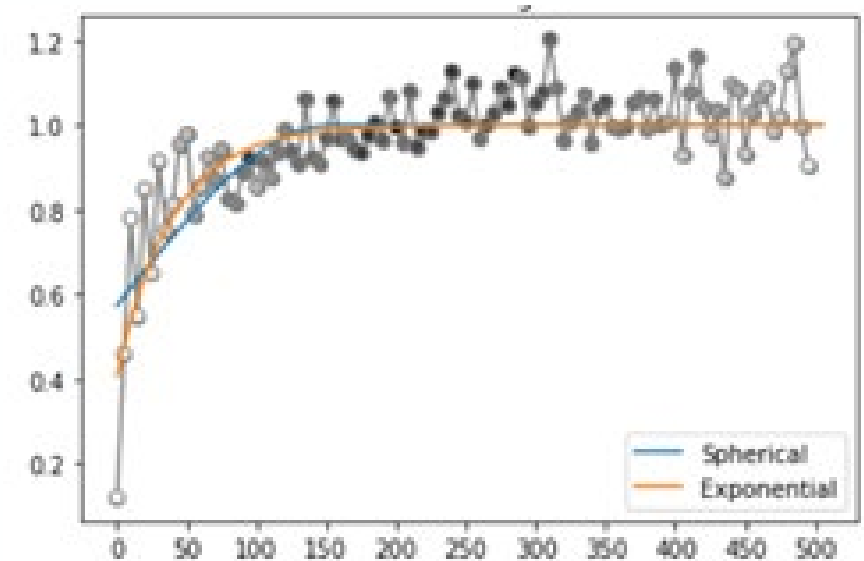
The spatial variability is modelled by a specific function fitted to an empirical variogram, essentially a plot that describes how variability between data values increases with distance.

Ideally you would use a different variogram for each time step. This is not a task easy to automate, and for each time step you might not have enough data to derive the empirical variogram.

Solution: use a **mean or climatological variogram**.

This is a fixed, pre-defined variogram that is derived from an analysis of past data, e.g. for the past 5 years or longer.

Depending on the amount of data, you could use monthly variograms or (more often) a variogram for the early and late stages of the rainfall season (including the dry season) and another for the wetter core rainfall season.



Station Data Assimilation

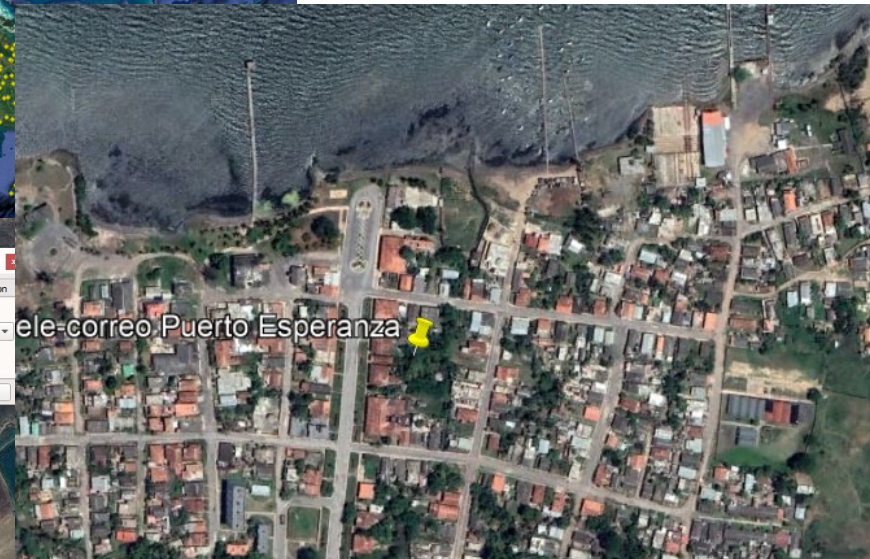
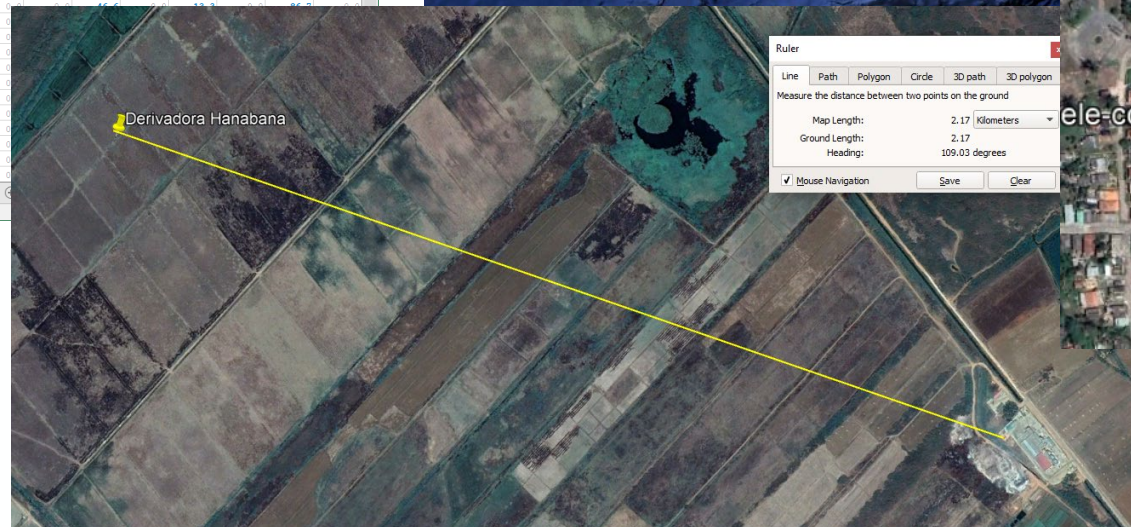
Excel spreadsheet showing station data assimilation. The spreadsheet has columns for station ID, name, municipality, and various data points. A formula bar at the top shows: `=VLOOKUP (G28, INDIRECT ("*" & LEFT (F21, 6) & "*" & G22:G2795"), 37+RIGHT (F21, 1), FALSE)`

