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

# Managing Water Resources in Arid and Semi Arid Regions of Latin America and Caribbean

## A focus on climate risk management…

Koen Verbist
UNESCO
International Hydrological Programme

CAZALAC

WITH THE SUPPORT OF THE FLEMISH GOVERNMENT

# Climate Risk Management

Development of a Climate Risk Management system for the region, based on three pillars:

1. **Identify Vulnerabilities and Oportunities**

➡ Evaluation of water use efficiency and vulnerabilities in pilot areas

2. **Reduce Uncertainties:**
   a) Learn from the Past
   b) Monitor the Present
   c) Assess Future scenarios

3. **Identify Technological Interventions that reduce climatic vulnerability**

➡ Evaluate water management alternatives (water harvesting, deficit irrigation)

Courtesy

IRI

# Climate Risk Management

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IWRM

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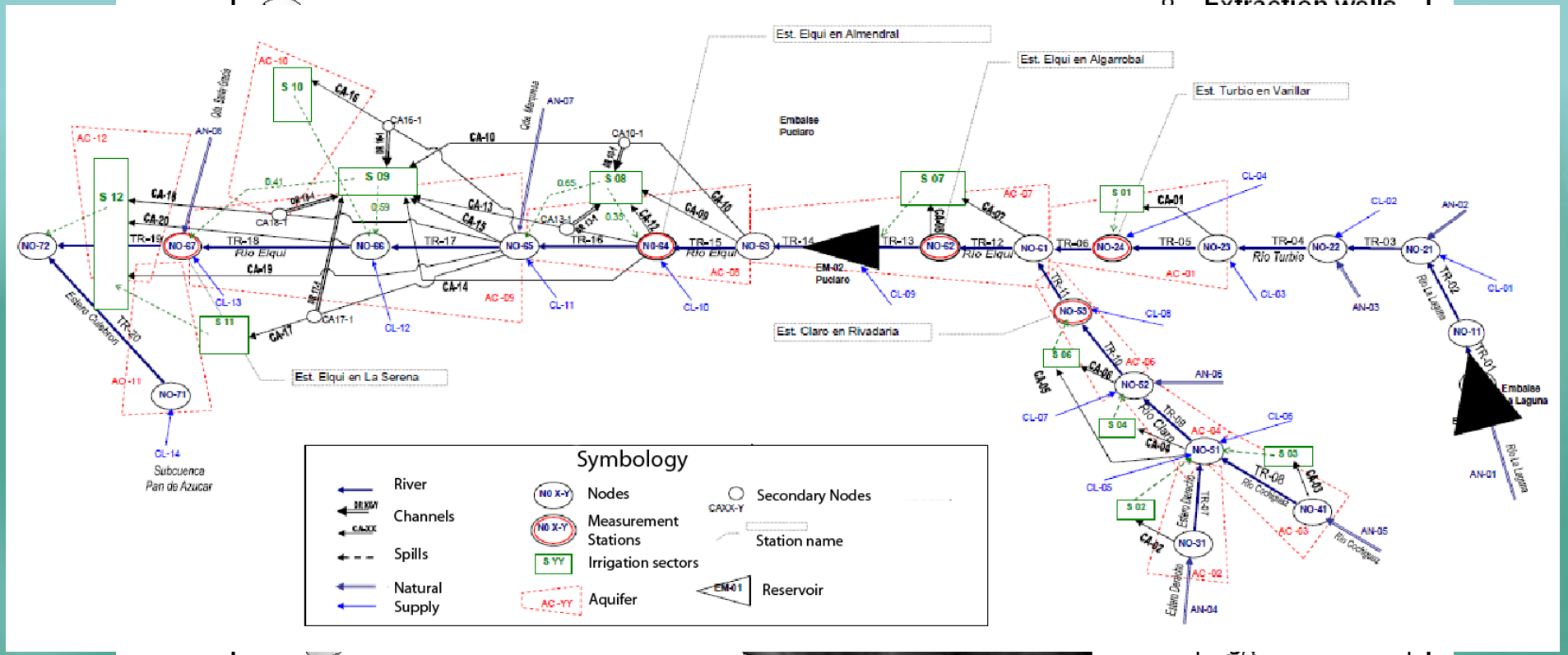
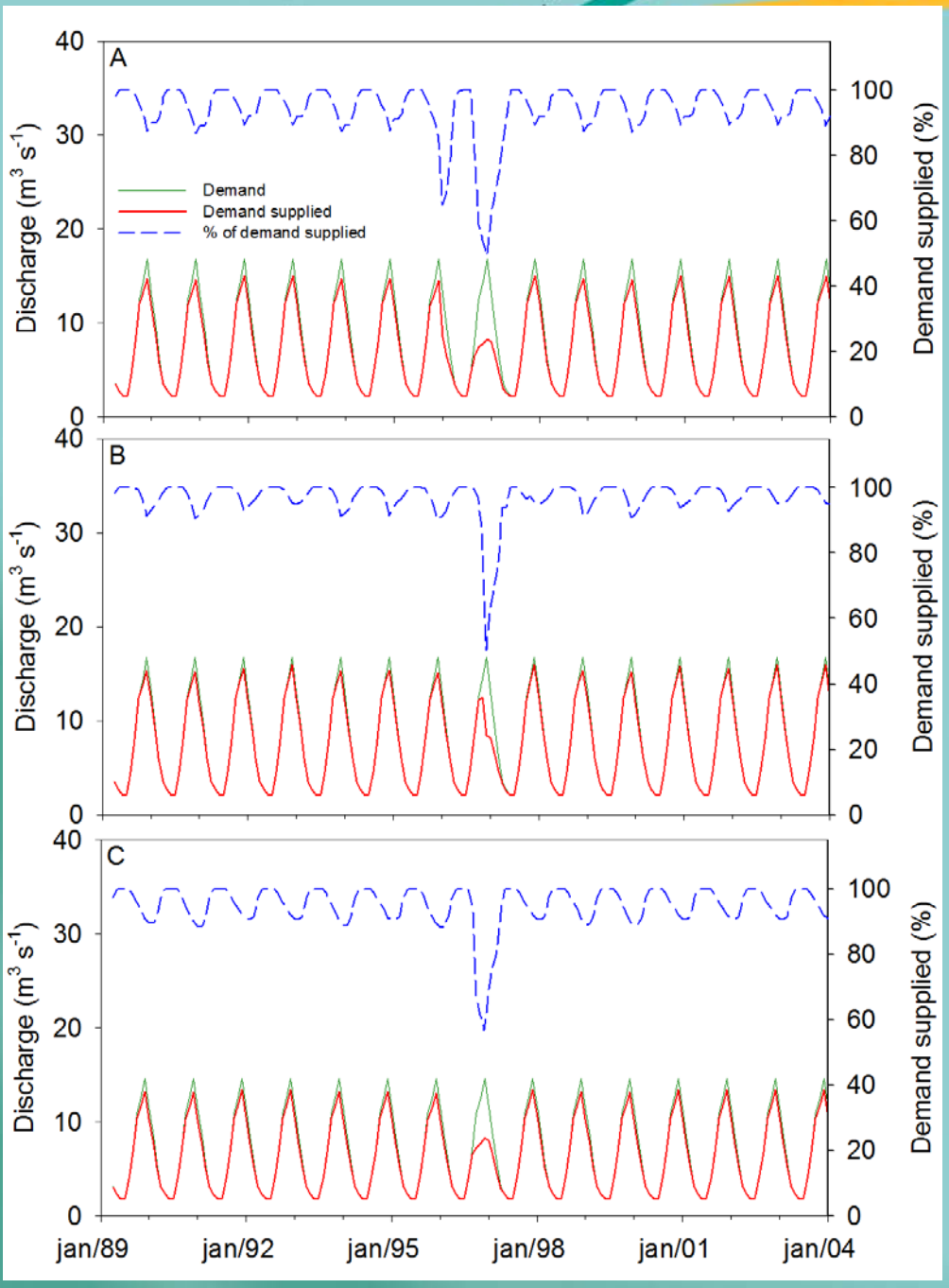
Courtesy

IRI

# Identify Vulnerabilities

- MAGIC water management model






# Identify Vulnerabilities

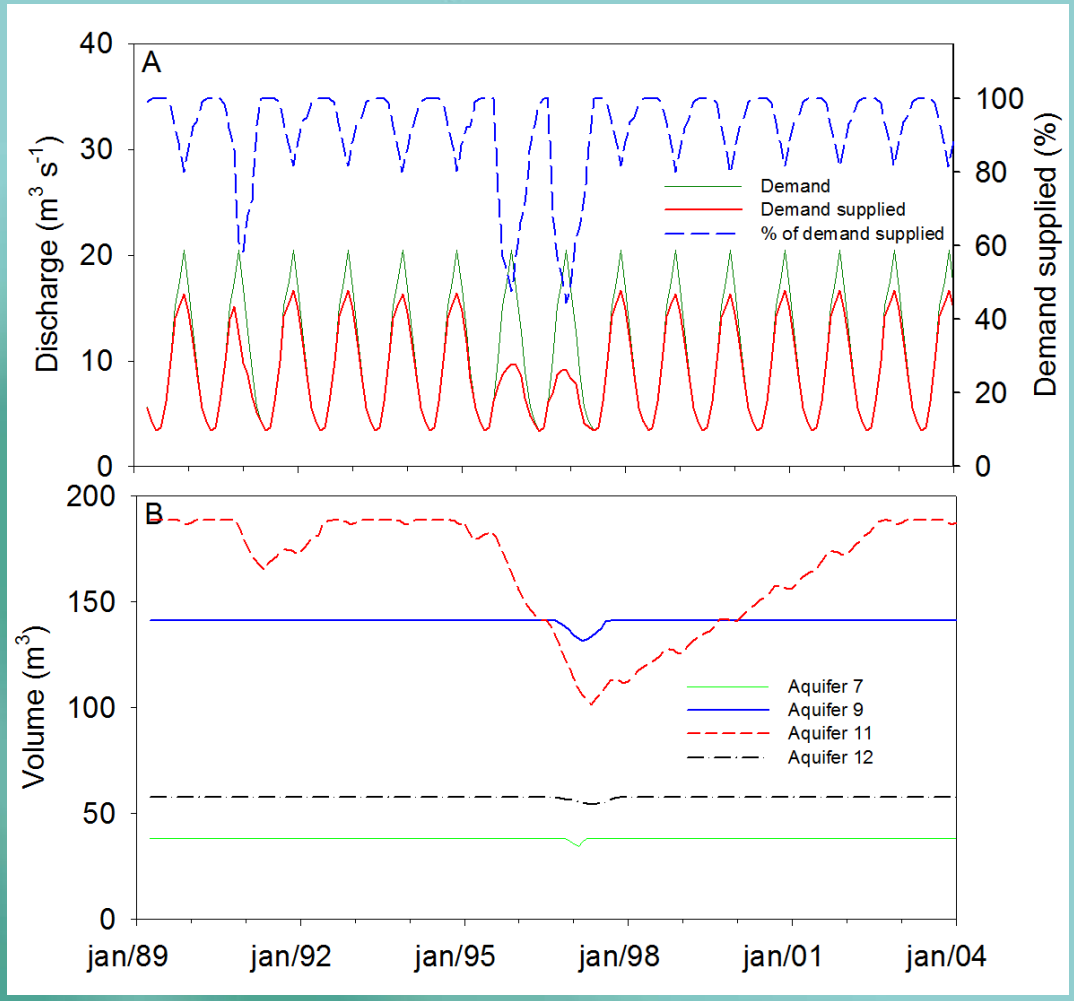
Base Case

Improved water use efficiency

Improved irrigation efficiency

(Orphanopoulos et al., SCAR, 2012)

# Identify Vulnerabilities




Increase in the cultivated area with 37%

Aquifer response

(Orphanopoulos et al., SCAR, 2012)

# Climate Risk Management

The Water Centre for Arid Zones in Latin America and the Caribbean (CAZALAC) has been developing a Climate Risk Management system for the region, based on three pillars:

