Oficina Regional de Ciencia para América Latina y el Caribe

Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura

Programa Hidrológico Internacional

Examples of Climate Informing Decisions in Chile:

Advances/Challenges at the National and Water Basin Level

Koen Verbist	Walter Baethgen	Antonio Yaksic	Jorge Nuñez	Jan VanWambeke
UNESCO-IHP	IRI	Ministry of Agriculture	CAZALAC	FAO

International Research Institute for Climate and Society
Earth Institute | Columbia University

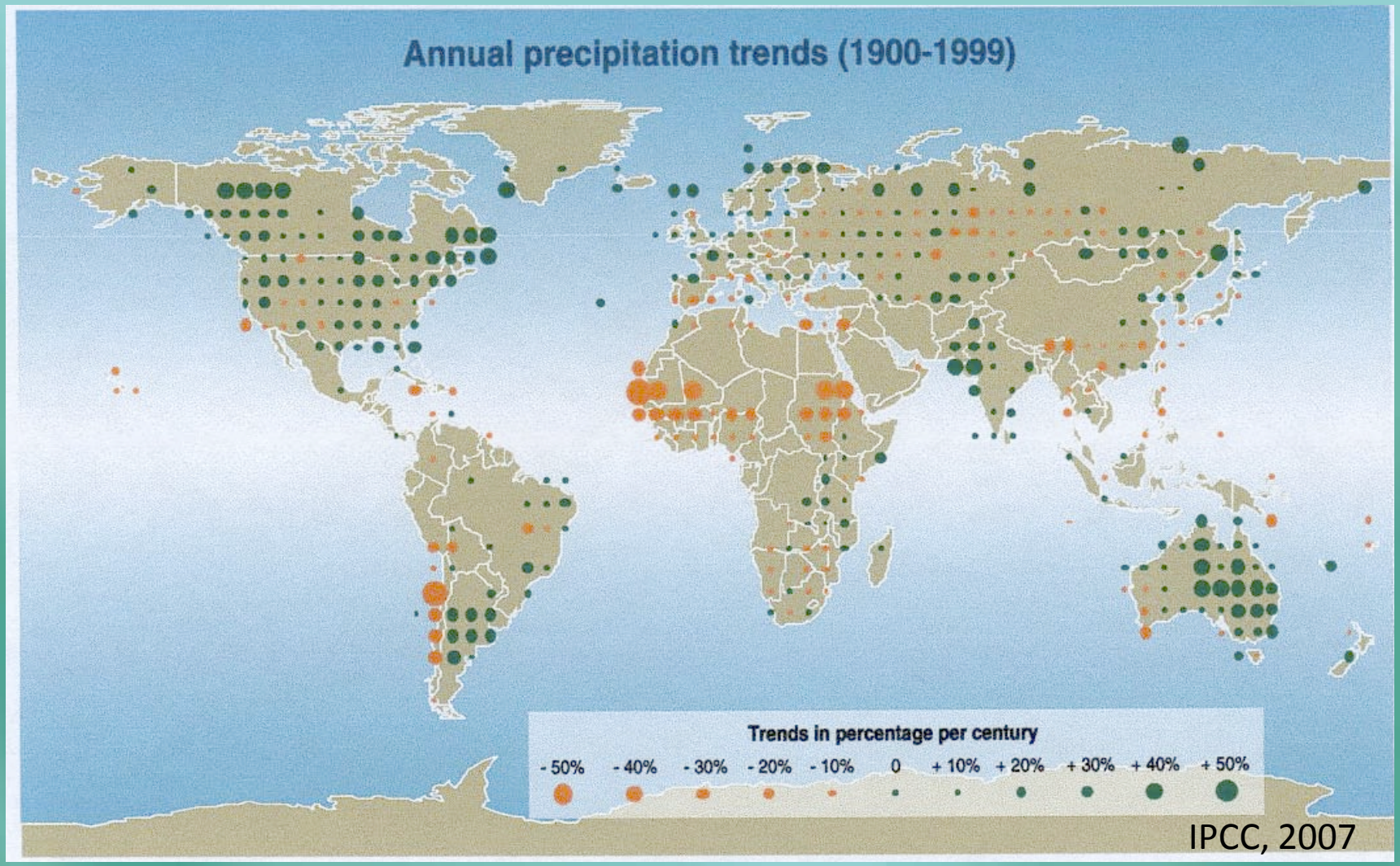
Developped by

With support from

WITH THE SUPPORT OF THE FLEMISH GOVERNMENT

Why is Climate Risk Management important in drylands of Chile?

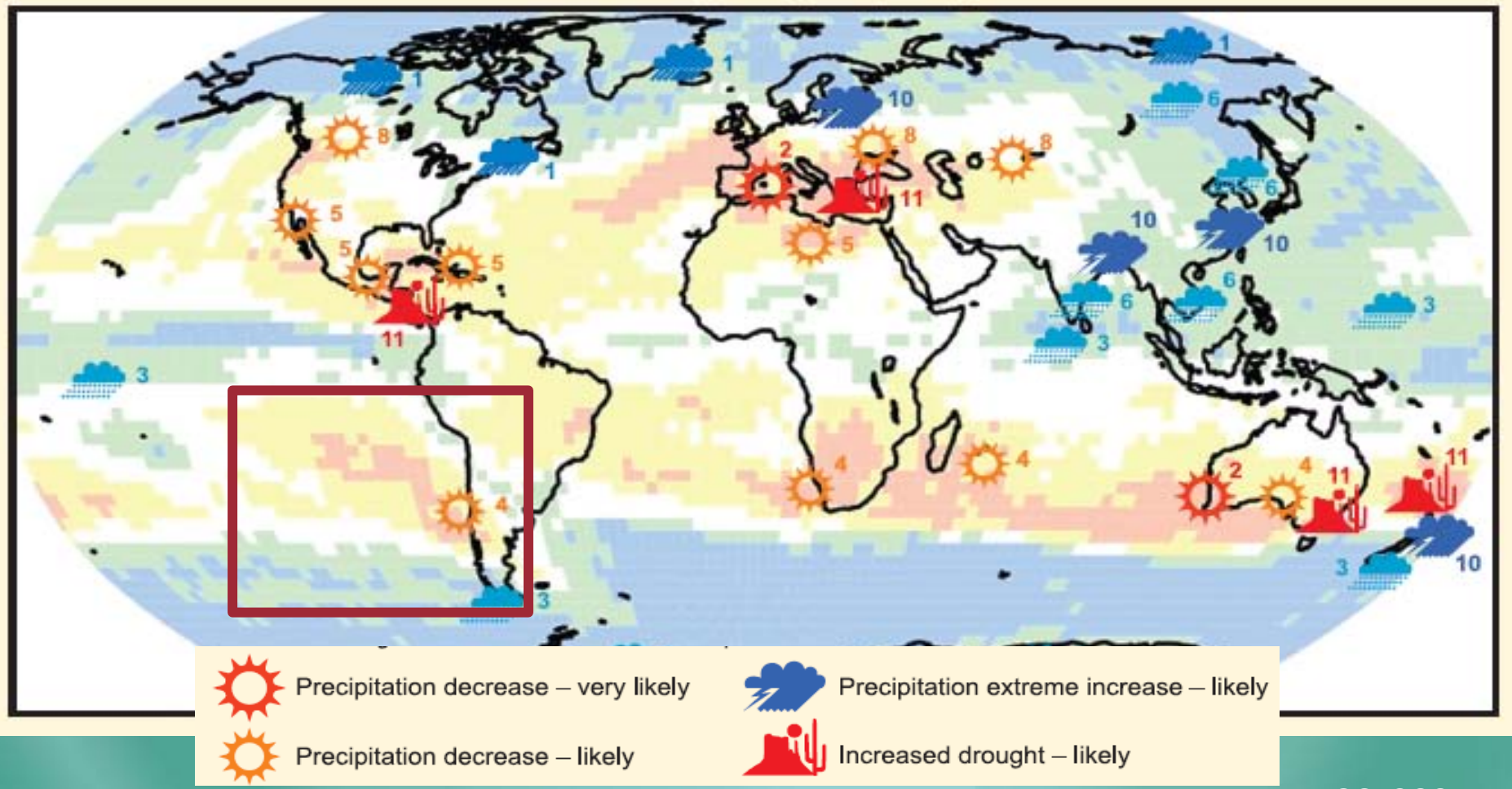
Past and current tendency for rainfall and resrvoir reductions



IPCC, 2007

Why is Climate Risk Management important in Chile?

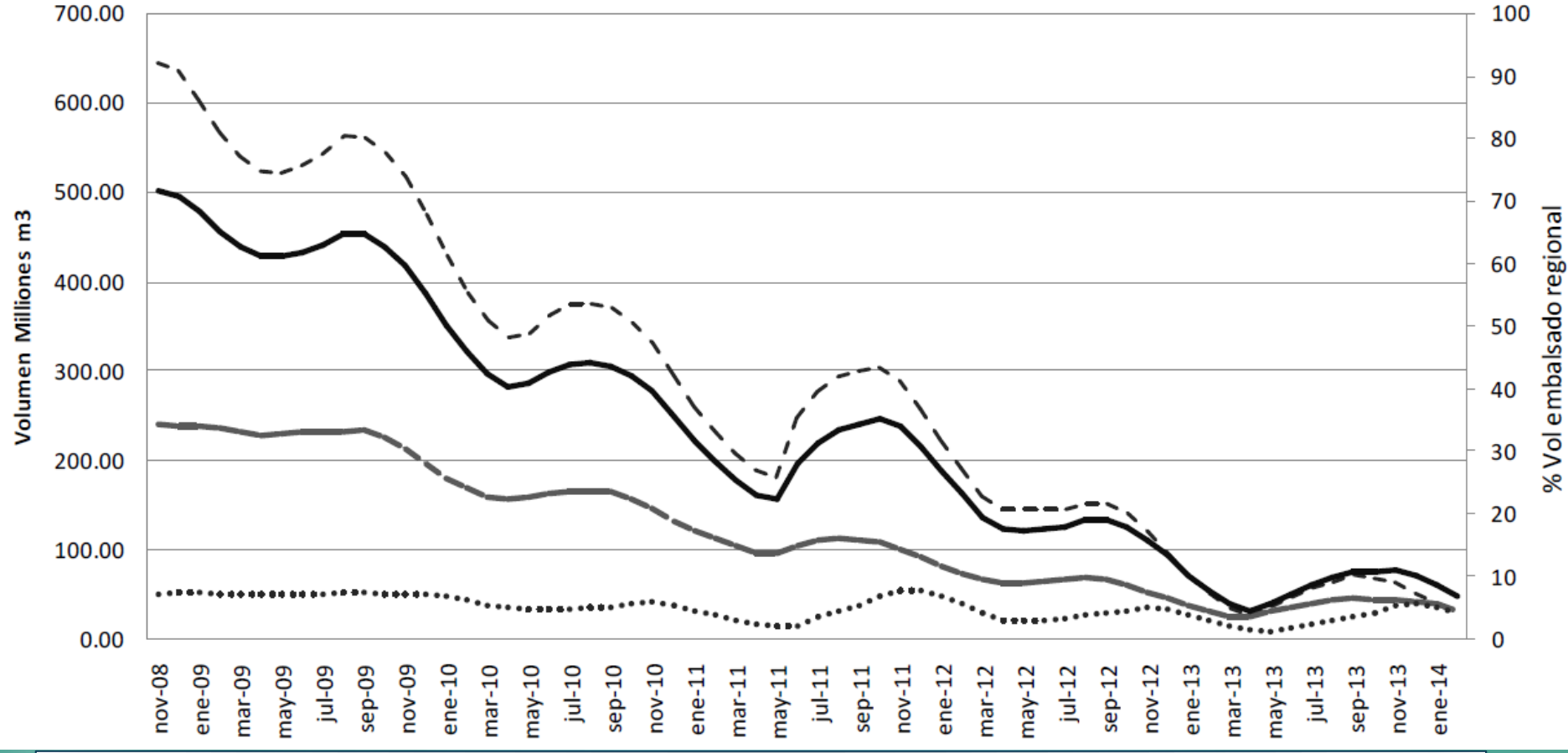
Climate models agree on further reductions in precipitation



IPCC, 2007

What is the impact on Water Resources Availability?

