Day 1
Drought Concepts and how they are Represented in the LAFDM

Latin American and Caribbean Flood and Drought Monitor
Training Workshop
Santiago, November, 2014

Outline

1. The challenge of drought
2. Drought definitions
3. Types of drought and their connections
4. Drought characteristics (Time and Space)
5. Drought indices
6. Drought propagation and feedbacks

We will illustrate these with examples from the LAFDM

The Challenge of Drought

- They are slow-onset hazards, which may also recede as slowly. Thus it is difficult to establish the exact timing of its start and finish.
- Furthermore, the societal impacts may also accumulate slowly, and then endure for months after the drought has physically receded.
- Often a drought has been going on for several months before government institutions declare an official drought.
- Since a drought is ignorant of political boundaries, drought-monitoring activities are challenging because they are often carried out on the basis of political regions.
- These challenges have important implications for drought relief because funds are usually only distributed when and where an official drought is called.
- Thus droughts are difficult to identify and characterize, they impact in non-structural and indirect ways and may linger for months or years over large regions.

Definition of Drought

Basic definition: deficit of water relative to normal conditions.

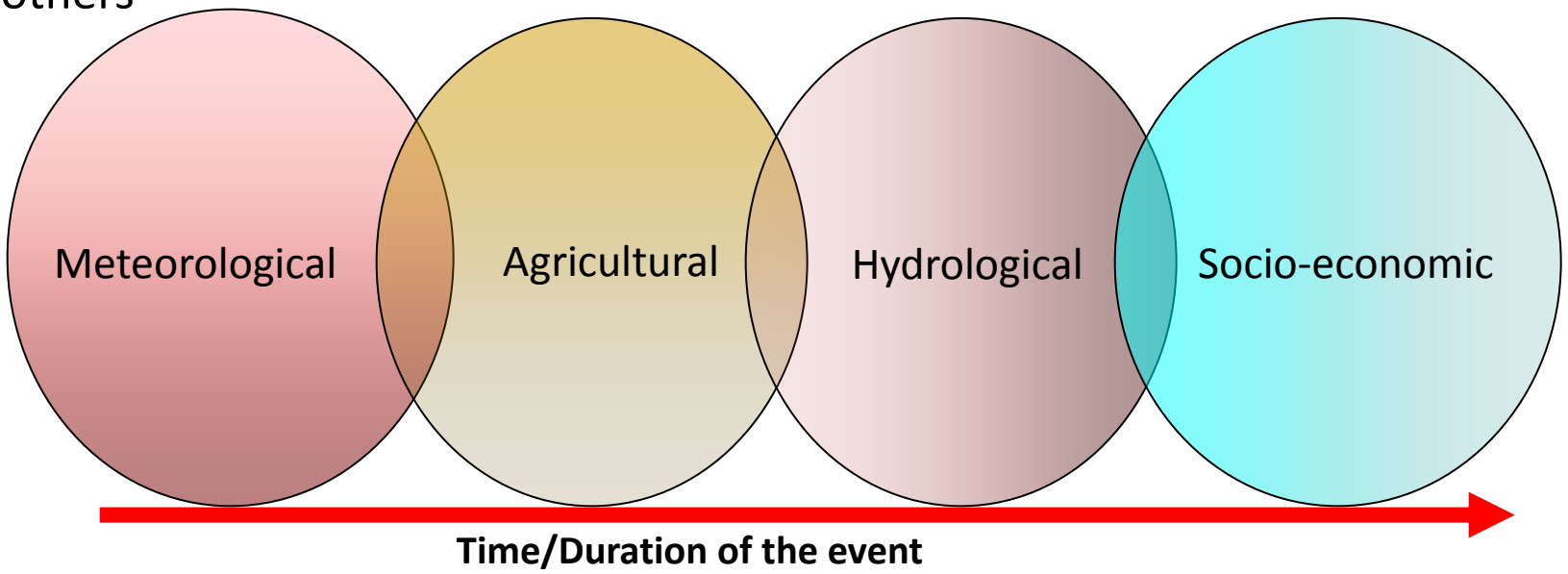
More specifically: a low amount of water in one or a combination of these stores (river, lake, reservoir, snowpack, soil water and groundwater) or fluxes (precipitation, evapotranspiration and run-off).

When the lack of water is sustained and spatially extensive, and is a deficit below a threshold that has adverse impacts.