1. **Identify Vulnerabilities and Oportunities**

➡ Evaluation of water use efficiency and vulnerabilities in pilot areas

2. **Reduce Uncertainties:**

Eventos Extremos

a) Learn from the Past

➡ b) Monitor the Present

c) Assess Future scenarios

3. **Identify Technological Interventions that reduce climatic vulnerability**

➡ Evaluate water management alternatives

Courtesy

IRI

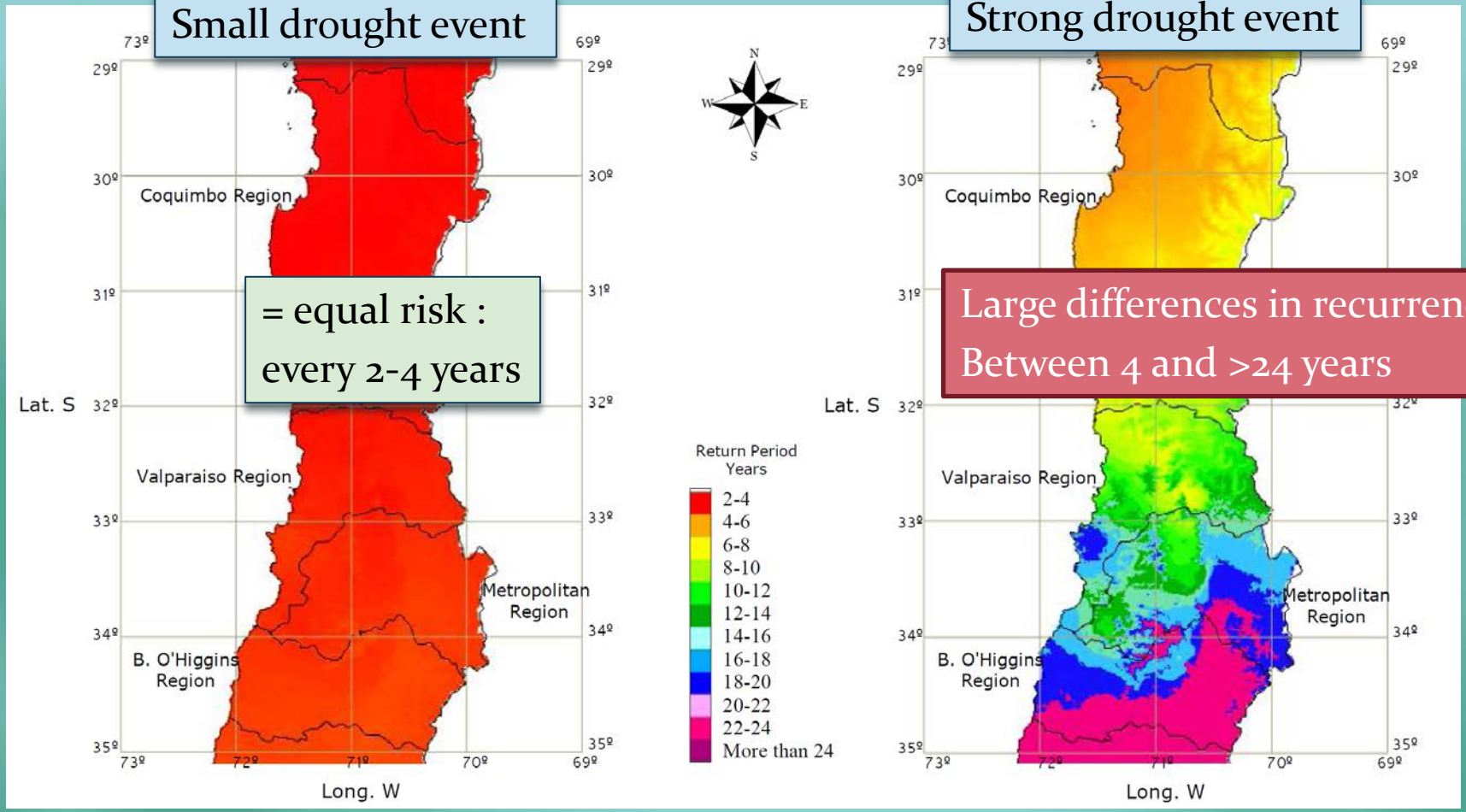
# Extreme events and drought

LAC Drought atlas

Capacitate the Caribbean countries

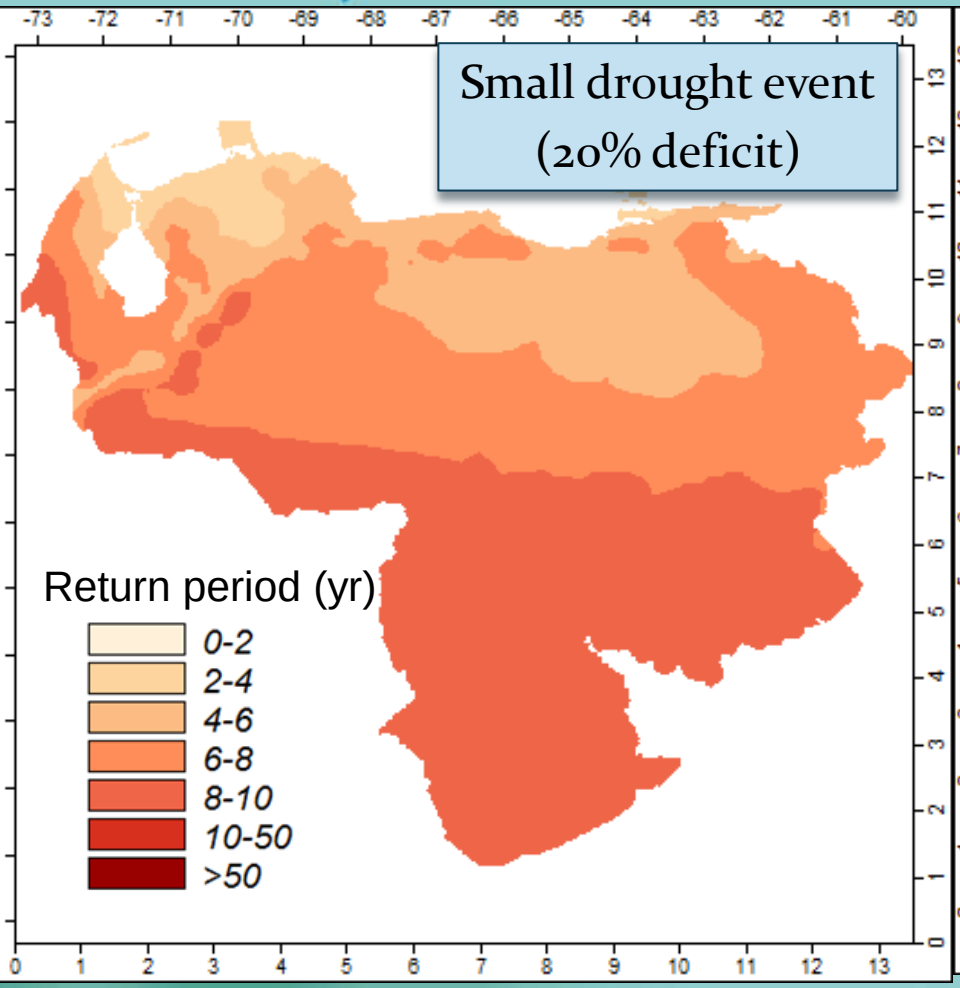
Establishing the first LAC drought Atlas (annual)

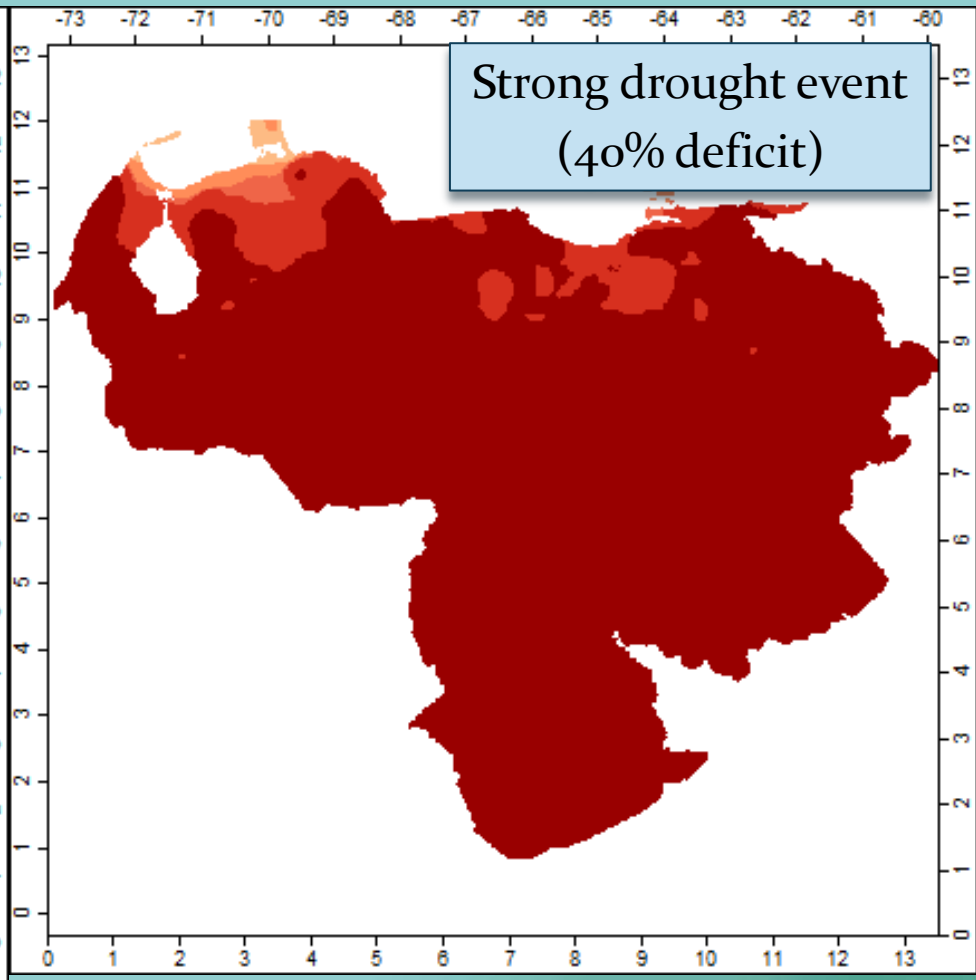
# Case Study: Frequency Analysis of Droughts in the Central Northern Region of Chile




(from Nunez et al., 2011, Journal of Hydrology)

