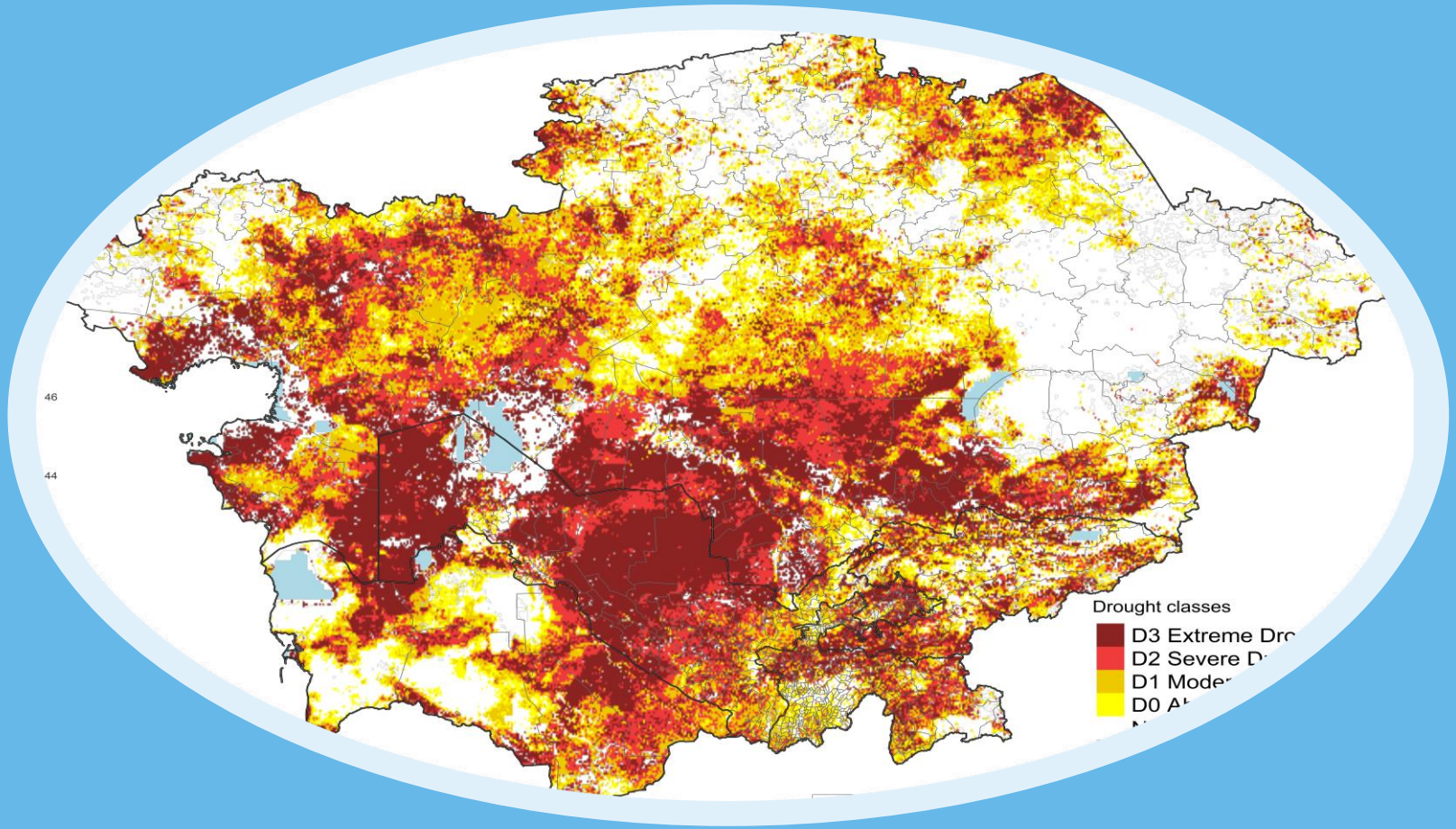
Drought Monitoring and Early Warning System for Central Asia



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Outline

- Drought management: concept and pillars
- Drought management in Central Asia
- Drought monitoring in Central Asia: existing systems
- Drought monitoring for Central Asia (RDMS-CA): prototype
- RDMS-CA: validation process
- Early Warning System for CA: drought forecasting system

