



# Seasonal Water Management for Semi-Arid Areas

Prof. Dr. Harald Kunstmann, Dr. Christof Lorenz & the SaWaM Team



*Karun, Iran*



*Upper Atbara, Sudan*

# Water Management: Challenge since Ancient Times



***Merowe Kingdom, 350BC***



***Karun & Sushtar-  
Hydraulic System 500 BC***



***Blue&White Nile @Khartoum***

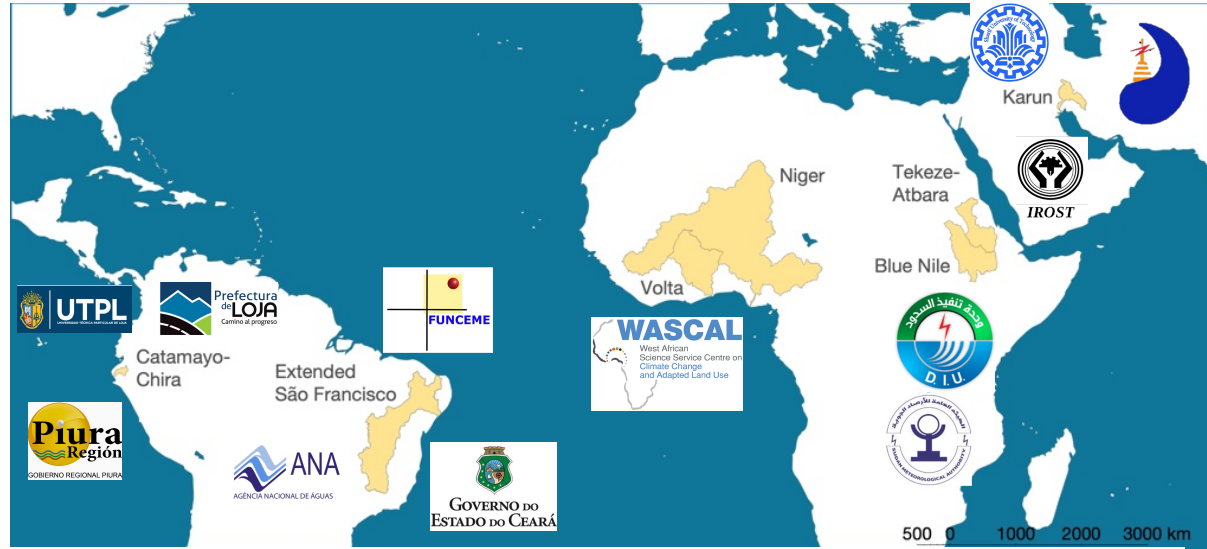


## Seasonal Water Management

- **Till today:** decisions based on few or **no meteo-hydro station data**
- Use of globally available information for **regional decisions:**  
**satellites & model systems?**
- **Crucial: knowledge of expected water availability **months ahead!****  
**... allows planning for intertwined water-food-energy provision**