# Frequency Analysis of Droughts in Venezuela

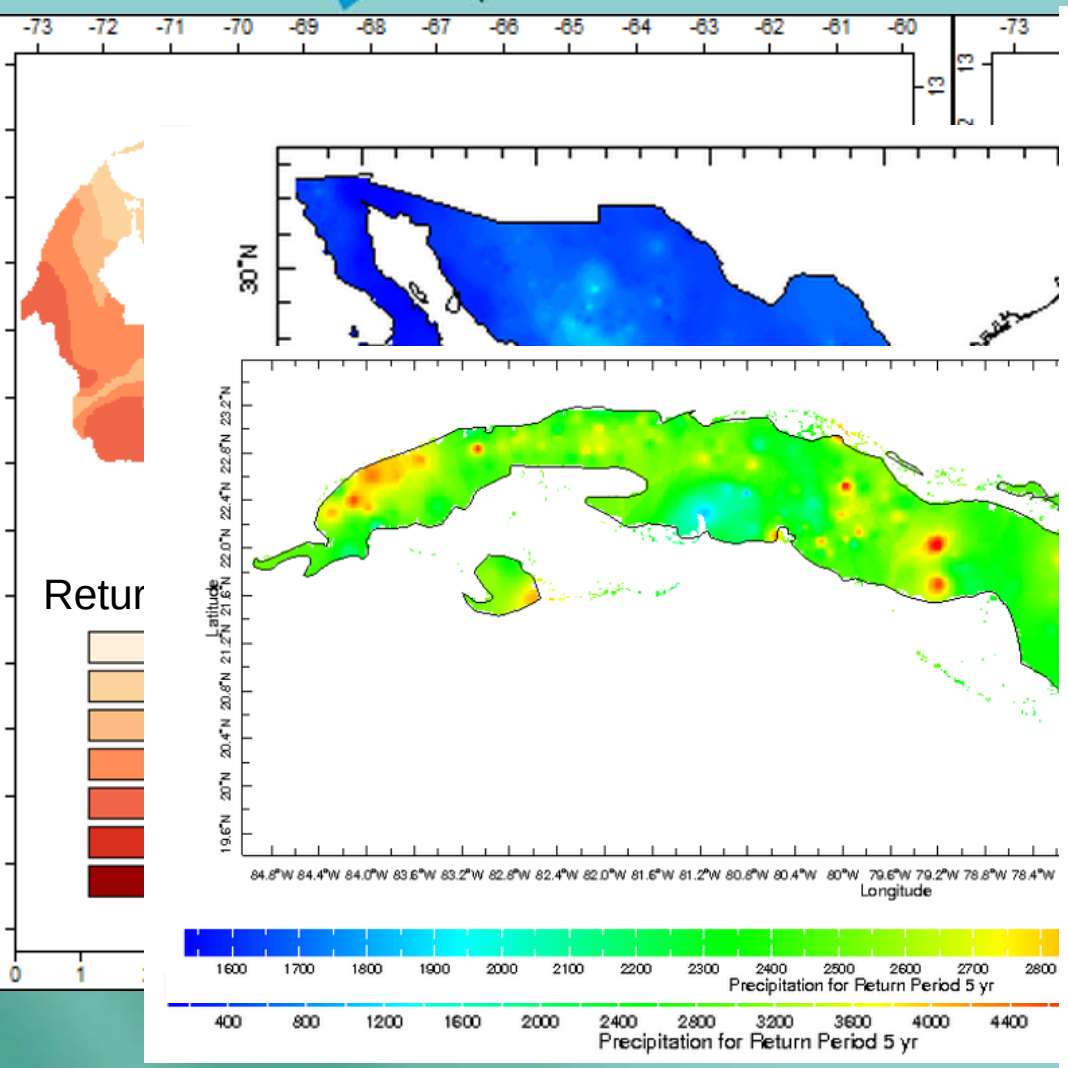


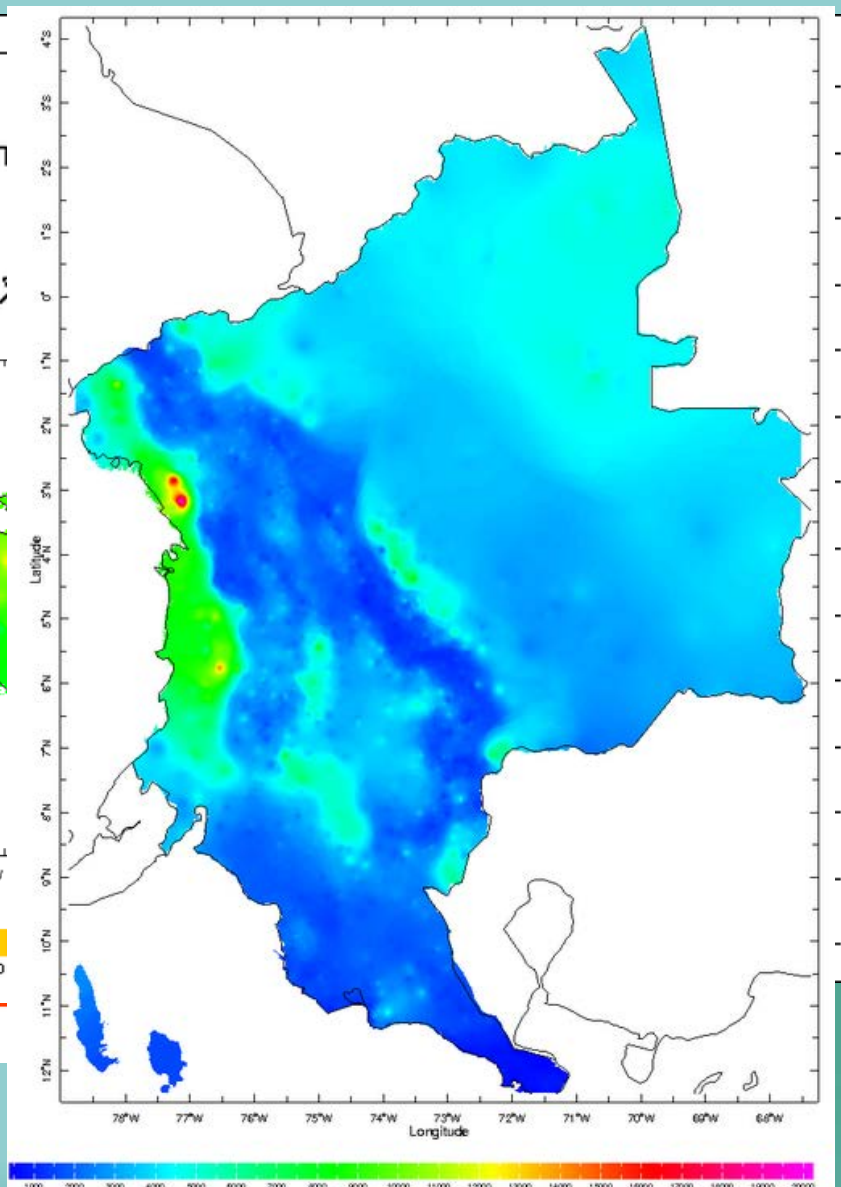




Common in the whole territory

Only frequent in the north

# The Latin American Drought Atlas

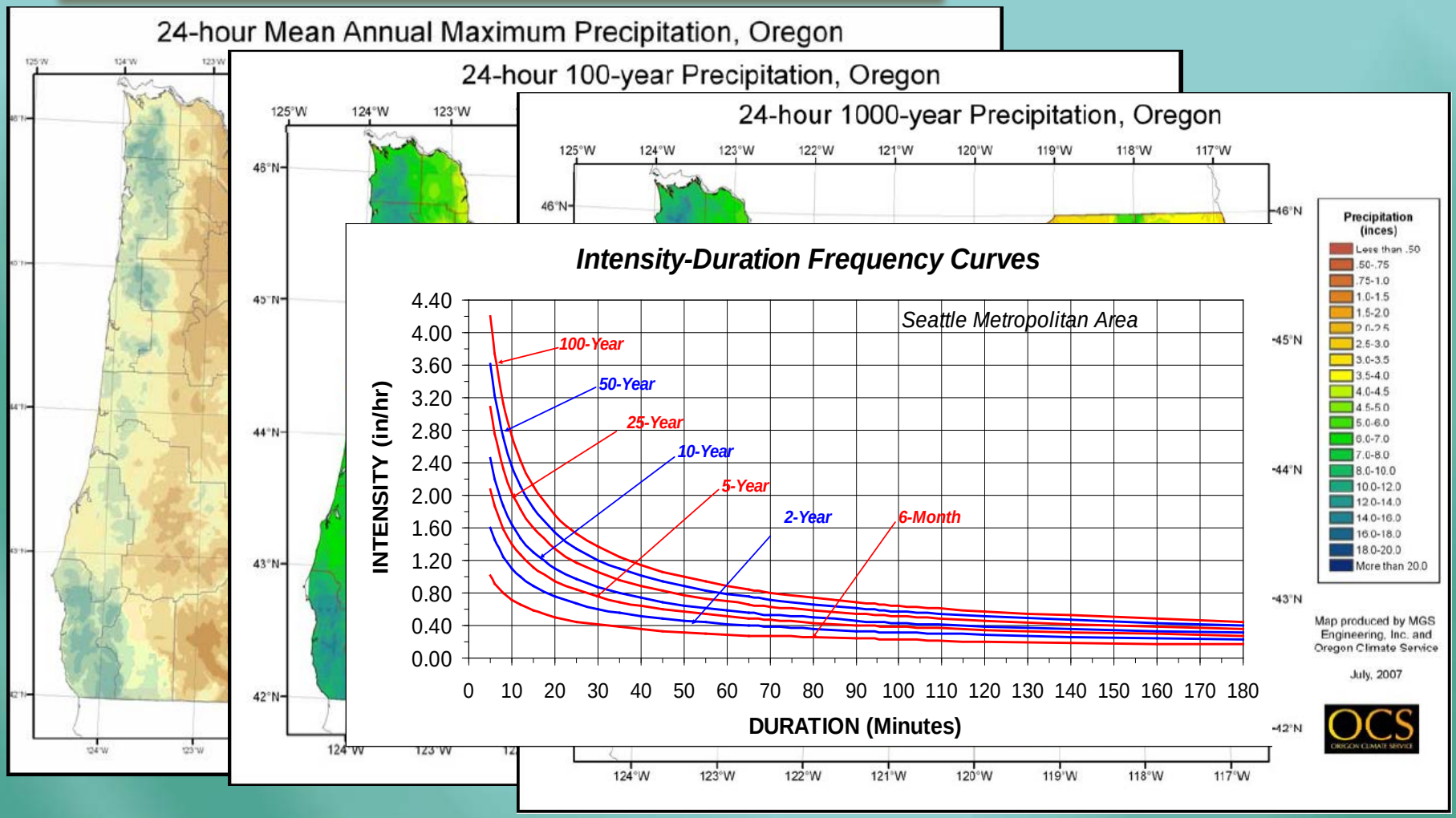



(Nuñez, Verbist et al., 2011, J. of Hydrology)

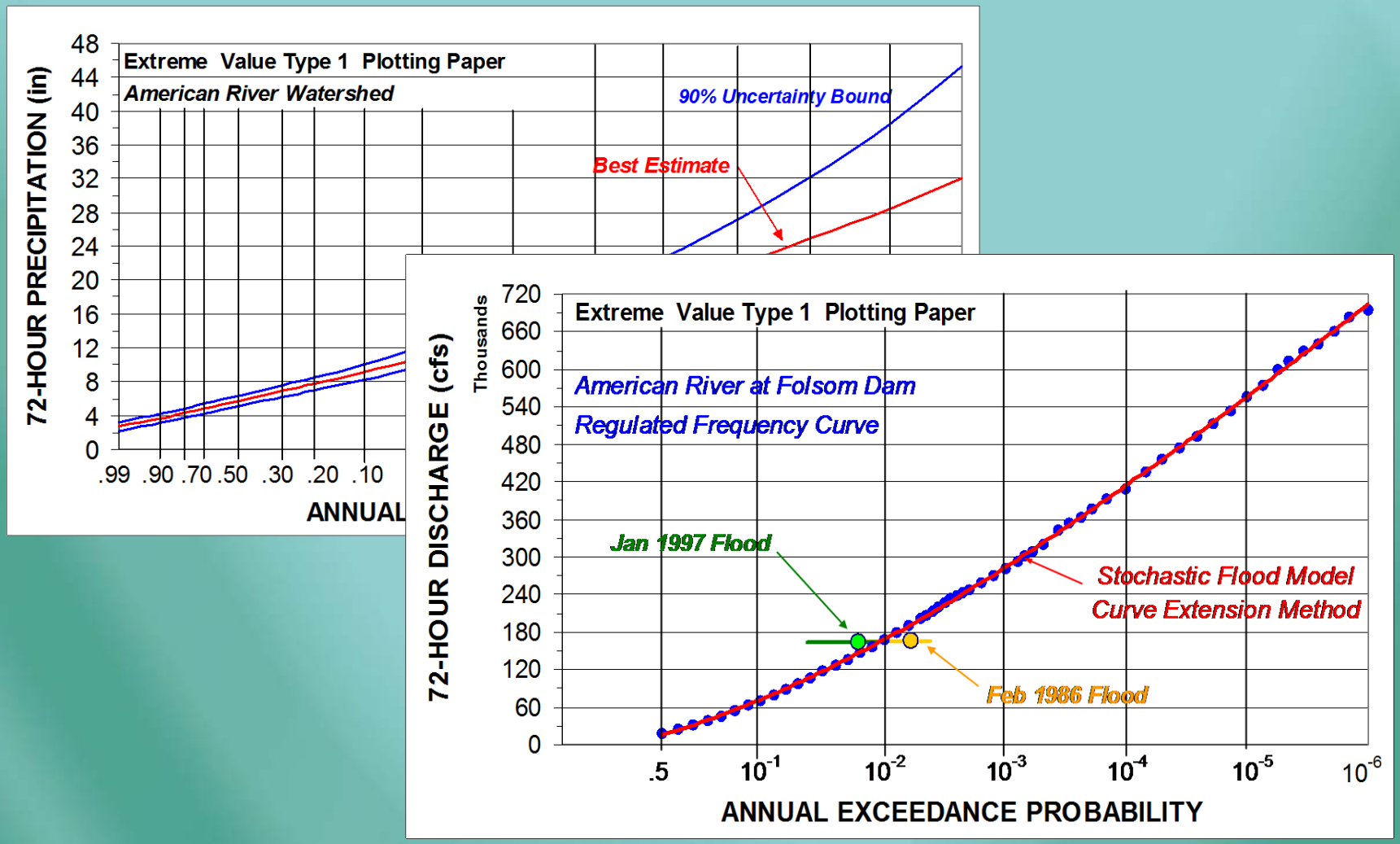
# Extreme Events

## Intensity – Duration – Frequency Maps



# P-5: Methodology

## Extreme discharge – frequency analysis



# Climate Risk Management

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Drought Monitoring

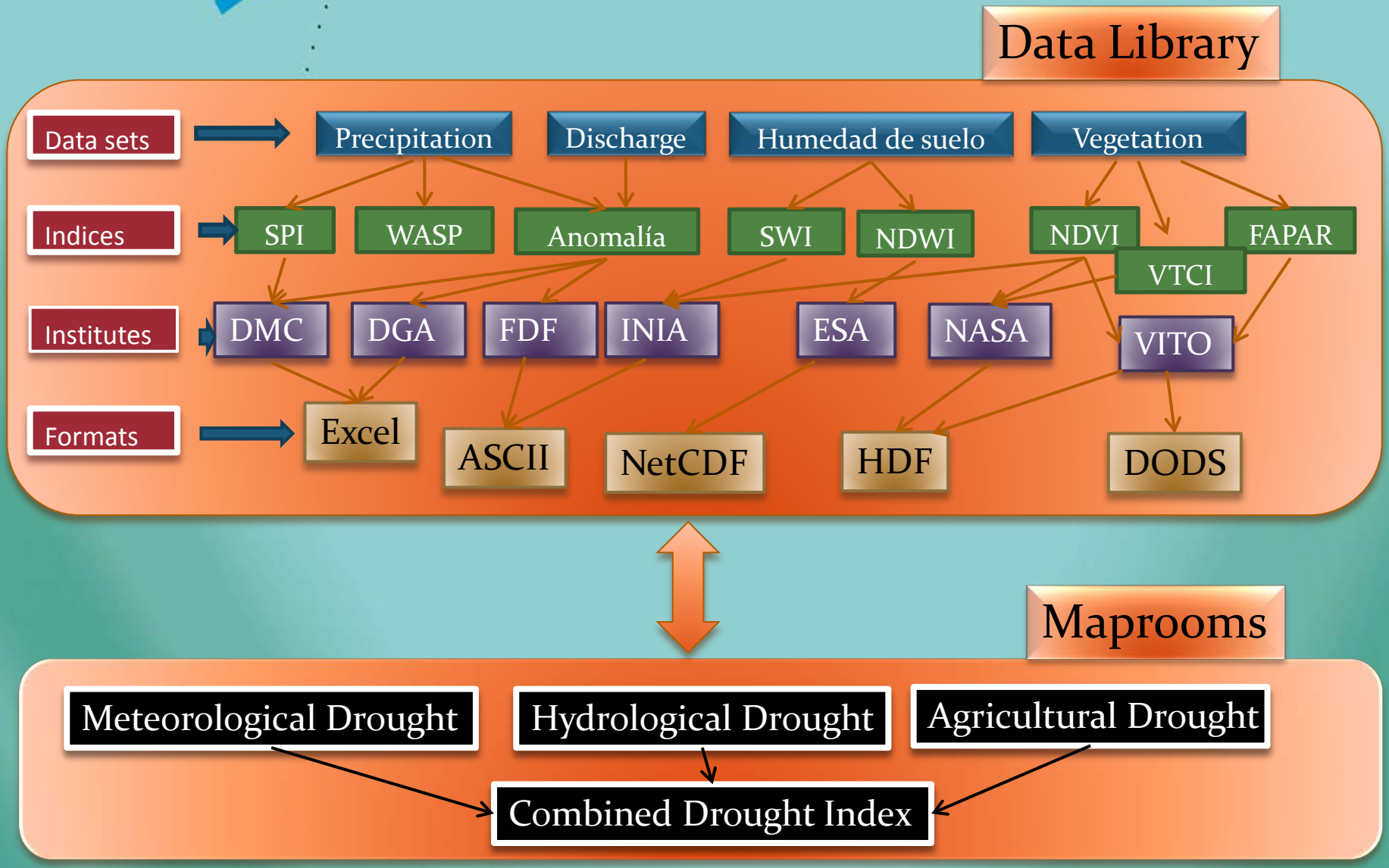
3. **Identify Technological Interventions that reduce climatic vulnerability**

➡ Evaluate water management alternatives

Courtesy

IRI

# Drought Observatory



# Drought Observatory

## Data Library

- Data Input
- Data Manipulation
- Visualization
- Output

data: USGS LandDAAC MODIS version_005 SSA NDVI - Mozilla Firefox

iridl.ldeo.columbia.edu/SOURCES/.USGS/.LandDAAC/.MODIS/.version_005/.SSA/.NDVI/

Most Visited BNP DB Tijd De Morgen Home TIAdaptativeManage... Google Maps connect IWRM as a tool for ada...