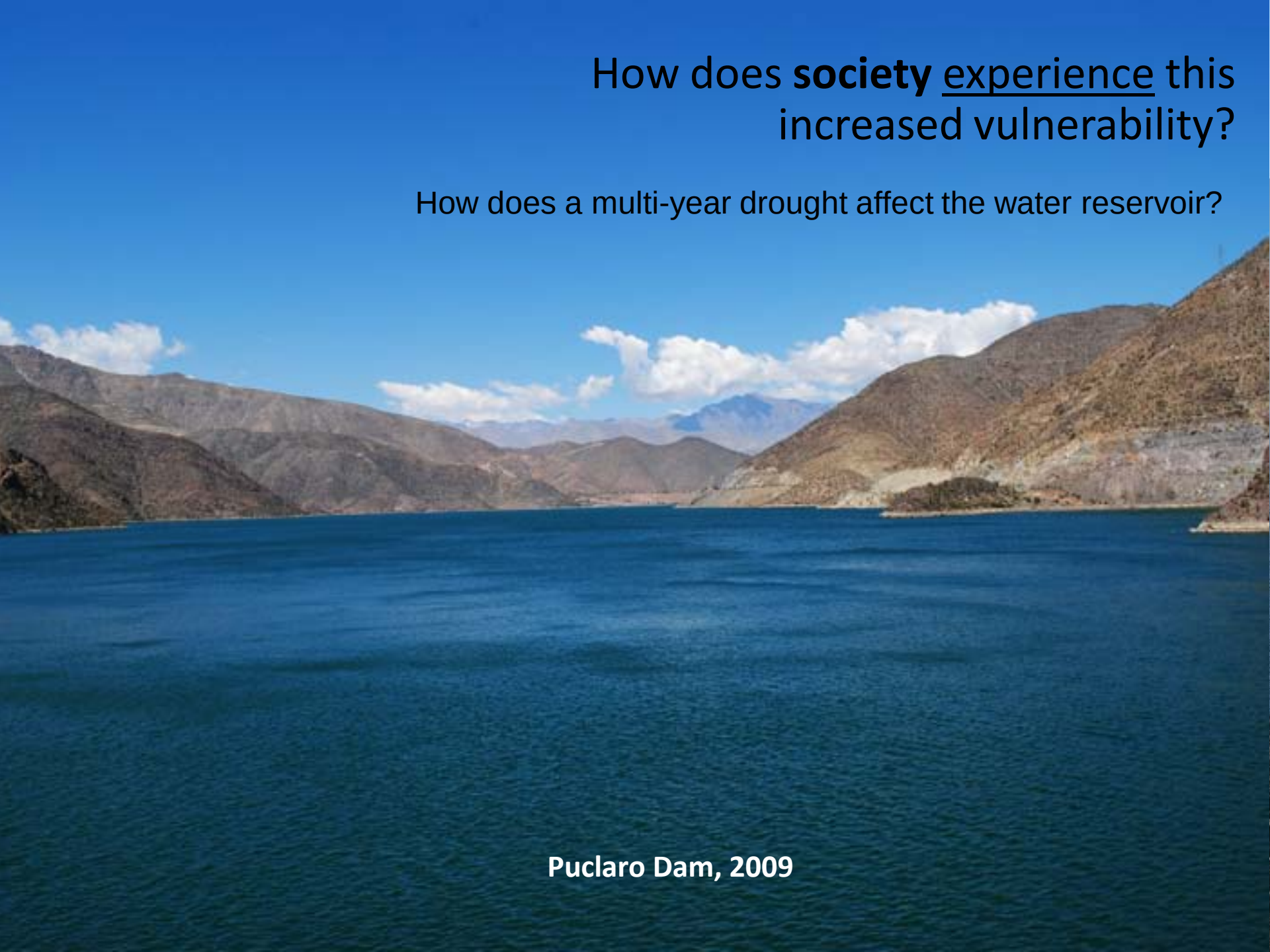
Occurrence of multi-year droughts



Reservoir levels in the Chilean Coquimbo Region

How does **society** experience this increased vulnerability?

How does a multi-year drought affect the water reservoir?



Puclaro Dam, 2009

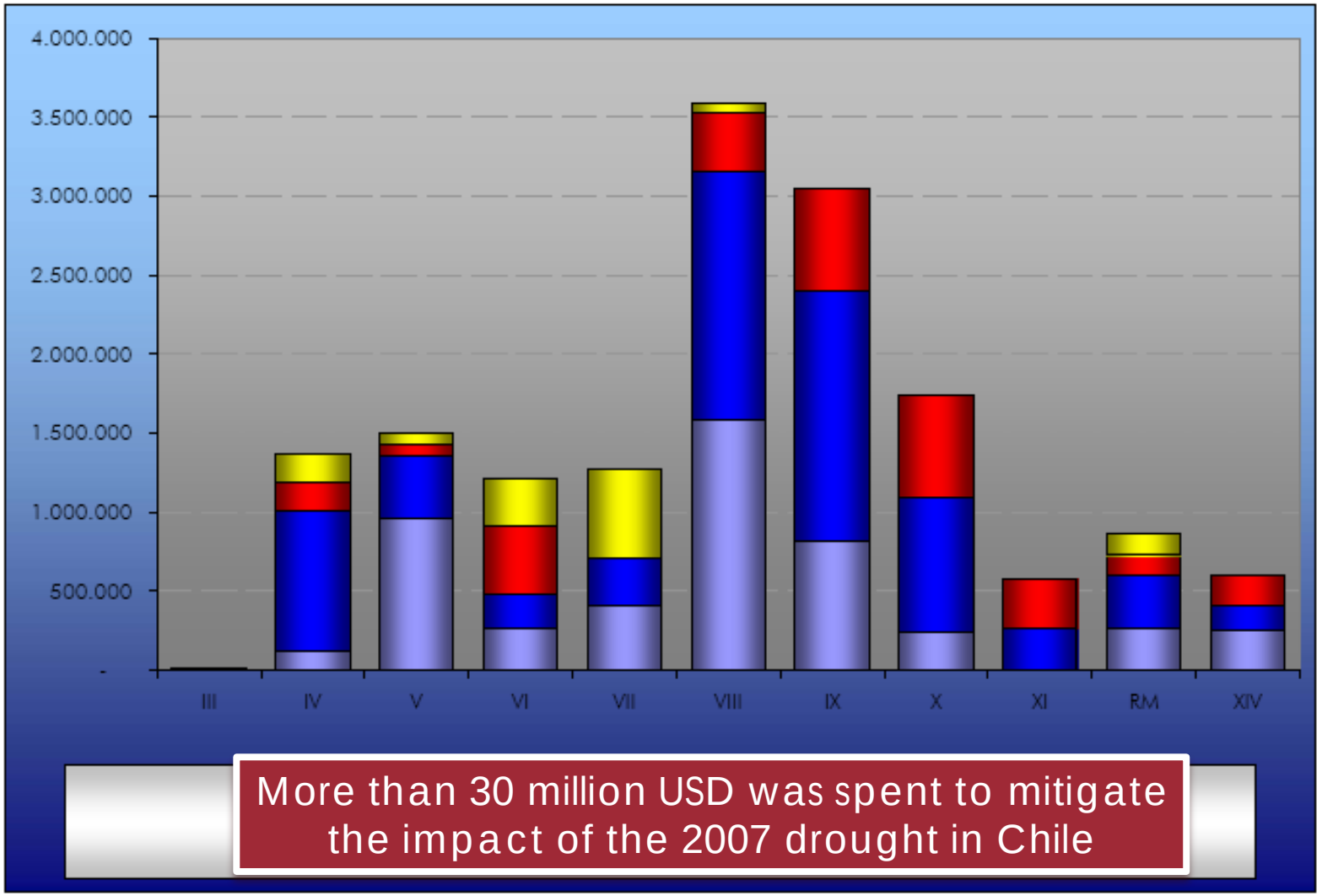
Puclaro Dam, May 2013

How do we approach drought risks?

2 different ways to address droughts

How do we approach drought risks?