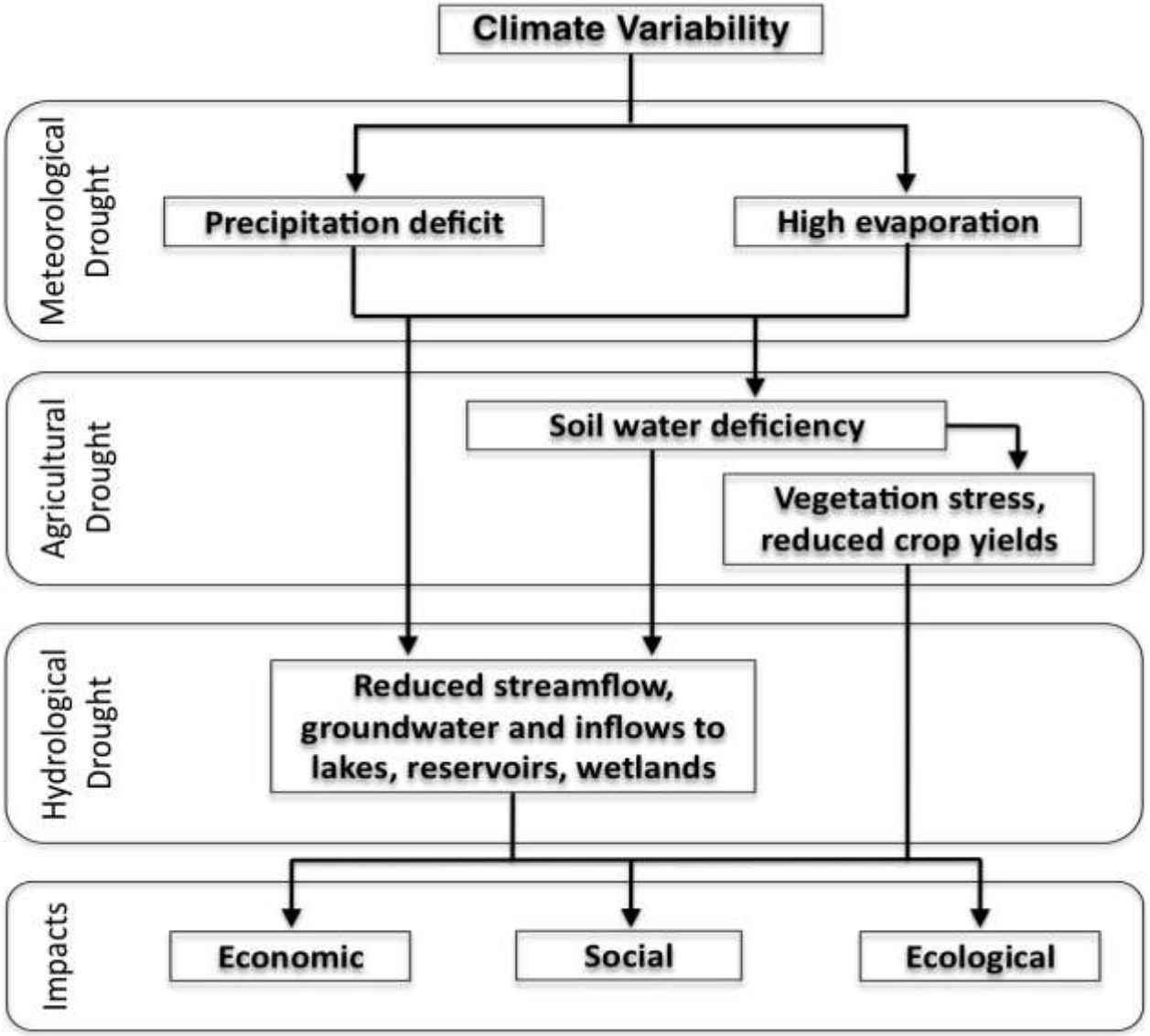
Types of Drought

1. *meteorological drought*, a significant negative deviation from mean precipitation;
2. *hydrological drought*, a deficit in the supply of surface and subsurface water;
3. *soil moisture* or *agricultural drought*, a deficit in soil moisture, driven by meteorological and hydrological drought, reducing the supply of moisture for vegetation;
4. *socio-economic drought*, a combination of the above three types leading to undesirable social and economic impacts.