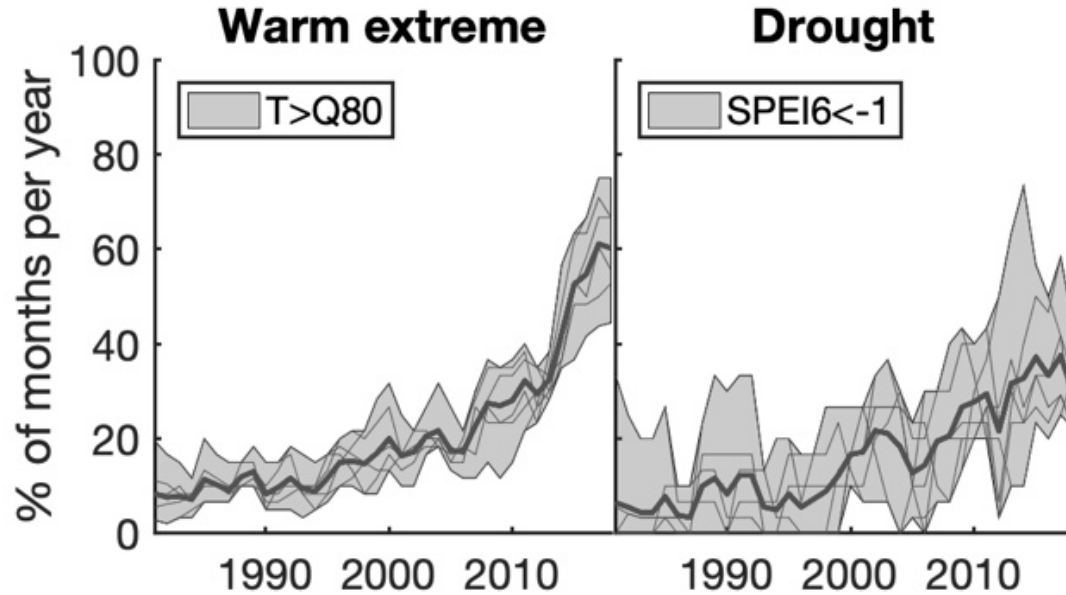


# ... With Stakeholders in 5 Drought- & Flood Prone Semi-Arid Regions

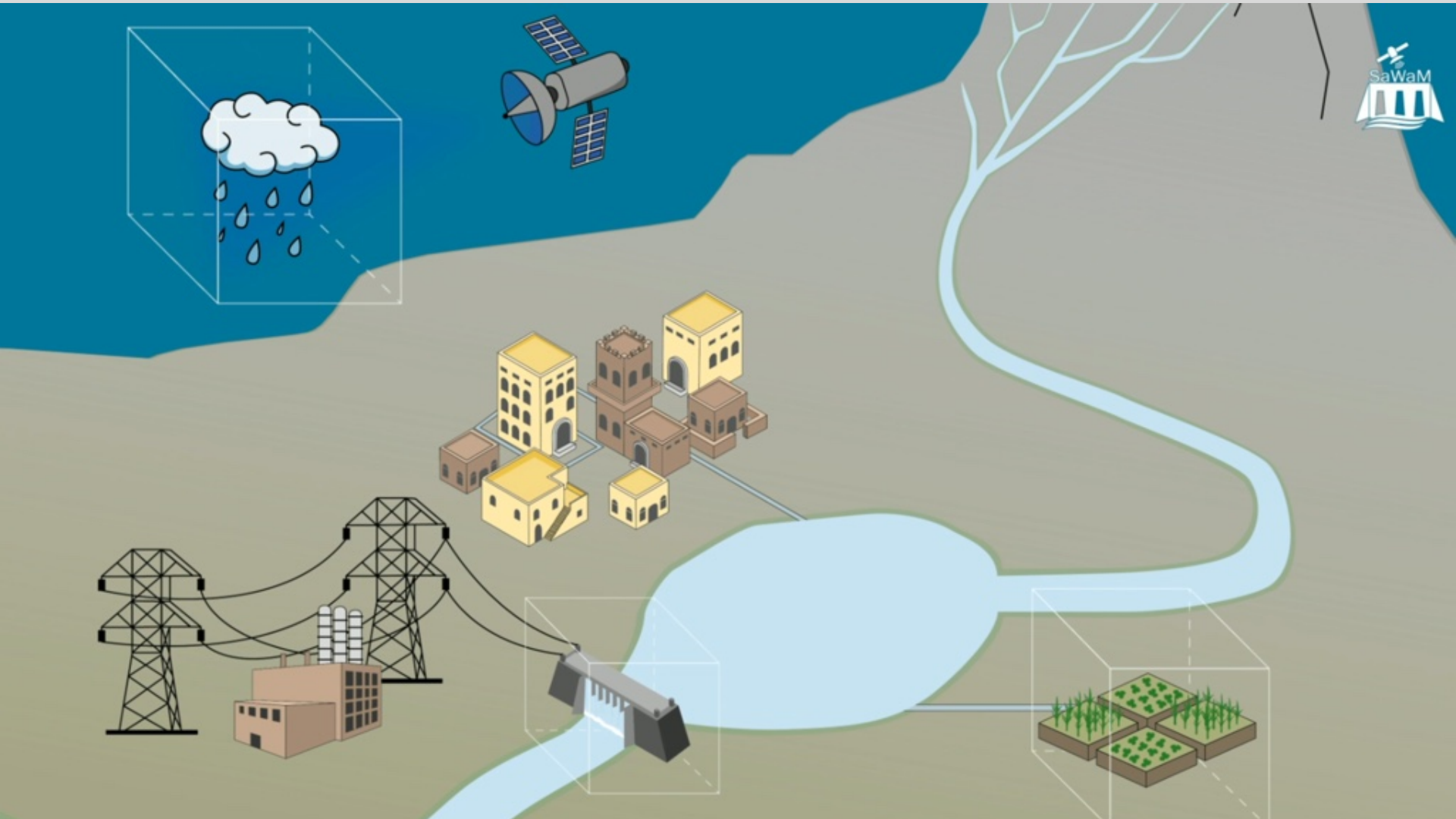




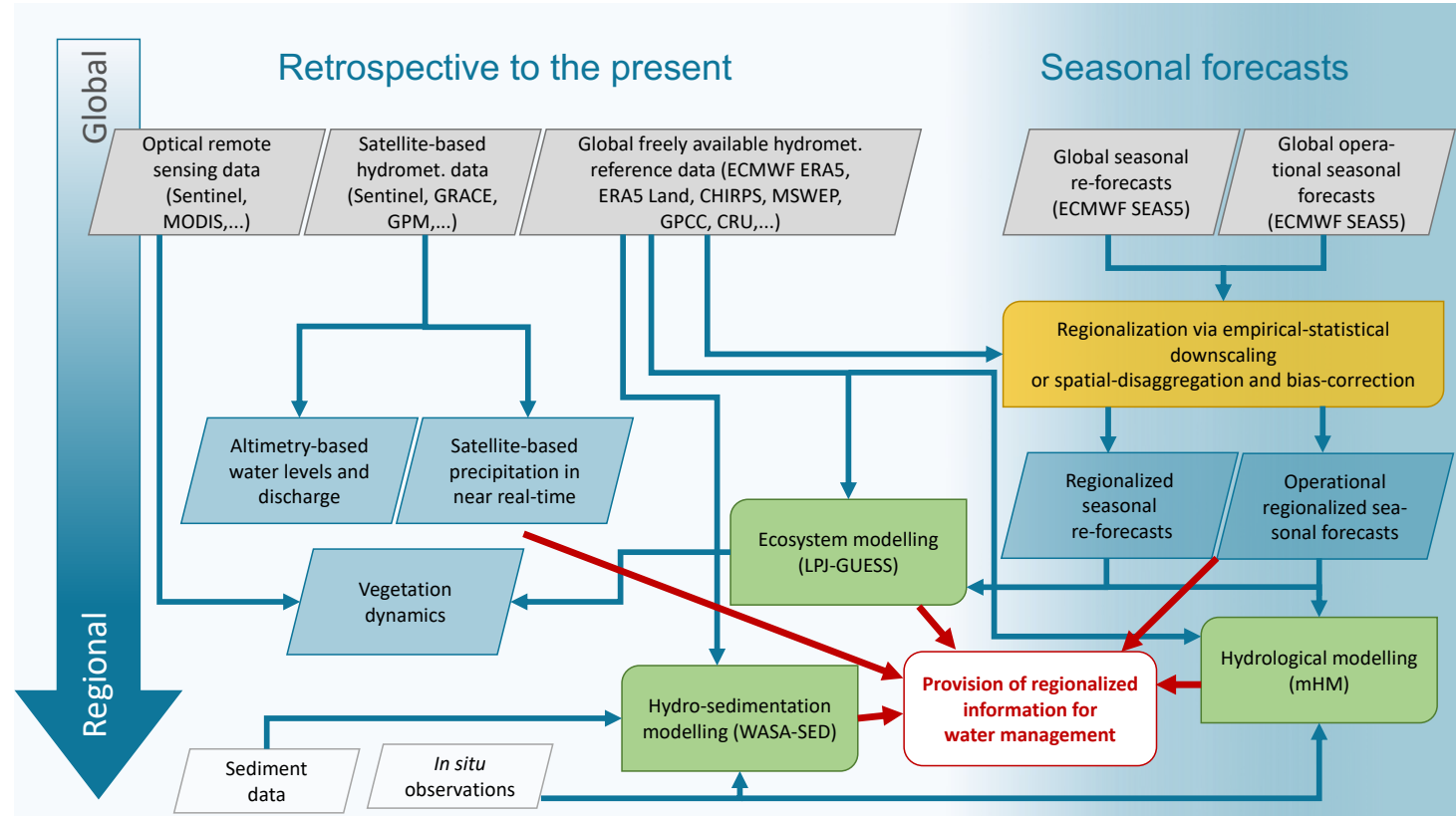
## Clear Increase of Extreme Events in SaWaM Regions