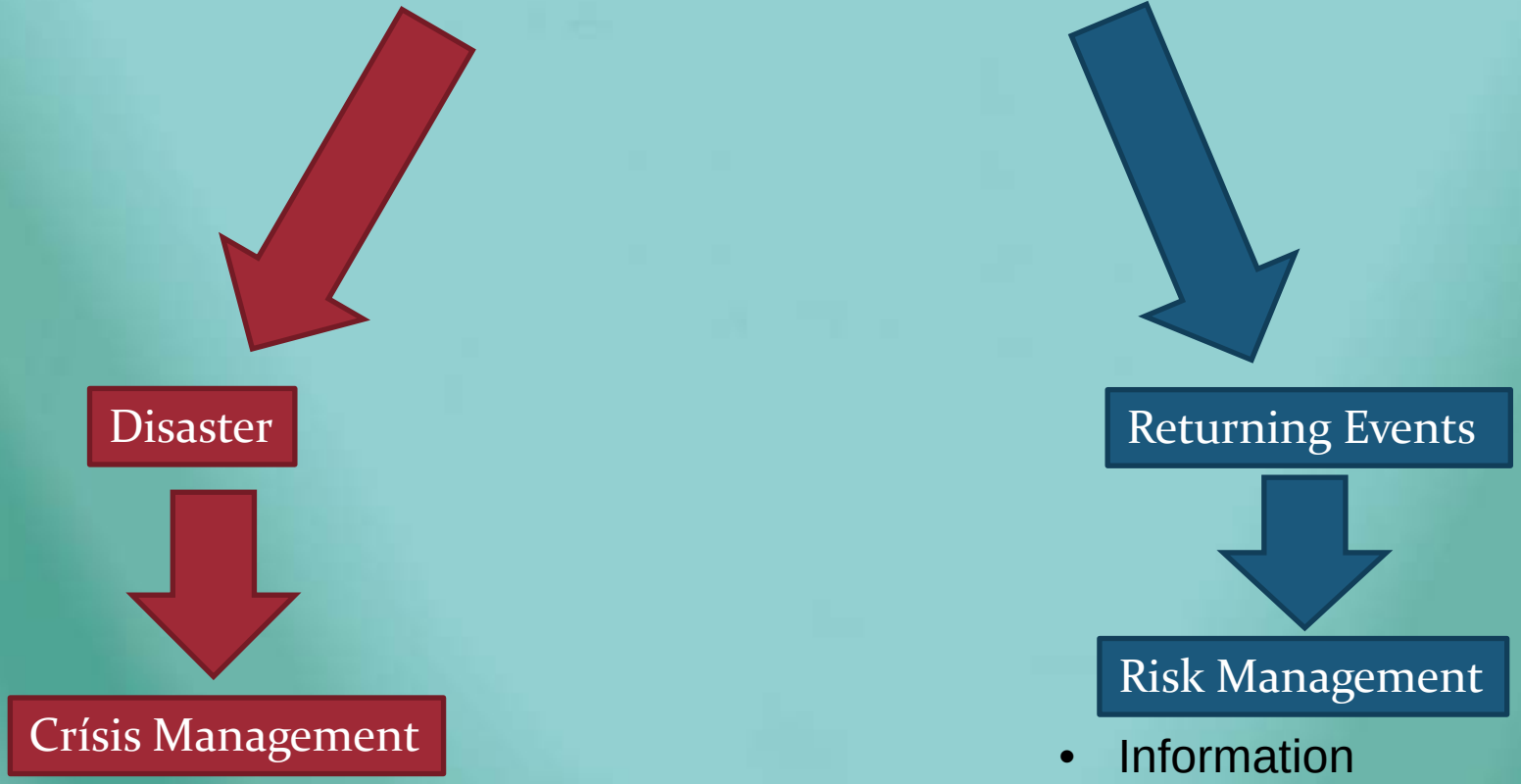
Managing the Crísis



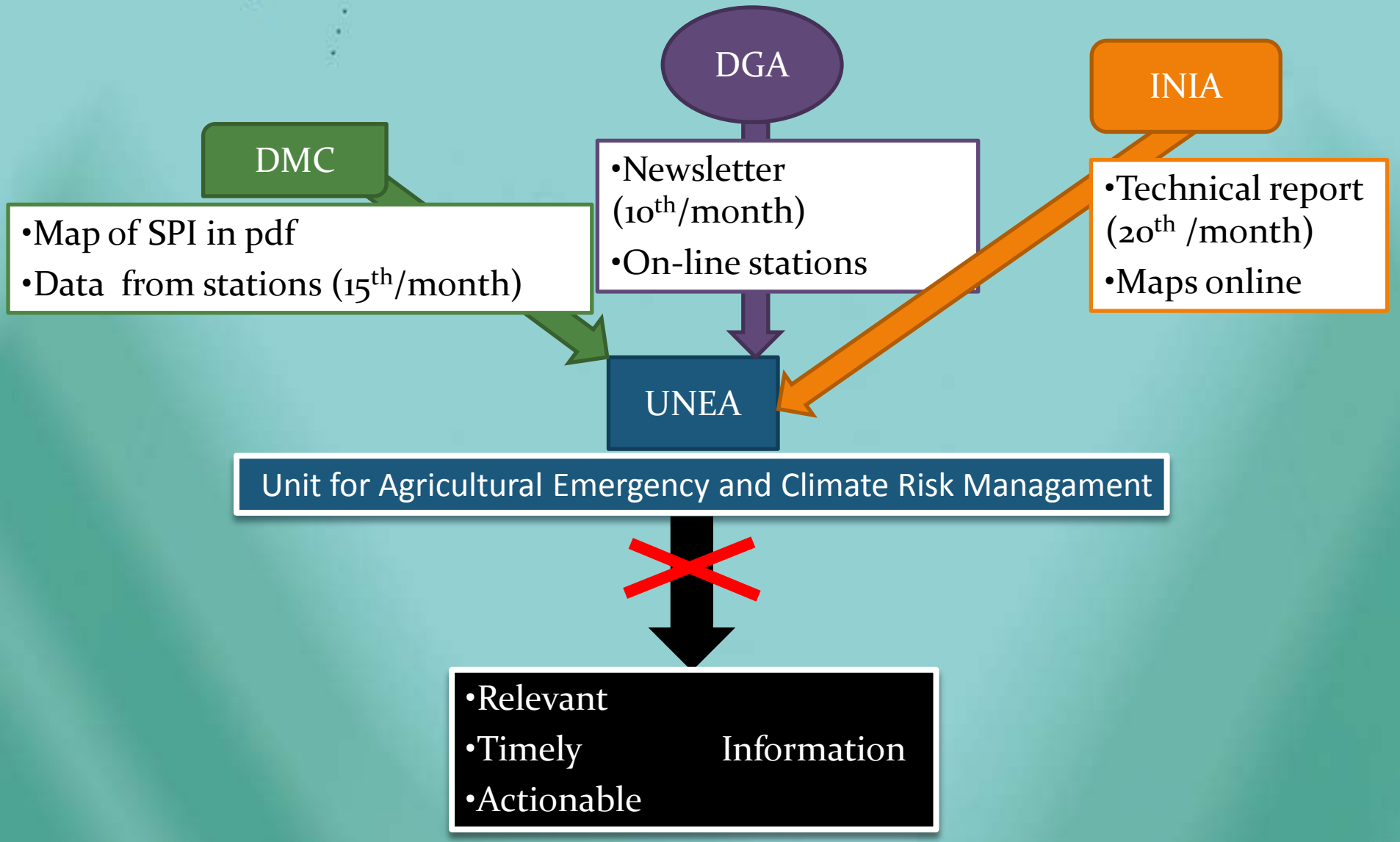
More than 30 million USD was spent to mitigate the impact of the 2007 drought in Chile

How do we approach drought risks?

2 different ways to address droughts



Why a National Drought Observatory?



Objectives of the agroclimatic observatory

Requieremements:

1. Count with all relevant agroclimatic information that:
   - are easy accessible
   - are up-to-date
   - consider different components of drought (meteorological, hydrological and agrícultural)

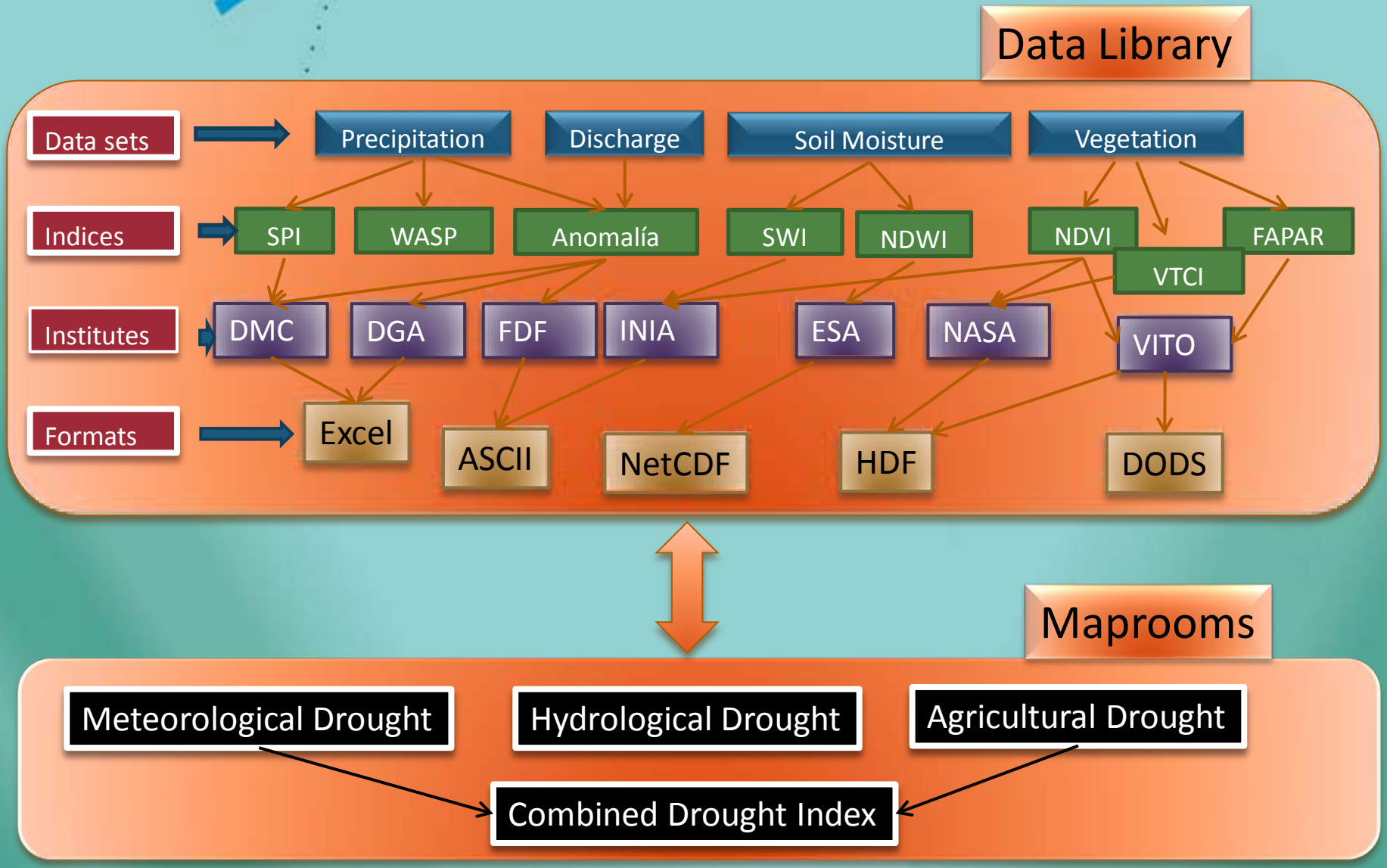
2. Be based upon already available information from the different national partners and complement with additional **remote sensing data sources**

3. Allow identifying areas most affected by droughts to allow prioritizing actions

4. Count with a seasonal outlook, on the evolution of drought conditions

5. Count with an environment that allows developping new applications

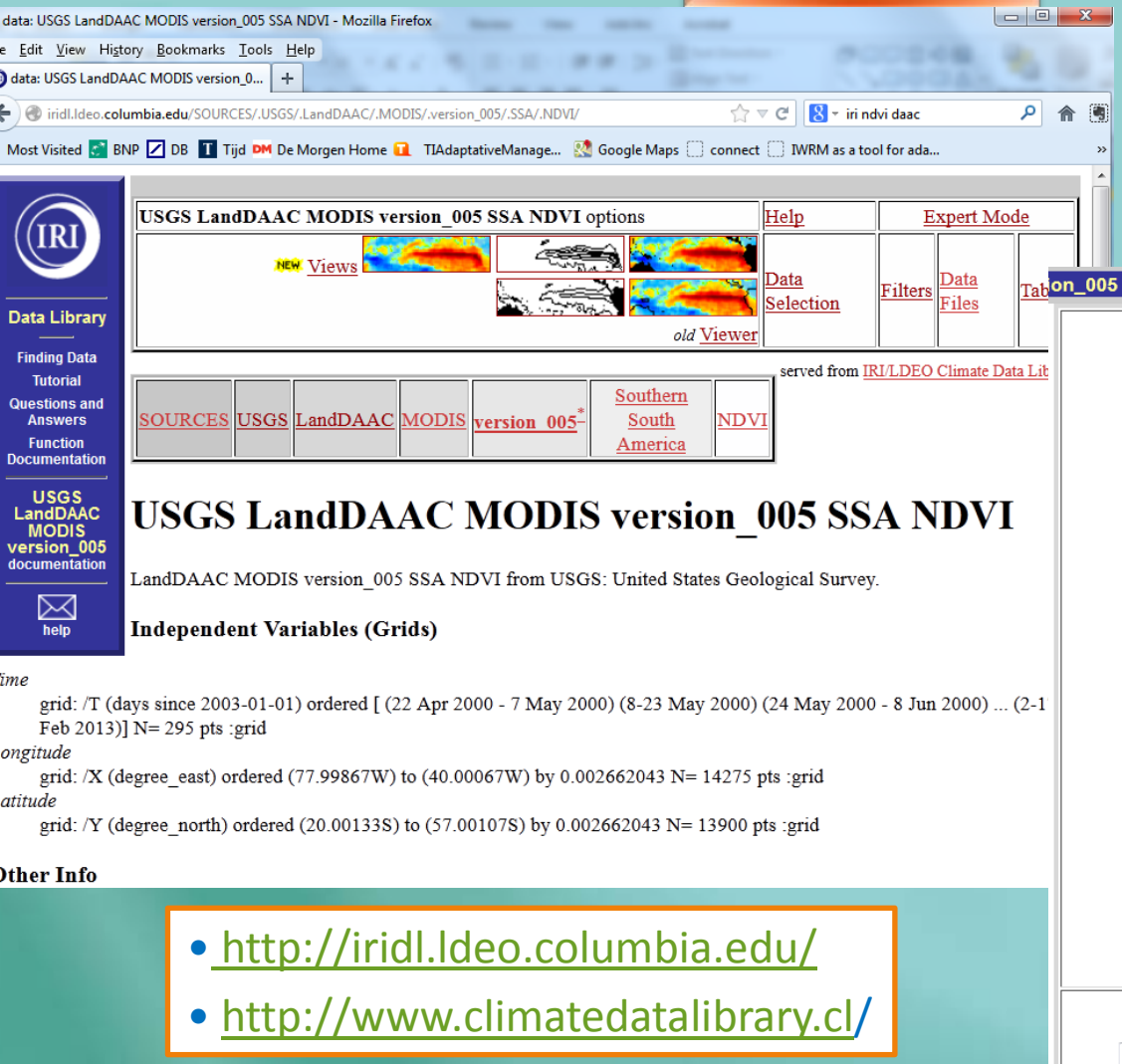
Architecture of the Observatory

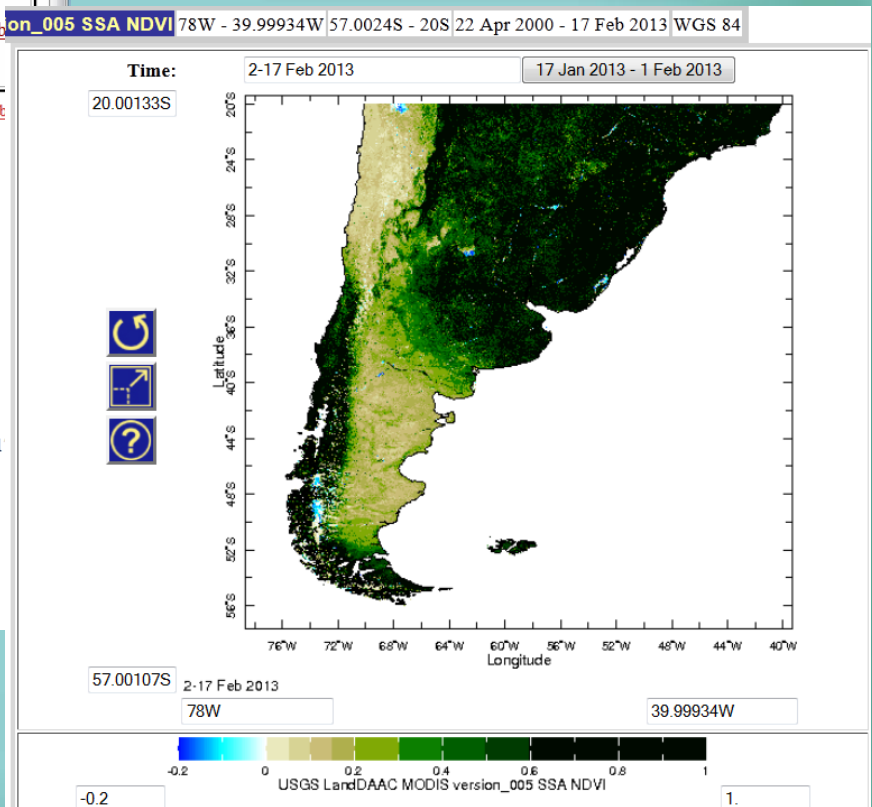


Architecture: Part 1

Data Library

- Data Input
- Data Manipulation
- Visualization
- Output





- http://iridl.ldeo.columbia.edu/
- http://www.climatedatalibrary.cl/

Architecture: Part 2

Maprooms

- Visualization for end users
- portal / observatory

Maproom: Monitoring | Agricultural Drought: Normalized Difference Vegetation Index | Language: english