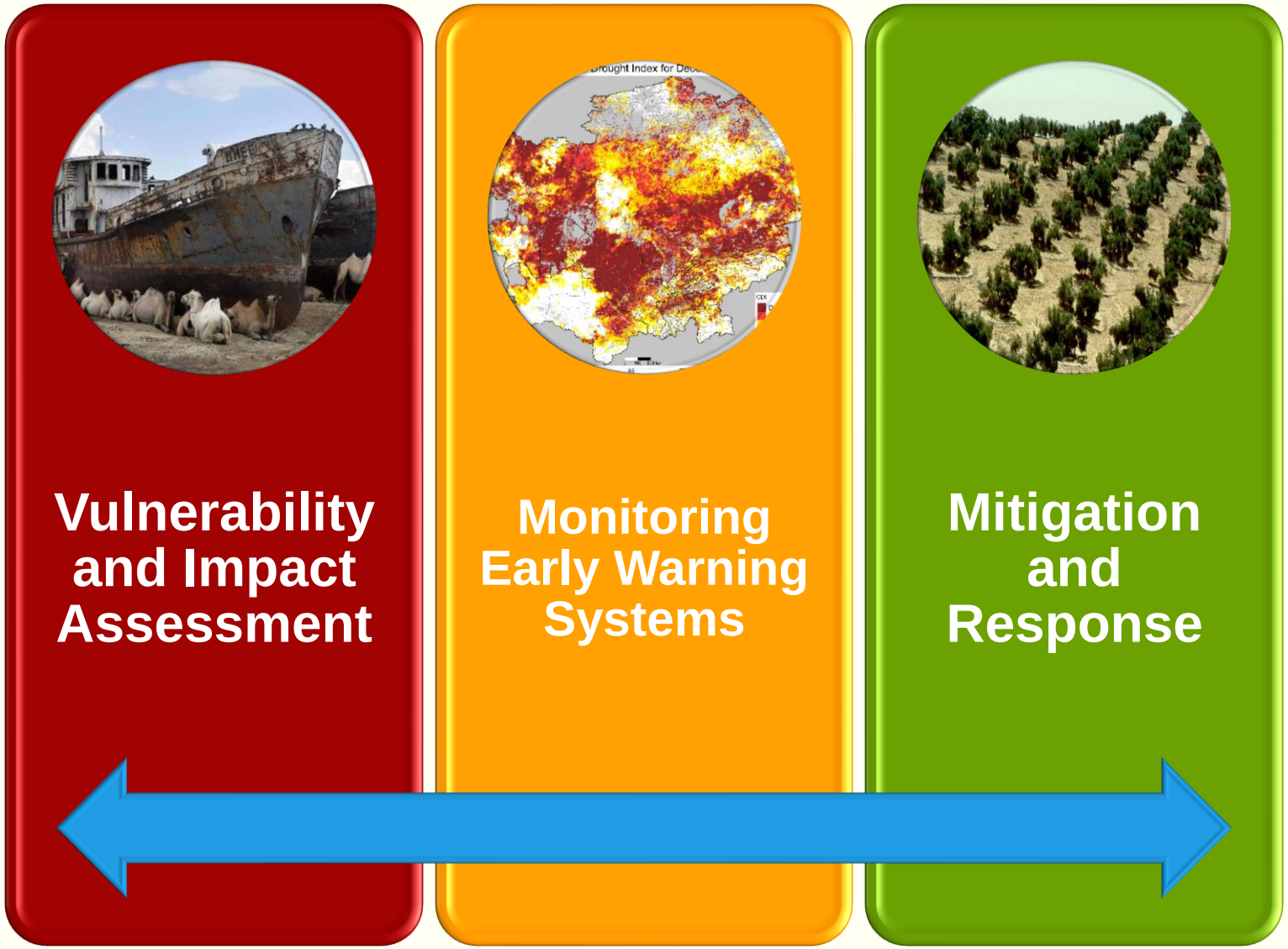
Drought management: concept and pillars

Based on Integrated Drought Management Plan (IDMP) developed by WMO and GWP

Vulnerability and impact assessment: who is at risk and when

Monitoring and early warning systems: which area is impacted and how

Mitigation and response: what to do, when and who to target



Drought management in Central Asia

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Center for Emergency Situations and Disaster Risk Reduction (2020) published a study on:

“ASSESSMENT OF DROUGHT CHALLENGES AND DROUGHT MONITORING MODELS IN CENTRAL ASIAN REGION”

Drought monitoring in Central Asia

National Hydrometeorological Services network (Soil moisture)

Some issues with this network (identified under CACILM-2):

- Agrometeorological equipment is physically outdated and requires urgent updating
- Technical conditions leading to disruption of the agrometeorological products
- In some stations, acute shortage of instruments for determining moisture, freezing and thawing of the soil
- No agrometeorological observations and software for predicting soil and atmospheric drought, dry wind, hail, and ice

Drought monitoring in CA: existing systems

Drought monitoring systems based on ground-based observations

Index Name	Symbol	Calculation	Initial information for calculation	Availability of information for its calculation
Hydrothermal coefficient of Selyaninov [17],	(HTC)[18],	$HTC = \frac{\sum r}{0{,}1\sum t}$	Σr - the sum of precipitation (mm) Σt - the sum of the sum of the active daily average air temperatures	Available
Coefficient of humidification by Ivanov[19]	K	$K = \frac{\overline{R}}{\overline{E_0}},$	R - the sum of total precipitation for the year, mm $\overline{E_0}$ - volatility per year, mm	Partially available
Pedya's Index (atmospheric soil drought)	Si	$S_i(\tau) = \frac{\Delta T}{\sigma_T} - \frac{\Delta R}{\sigma_R} - \frac{\Delta E}{\sigma_E}$	□T, □R, □Y - anomalies of air temperature, precipitation and humidity in the active soil layer (up to 1 m)	Partially available
Pedya's Index (atmospheric drought)	Si	$S_i(\tau) = \frac{\Delta T}{\sigma_T} - \frac{\Delta R}{\sigma_R}.$		Available
Pedya's Index (soil drought)	Si	$S_i(\tau) = \frac{\Delta E}{\sigma_E}$		Partially available
Standardized Precipitation Index[20 21].	SPI	$SPI = F^{-1}G(R)$	Precipitation	Available
Standardized Precipitation Evapotranspiration index.[22]	SPEI	Di= Ri-PETi	(R)-Monthly precipitation and PET potential evapotranspiration	
Palmer Drought Severity Index.[23 2425]	PDSI		Precipitation, temperature, moisture available	Partially available