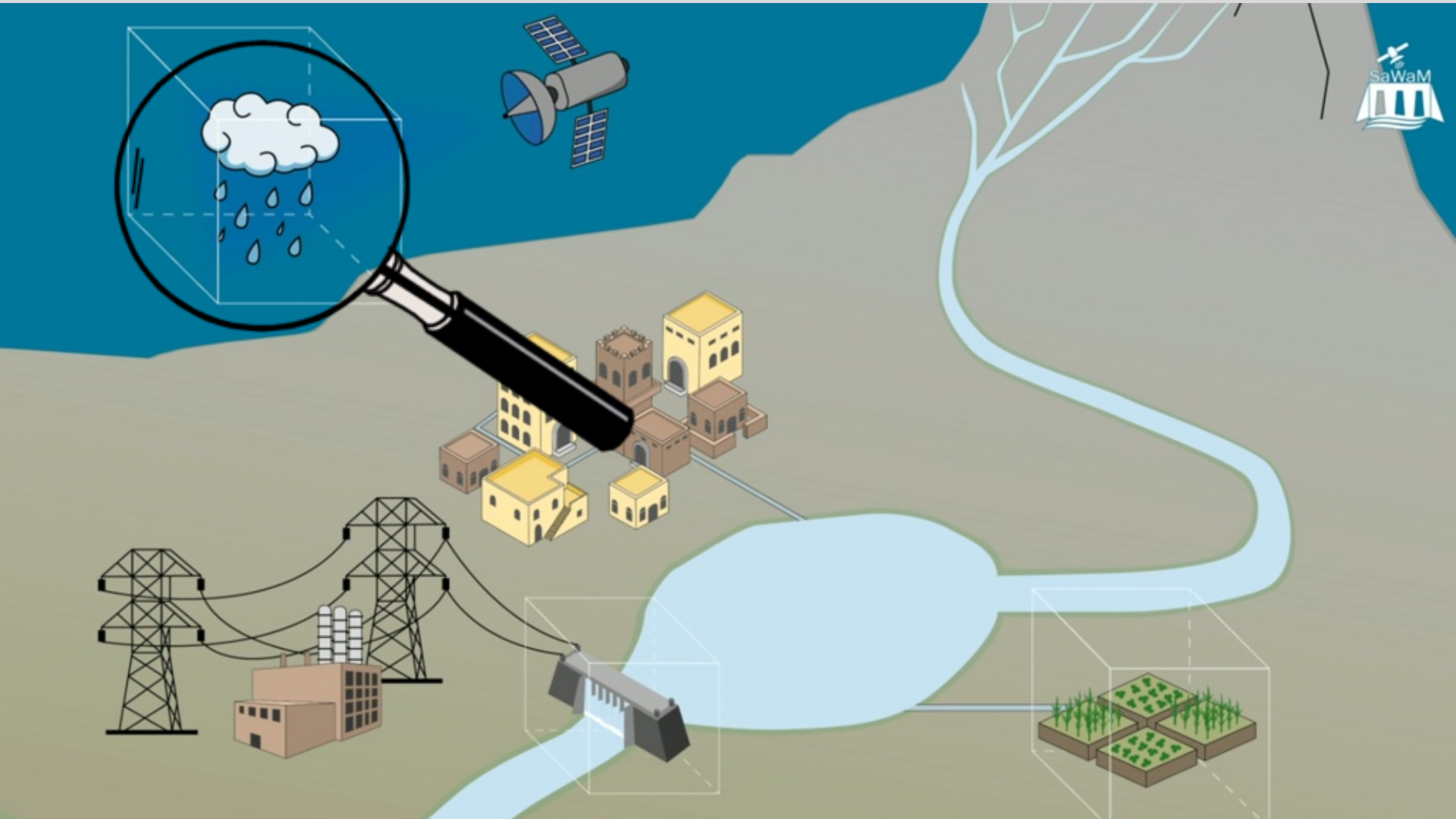


**Relative frequency of drought months significantly increased from 10 to 30 % between 1981 and 2018 in our SaWaM regions**



# Methods







# Seasonal Predictions: Hydrometeorology

**SPIEGEL** Politik

14.10.2020

Überschwemmungen im Sudan

## "Wo immer die Menschen gehen sie hin"

Seit Beginn der Aufzeichnungen gab es wie in diesem Jahr. Hameed Nuru, Land spricht über die Folgen.