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	CodigoInform	Municipio	Nombre	LONGITUD	LATITUD	202101D1	202101D2	202101D3	202102D1	202102D2	202102D3	202103D1	202103D2	202104D1
2	Inf2100001	Sandino	Estación Meteorológica Cabo	-84.949588	21.866379	15.3	18.2	4.0	0.0	19.0	0.7	3.1	0.0	3.8
3	Inf2100002	Sandino	Estación Meteorológica y ras	-84.422845	21.923206	1.5	15.5	0.0	0.3	77.6	0.0	3.7	20.5	0.0
4	Inf2100007	Sandino	Tele-correo Las Martinas	-84.141107	21.967257	0.0	0.0	0.0	0.0	27.9	2.0	0.0	0.0	0.0
5	Inf2100009	Sandino	Tele-correo Cortés	-83.996572	22.046789	0.0	0.0	0.0	0.0	4.2	0.0	0.0	7.2	0.0
6	Inf2100010	Manzanilla	Tele-correo Arroyos de Manzanilla	-84.378817	22.348210	3.5	3.5	0.0	0.0	-99.0	18.2	3.2	0.0	0.0
7	Inf2100012	Manzanilla	Tele-correo Dimas	-84.236311	22.484818	17.5	0.0	0.0	0.0	51.4	0.0	0.0	0.0	0.0
8	Inf2100013	Sandino	Estación Meteorológica Isabell	-84.114113	22.147551	27.7	3.6	0.0	0.6	18.7	2.4	4.1	0.0	3.3
9	Inf2100015	San Juan y Martínez	Tele-correo El Sabalero	-83.971158	22.173728	5.0	0.0	0.0	0.0	-99.0	3.0	0.0	0.0	-99.0
10	Inf2100026	Vifales	Tele-correo Puerto Esperanza	-83.730674	22.773232	6.0	5.5	0.0	0.0	58.0	0.0	14.0	0.0	0.0
11	Inf2100028	Vifales	Tele-correo San Vicente	-83.706287	22.670670	8.2	2.0	0.0	0.0	30.2	15.0	29.7	0.0	70.0
12	Inf2100030	Vifales	Embalse El Salto	-83.661759	22.581081	13.0	0.0	0.0	0.0	53.9	0.0	5.3	0.0	0.0
13	Inf2100031	Pinar del Río	Instituto de Meteorología	-83.645552	22.495538	19.4	13.7	0.0	0.0	107.0	7.6	7.2	20.8	0.0
14	Inf2100033	Pinar del Río	Tele-correo La Esperanza	-83.387274	22.553606	8.3	3.1	0.0	0.0	-99.0	0.0	1.4	0.0	0.0
15	Inf2100034	Pinar del Río	Embalse El Jibaro	-83.645552	22.495538	19.4	13.7	0.0	0.0	107.0	7.6	7.2	20.8	0.0
16	Inf2100041	La Palma	Tele-correo San Diego de los	-83.351581	22.643680	0.0	0.0	0.0	0.0	63.8	13.5	0.0	0.0	0.0
17	Inf2100043	La Palma	Tele-correo San Juan de los	-83.387274	22.553606	8.3	3.1	0.0	0.0	-99.0	0.0	1.4	0.0	0.0
18	Inf2100044	La Palma	Tele-correo La Mulata	-83.387274	22.553606	8.3	3.1	0.0	0.0	-99.0	0.0	1.4	0.0	0.0
19	Inf2100045	Los Palacios	Tele-correo San Diego de los	-83.351581	22.643680	0.0	0.0	0.0	0.0	63.8	13.5	0.0	0.0	0.0
20	Inf2100046	Consolación del Sur	Embalse Juventud	-83.320166	22.568261	5.0	-99.0	0.0	0.0	78.0	0.7	5.3	0.0	0.0
21	Inf2100048	Consolación del Sur	Embalse Los Palacios	-83.290869	22.620162	9.7	1.2	0.0	0.0	76.0	1.8	4.8	8.0	0.8
22	Inf2100050	Los Palacios	Canal Registral Los Palacios	-83.227910	22.515361	3.1	0.0	0.0	0.0	84.8	0.0	7.0	2.1	0.0
23	Inf2100057	Los Palacios	Embalse Bacunagua	-83.200940	22.654825	2.1	10.4	0.0	0.0	71.0	5.9	1.3	0.0	0.0
24	Inf2100063	San Juan y Martínez	Tele-correo Punta de Cartas	-83.830422	22.169122	0.0	0.0	0.0	0.0	-99.0	0.0	0.0	0.0	0.0
25	Inf2100065	Pinar del Río	Embalse El Punto	-83.577155	22.317787	0.0	3.0	0.0	0.0	-99.0	0.0	2.0	0.0	0.0
26	Inf2100066	Pinar del Río	Embalse El Rancho	-83.785695	22.406471	12.0	7.2	0.0	0.0	9.6	97.4	16.7	4.5	59.0
27	Inf2101001	Sandino	Embalse Laguna Grande	-84.279786	22.100099	7.9	7.3	-99.0	0.0	8.4	51.9	0.7	0.0	0.0
28	Inf2101002	Sandino	Acueducto Laguna Grande	-84.196027	22.085387	0.0	13.0	0.0	0.0	85.5	0.0	0.0	0.0	0.0
29	Inf2101003	Sandino	Embalse Cuyquateye	-84.075263	22.100416	29.4	5.0	0.0	0.0	22.4	0.0	3.5	0.0	3.0
30	Inf2101004	Manzanilla	Acueducto Manzanilla	-84.281374	22.292398	13.0	0.2	0.0	0.0	40.0	21.0	21.8	0.0	0.0
31	Inf2101005	Minas de Matahambre	Embalse Nombre de Dios	-84.007612	22.607556	25.4	1.8	0.0	0.0	15.0	13.3	11.3	0.0	16.5
32	Inf2101006	Minas de Matahambre	Estación Meteorológica Santa	-83.960040	22.658112	25.1	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	Inf2101007	Minas de Matahambre	Acueducto Minas de Matahambre	-83.940056	22.587115	42.3	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	Inf2101008	Minas de Matahambre	Estación Hidrométrica V Anis	-83.911882	22.448514	8.2	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	Inf2101009	Minas de Matahambre	Embalse El Mulo	-83.855304	22.437779	14.7	16.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	Inf2101010	Vifales	Planta Potabilizadora El Sal	-83.706211	22.616476	15.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	Inf2101011	Vifales	Embalse Laguna de Piedra	-83.640844	22.658199	3.4	-99.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38	Inf2101012	Vifales	Embalse El Junco	-83.601670	22.383335	11.1	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	Inf2101013	La Palma	Estación Meteorológica La Pa	-83.546373	22.760871	17.5	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	Inf2101014	La Palma	Embalse Mártires de la Palma	-83.501798	22.773305	9.8	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41	Inf2101026	Los Palacios	Embalse Herradura	-83.406091	22.531783	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	Inf2101027	Los Palacios	Embalse La Bija	-83.405924	22.606935	5.5	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