Drought monitoring in CA: existing systems

Drought monitoring systems based on remote sensing

Index Name	Symbol	Calculation formula	Initial information for calculation	Availability of information for its calculation
Normalized Differential Vegetation Index [28]	NDVI	$NDVI = \frac{NIR - RED}{NIR + RED}$	Low and medium spatial resolution satellite data (NOAA-AVHRR, SPOT-IV, MODIS), air temperature	Available
Vegetation Index [29]:	VCI	$VCI = \frac{NDVI_i - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$		
Integral Vegetation Index	IVI	$IVI = \sum_{i=1}^{18} NDVI_i$		
Integral index of vegetation conditions	IVCI	$IVCI = \frac{IVI_i - IVI_{min}}{IVI_{max} - IVI_{min}}$		
Drought Index [30]	ID	ID = (T4d + T4n) / NDVI		

In 2011, the Kazakhstan National Center for Space Research and Technology (NCSRT) together with the LLP (Scientific and Production Center for Grain Management named after A.I. Barayev) developed a drought monitoring system based on remote sensing

Drought monitoring: existing global systems

System	Index used	Resolution	Type of information	Open source
https://iridl.ldeo.columbia.edu/maproom/Global/Drought/Global/CPC_GOB/Analysis.html	3-month SPI	1^{o}x1^{o}	Global map and time series at locations	No
https://gdis-noaa.hub.arcgis.com/pages/drought-monitoring	SPI, SPEI, ESI, Soil Moisture, CDI for Europe only	Various resolutions	Static maps	No
https://www.apcc21.org/ser/global.do?lang=en	1, 3, 6 and 12 months SPI	2.5^{o}x2.5^{o}	Static maps	No
http://drought.eng.uci.edu/	SPI, SSI and MSDI	Various resolutions	Static maps (last map available February 2016)	No

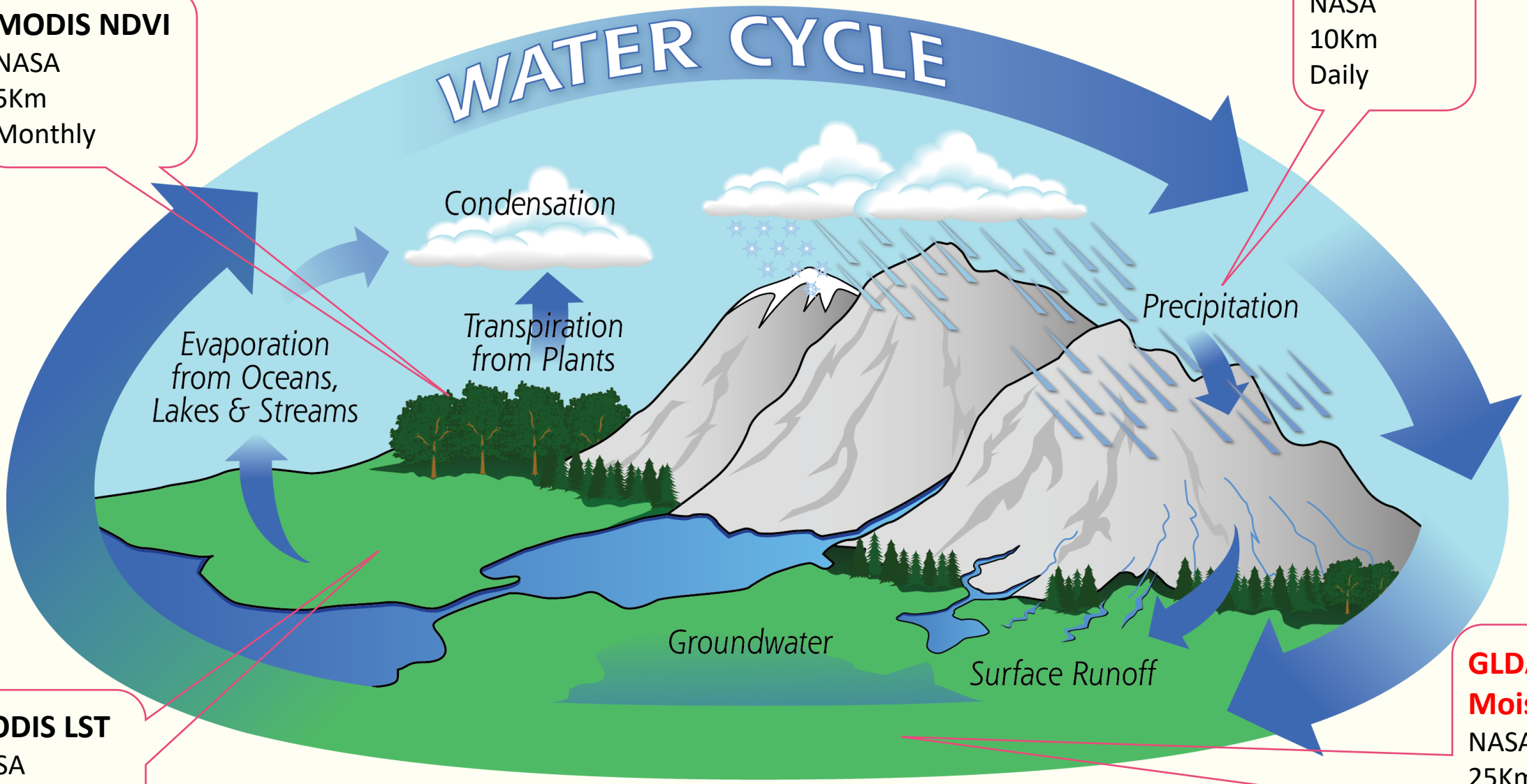
Main characteristics

- Meteorological SPI and SPEI indices only
- Coarse resolution (around 100km by 100km)
- Providing only static maps