IRI

Data Library

Finding Data
Tutorial
Questions and Answers
Function Documentation

USGS LandDAAC MODIS version_005 documentation

help

USGS LandDAAC MODIS version_005 SSA NDVI options | Help | Expert Mode

NEW Views | Data Selection | Filters | Data Files | Tab

old Viewer

served from IRI/LDEO Climate Data Lit

SOURCES | USGS | LandDAAC | MODIS | version_005* | Southern South America | NDVI

# USGS LandDAAC MODIS version_005 SSA NDVI

LandDAAC MODIS version_005 SSA NDVI from USGS: United States Geological Survey.

**Independent Variables (Grids)**

*Time*
grid: /T (days since 2003-01-01) ordered [ (22 Apr 2000 - 7 May 2000) (8-23 May 2000) (24 May 2000 - 8 Jun 2000) ... (2-1 Feb 2013)] N= 295 pts :grid

*Longitude*
grid: /X (degree_east) ordered (77.99867W) to (40.00067W) by 0.002662043 N= 14275 pts :grid

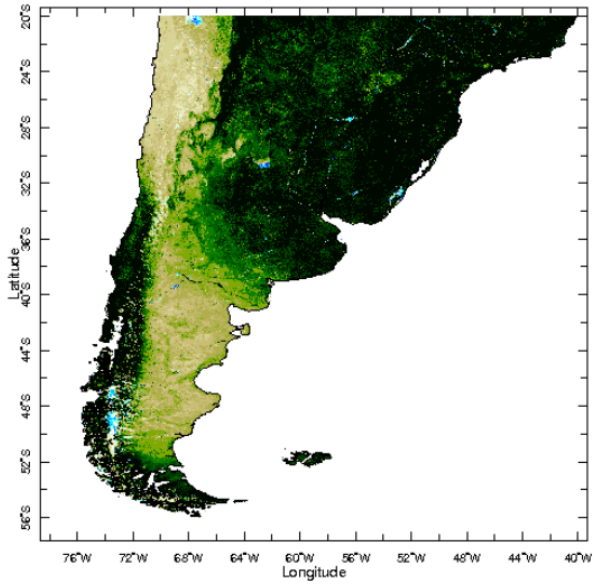
*Latitude*
grid: /Y (degree_north) ordered (20.00133S) to (57.00107S) by 0.002662043 N= 13900 pts :grid

**Other Info**

on_005 SSA NDVI | 78W - 39.99934W | 57.0024S - 20S | 22 Apr 2000 - 17 Feb 2013 | WGS 84

Time: 2-17 Feb 2013 | 17 Jan 2013 - 1 Feb 2013

20.00133S




57.00107S 2-17 Feb 2013

78W 39.99934W

-0.2 0 0.2 0.4 0.6 0.8 1

USGS LandDAAC MODIS version_005 SSA NDVI

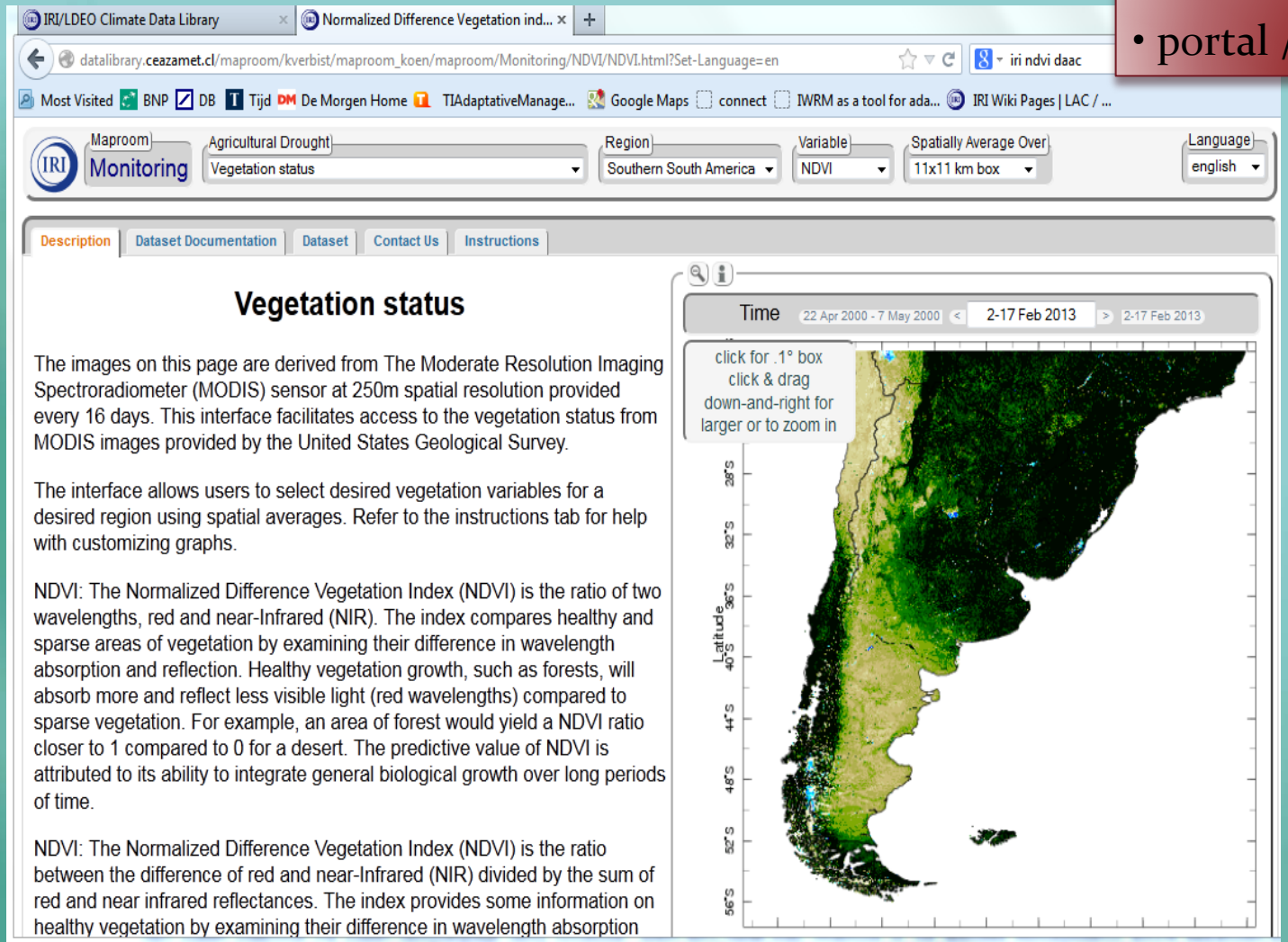
-0.2 1.

- http://iridl.ldeo.columbia.edu/
- http://datalibrary.ceazamet.cl

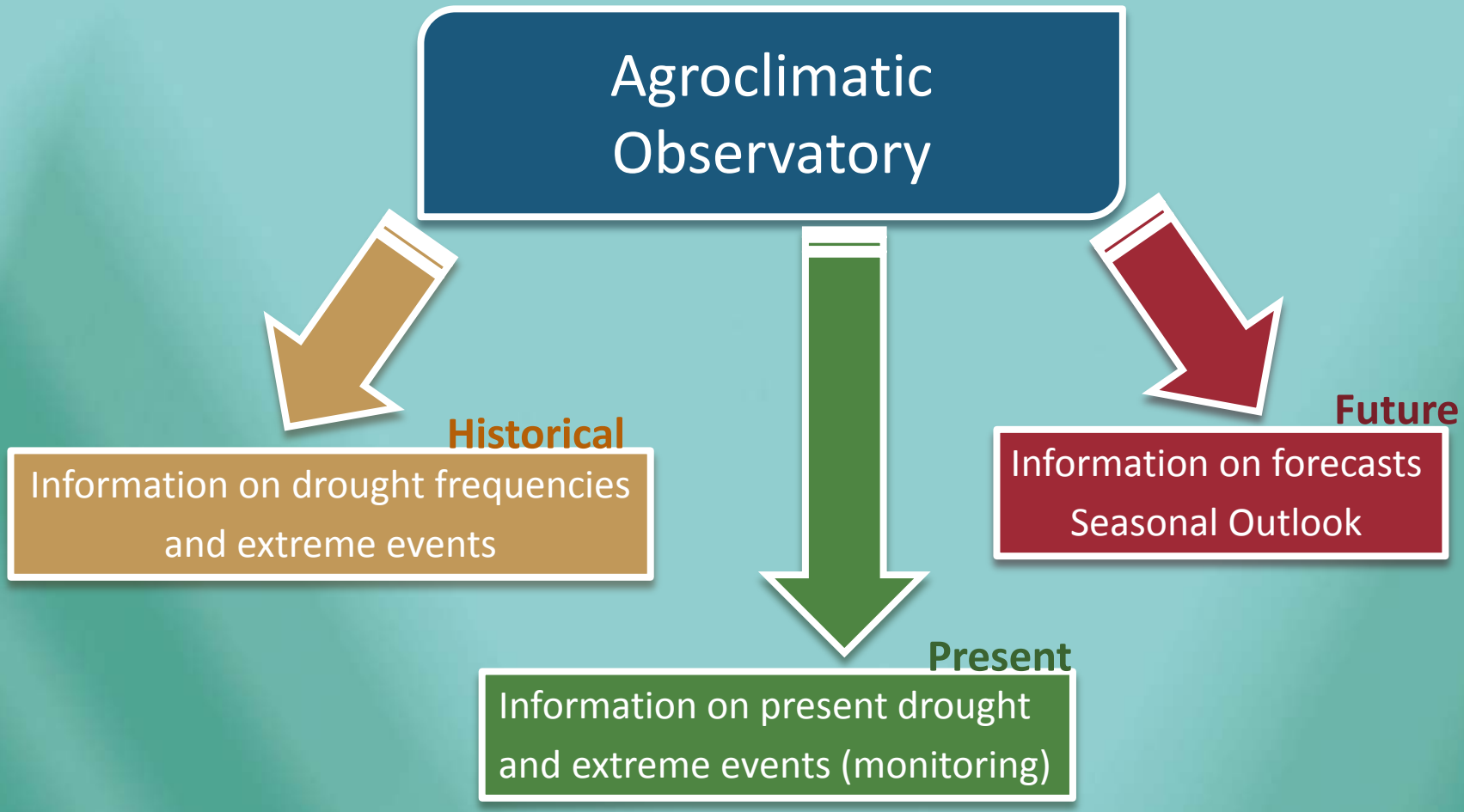
# Drought Observatory

## Maprooms

- Visualization for end user
- portal / observatorio



# Structure of the Observatory



# Structure of the Observatory

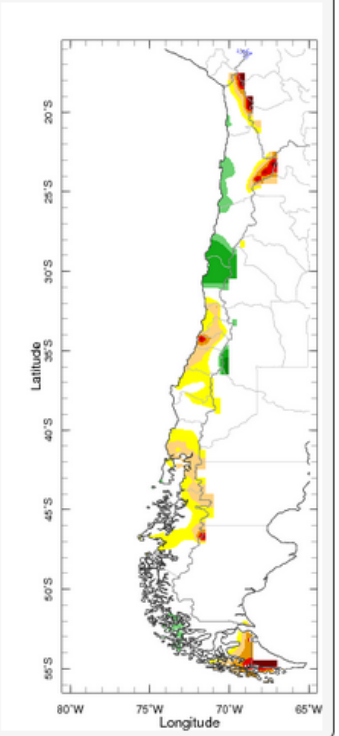
Data Library | Maprooms | Region: Chile | Language: english

## 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.

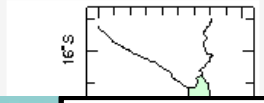
### Drought Monitor

A drought monitor showing relevant drought indicators.



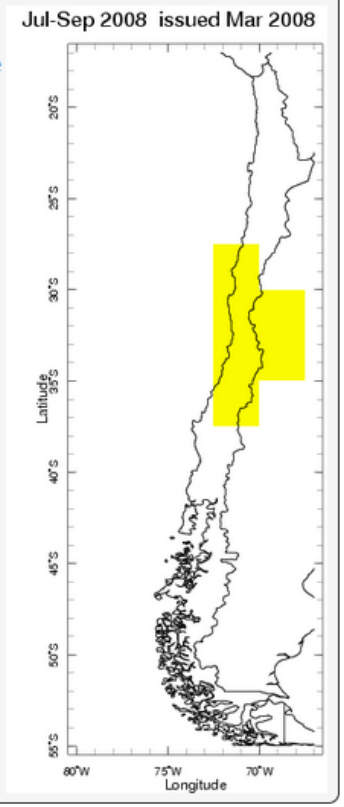

### Historical Drought Frequencies

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

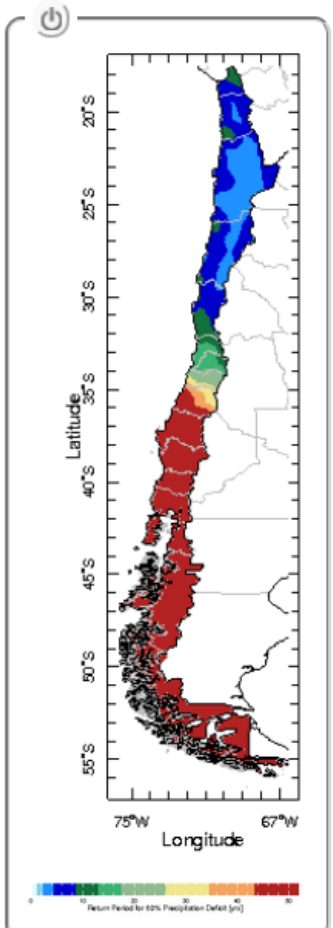
Description | Dataset Documentation | Contact Us