Ein Interview von **Fritz Schaap**, Kapstadt  
14.10.2020, 20.25 Uhr



**Recent Sudan 2020 flood: Indications of extreme  
3 months ahead with our forecast system**

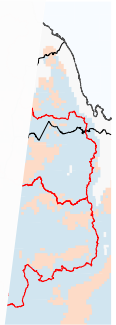
Tuesday, October 13, 2020 at 2:41:28 PM Central European Summer Time

**Subject:** Re: Monthly Precipitation Forecast  
**Date:** Tuesday, 13. October 2020 at 13:41:27 Central European Summer Time  
**From:** Lorenz, Christof (IMK)  
**To:** Mehrdad Taghian  
**CC:** Kunstmann, Harald (IMK)  
**Attachments:** Khuzestan\_prec\_202010.pdf

Dear Mehrdad,

**Nuru:** Please find the newest forecast attached to this mail. Similar to the forecast from last month, the rainy season is predicted with quite dry conditions. Do you have any new information from your own forecasts?

Cheers,  
Christof



1/09

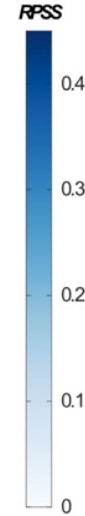
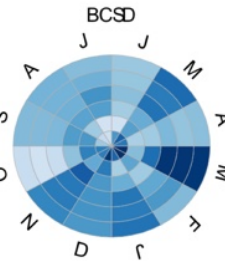
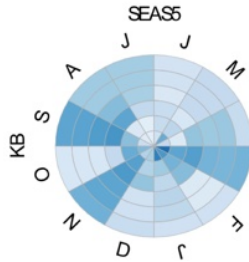
eme Wet

# Seasonal Predictions: Skill Scores Hydrometeorology 1983-2015

**Raw ECMWF-SEAS5**

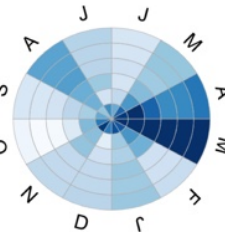
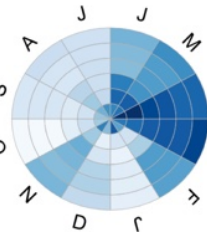
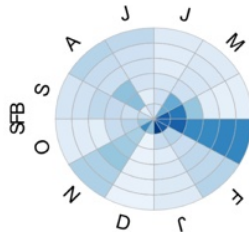
**Different Bias Corrections**

@ Karun



Ranked  
Probability  
Skill Score

@ São Francisco



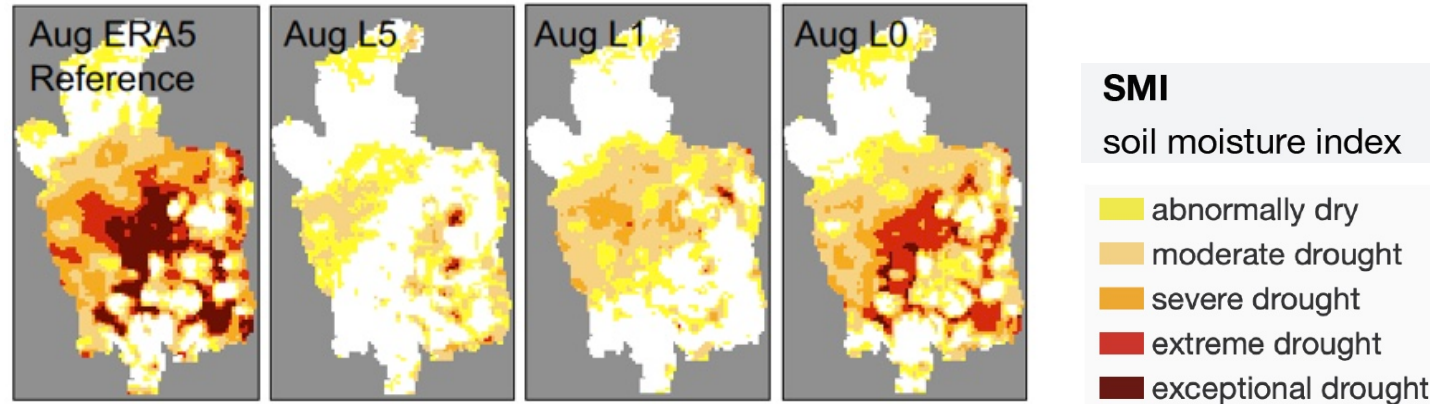
**Bias correction of ensemble based prediction significantly improves predictability skill scores**