Region: Chile | Variable: NDVI | Variable: Observed

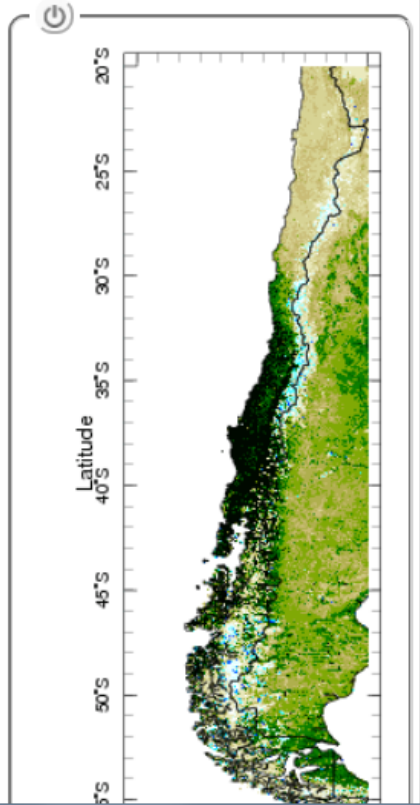
Description | Dataset Documentation | Dataset | Contact Us | Instructions

Normalized Difference Vegetation Index

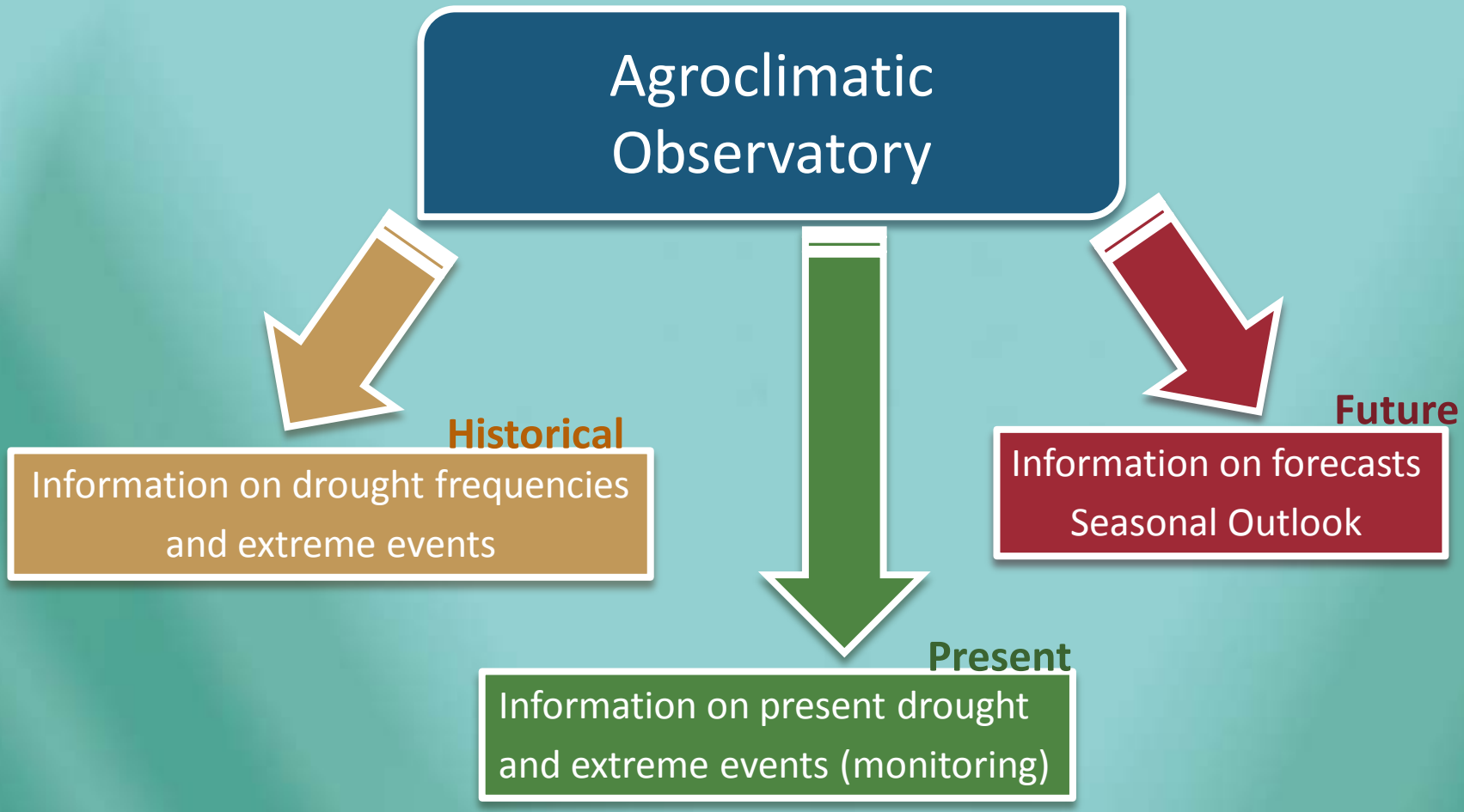
The images on this page are derived from The Moderate Resolution Imaging Spectroradiometer (MODIS) sensor at 250m spatial resolution provided every 16 days. This interface facilitates access to the vegetation status from MODIS images provided by the United States Geological Survey.

The interface allows users to select desired vegetation variables for a desired region using spatial averages. Refer to the instructions tab for help with customizing graphs.

NDVI: The Normalized Difference Vegetation Index (NDVI) is the ratio of two wavelengths, red and near-Infrared (NIR). The index compares healthy and sparse areas of vegetation by examining their difference in wavelength absorption and reflection. Healthy vegetation growth, such as forests, will absorb more and reflect less visible light (red wavelengths) compared to sparse vegetation. For example, an area of forest would yield a NDVI ratio closer to 1 compared to 0 for a desert. The predictive value of NDVI is attributed to its ability to integrate general biological



Structure of the Observatory



Structure of the Observatory

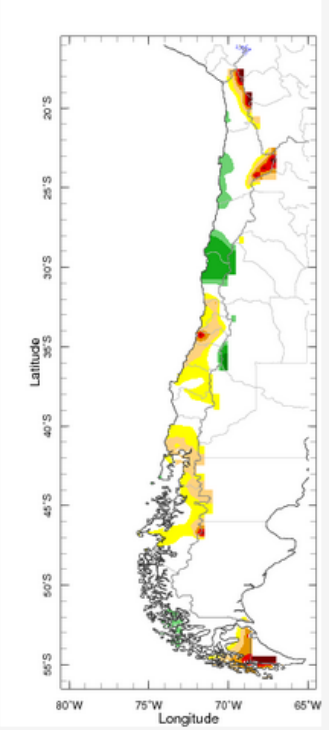
Data Library | Maprooms | Region: Chile | Language: english

Drought Monitor

The maproom is a collection of maps and other figures that monitor drought at present, near furture and in the recent past. The maps and figures can be manipulated and are linked to the original data. Even if you are primarily interested in data rather than figures, this is a good place to see which datasets are particularly useful for monitoring current conditions.

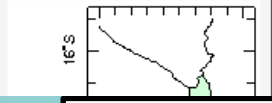
Drought Monitor

A drought monitor showing relevant drought indicators.



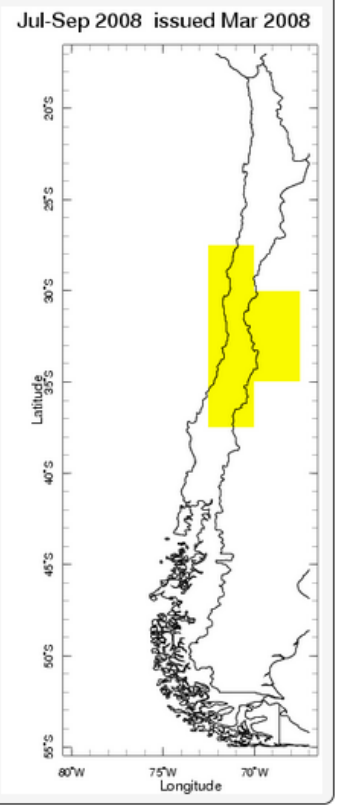
Historical Drought Frequencies

Historical drought frequency analysis for Chile.



Forecasts

Climate forecasts can be relevant instruments to prepare for upcoming climate risks. In this maproom, the results from international forecasts as well as national tailored forecasts are shown.



www.climatedatalibrary.cl/UNEA/maproom/

Historical

Information on drought frequency and extreme events

Maproom: Historical | Historical Drought Frequencies: Drought Return Periods | Region: Chile | Variable: 60% Rainfall Deficit | Language: english

Description | Dataset Documentation | Contact Us

Drought Return Periods

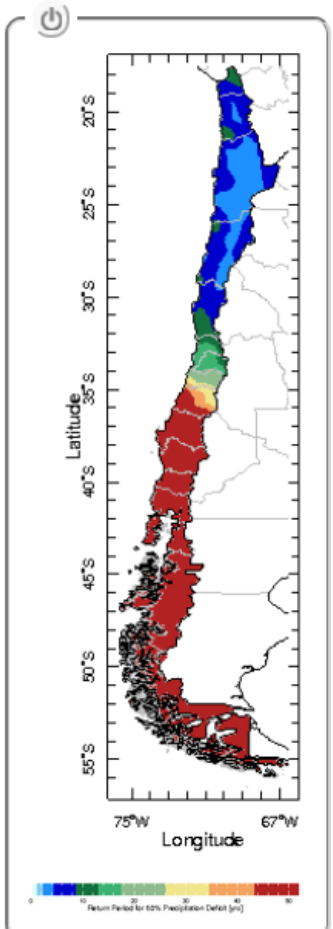
This map shows the return periods for droughts, expressed as a deficit compared to mean precipitation amounts, using a Regional Frequency Analysis using L-moments (RFA-LM).

The RFA-LM (Nunez et al., 2010) determines the frequency of drought events by pooling stations in climatologically homogeneous regions. This allows application of more robust statistics, especially in regions with limited datasets such as the drylands.

The L-moment-approach is an improvement over normal moment theory, as outliers and extreme events do not disproportionately influence distribution selection. As such, the RFA-LM method is the most approriate method in regions with interannual variability and short record lengths. More information on the methodology of the RFA-LM can be found here.

References

Nunez, J.H., K. Verbist, J. Wallis, M. Schaeffer, L. Morales, and W.M. Cornelis. 2011. Regional frequency analysis for mapping drought events in north-central Chile. *J. Hydrol.* **405** 352-366.



Historical

Information on drought frequency and extreme events

Maproom: Historical

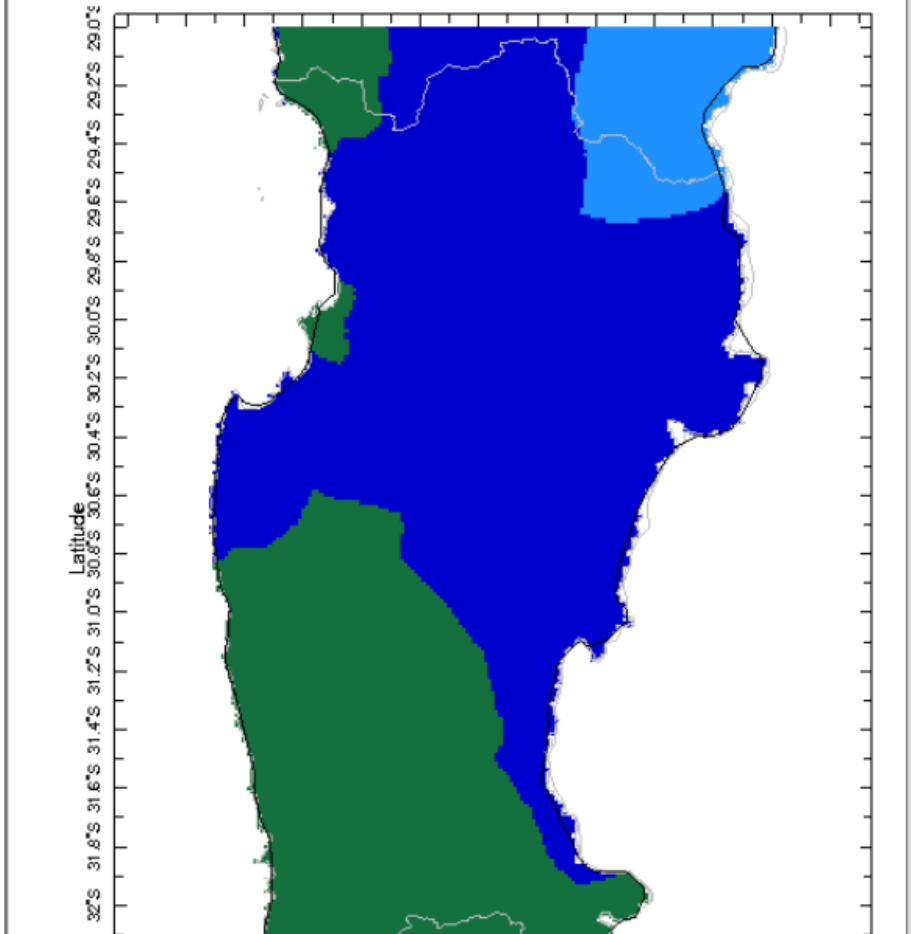
Historical Drought Frequencies: Drought Return Periods