RDMS-CA: Prototype developed by ICBA

MODIS NDVI
NASA
5Km
Monthly

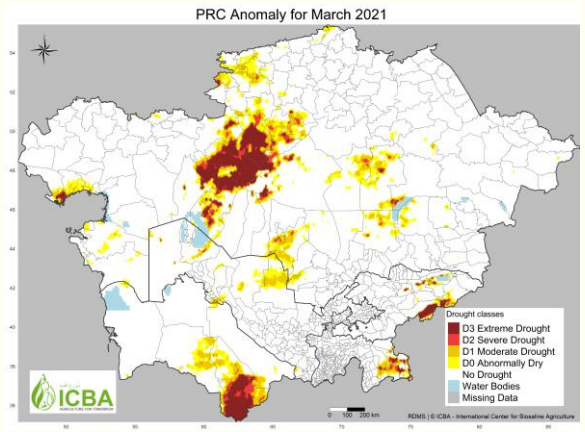
IMERG
NASA
10Km
Daily

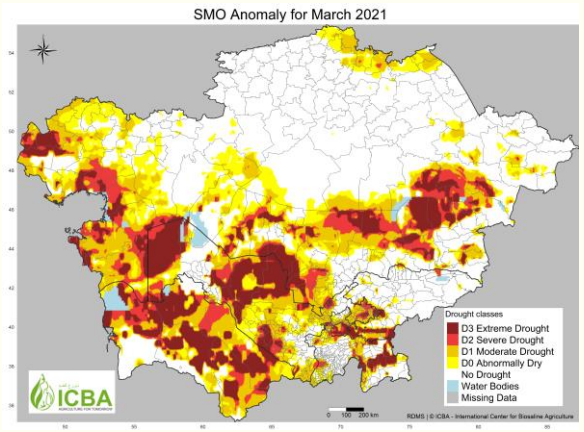


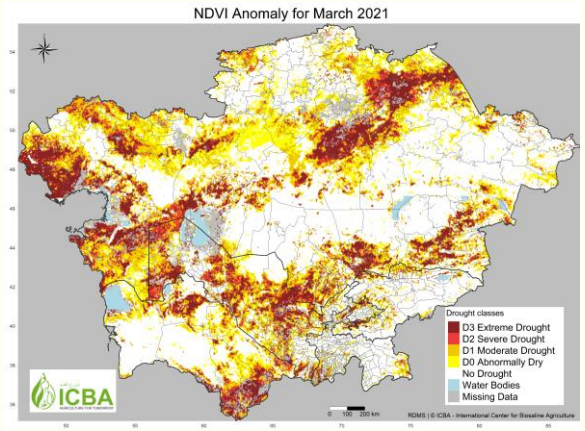
MODIS LST
NASA
5Km
Monthly

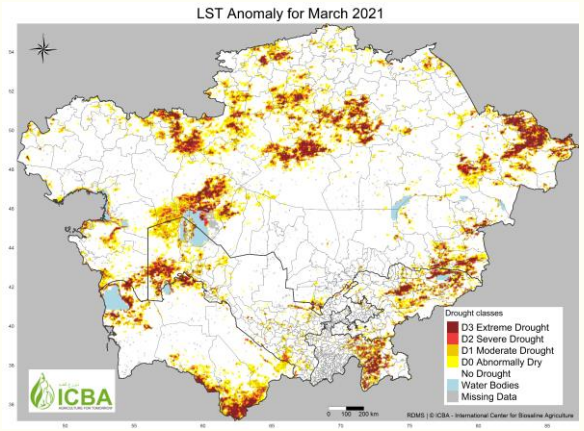
GLDAS Soil Moisture
NASA
25Km
Monthly