## 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

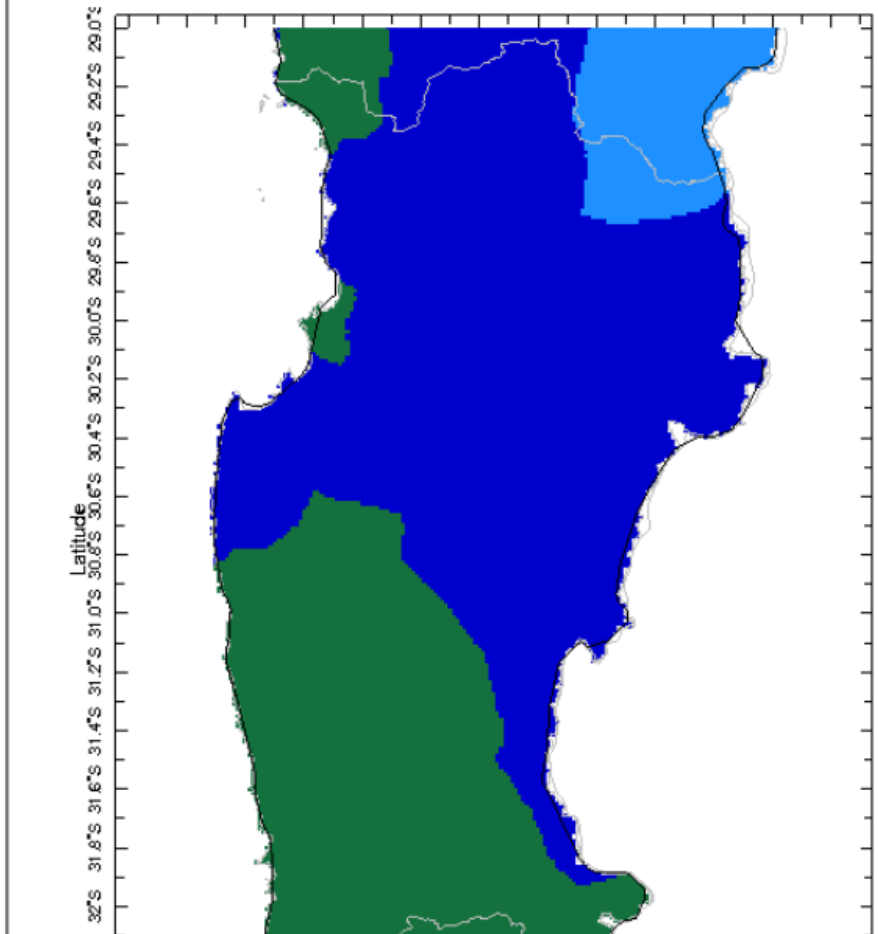
Historical Drought Frequencies: Drought Return Periods

Region: Coquimbo

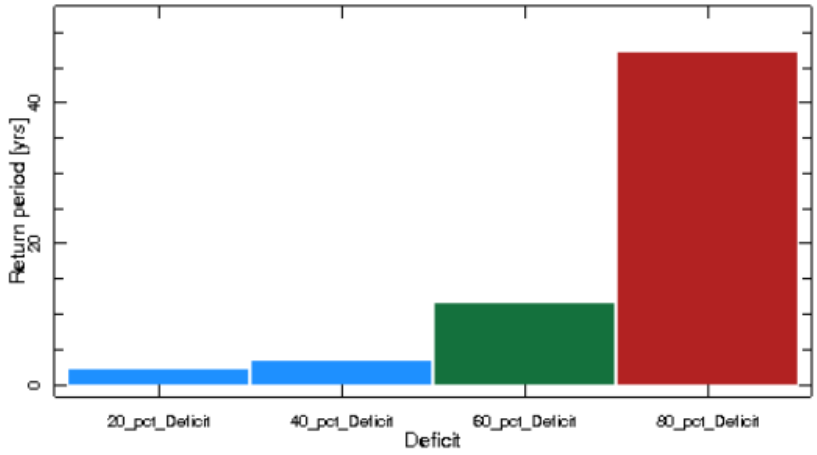
Variable: 60% Rainfall Deficit

Language: english

Description | Dataset Documentation | Contact Us




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



# 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.

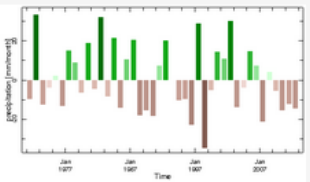
The indicators were selected to show conditions with respect to meteorological, hydrological and agricultural drought.

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.

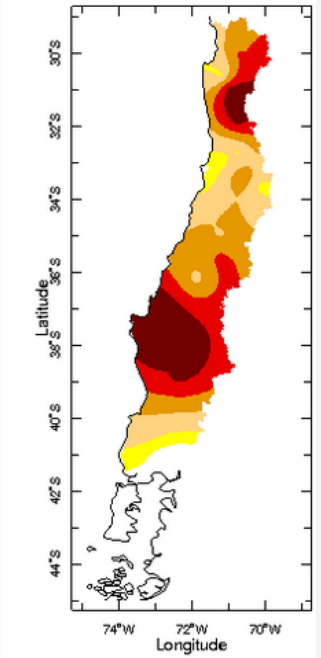


**Observed Precipitation**

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

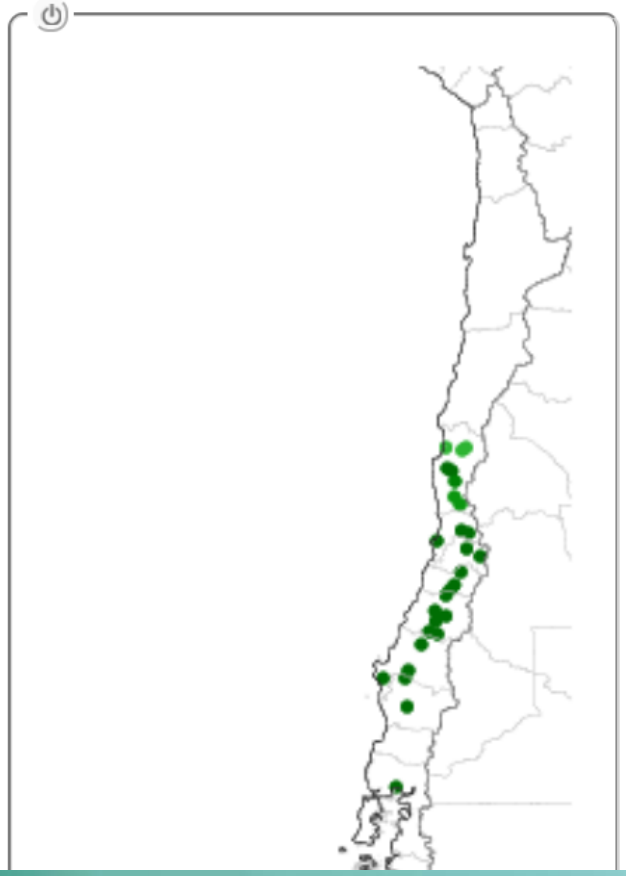
Description | More information | Dataset Documentation | Contact Us | Instructions

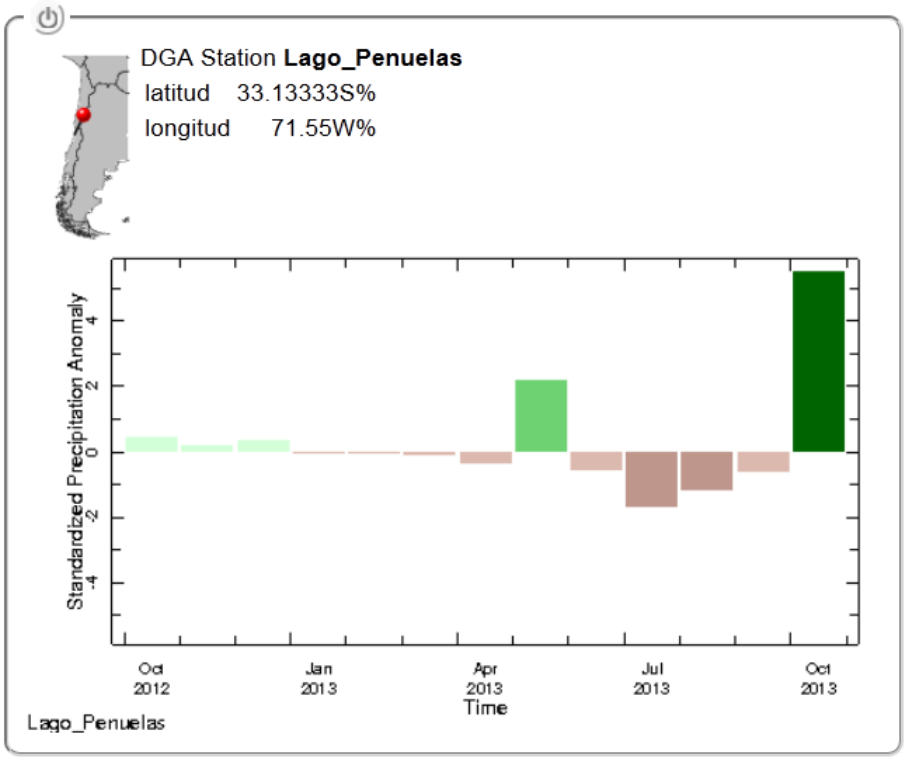
**Observed Precipitation**

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

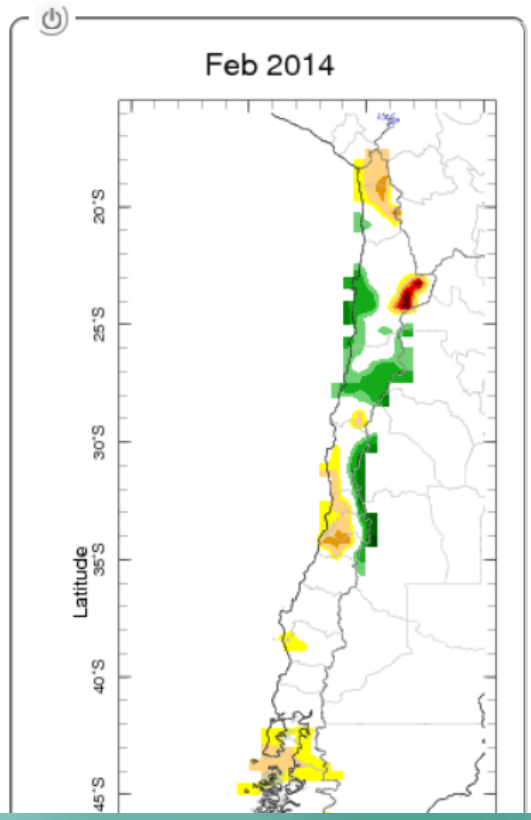
## Standardized Precipitation Index

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

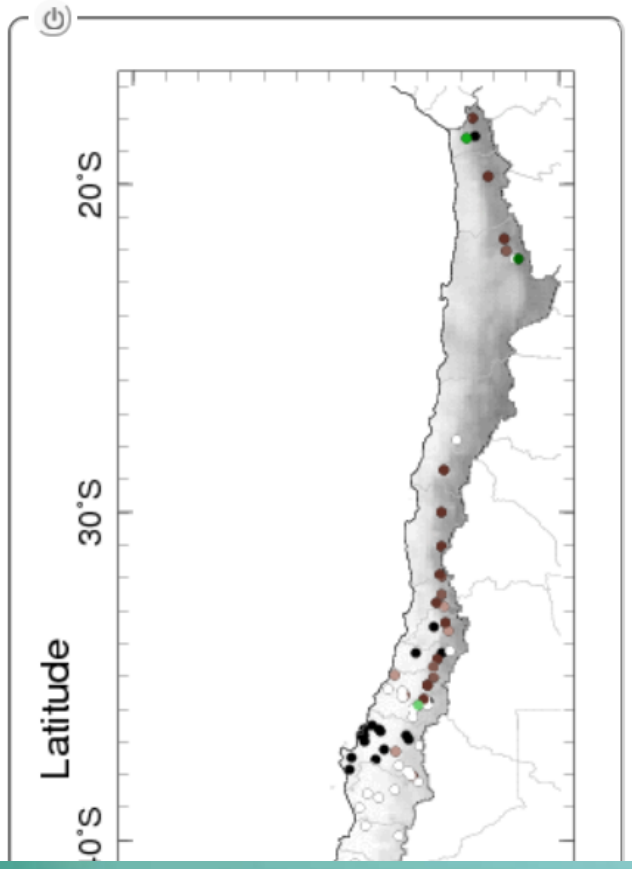
**Observed discharge**

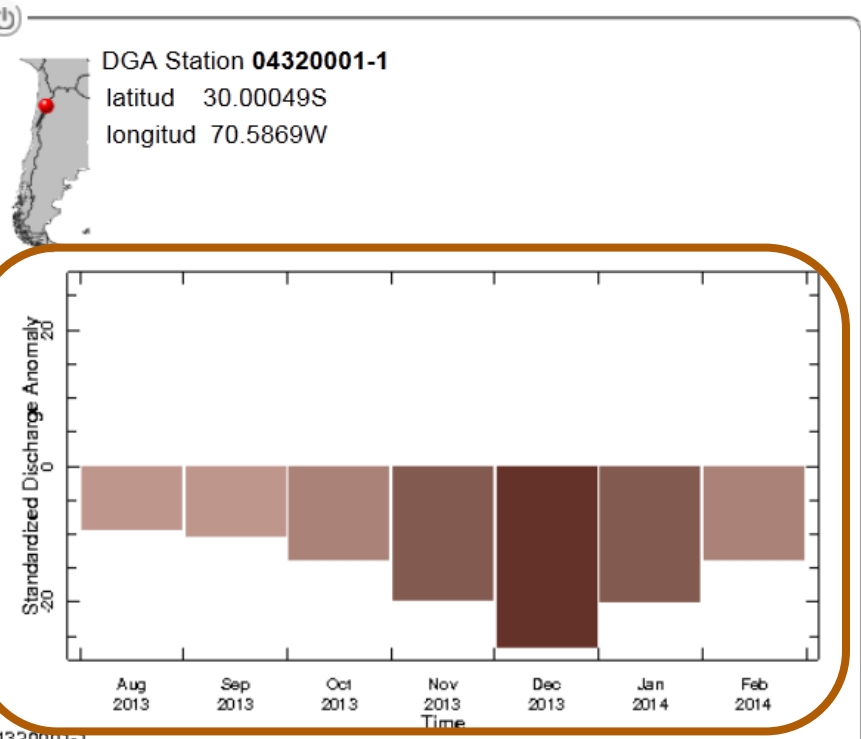
Information on the discharges observed in Chilean rivers is available here.