Region: Coquimbo

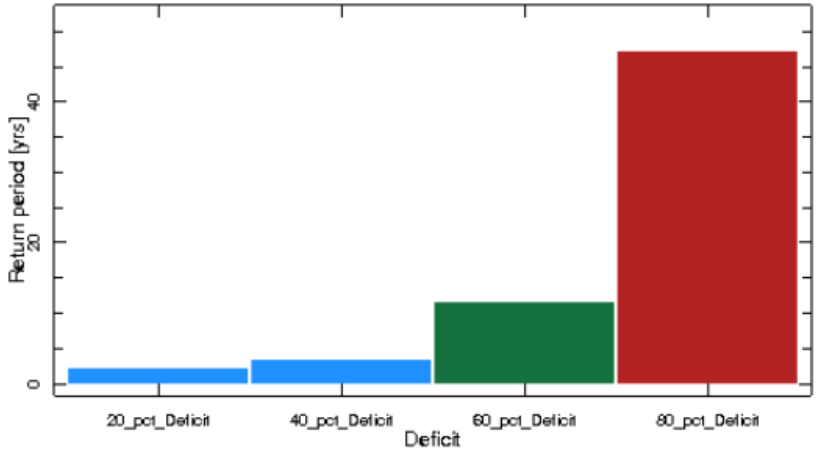
Variable: 60% Rainfall Deficit

Language: english

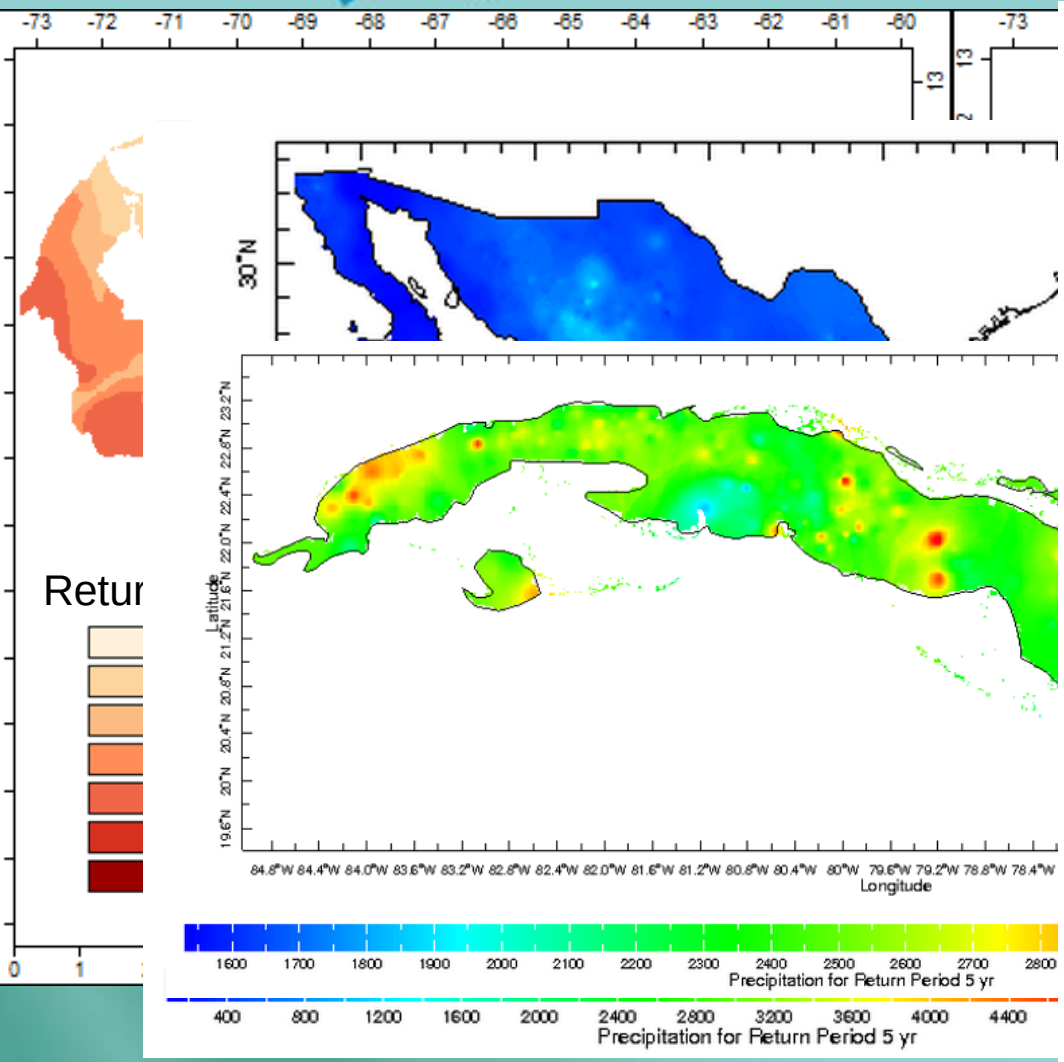
Description | Dataset Documentation | Contact Us

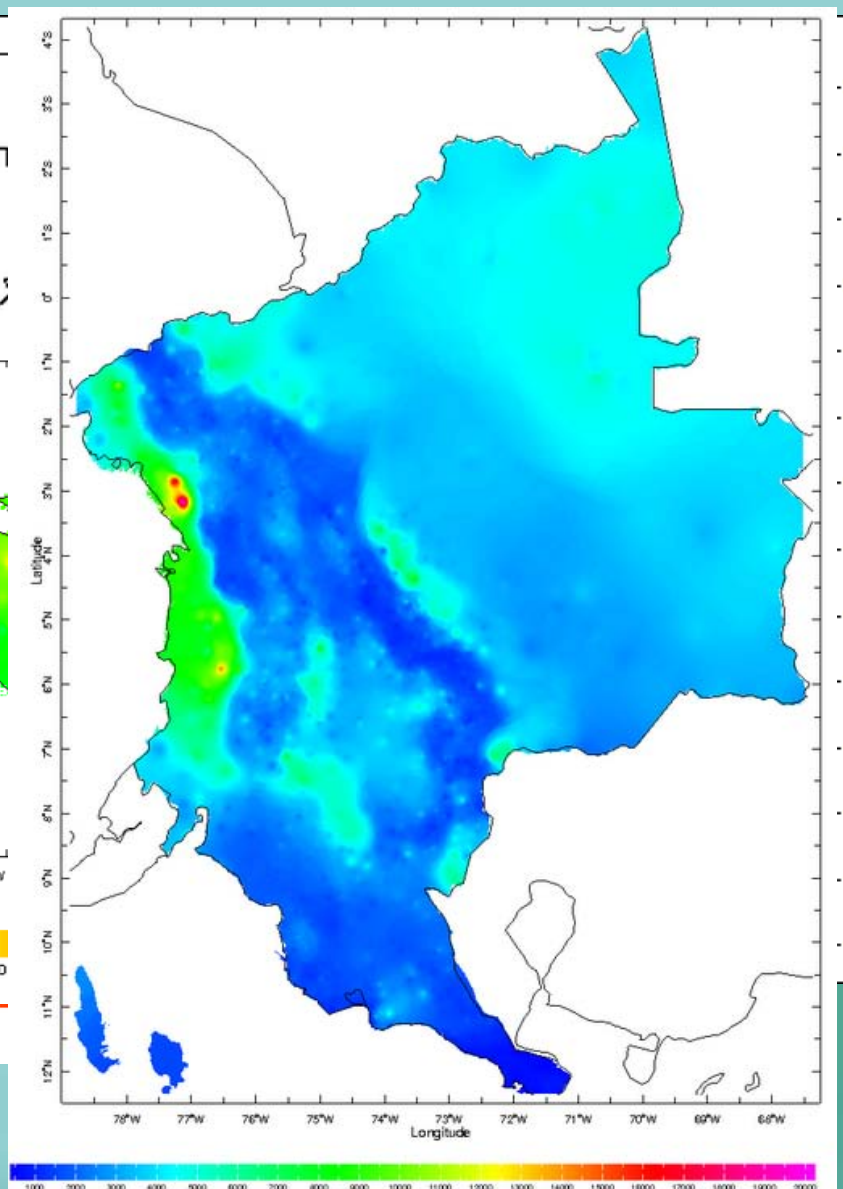


Observations for **[71.325W-71.3125W, 31.925S-31.9125S]**



The Latin American Drought Atlas (Jun '14)





(Nuñez, Verbist et al., 2011, J. of Hydrology)

Present

Information on present drought and extreme events (monitoring)

Maps: Maproom | Maproom: Monitoring | Region: Chile | Language: english

Drought Monitor

A drought monitor showing relevant drought indicators.

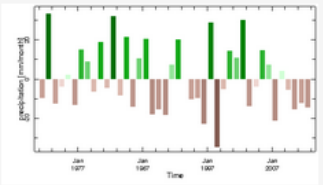
The indicators were selected to show conditions with respect to meteorological, hydrological and agricultural drought.

Meteorological Drought | Hydrological Drought | Agricultural Drought | Combined Drought Index

Meteorological Drought

Regional Precipitation

Precipitation observed and its anomaly for different regions of Chile is presented here.

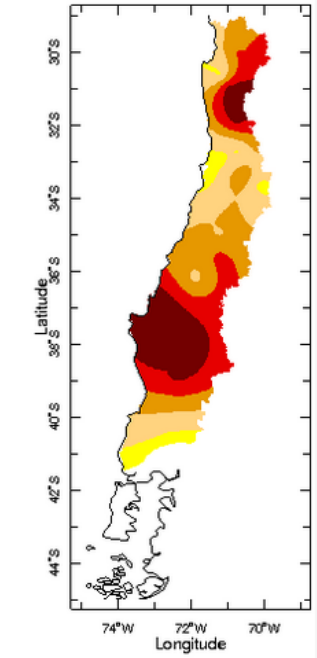


Observed Precipitation

Precipitation as observed in meteorological stations in Chile is presented here.

Standardized Precipitation Index - DMC

This map can be used to identify the intensity and duration of drought or excess of rainfall for each month. It shows the Standardized Precipitation Index (SPI).



Sep 2013

CPC Unified Precipitation

Precipitation as delivered by

Present

Information on present drought and extreme events (monitoring)

1. Meteorological Drought

Maproom: Monitoring | Meteorological Drought: Observed Precipitation | Region: Chile | Analysis: Anomaly | Language: english

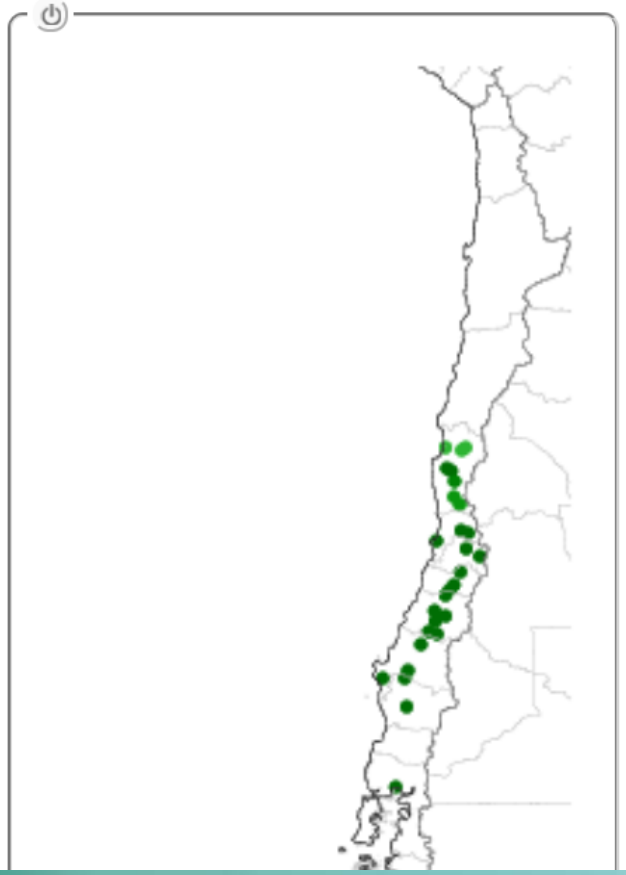
Description | More information | Dataset Documentation | Contact Us | Instructions