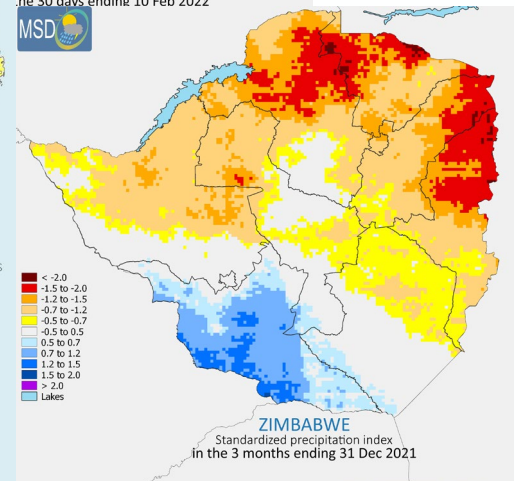
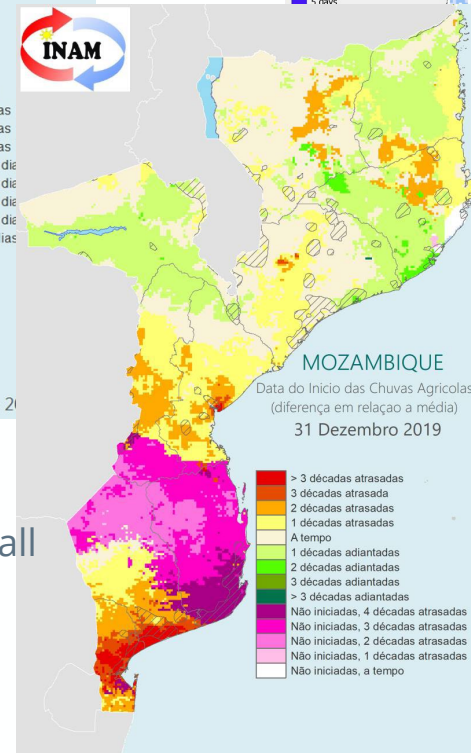
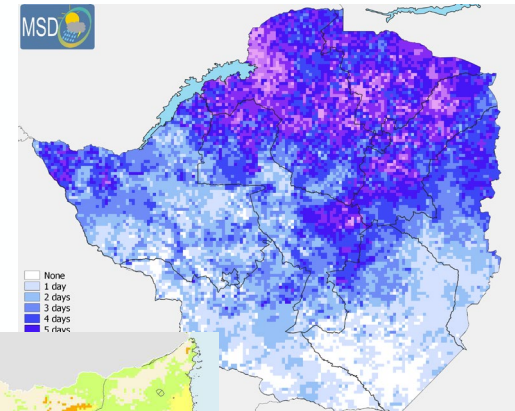
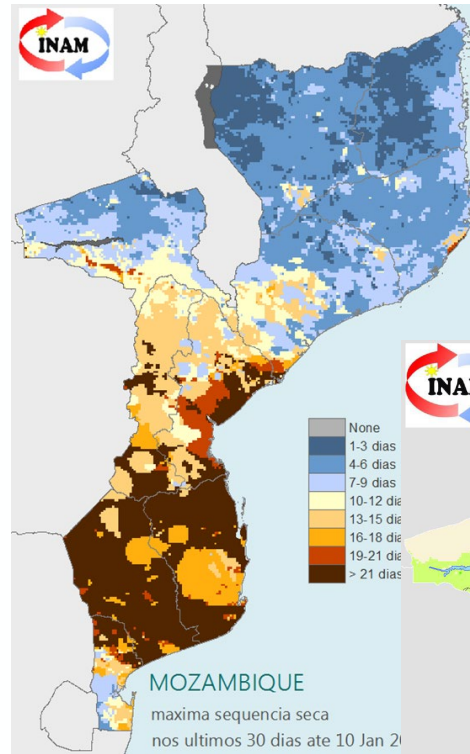
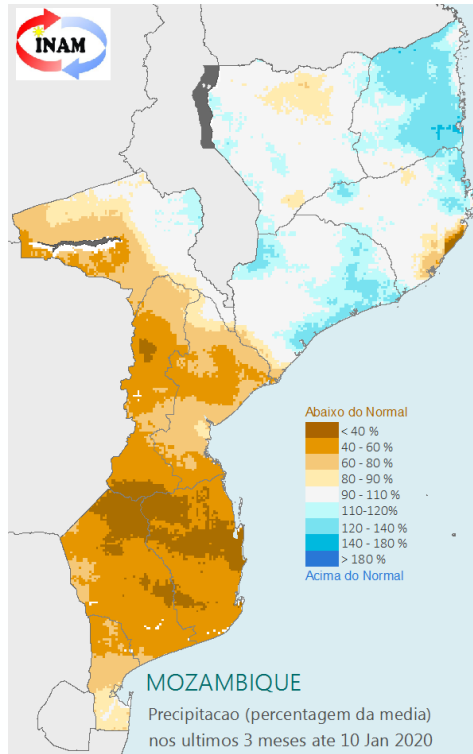
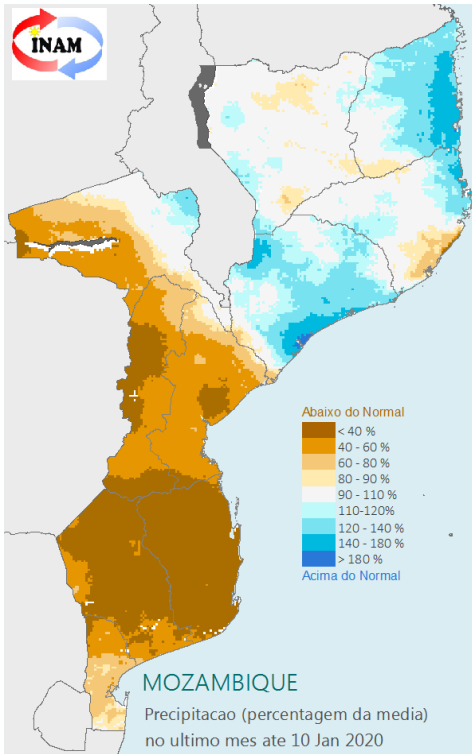
Assimilation File Quality Control