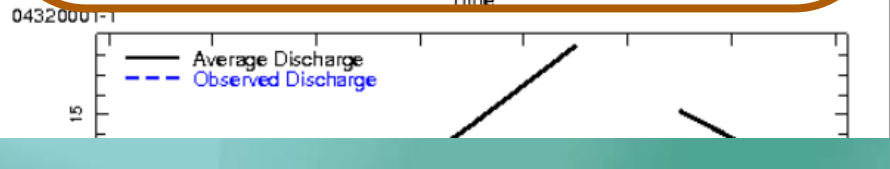
In menu>variable you can select the variable: measured and anomaly. In menu>region you can select a region.

**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

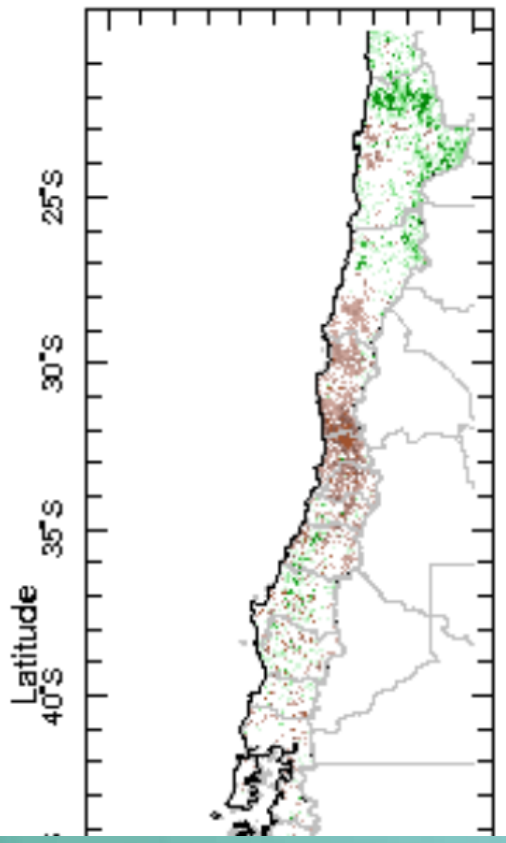
Maproom: Monitoring | Agricultural Drought: Normalized Difference Vegetation Index | Region: Chile | Analysis: Anomaly | Language: english

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

**Normalized Difference Vegetation Index**

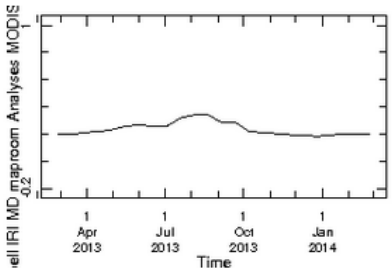
This map shows the actual situation of the vegetation as reflected by the Normalized Difference Vegetation Index (NDVI).

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.

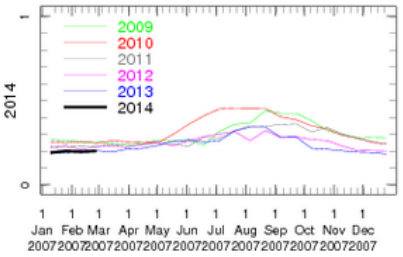



Observations for **[71.1W-71W, 32S-31.9S]**

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.

# Climate Risk Management

The Water Centre for Arid Zones in Latin America and the Caribbean (CAZALAC) has been developing a Climate Risk Management system for the region, based on three pillars:

1. **Identify Vulnerabilities and Oportunities**

➡ Evaluate water use efficiency and vulnerabilities

2. **Reduce Uncertainties:**
   a) Learn from the Past
   b) Monitor the Present
   c) Assess Future scenarios

➡ Drought Forecasting

3. **Identify Technological Interventions that reduce climatic vulnerability**

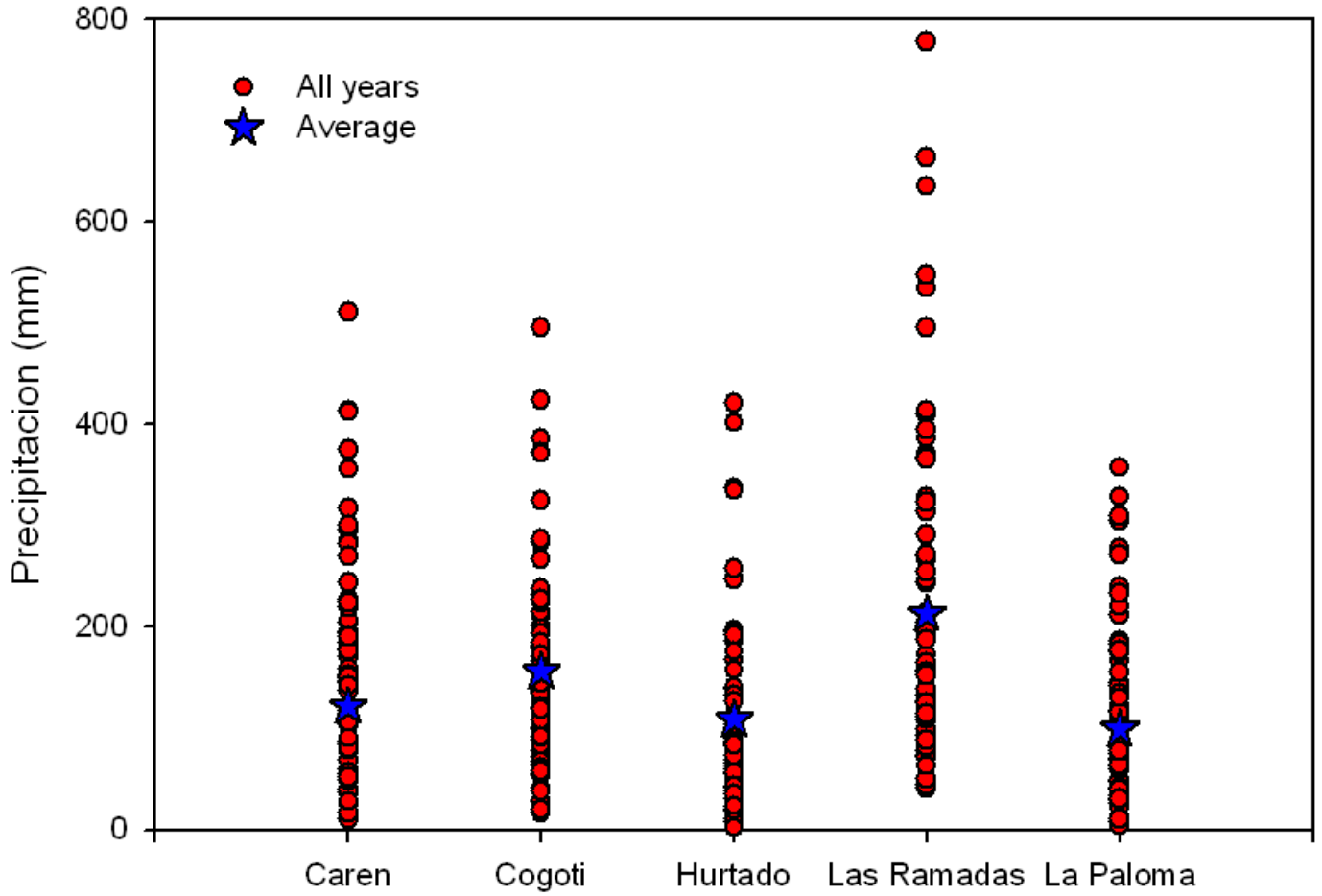
➡ Evaluate water management alternatives

Courtesy

IRI

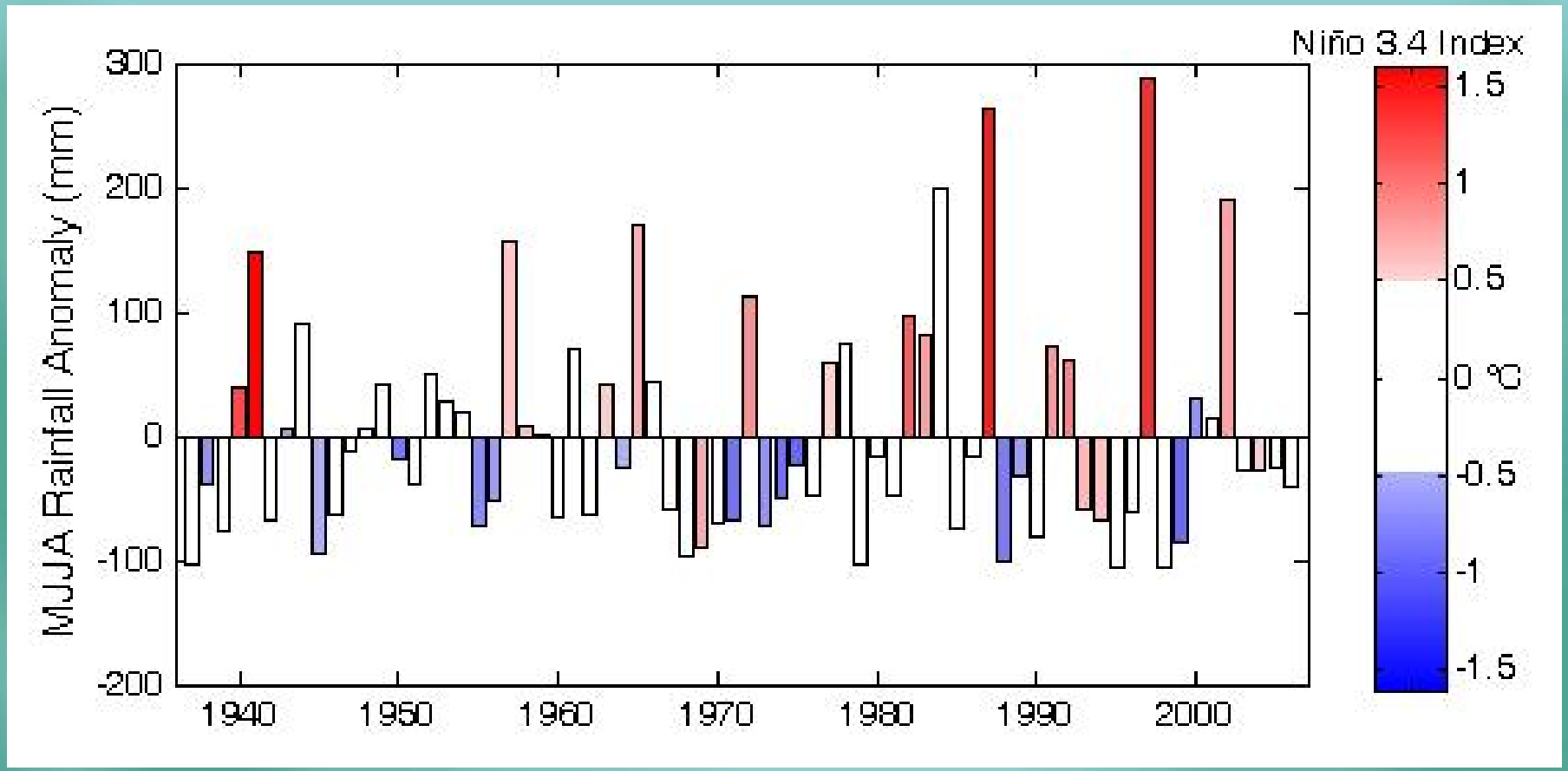
# Climatic variability in the drylands

Example: What is the average rainfall in the 4th Region?



# Drought Prediction

Can we identify a common regional influence on rainfall?



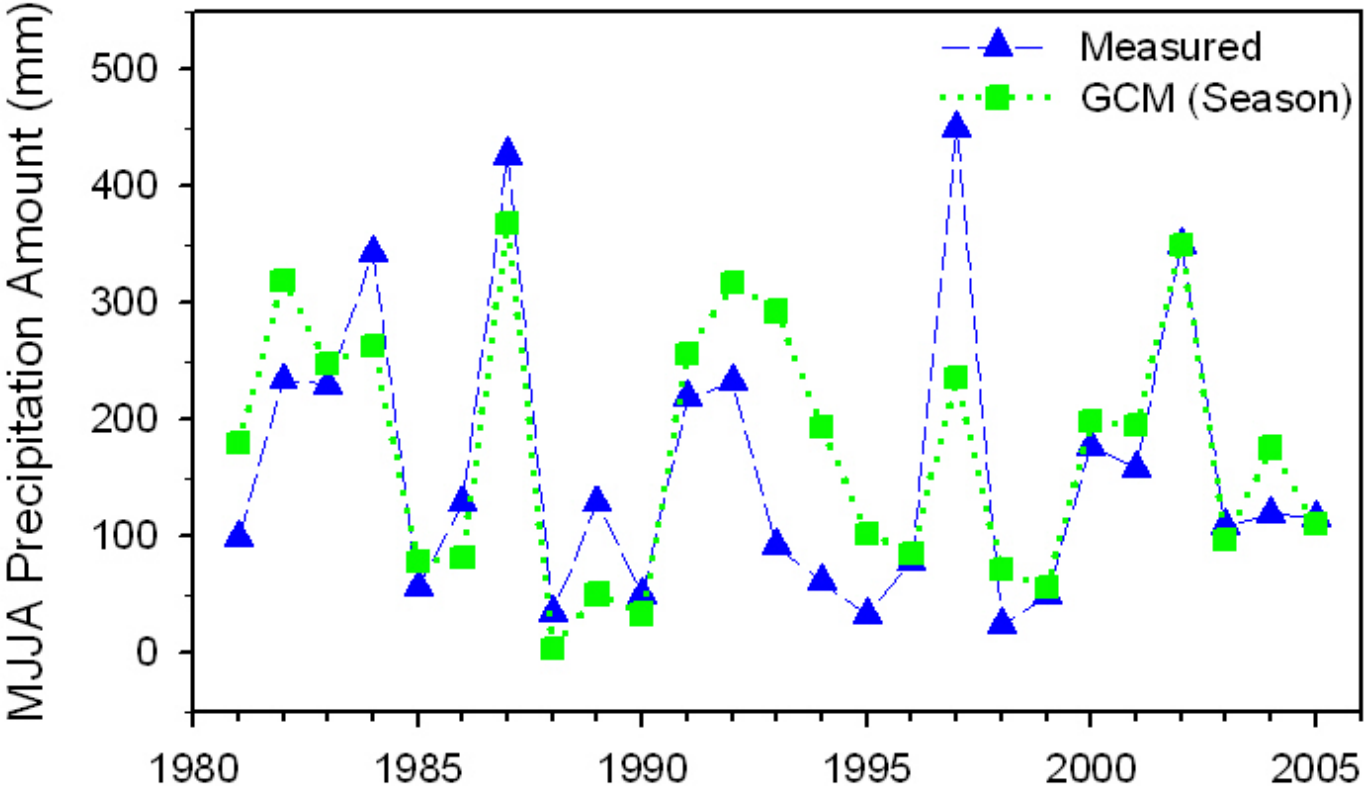

(K. Verbist et al., 2010, JAMC)