# Seasonal Predictions: Hydrology



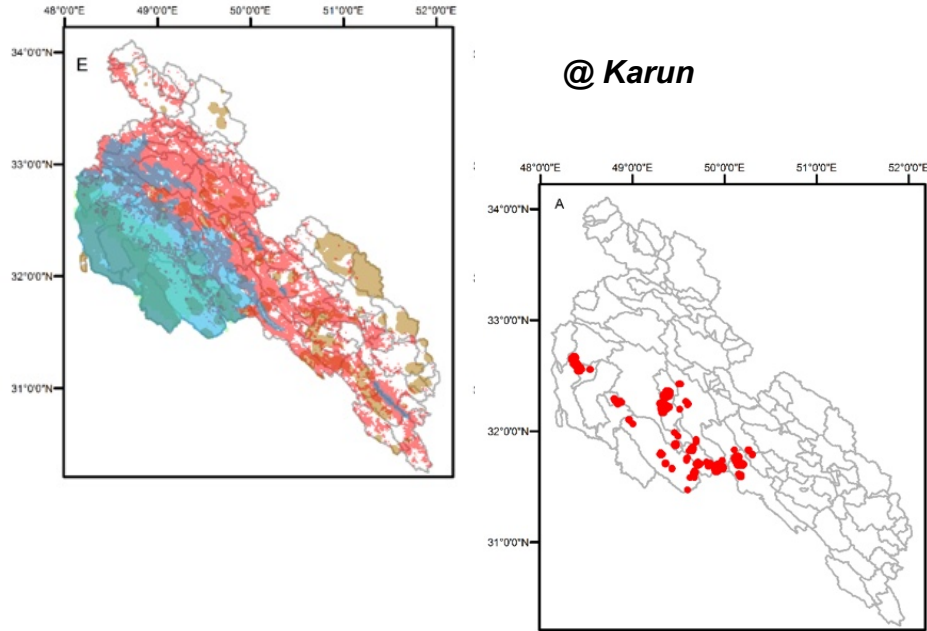
@ *Blue Nile / Tekezé Atbara*



**Sudan drought 2015: indication of drought already forecasted 6 months ahead (L5) and intensify with lower forecast horizons (L0,L1)**

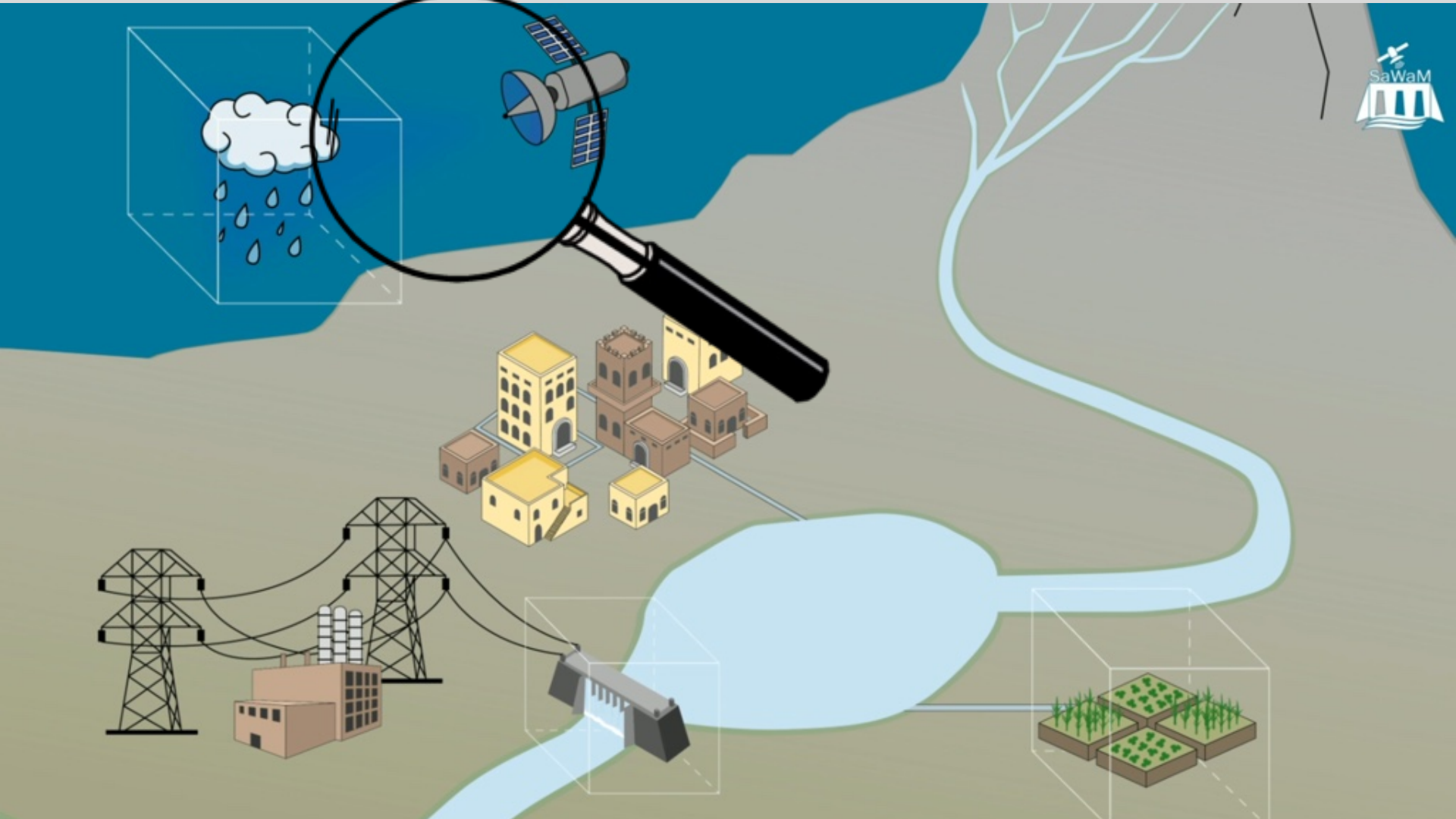


# Erosion Hot Spot Tool to Prevent from Reservoir Sedimentation



**Leverage areas:** Management of very small fraction of catchment results in significant reduction of erosion & siltation