Station Location Checks



Product Portfolio

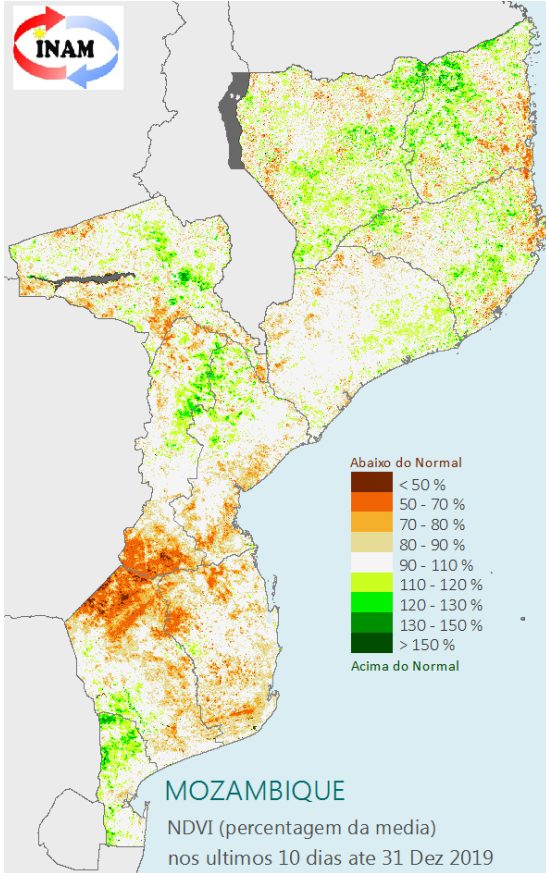


Blended

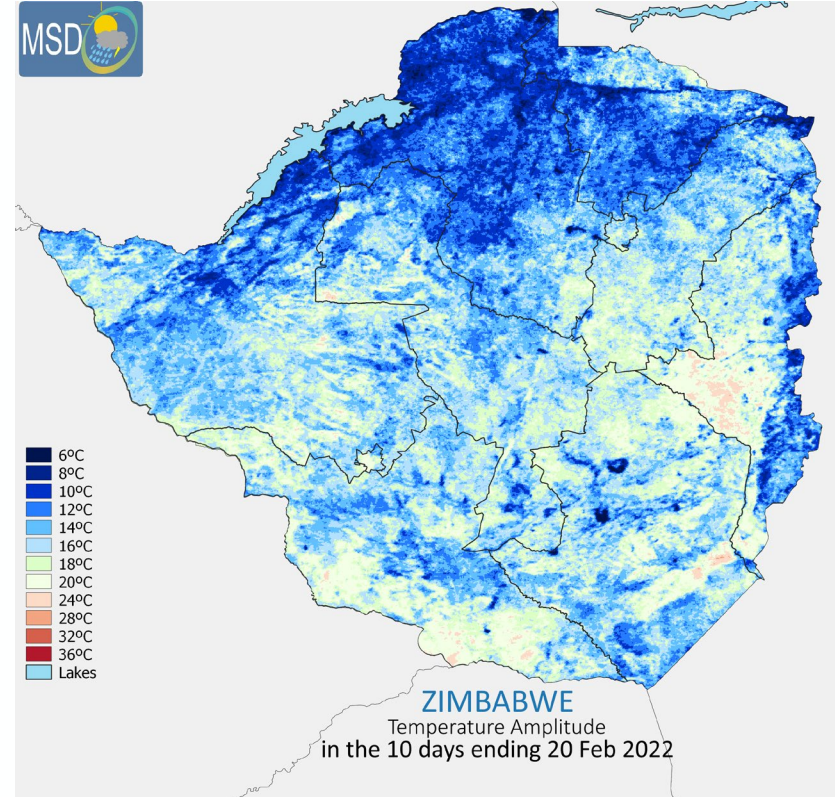
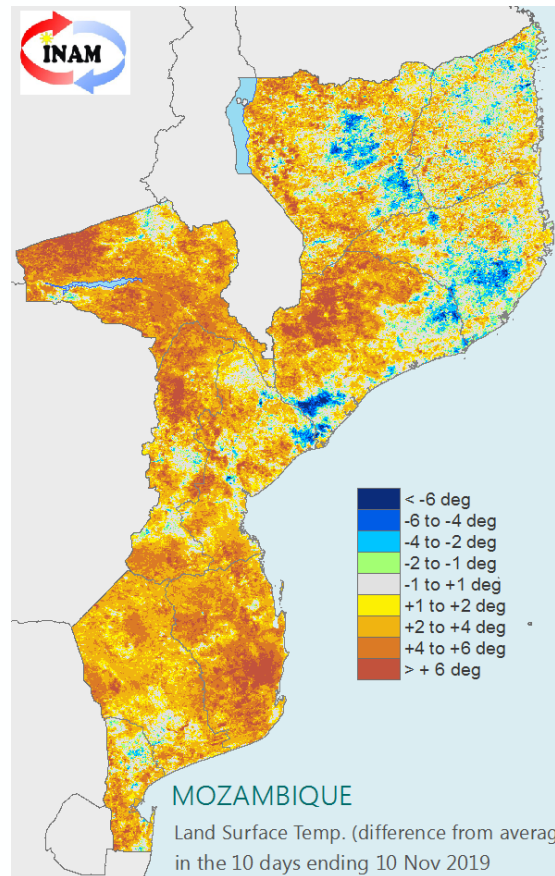
Rainfall accumulations and respective anomalies

CHIRPS Derived

Dry Spell, Extreme Rainfall Onset of season, SPI



Biophysical NDVI, LST, Amplitude



Seasonal Monitor (Cloud based)