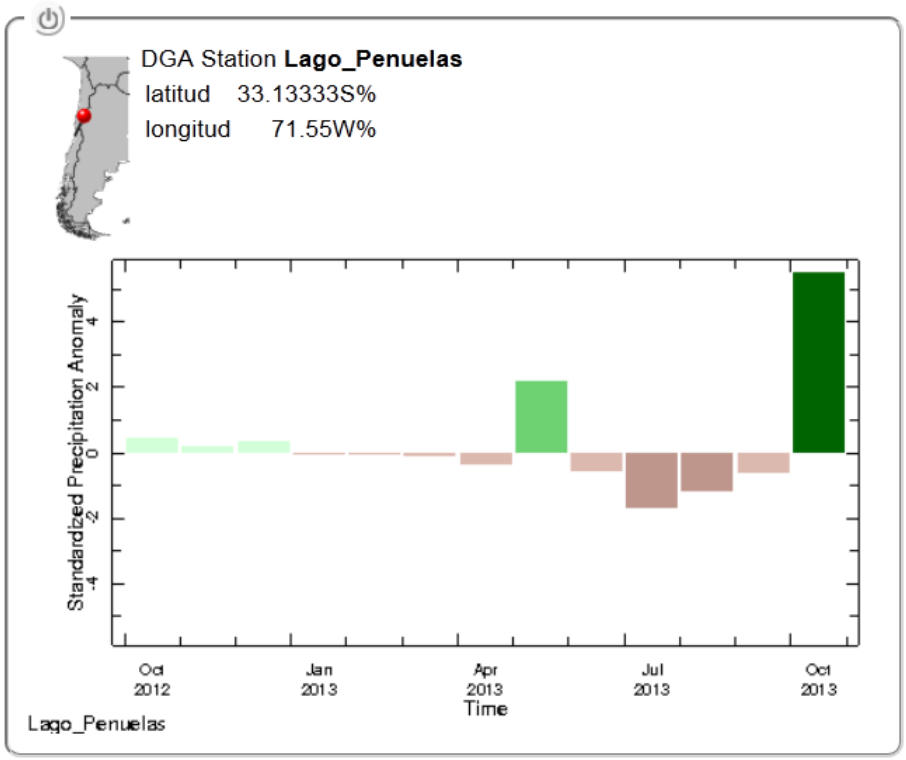
Observed Precipitation

Precipitation as observed in meteorological stations in Chile is presented here.

Select observed or anomaly in menu>analysis to visualize the variable of interest. In menu>region you can specify the region. Use the time navigator to select the month of preference.

Observed: This map shows the monthly precipitation (in [mm/month]) as observed in the meteorological stations. Every point on the map indicates the localization of a meteorological station. The





Present

Information on present drought and extreme events (monitoring)

1. Meteorological Drought

Maproom: Monitoring | Meteorological Drought: Standardized Precipitation Index | Region: Chile | Analysis: 1-Month SPI | Language: english

Description | More information | Dataset Documentation | Contact Us | Instructions

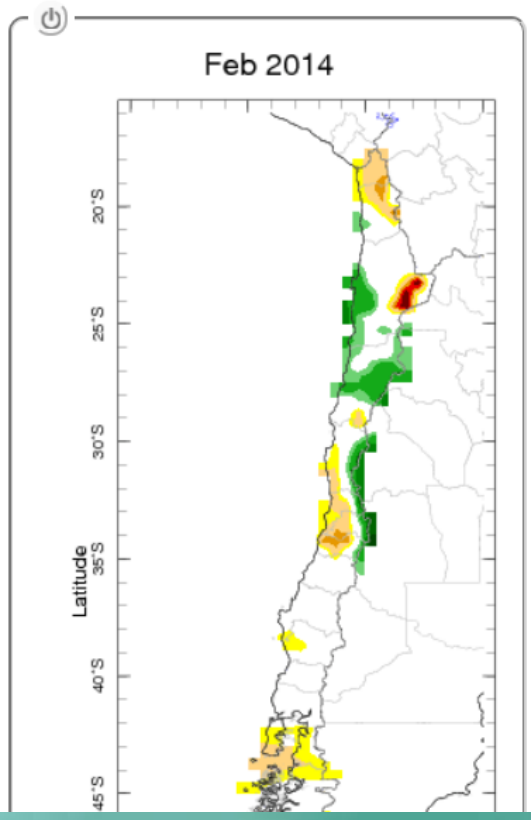
Standardized Precipitation Index

This map can be used to identify the intensity of drought or excess of rainfall for each month. It shows the Standardized Precipitation Index (SPI).

- Allows comparing deficit throughout Chile
- Allows evaluating the duration of the deficit

SPI values … lue the more severe the … a normal situation. W… The table below can be used to interpret the SPI value.

Range of the Standardized Precipitation Index	
SPI >= 2.00	Extremely wet
1.50 < SPI = 2.00	Severely wet
1.00 < SPI = 1.50	Moderately wet
-1.00 < SPI = 1.00	Normal
-1.50 < SPI = -1.00	Moderately dry
-2.00 < SPI = -1.50	Severely dry
SPI =< -2.00	Extremely dry



Present

Information on present drought and extreme events (monitoring)

2. Hydrological Drought

Maproom: Monitoring | Hydrological Drought: Observed discharge | Region: Chile | Analysis: Anomaly | Language: english

Description | More information | Dataset Documentation | Contact Us | Instructions

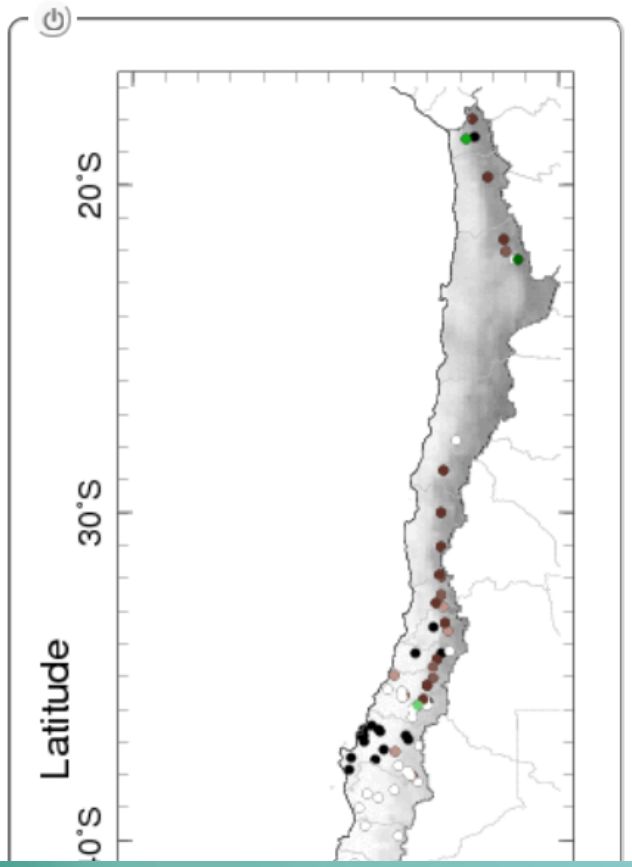
Observed discharge

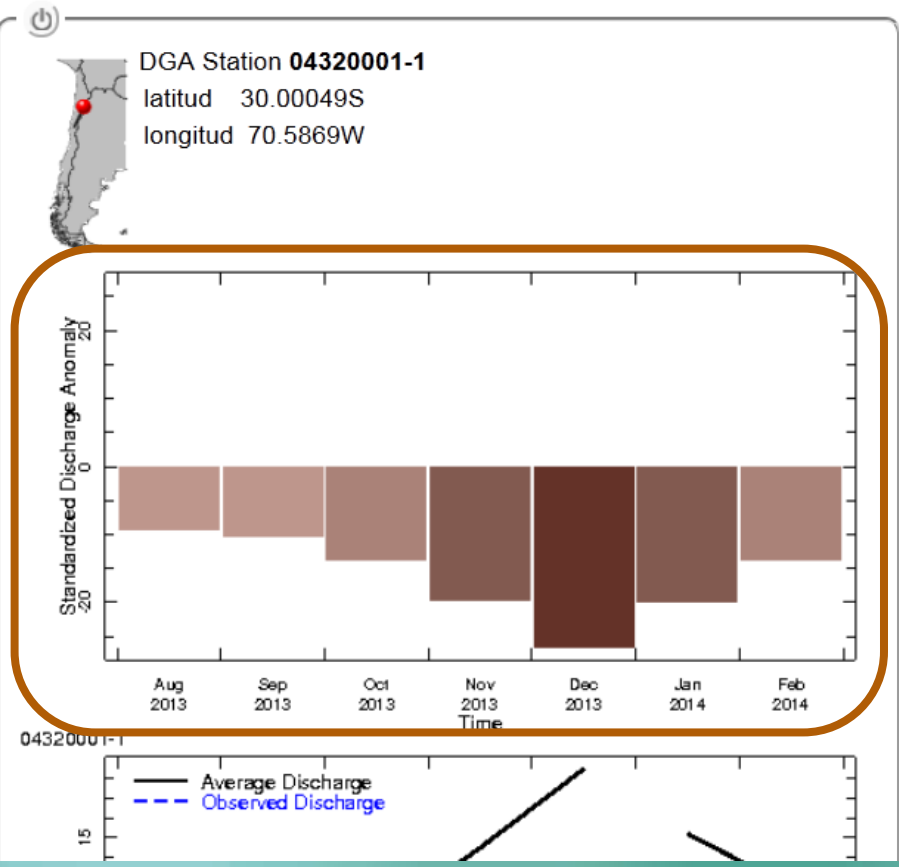
Information on the discharges observed in Chilean rivers is available here.

In menu>variable you can select the variable: measured and anomaly. In menu>region you can select a region.

Measured: This map shows the discharge, as measured in the principal Chilean rivers. The measurements are in m^3/s. The discharge data are available on a monthly basis.

Standardized Anomaly:





Present

Information on present drought and extreme events (monitoring)

3. Agricultural Drought

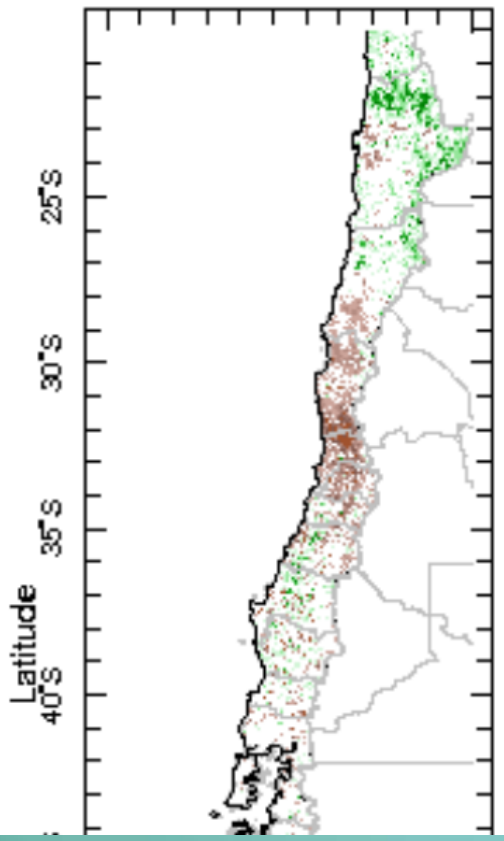
Maproom: Monitoring | Agricultural Drought: Normalized Difference Vegetation Index | Region: Chile | Analysis: Anomaly | Language: english

Description | More information | Dataset Documentation | Dataset | Contact Us | Instructions

Normalized Difference Vegetation Index

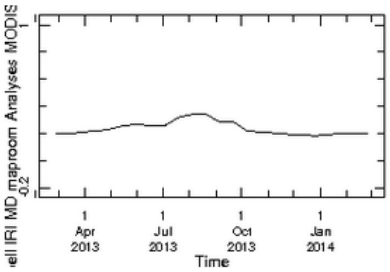
This map shows the actual situation of the vegetation as reflected by the Normalized Difference Vegetation Index (NDVI).

The NDVI uses information of reflectance of two spectral regions: visible light region and near infrared region. The condition of the vegetation influences the interaction between these two spectral regions and the vegetation. This way the NDVI can be related to the condition of the vegetation. The NDVI has a value between -1 and +1.

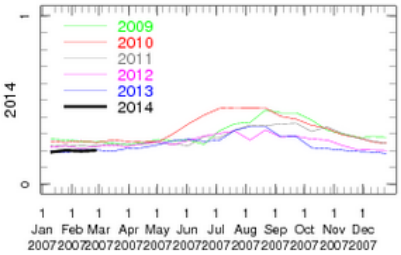


Observations for **[71.1W-71W, 32S-31.9S]**

a)



b)



a) Monthly estimates of NDVI for the selected region selected for the last 12 months.

b) Monthly estimates of NDVI for the current and five most recent years are plotted for comparison. The thick black line is the same series shown in a.