# 1. Seasonal prediction

SST → GCM → Winter Precipitation

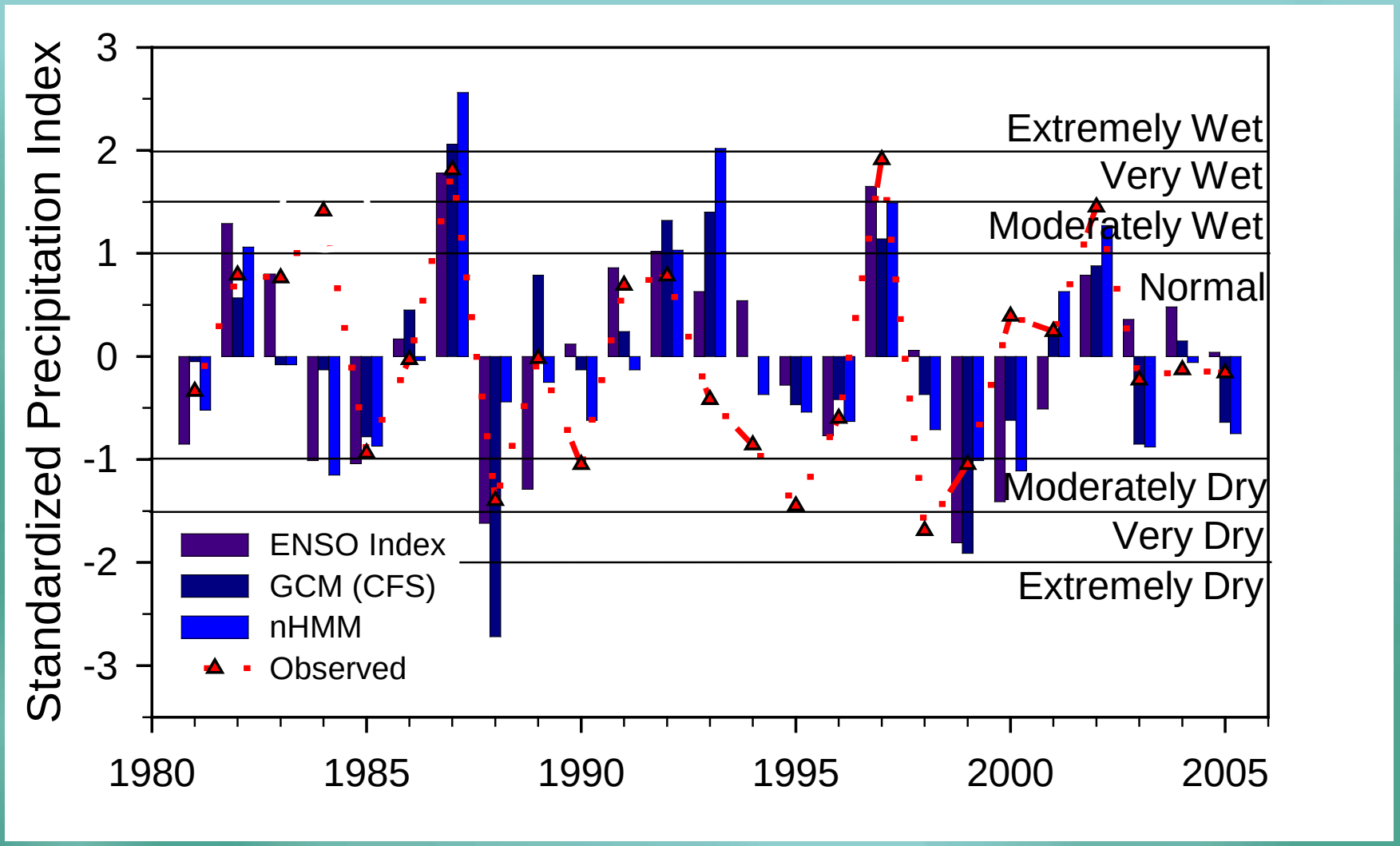
Retrospective cross-validated prediction

4 months lead time

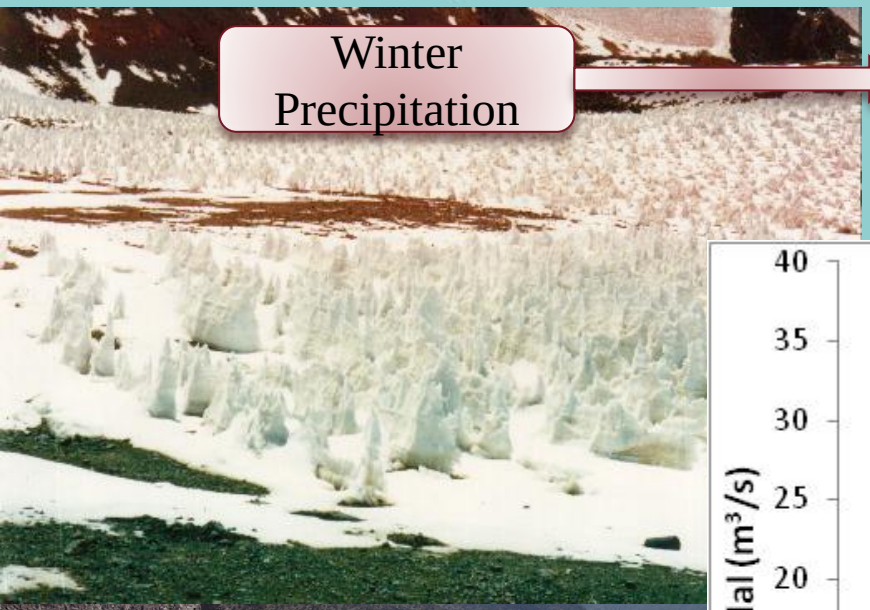



(K. Verbist et al., 2010, JAMC)

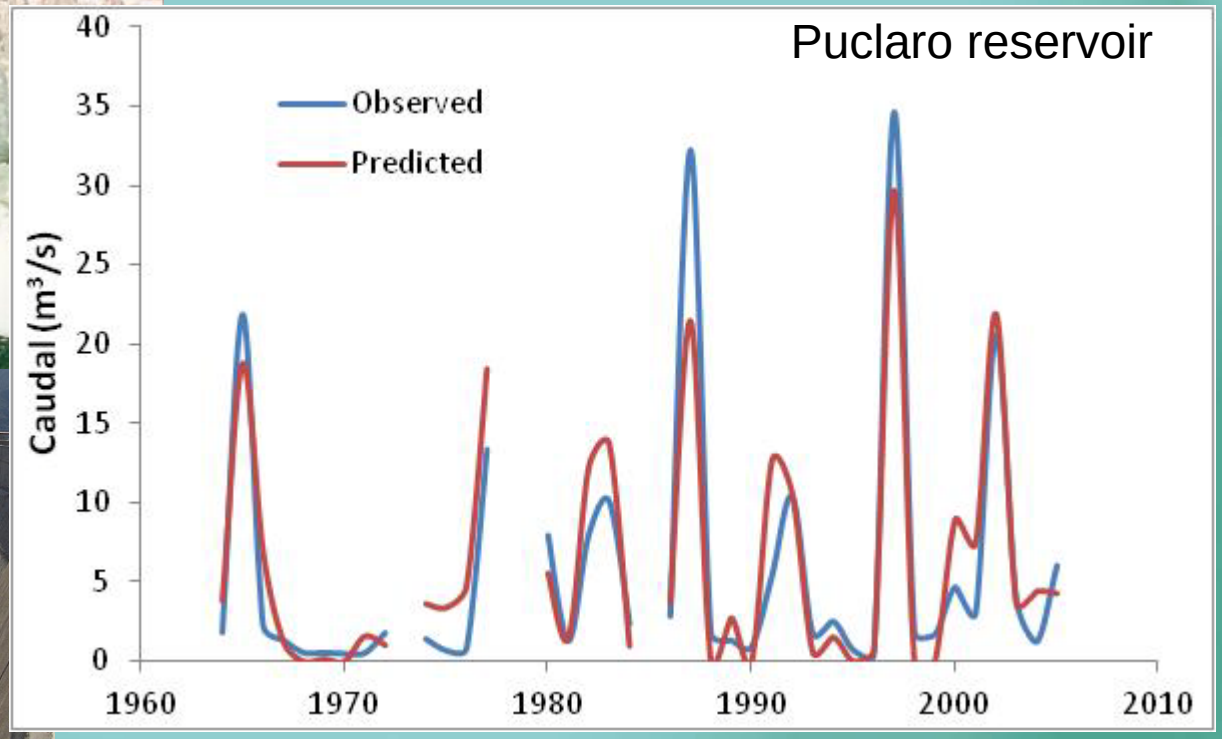
# Can we use these approaches to predict drought?



# 2. Streamflow prediction for reservoir management



Winter Precipitation → Melting → Summer discharge




Support water allocation to agriculture, cities and industry (mining)

# Climate Risk Management

The Water Centre for Arid Zones in Latin America and the Caribbean (CAZALAC) has been developing a Climate Risk Management system for the region, based on three pillars:

1. **Identify Vulnerabilities and Oportunities**

➡ Evaluate water use efficiency and vulnerabilities

2. **Reduce Uncertainties:**
   a) Learn from the Past
   b) Monitor the Present
   c) Assess Future scenarios

➡

Climate Change Impact

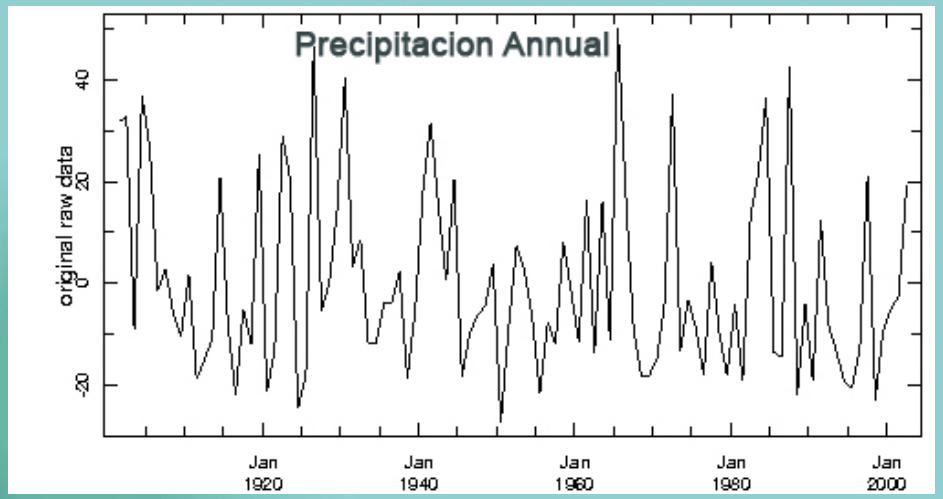
3. **Identify Technological Interventions that reduce climatic vulnerability**

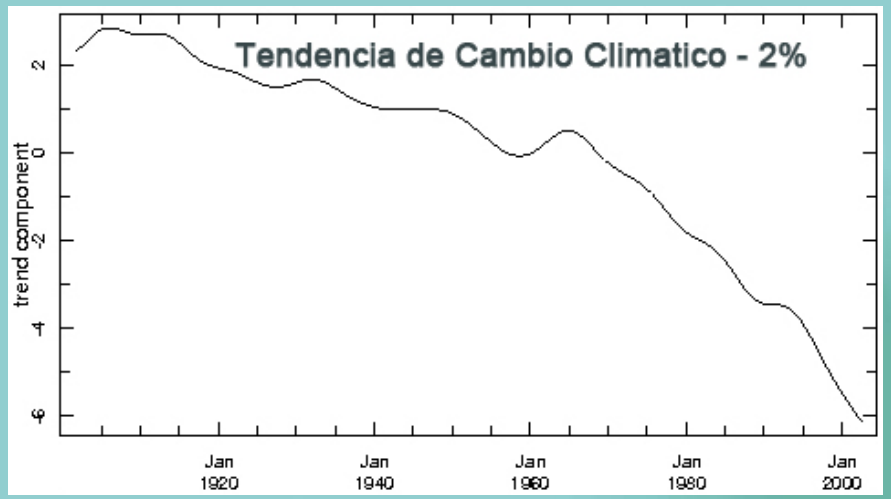
➡ Evaluate water management alternatives