INPUTS

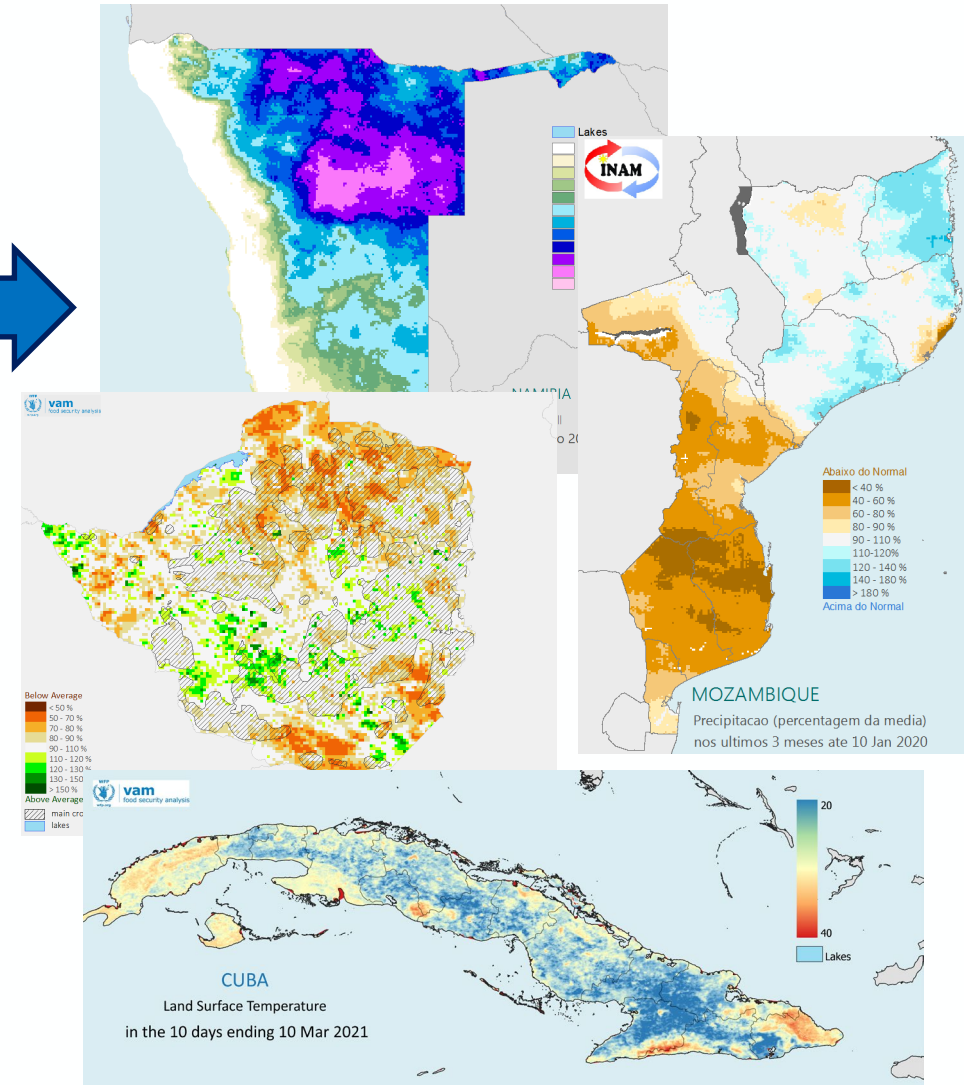
CHIRP/S:
Rainfall Estimates

MODIS:
Vegetation
Land Surface Temperature
Snow Cover
ETp (NASA)

INAM:
Station Rainfall
Station Tmax, Tmin



Accumulated Rainfall
Vegetation
Soil Temperature
Precip Extremes
Drought Indices
Crop Water Indices
(...)