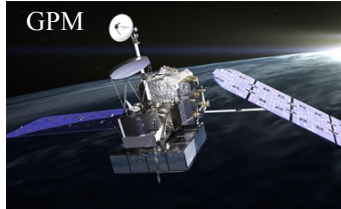
Emerging hotspots of **rainfall**, **connectivity**, **soil erodibility**, **vegetation**



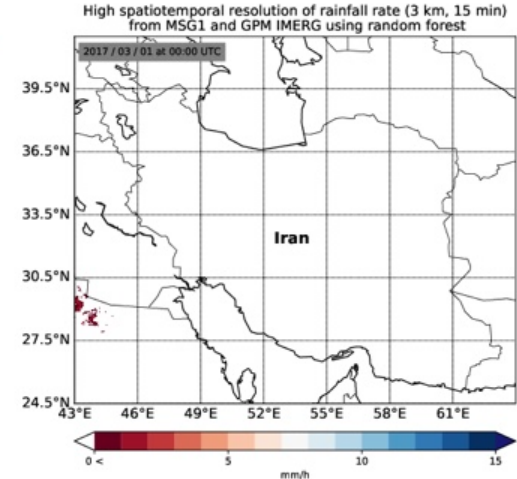
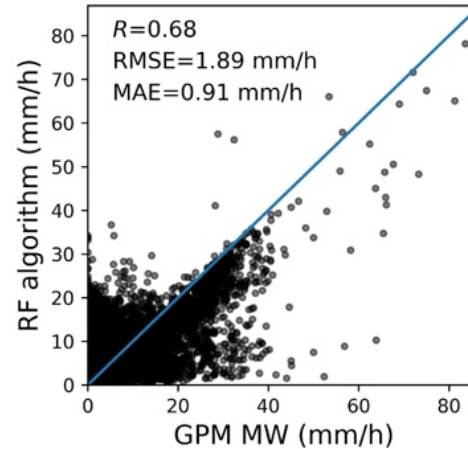
# Remote Sensing of Precipitation

GEO multispectral  
satellite  
data in high spatial  
(2-3 km) &  
temporal (15 min)  
resolution

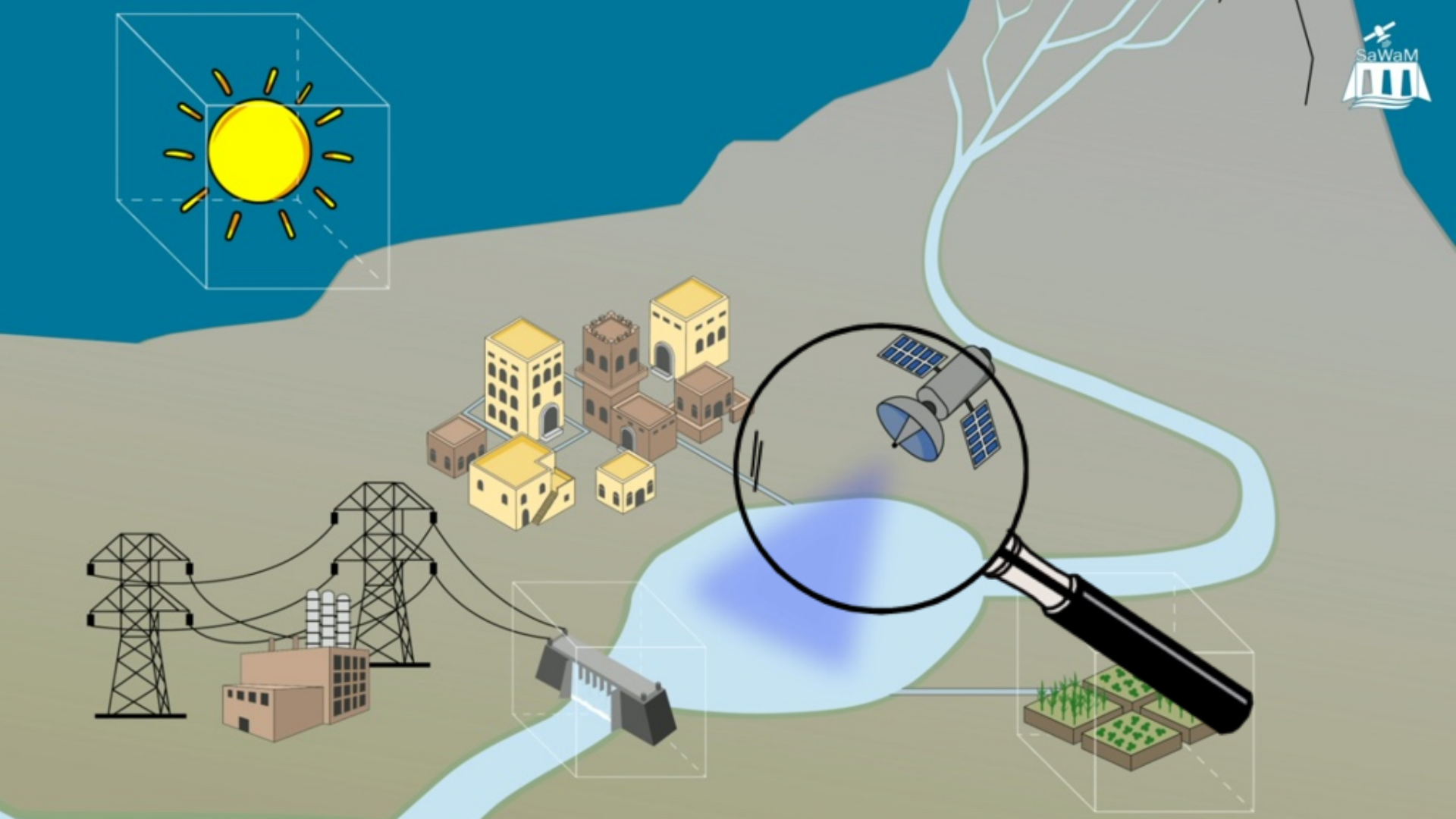
High quality MW  
precipitation  
information  
lower spatial  
(11km) & temporal  
(3 h) resolution