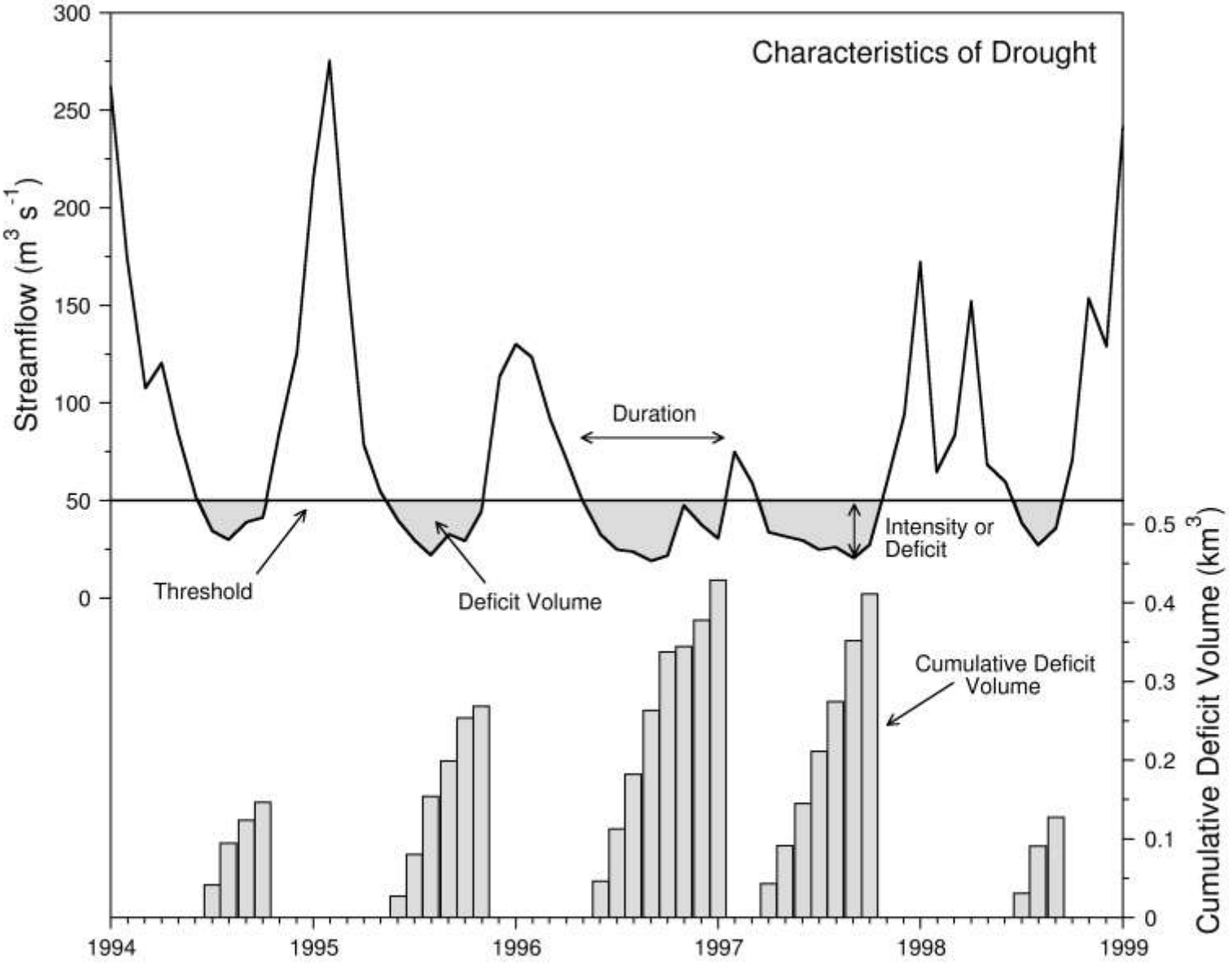
... others



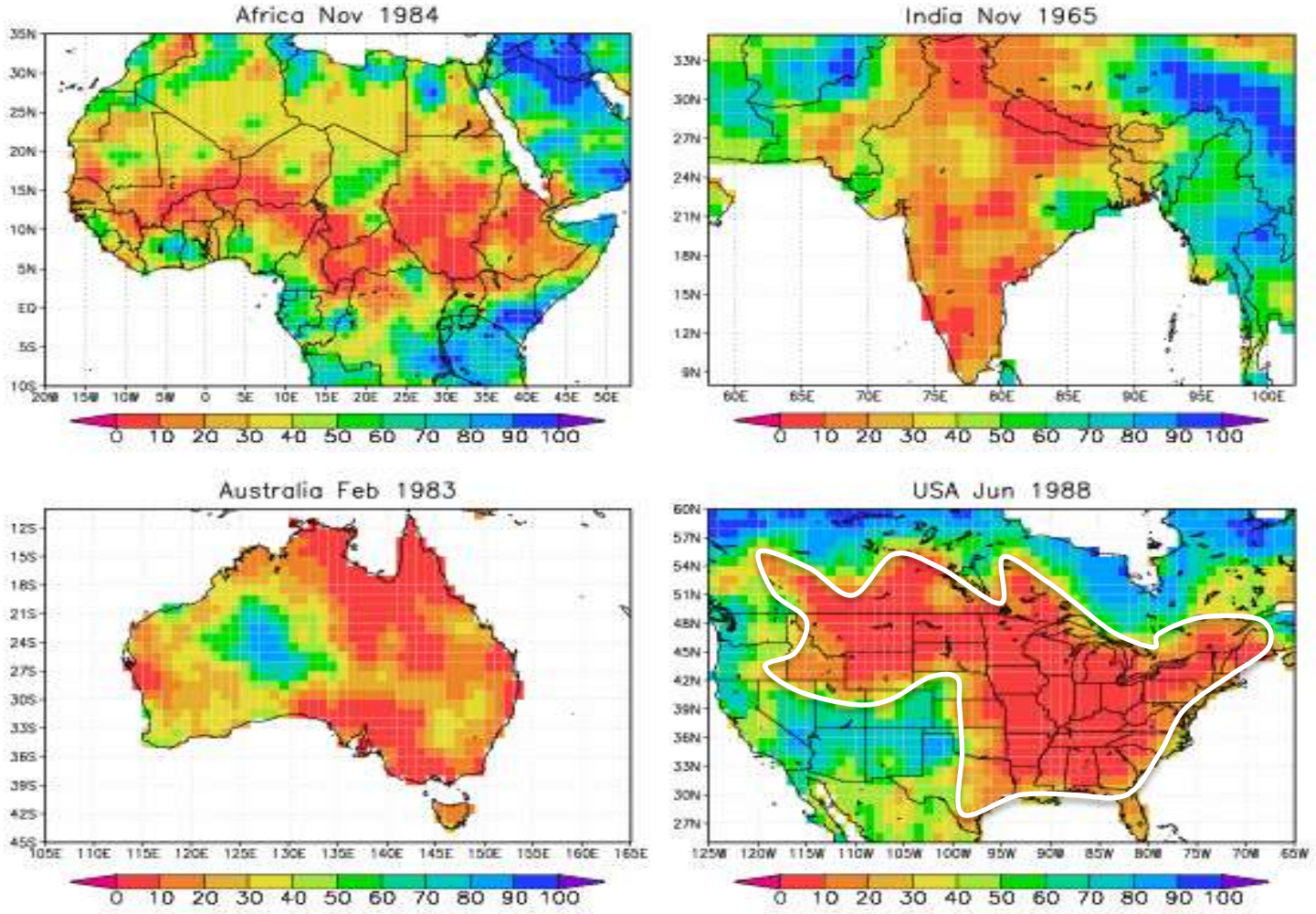
Types of Drought, Their Connections and Impacts



Drought Terminology: Temporal Characteristics



Drought Terminology: Spatial Characteristics



Examples of monthly soil moisture quantiles for four major regional droughts: a) Sahel, 1983-84; b) India, 1965-66; c) Australia, 1983; d) USA, 1988.

Quantifying Drought with Indices

- For the application of interest, whether it is the condition of a water supply system, the requirements for irrigation or the sustainability of an ecosystem, **a quantitative expression for the state of drought** is required.

- This is usually called a **drought index** and allows a farmer, a manager or policy-maker to **objectively analyse** a system and make quantitative management and policy decisions.

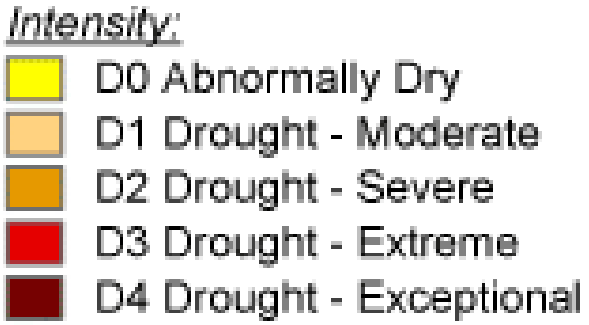
- Drought indices are used in both operational drought monitoring and when forecasting drought within a warning system, where an index can provide an objective basis for acting upon the drought.