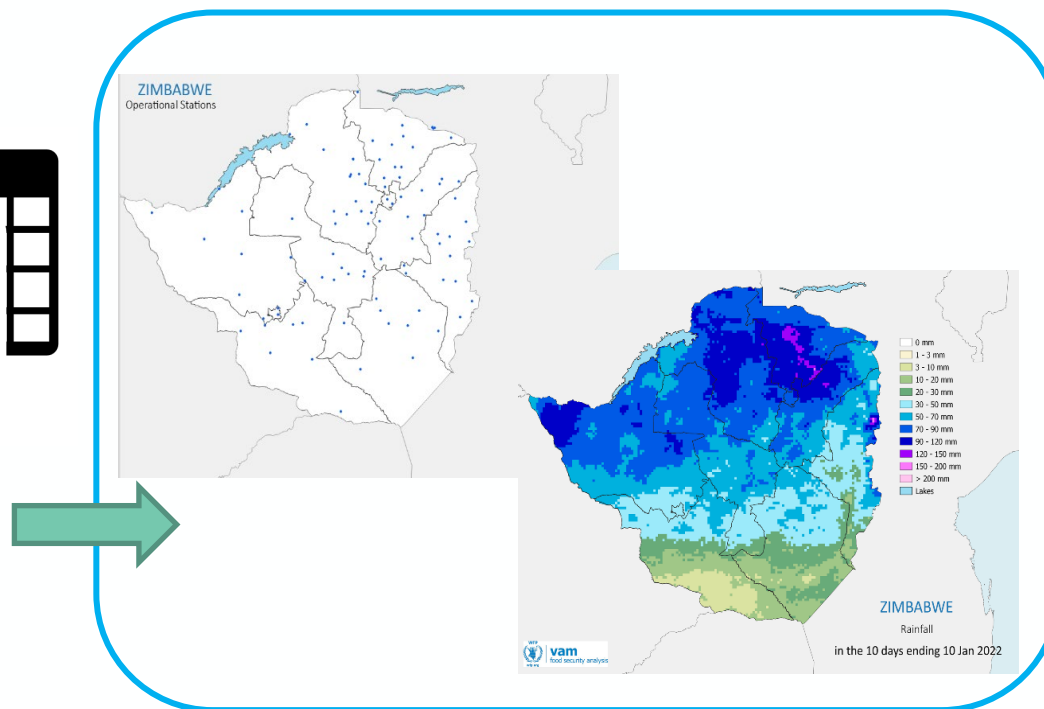


Meteo Data :

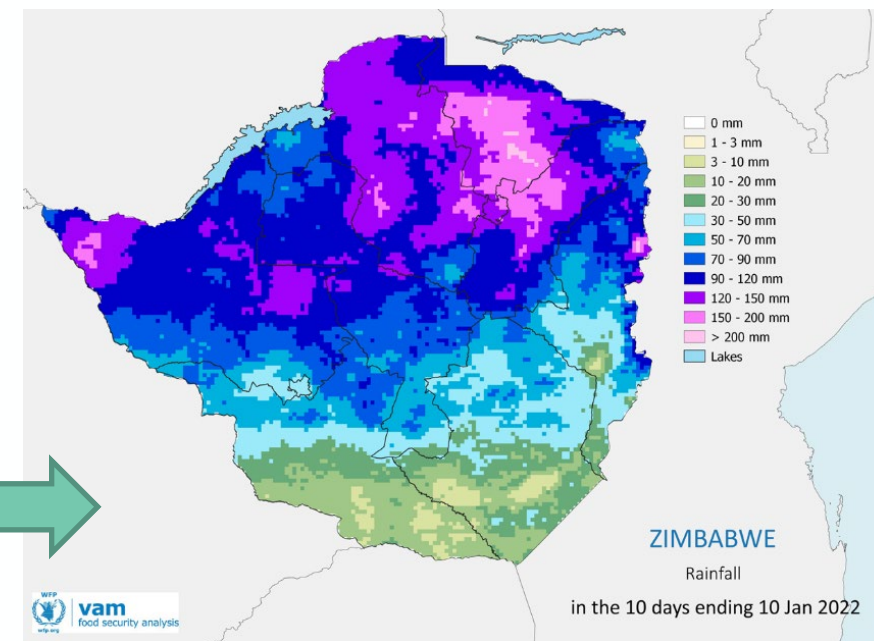
Precip, Temperature, Humidity, WindSpeed
Varying formats and sources