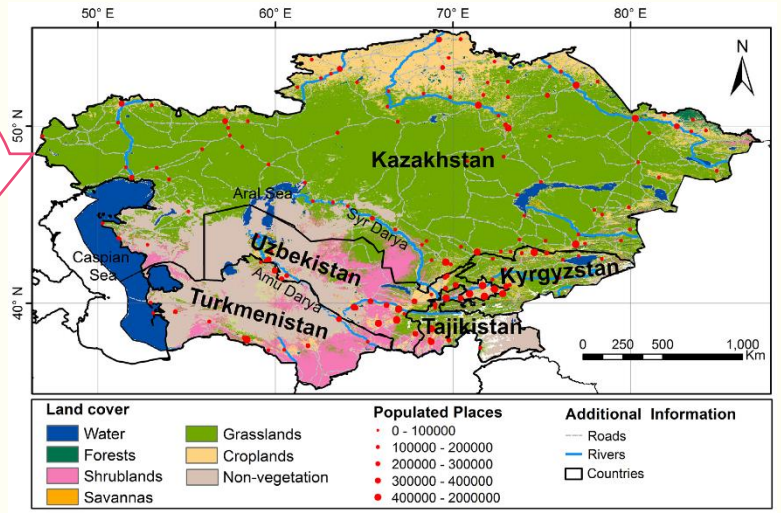
RDMS-CA: Prototype version 1

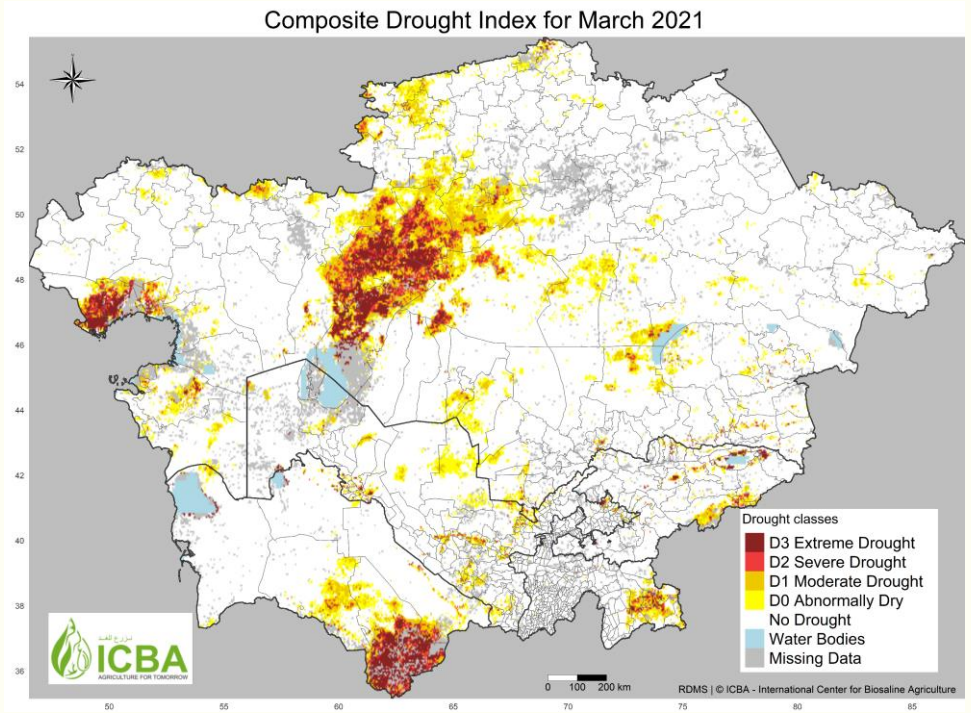












- Missing points due to cloud contamination in the LST and/or NDVI products

RDMS-CA: Validation process

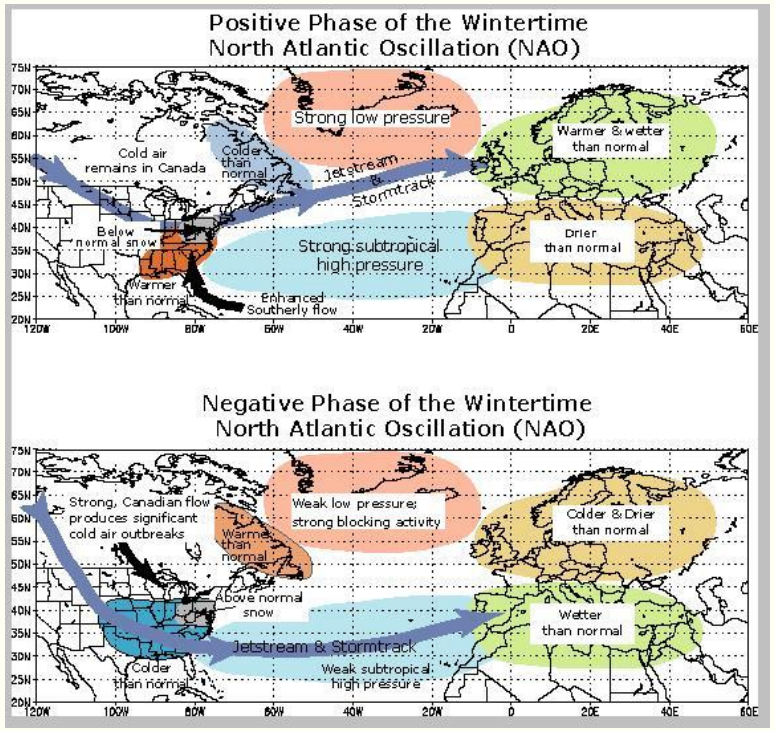
Understanding drought drivers: Teleconnections