Calculation of Indices

Usually a threshold is chosen below which there is drought and above which there is not.

This threshold can be fixed but may also vary in time or be fuzzy in the sense that there is a gradation between drought and non-drought.

There may be a number of categories of drought severity, such as ‘abnormal’, ‘moderate’, ‘severe’ and ‘extreme’ (e.g. USDM).



Often a drought threshold will be used to declare an official drought in a region and trigger a set of management responses or provide aid.

Popular Drought Indices

Table 4.1 *Popular drought indices, their rationale and advantages/disadvantages*

Index	Description	Advantages	Disadvantages
Meteorological Drought			
Precipitation percentage of normal	Calculated as the actual precipitation divided by the average annual value	Simple and effective for single locations and seasons	The mathematical meaning of normal is different to the general concept of normal weather
Rainfall deciles	Stratifies precipitation into deciles. Used mainly	Gives an accurate statistical measure	Long records of data are required ccurate values
Standardized Precipitation Index (SPI)	Based on the probab precipitation		change as new data d. Reflects only
Agricultural Drought			
Palmer Drought Severity Index (PDSI)	Calculated as moisture from simple water b Used by many drought trigge		behind emerging veral months; does snow; does not t climatic plex
Crop Moisture Index (CMI)	Reflects short- supply for crog from the Palm		to long-term s from the general f the Palmer
Palmer Moisture Anomaly Index (Z-index)	Same as the moisture anomalies in the PDSI	Quick response time to changing conditions	Same as PDSI; does not consider antecedent conditions
Soil moisture percentiles	Calculated from modelled or observed soil moisture data	Provides a statistically robust measure of soil moisture, which reflects hydrological inputs and outputs	Usually calculated from complex hydrological models; requires detailed input data

Indices available in the LAFDM

INDICES

- SPI (1 month)
- SPI (3 month)
- SPI (6 month)
- SPI (12 month)
- Drought Index (%)
- NDVI Percentile (30-day moving average)
- Streamflow Percentile (%)

Sheffield and Wood, 2011

Popular Drought Indices, continued

Table 4.1 *Popular drought indices, their rationale and advantages/disadvantages*

Index	Description	Advantages	Disadvantages
Hydrological Drought			
Palmer Hydrological Drought Index (PHDI)	Quantifies the severity of a wet or dry period. The monthly index values are exactly the same as PDSI	Used to monitor long-term drought conditions	Suffers from the same problems as the PDSI
Mean annual minimum *n*-day flow	Calculated from the time series of annual minima of the *n*-day average flow	Can be used to estimate the return period of low flows	Requires long time series and is difficult to apply in intermittent or ephemeral streams
Baseflow index (BFI)	Ratio of base total flow		records required to separate flow from total flow
Surface Water Supply Index (SWSI)	Combi streamfl reservoi		is unique to each iting basin ons
Ecological Drought			
Normalized Difference Vegetation Index (NDVI)	Differer absorpti infrared		data from airborne or e sensors. Difficult to her influences on health
Vegetation Condition Index (VCI)	Normal		VI
Regional Drought			
Regional Drought Area or Deficit Area	Percentage area in drought within a region	Quantifies the spatial extent of drought	Requires spatially continuous or regional data
Regional Drought Severity or Total Deficit Area	The area-weighted intensity over a region	Quantifies the average severity over a region	As above