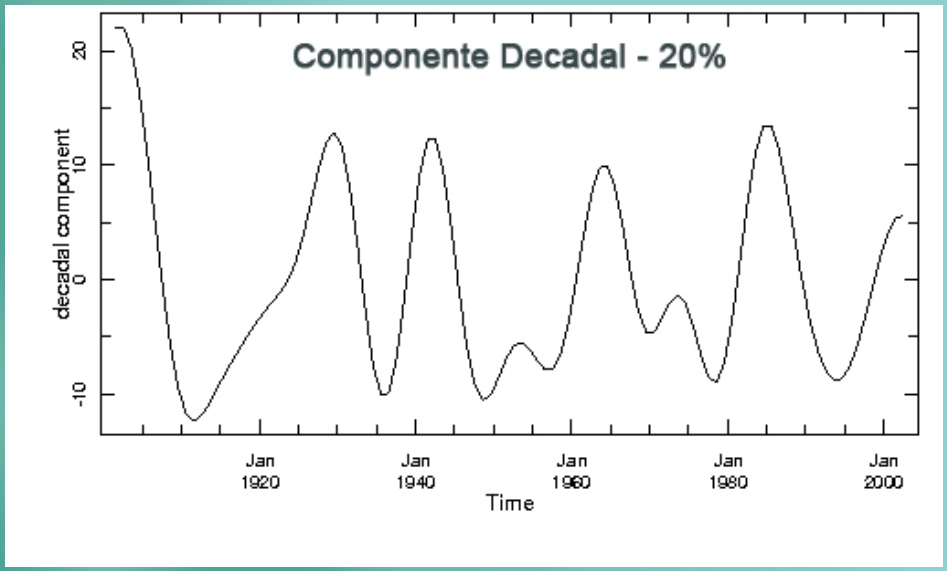
Courtesy

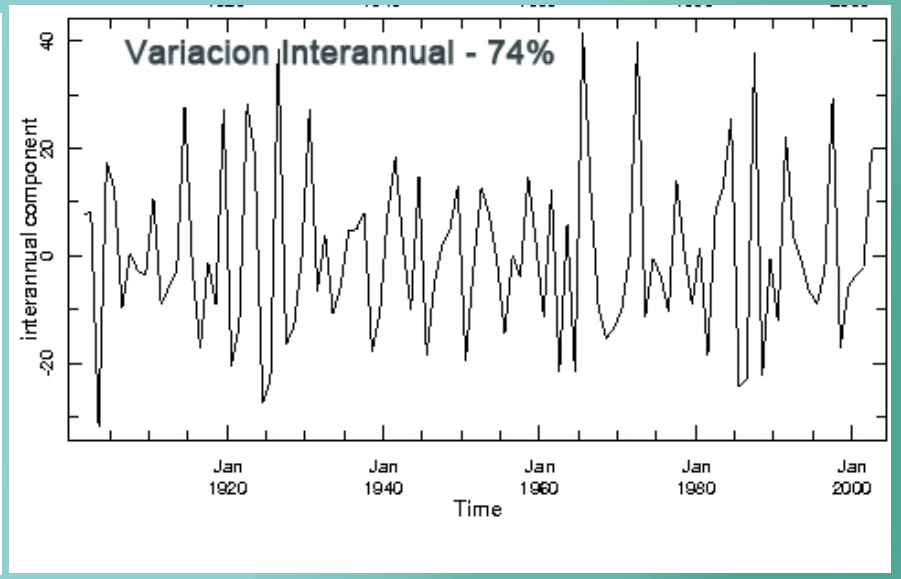
IRI

# What are the components of variability?



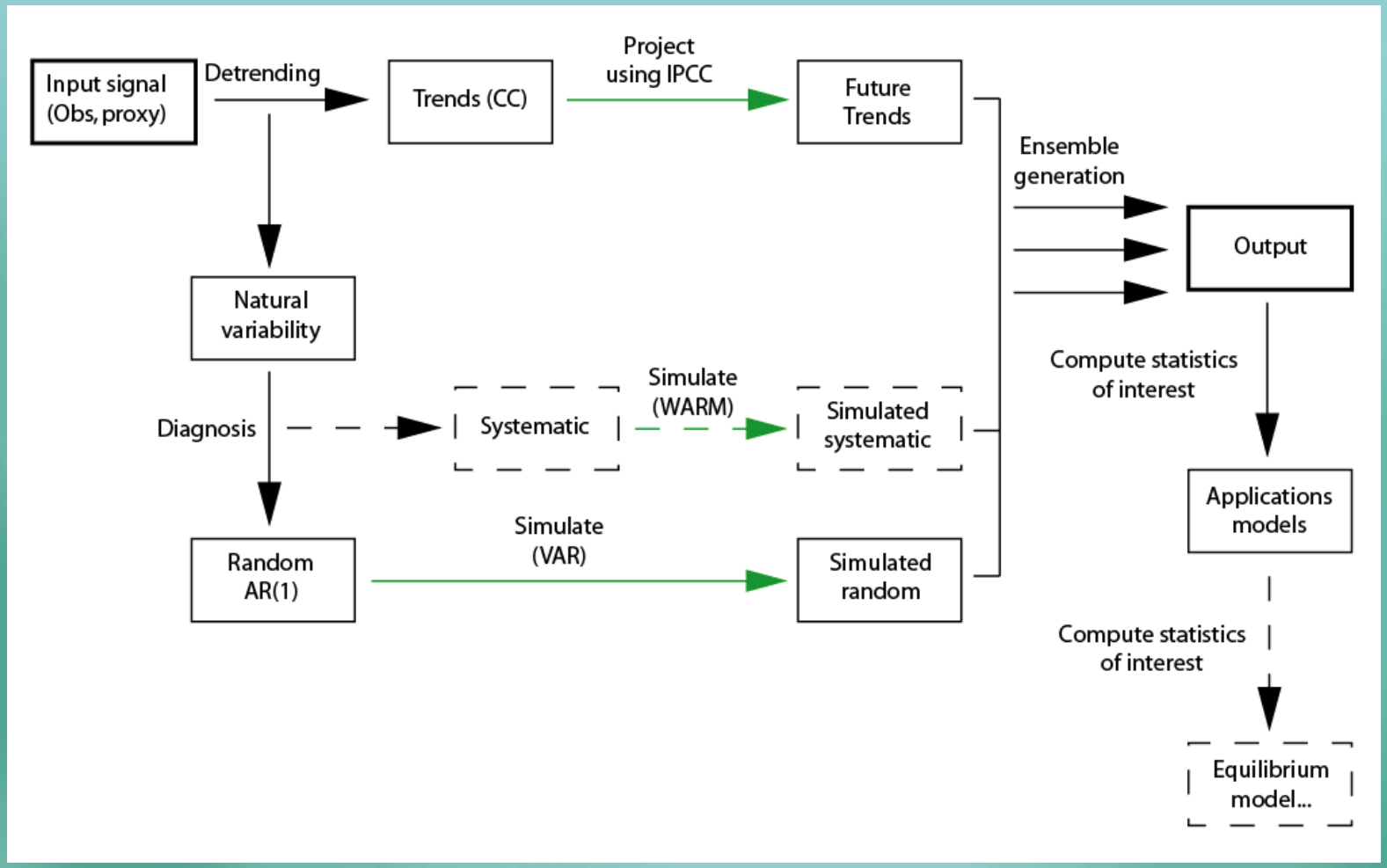



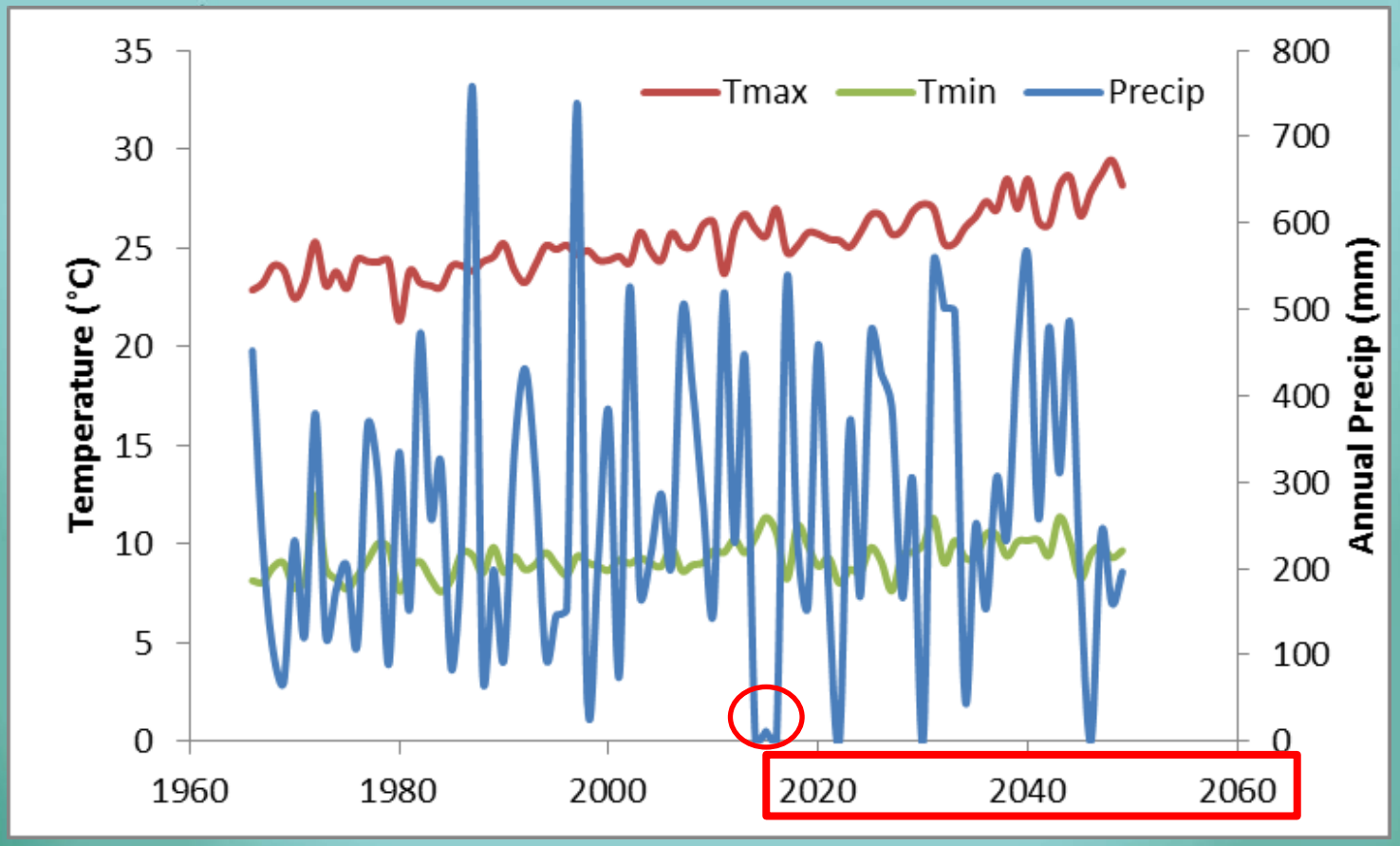
# Methodology

Near-term climate change scenario analysis tool




(Greene, Hellmuth and Lumsden, 2012, WRR).

# Downscaling of projections to the local level

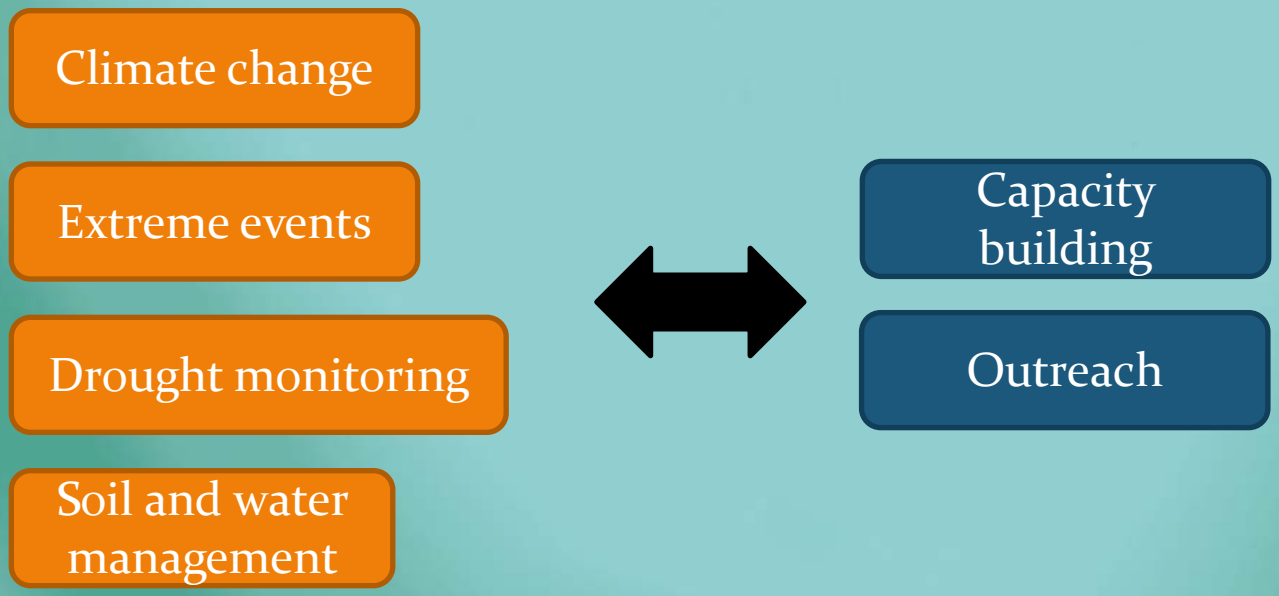



- Variables maintain their correlation and are consistent with past conditions
- Allows to evaluate the probability of droughts and extreme events and evaluate the potential impact on water resources

# MWAR-LAC Project outlooks (2013-2014)

- **Overall objective**

The overall goal of the project is to contribute to a reduction in the vulnerability of water resources systems to global changes in local communities of arid and semiarid environments in LAC, based on sound scientific knowledge.



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

# Managing Water Resources in Arid and Semi Arid Regions of Latin America and Caribbean

## A focus on climate risk management…

Project website: www.cazalac.org/mwar_lac

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CAZALAC

WITH THE SUPPORT OF THE FLEMISH GOVERNMENT