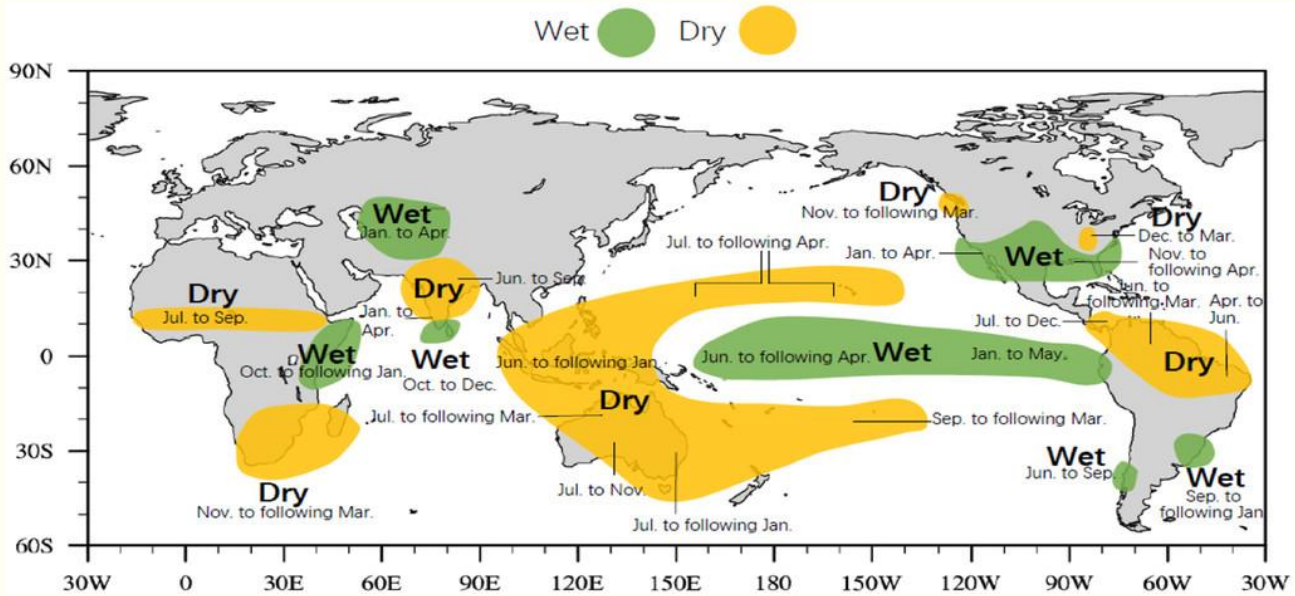
- Periodic variation of **relative position of pressure lows/highs**
- Associated with **sea-surface temperature and precipitation**

→ Can **influence even at great distance**

Examples:

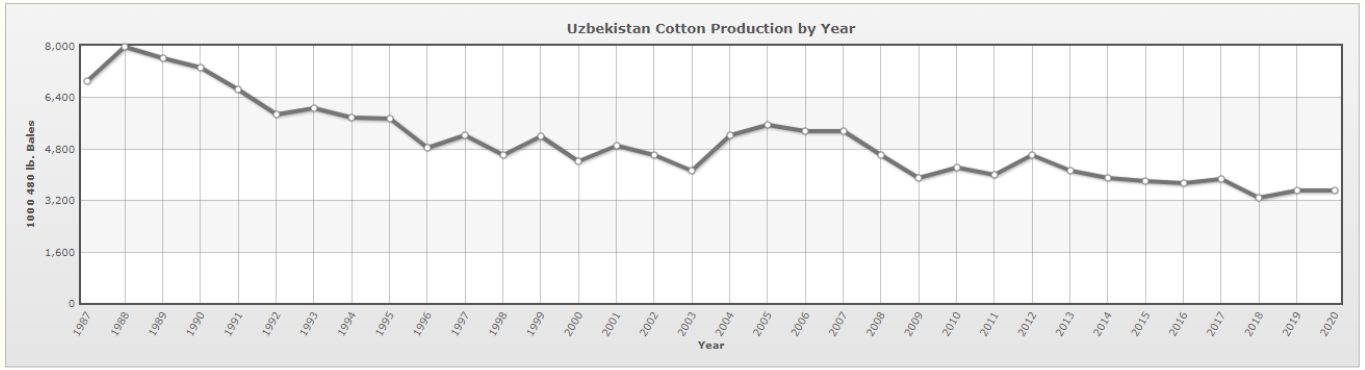
- **North Atlantic Oscillation,**
- **El Nino Southern Oscillation,**
- etc.