Source: from NDMC and Keyantash and Dracup, 2004

Indices available in the LAFDM

INDICES

- SPI (1 month)
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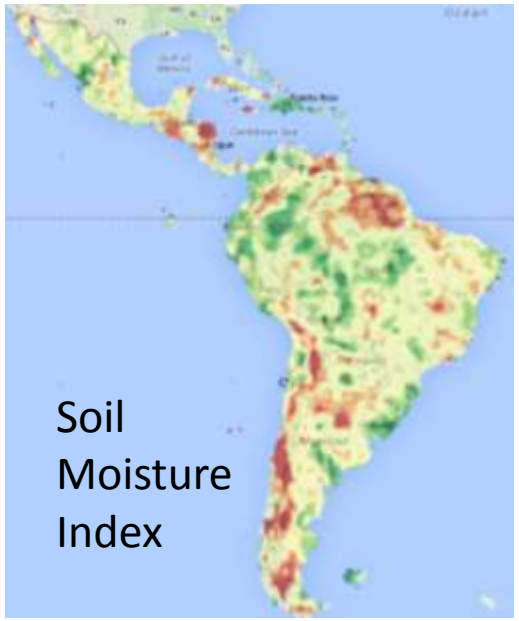
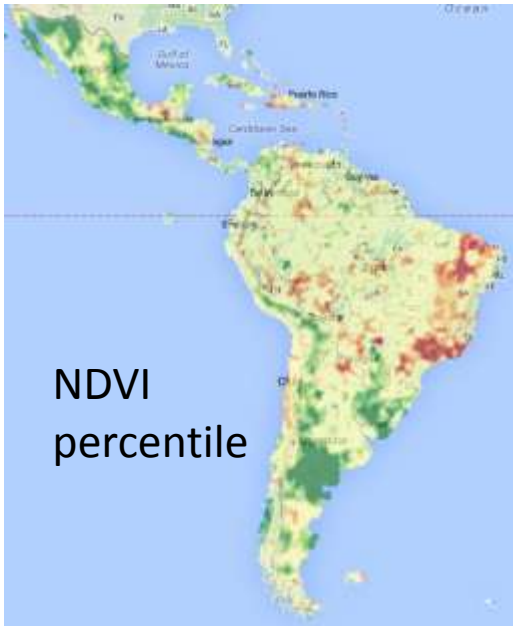
Sheffield and Wood, 2011