Present

Information on present drought and extreme events (monitoring)

4. Combined Drought Index

Combined Drought Index

This map shows the Combined Drought … e shows actual drought conditions for Chile.

The Comb… …n
Index, SP… …s
way it is …
situation …

The CDI …

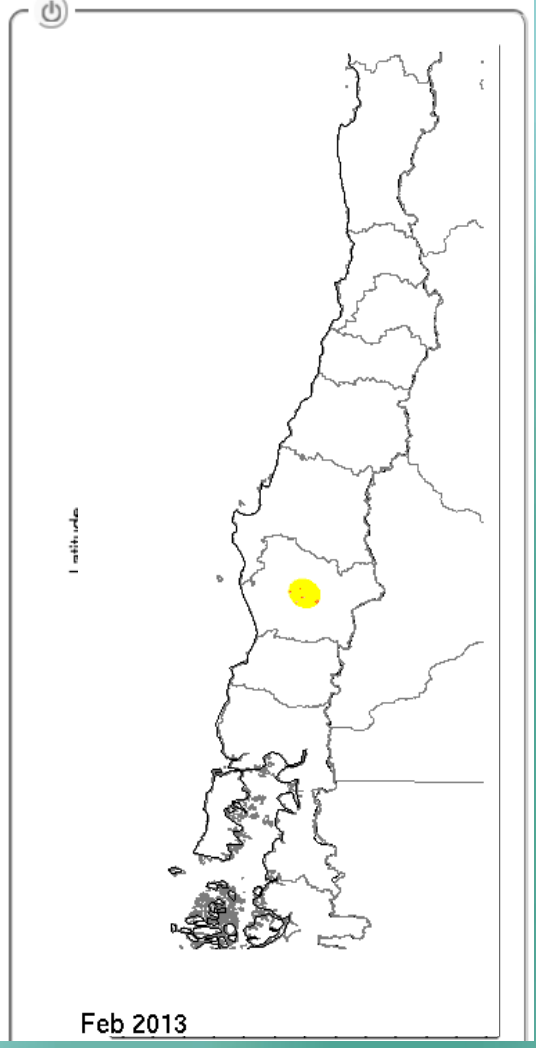
Table 1: Imp…

Impact level		
Watch – …		
Warning – …		
	5	Anomaly Soil Water Index < -1 + SPI-3 < -1
	6	Anomaly Soil Water Index < -1 + SPI-3 < -1 + SPI-12 < -1
Alert – St…		
	10	FAPAR anomaly < -1 + SPI-3 < -1 + SPI-12 + Anomaly Soil Water Index < -1

Challenge 1

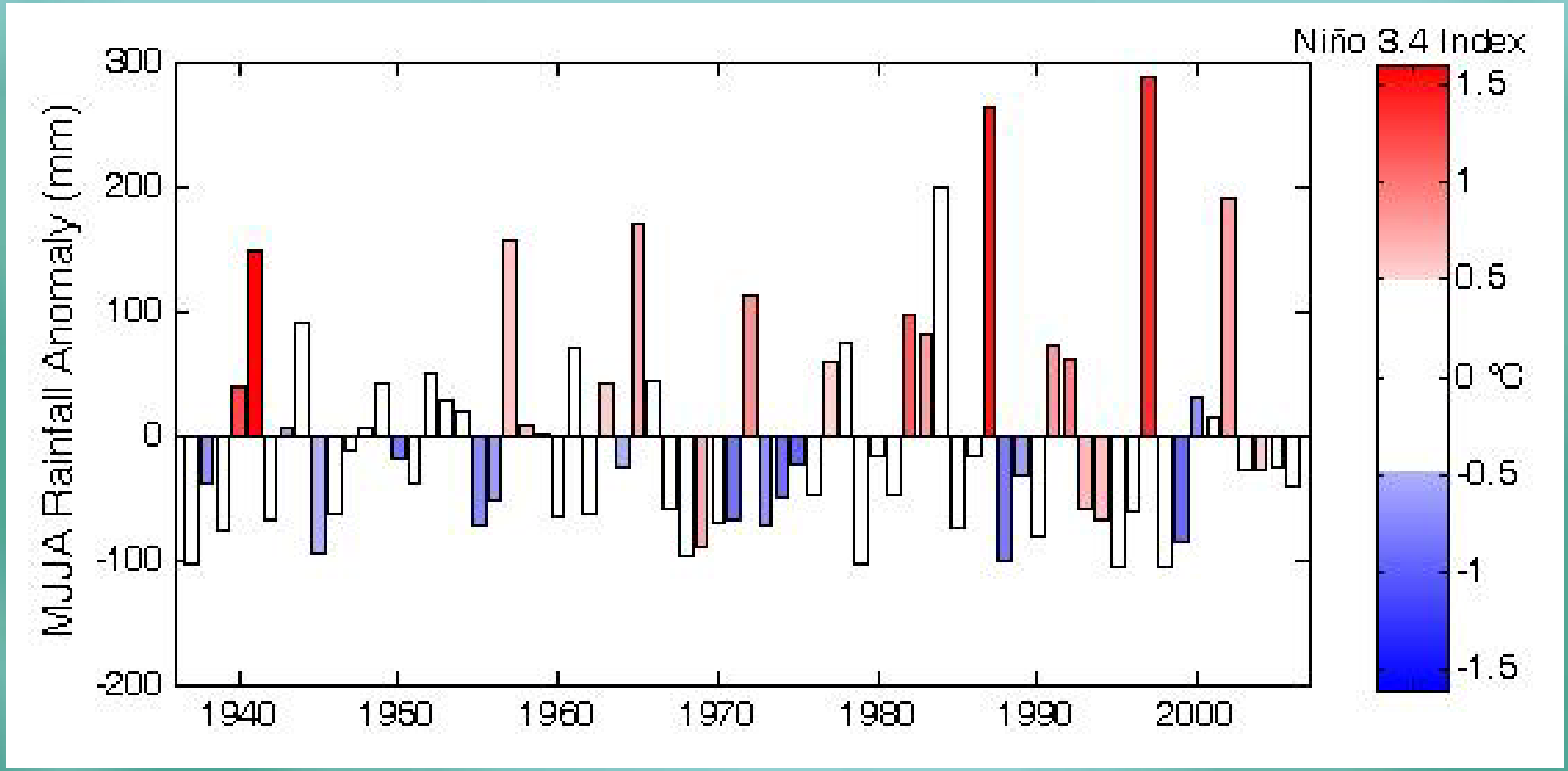
- SPI-calculations from station data are often inaccurate , due to limited station data and inadequate interpolation techniques
- Remote sensing datasets are too coarse to form a real alternative
- Holistic Drought Indicators that combine different aspects of drought are dependent on climatic conditions: poor performance in drylands.

- Merging techniques can provide partly solutions



Drought Early Warning

There is a close relation between drought and ‘el Niño’ (SST)



(Verbist, Robertson et al., JAMC, 2010)

Future

Seasonal forecasts

Data Library Maproom | Maproom Forecasts | Language: english

Forecasts

Climate forecasts can be relevant instruments to prepare for upcoming climate risks. In this maproom, the results from international forecasts as well as national tailored forecasts are shown.

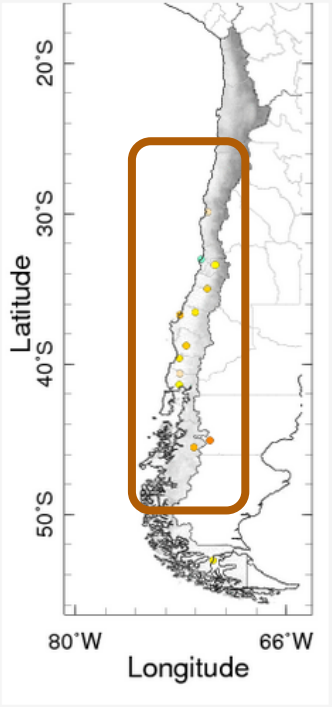
Forecasts are downscaled to station level using the IRI Climate Prediction tool.

Seasonal Forecasts

Seasonal Forecasts

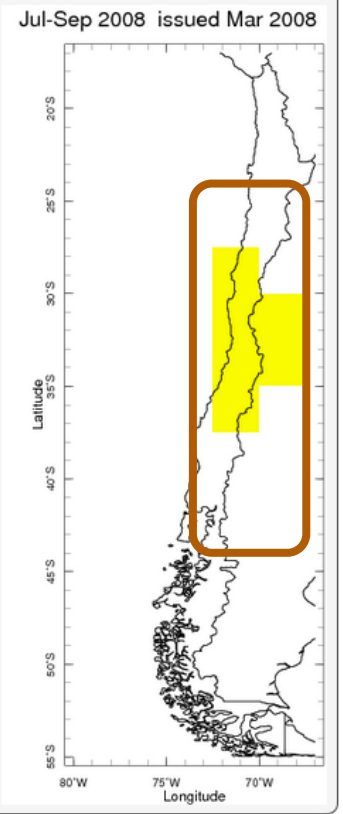
Precipitation Forecast from the Chilean Meteo Service (DMC)

Seasonal deterministic precipitation forecasts and a series of analysis to apply to a map of the region or to selected grid box



IRI Seasonal Precipitation Forecast

This map shows the seasonal precipitation forecast for Chile. Forecasts are indicating the expected rainfall as above-, below- and near-normal.

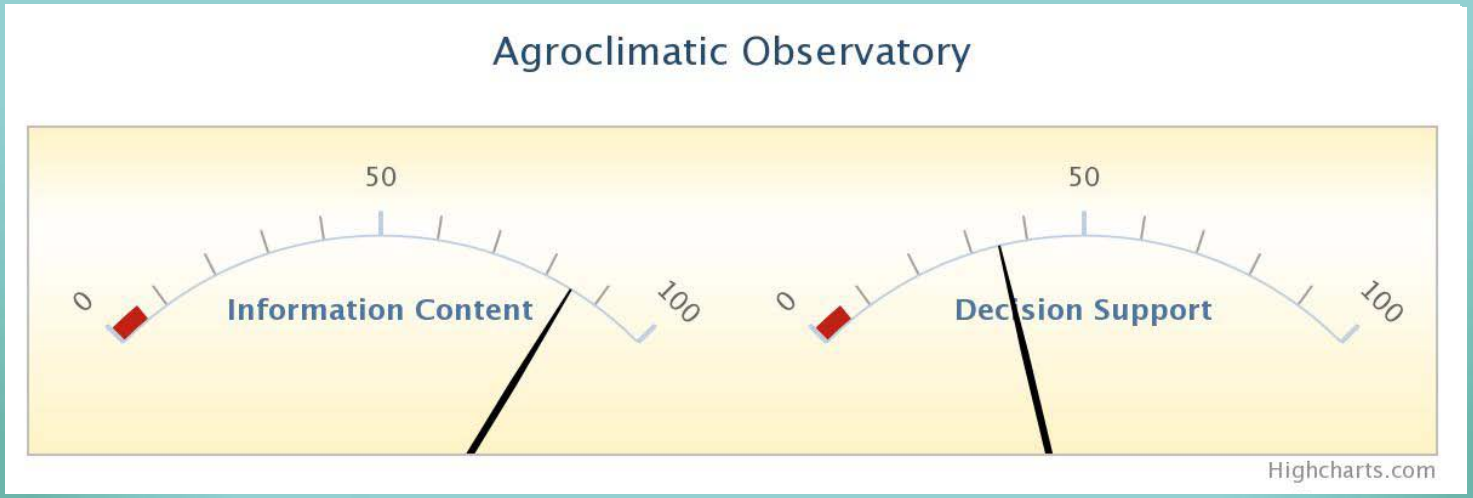


Downscaled seasonal forecast

IRI Net Assessment - GCM

Challenges Remaining

Challenge 2

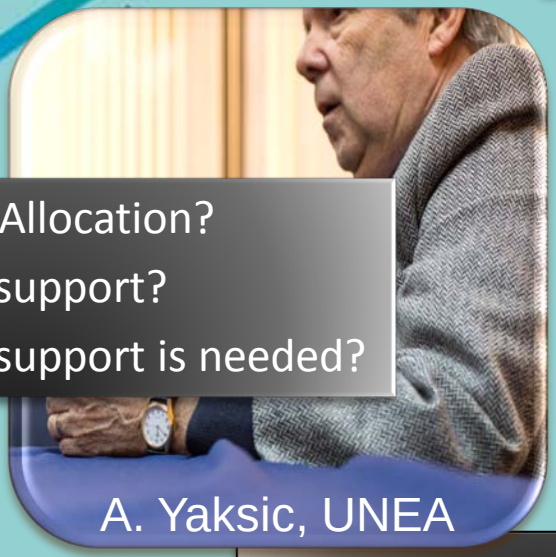


- The Observatory counts with Relevant and Timely information, covering all Essential Drought Parameters
- Providing Actionable Information remains a challenge and requires understanding Decision Making Process of the different stakeholders

Impact of Drought on Decision Making?