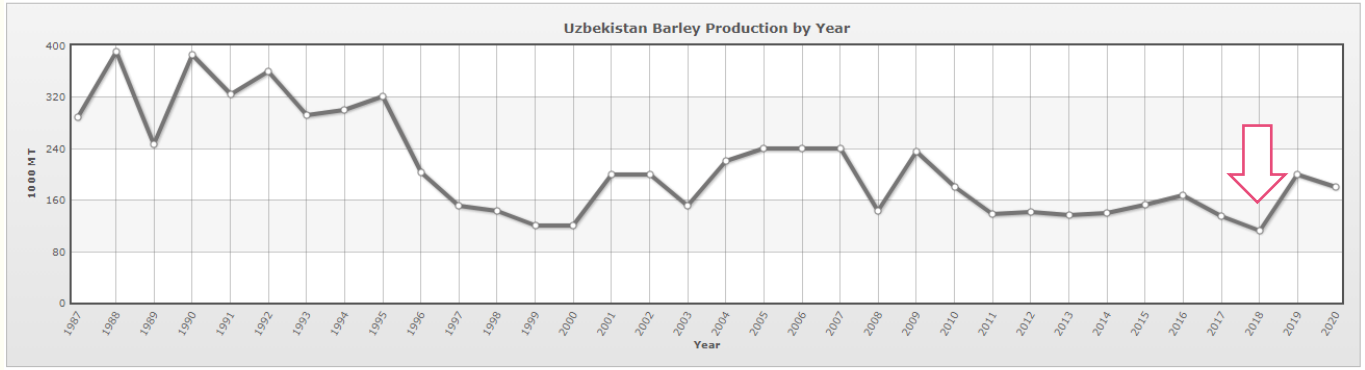


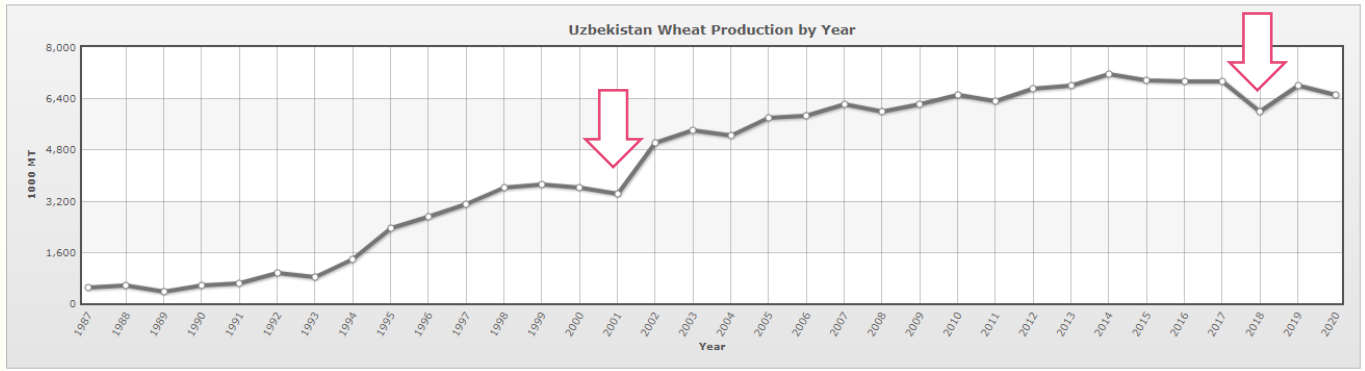


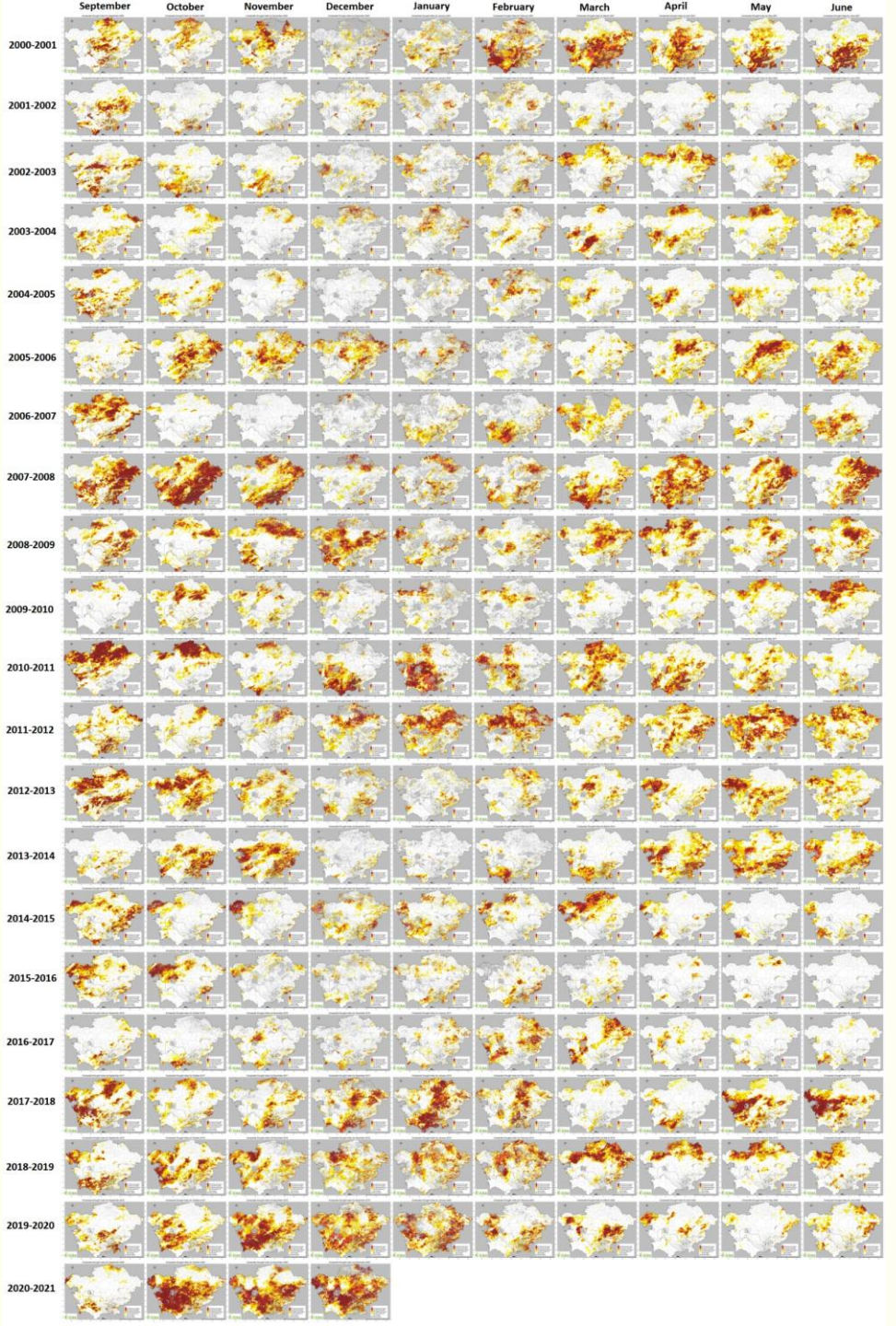
RDMS-CA: Validation process

Data on cereal production and others (water and livestock) will help in tuning CDI for the region and for each country









Early Warning System for CA: drought forecasting system

- Seasonal forecasting of weather parameters: provided by Copernicus climate service including data from ECMWF, UK Met Office, Meteo France, DWD, CMCC, NCEP and JMA

- List of available parameters
- Period covered: 1993-present
- Forecast range: 7 months
- Time frequency: 6 hours
- Resolution: $1^{o}x1^{o}$
- Area covered: Globe, possibility to extract sub-region

- [ ] 10m u-component of wind
- [ ] 10m wind gust since previous post-processing
- [ ] 2m temperature
- [ ] Evaporation
- [ ] Maximum 2m temperature in the last 24 hours
- [ ] Minimum 2m temperature in the last 24 hours
- [ ] Orography
- [ ] Sea surface temperature
- [ ] Snow density
- [ ] Snowfall
- [ ] Sub-surface runoff
- [ ] Surface net solar radiation
- [ ] Surface runoff
- [ ] Surface solar radiation downwards
- [ ] TOA incident solar radiation
- [ ] Top net thermal radiation
- [ ] Total precipitation
- [ ] 10m v-component of wind
- [ ] 2m dewpoint temperature
- [ ] Eastward turbulent surface stress
- [ ] Land-sea mask
- [ ] Mean sea level pressure