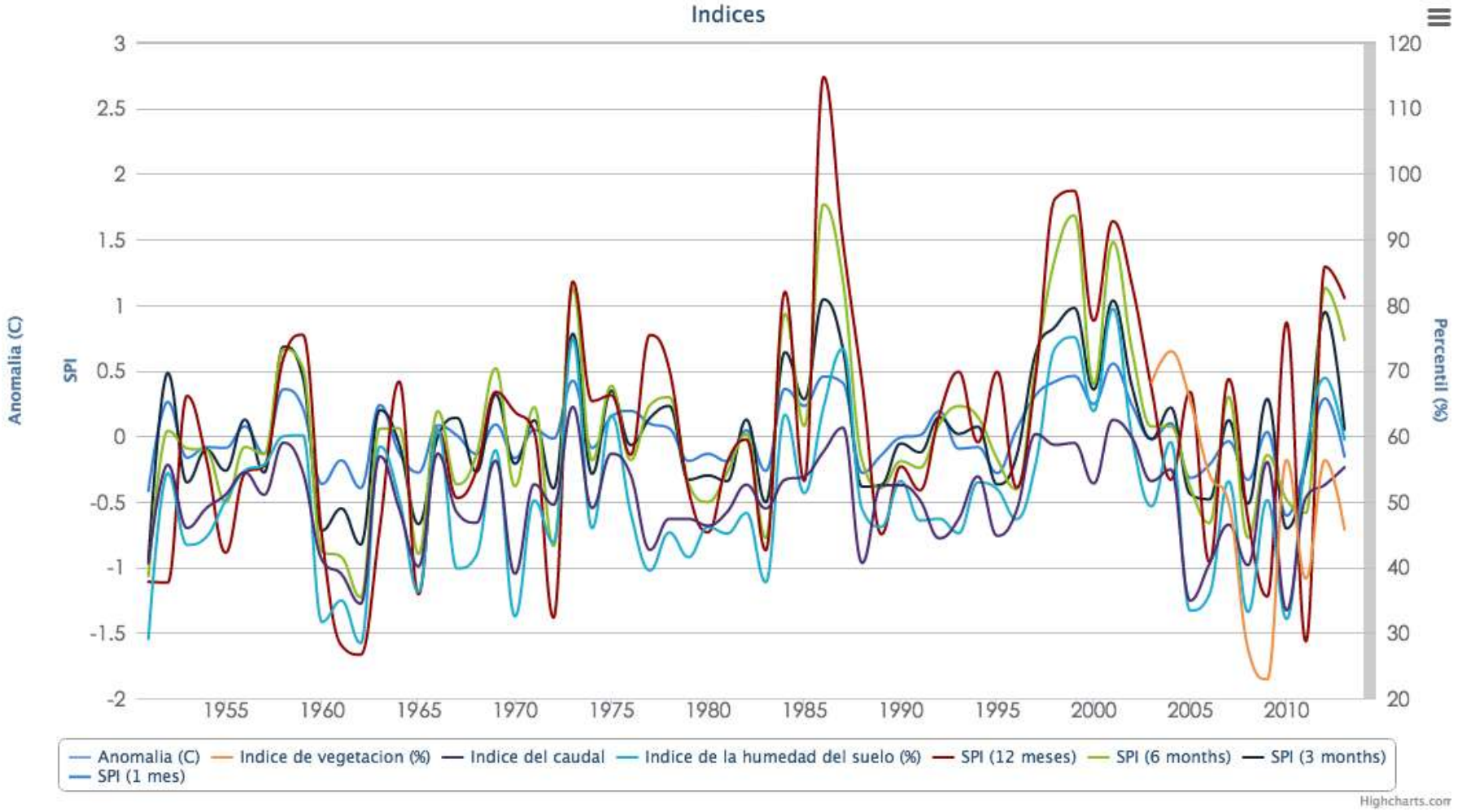
Drought Indices in the LAFDM





Drought Indices in the LAFDM

An example from Argentina 1950-2013