Paper, Excel, Old DB



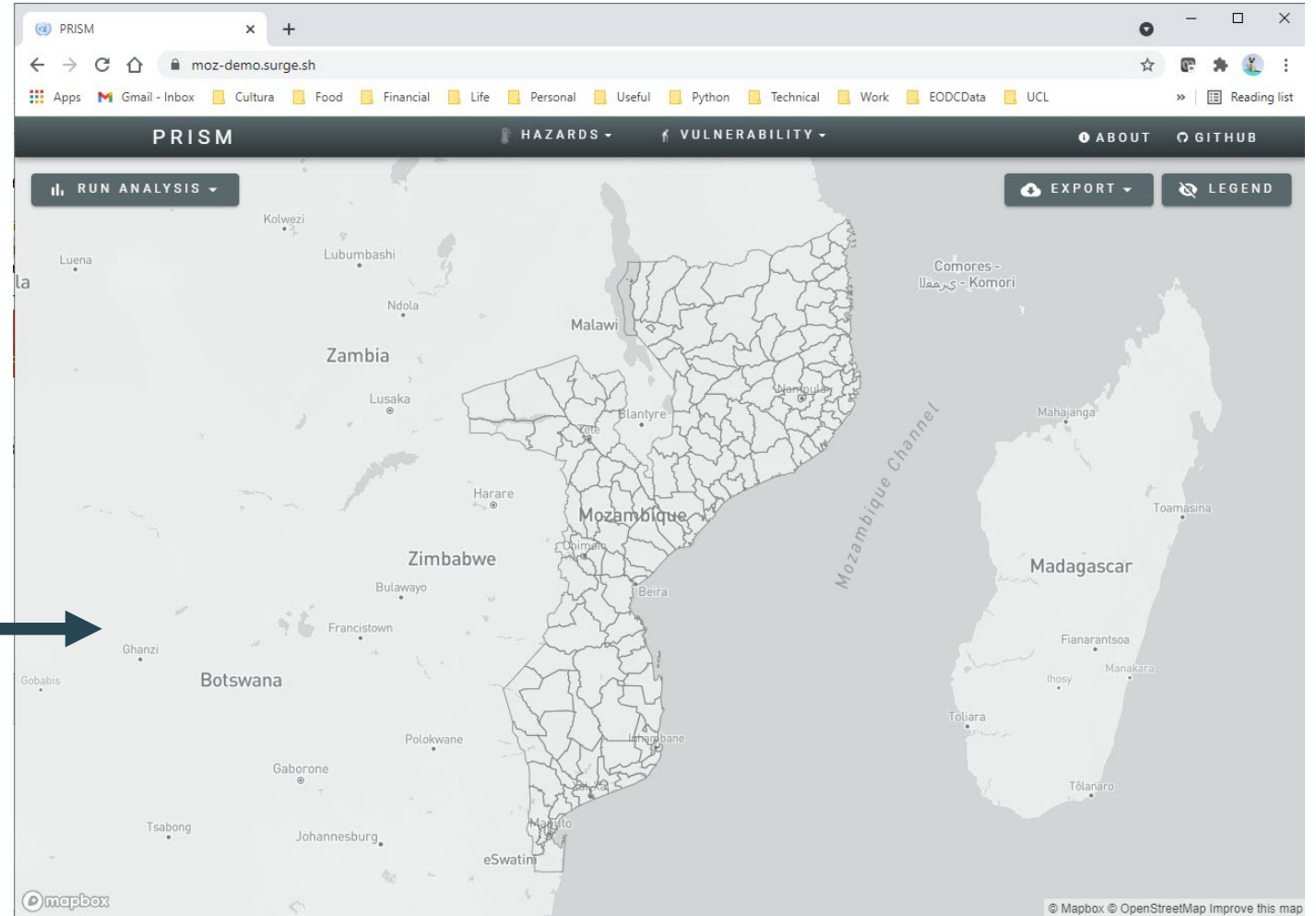
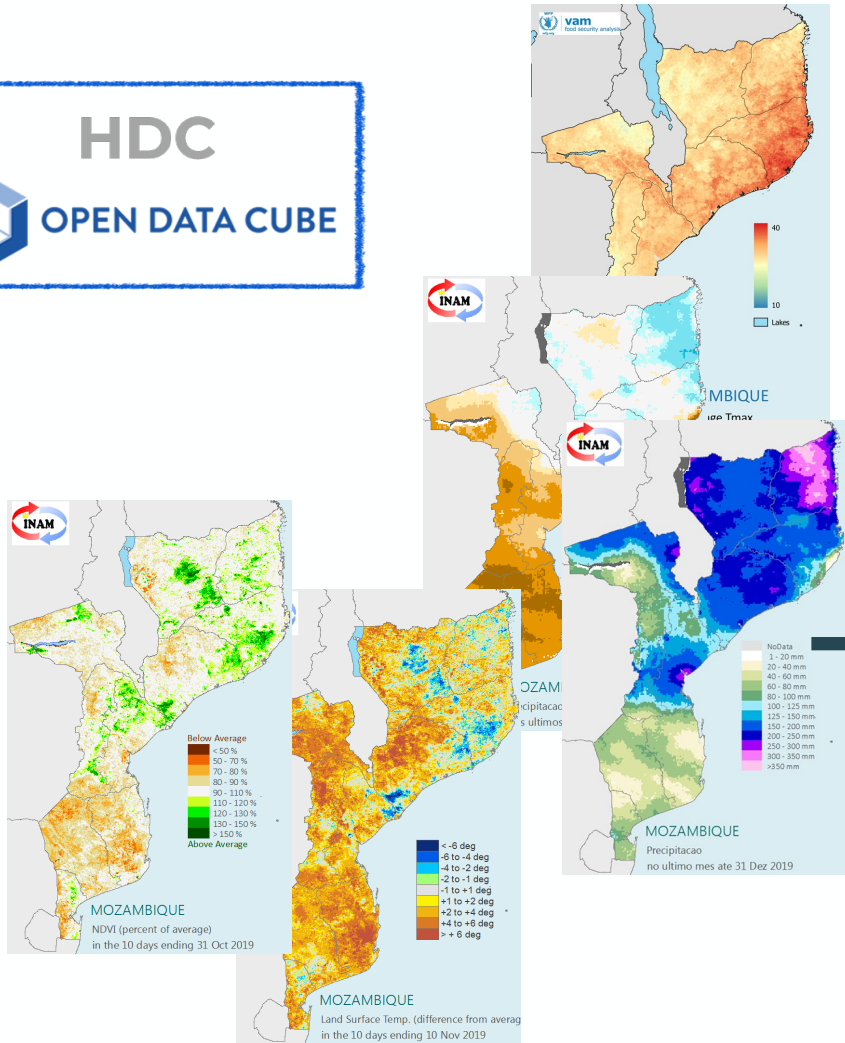
40 year Rainfall Database



Applications:

Climate Risk Analysis, Improved FbF Triggers

PRISM: Government oriented Platform





living planet symposium

BONN
23–27 May
2022

TAKING THE PULSE
OF OUR PLANET FROM SPACE



Thank You!