- [ ] Northward turbulent surface stress
- [ ] Runoff
- [ ] Sea-ice cover
- [ ] Snow depth
- [ ] Soil temperature level 1
- [ ] Surface latent heat flux
- [ ] Surface net thermal radiation
- [ ] Surface sensible heat flux
- [ ] Surface thermal radiation downwards
- [ ] Top net solar radiation
- [ ] Total cloud cover

Early Warning System for CA: drought forecasting system

Version 0 of Early Warning system will include:

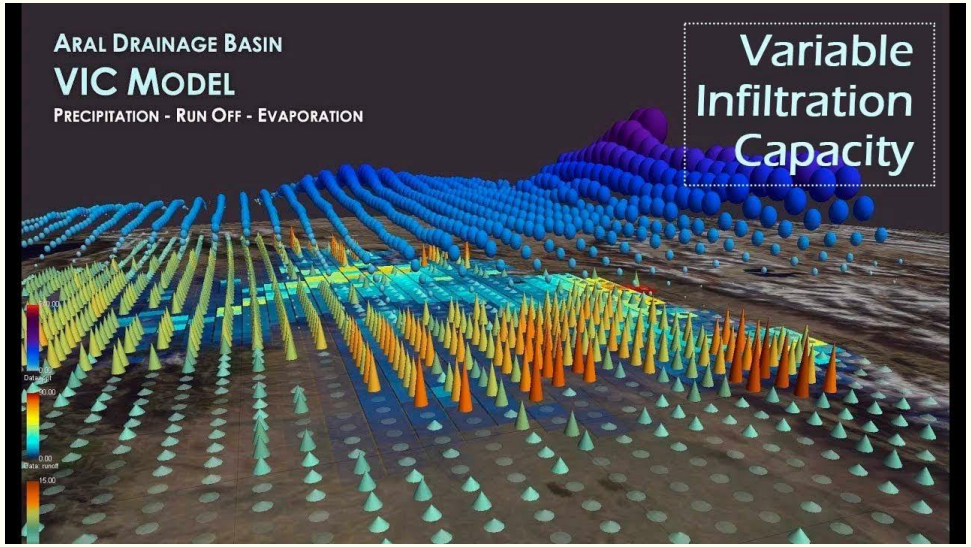
- SPI (1, 3 and 6 months)
- SPEI (1, 3 and 6 months)

Version 1 of EWS: Crop growth simulations

- An ensemble of simulations based on seasonal weather forecasts in selected agro-climate zones
- Candidate models: WOFOST and CROPSYST

Version 1-Bis of EWS: Hydrological simulations

- An ensemble of simulations based on seasonal weather forecasts in selected basins
- Candidate models: VIC, SWAT and LIS



Next steps

- Identify regional and local partners to validate the Drought Monitoring and Early Warning system at regional, national and sub-national levels
- Discuss with CAREC and local partners the requirements for such collaboration and alignment with the current project objectives
- Develop, in partnership with CAREC and partners, an implementation workplan and identify potential donors to support this activity

Thank you

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