Government

Large Scale Irrigated Farmer



A. Yaksic, UNEA

Changes in Water Allocation?
Which farmers to support?
How much/when support is needed?

Bruno Espinoza

More Water Rights needed?
Install Micro-Reservoirs?

Decision Support?

Dina Cifuentes

How much water will I get?
What area do I cultivate?

Modesto Geraldo

How many animals can I feed?
Should I seek external support?

Small Scale Irrigated Farming

Dryland farmer

Challenge 3

Provide tailored seasonal forecasts for Agricultural Management

Seasonal forecasts

Temperature

Precipitation

Need to bridge the gap

Increased likelihood of plagues?

Optimal Sowing Date?

Impact on pasture?

Challenge 4

Provide relevant information at the watershed level

Monitoring of local water balance

Monitoring Water Supply and Demand

Challenge 4

Provide relevant information at the watershed level

Monitoring of local water balance

Expected water resources conditions

Improved local seasonal forecasts for Reservoir Management

- Use of snow cover / thickness
- Incoporate additional sources of variability (decadal, MJO)

Challenge 4

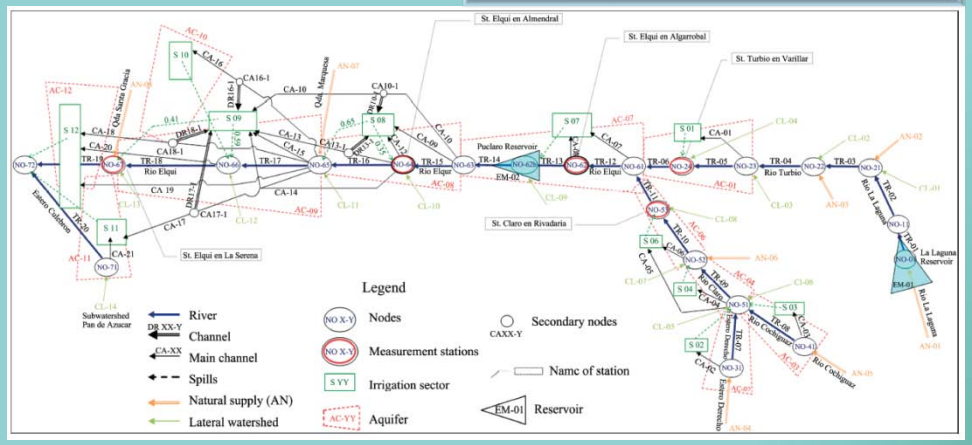
Provide relevant information at the watershed level

Monitoring of local water balance

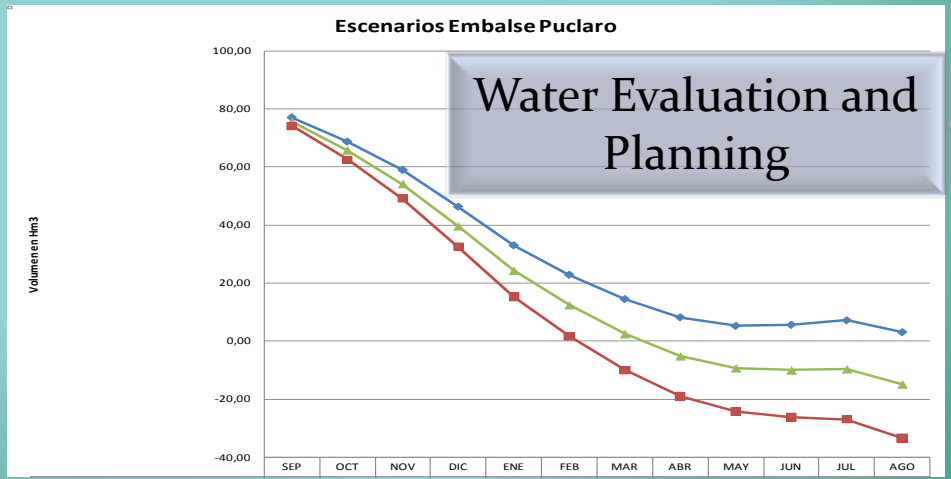
Expected water resources conditions

Provide Different Water Management Alternatives

Modelling Water Supply and Demand

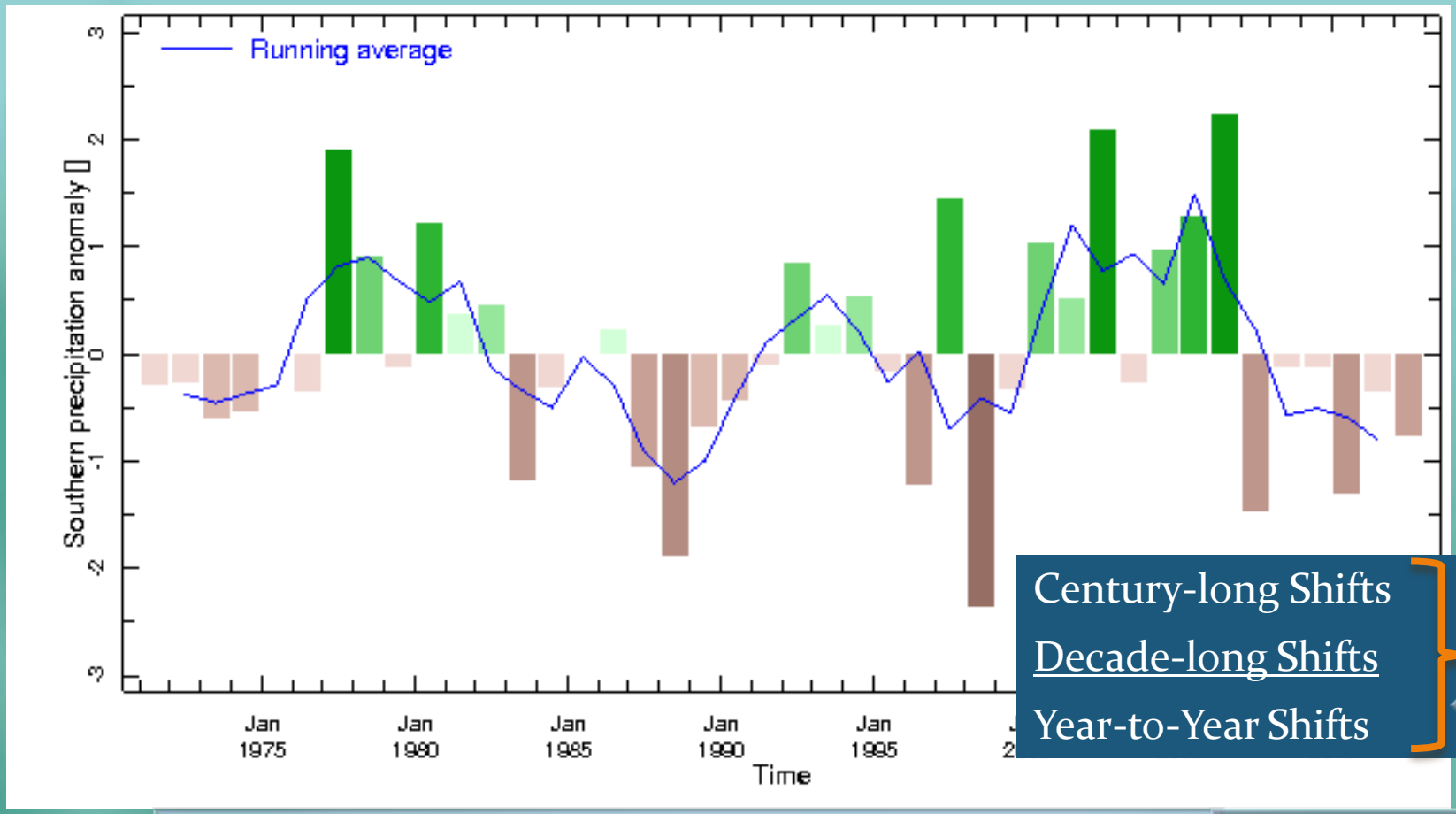


Water Evaluation and Planning



Challenge 5

Provide Water Resources Projections at the Near Term Climate Change Horizon

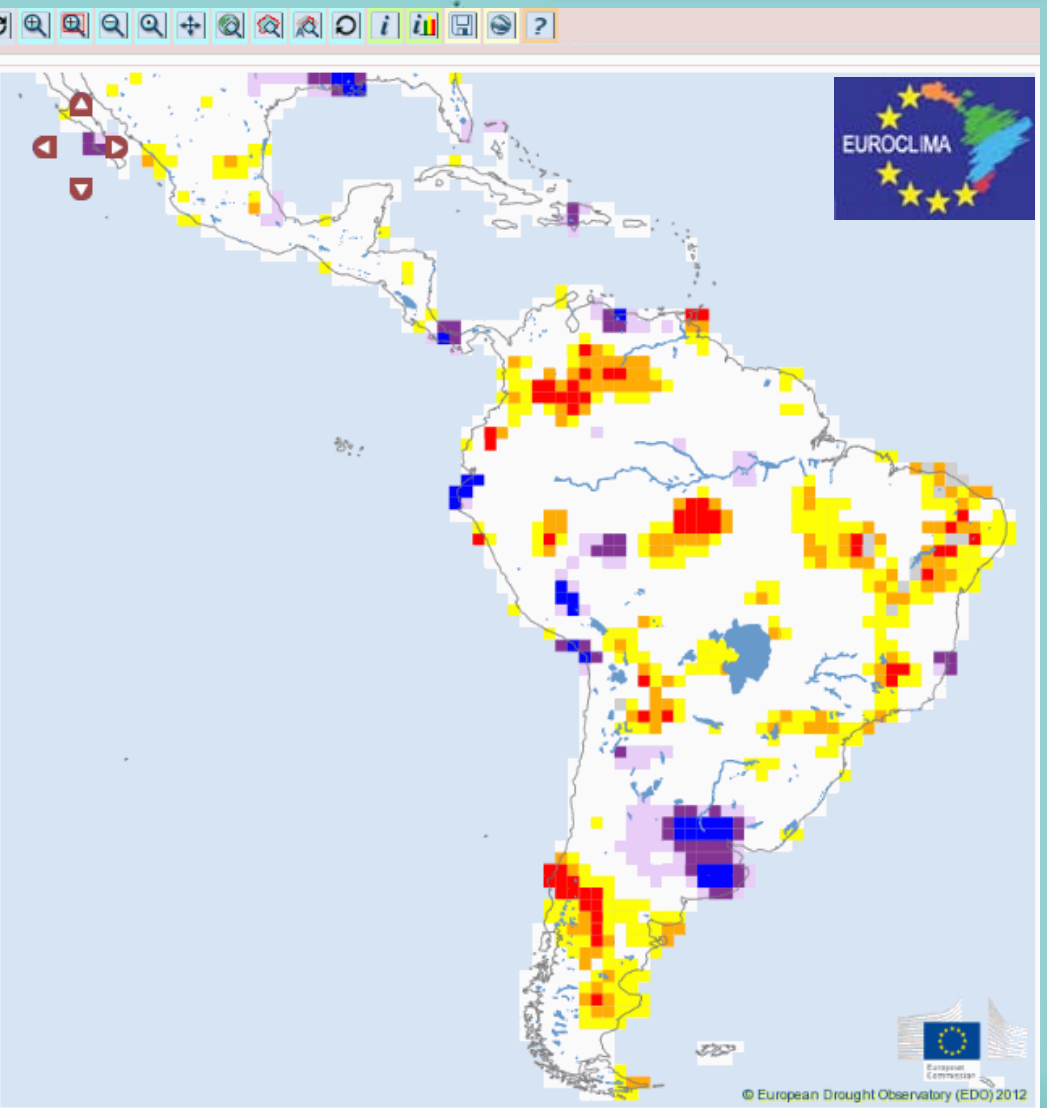


Century-long Shifts	2%
Decade-long Shifts	19%
Year-to-Year Shifts	70%

Need to count with probable scenarios for Water Resources Availability at the 2020-2035 timesscale

Challenge 6

Link national CRM efforts with Global Initiatives



- National Agroclimatic Observatory
- Regional Drought Monitor
- Global Drought Monitor (GEO/GEOSS)
- Global Programs:
  - UNESCO G-WADI/FRIEND
  - GEWEX(WCRP), HEPEX, GFCS

Need for more interaction with Regional/Global activities

k.verbist@unesco.org

MWAR-LAC Project Website:

www.cazalac.org/mwar_lac/

Agroclimatic Observatory:

www.climatedatalibrary.cl/UNEA/maproom/