Random Forest algorithms (RF)

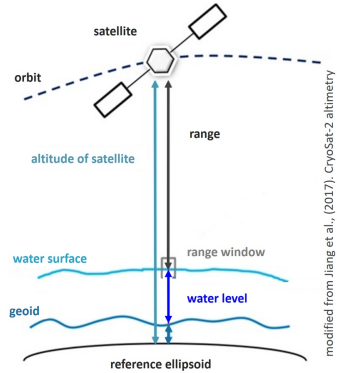


High resolution near real time rainfall information from satellites via RF





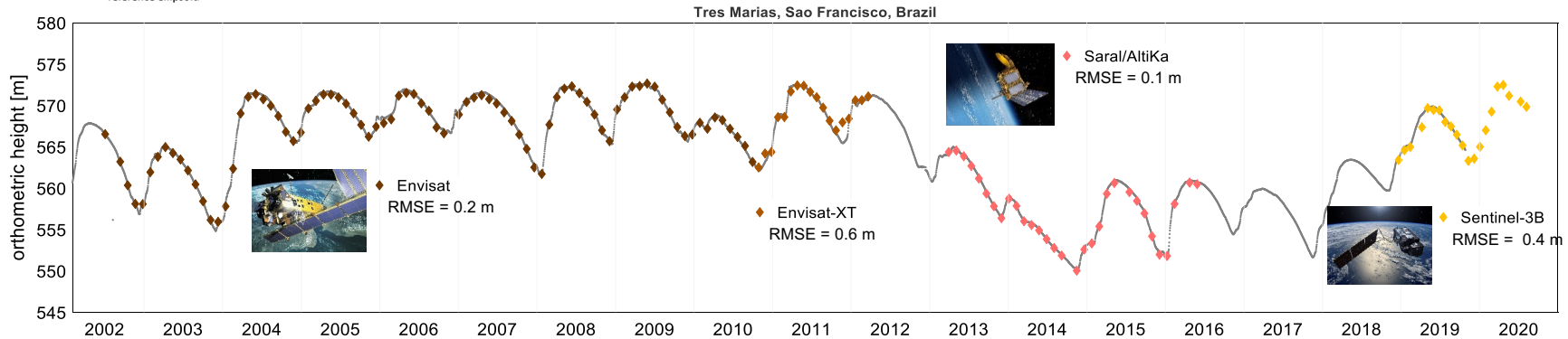
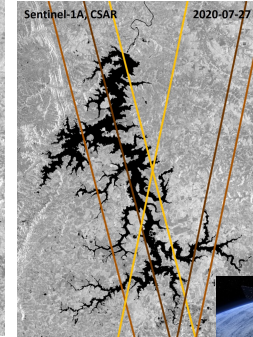
# Remote Sensing of Water Variables



modified from Jiang et al., (2017). CryoSat-2 altimetry applications over rivers and lakes. Water, 9(3), 211.



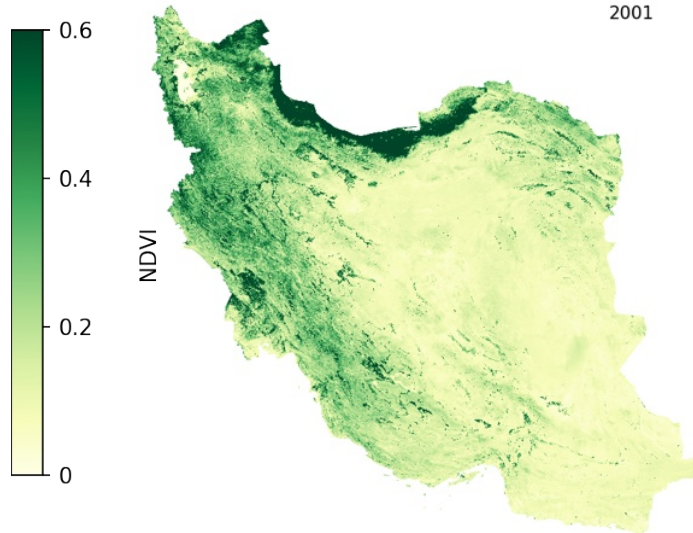
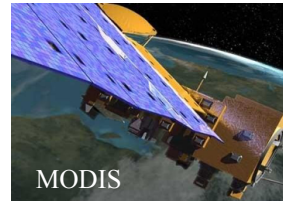
@ São Francisco



**Satellite altimetry allows for monitoring of streamflow and reservoir levels**



# Remote Sensing of Vegetation



Annual vegetation dynamics 2001-2019

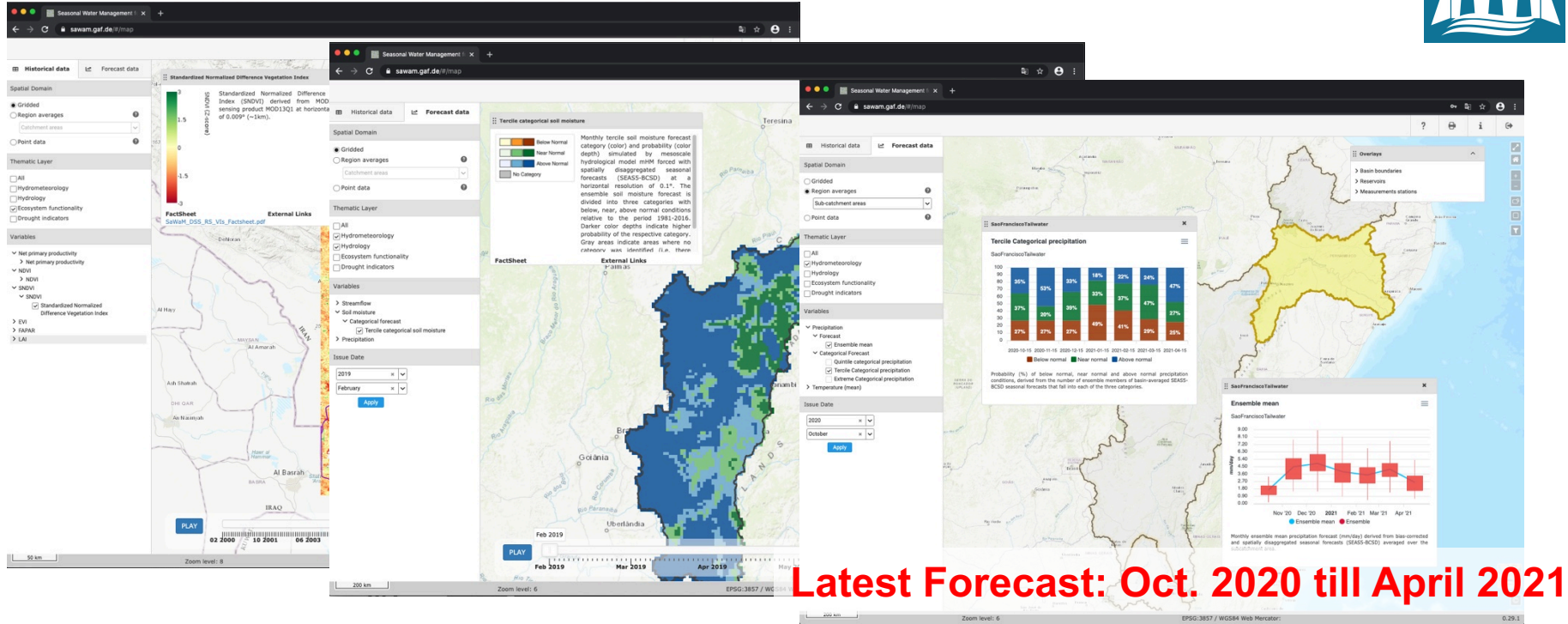


Surface water dynamics  
Khuzestan flooding 2018-2019

**Monitoring for decision support during flood and drought conditions**



# Online Decision Support System



Ensemble based seasonal prediction 7 months ahead for decision support in water– and ecosystem management



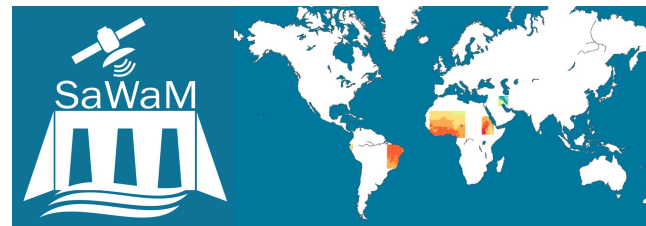
# Outreach: Highlights



# GROW Synergy: Prototype for *Global* Seasonal Drought Prediction

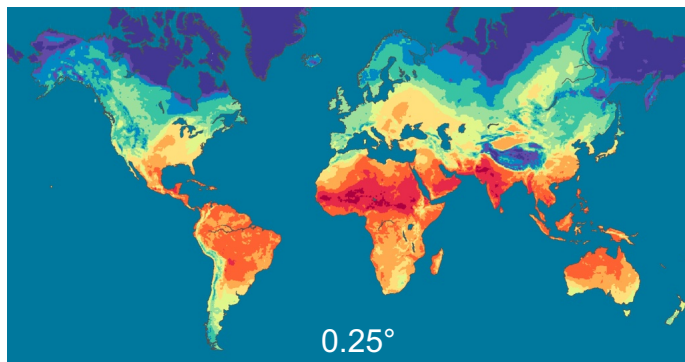


GRoW - GlobeDrought  
Characterizing drought risk and impact



**Bias corrected seasonal forecasts**  
51-member Ensemble

GCWM crop model: **Global  
Agricultural Drought Forecast**



Exemplarily  
March-Sep 2018



**From regional to global  
seasonal forecasts &**

**Towards detailed  
agricultural drought  
indicators**

# Summary



- We are running an **operational seasonal prediction system**
- Via **bias correction** and **regionalization**, seasonal forecasts achieve **skill** even for forecast horizons **up to seven months ahead**
- Our regionalized seasonal forecasts are **available 6./7. of current month** (i.e. 1 day after ECMWF-SEAS5 raw data release)
- **Multi-aspect drought assessment** by monitoring, remote sensing and forecasting
- **Bridging between scientists and stakeholders** was key for successful development of our methods and tools