Drought Development and Propagation

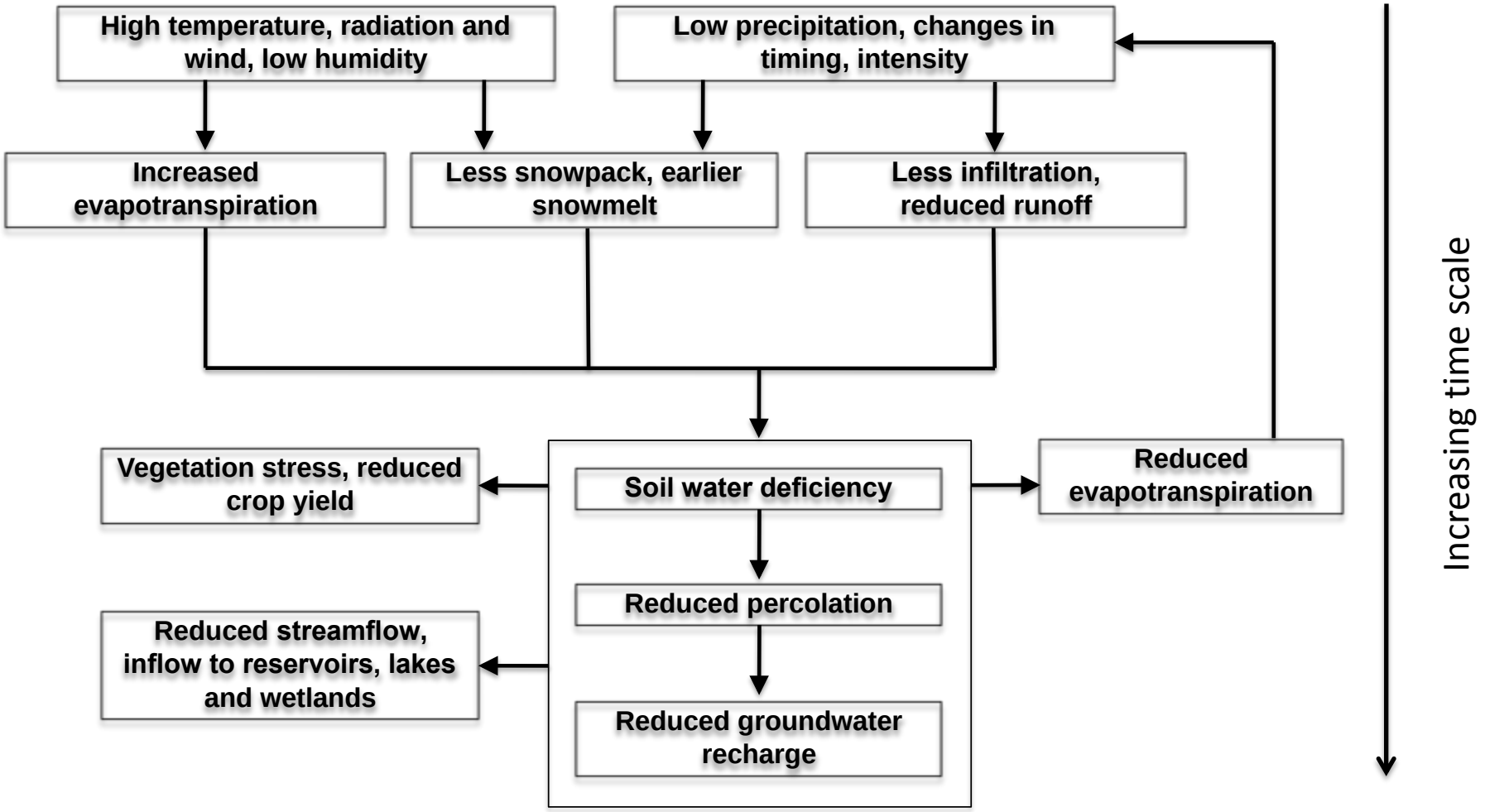
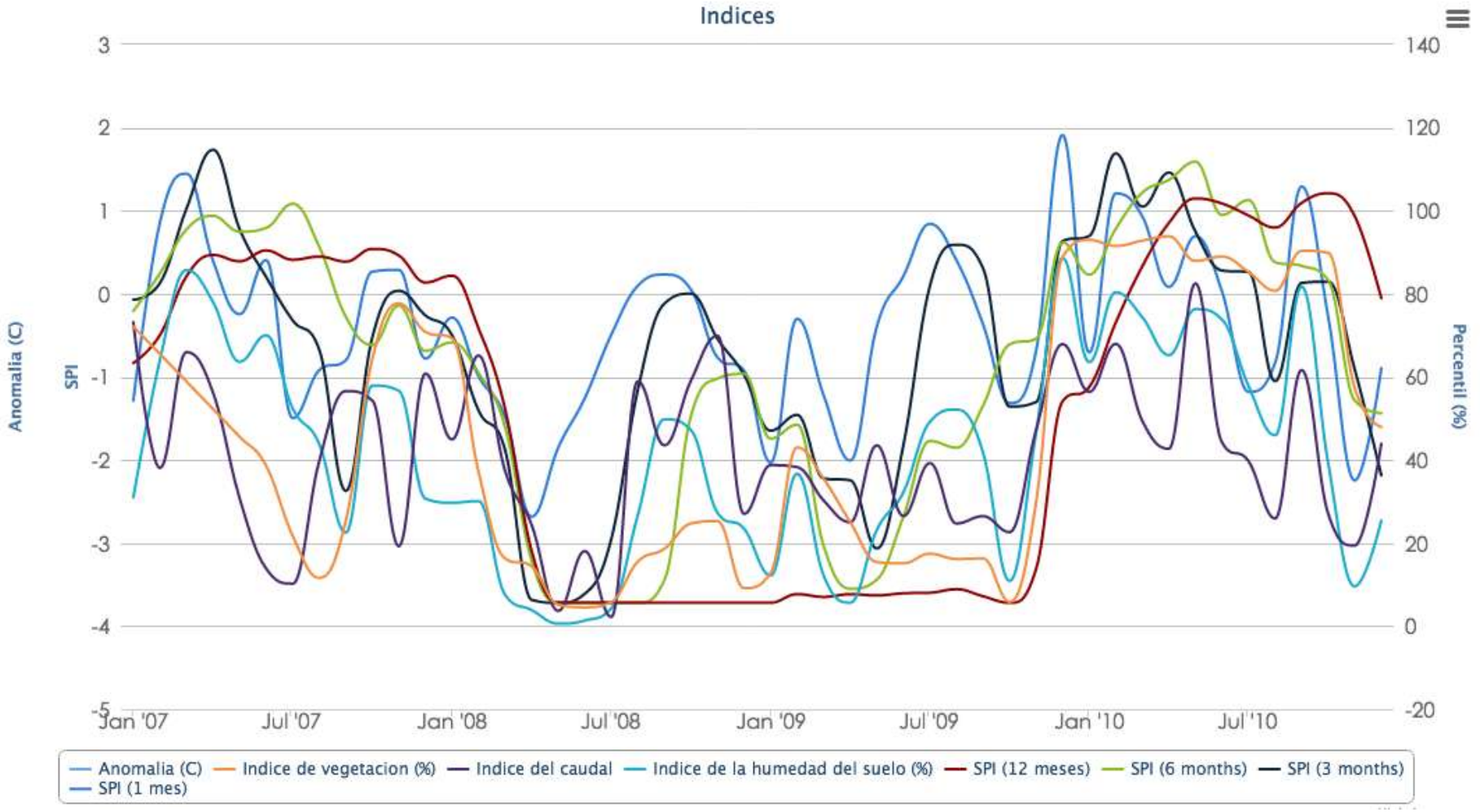


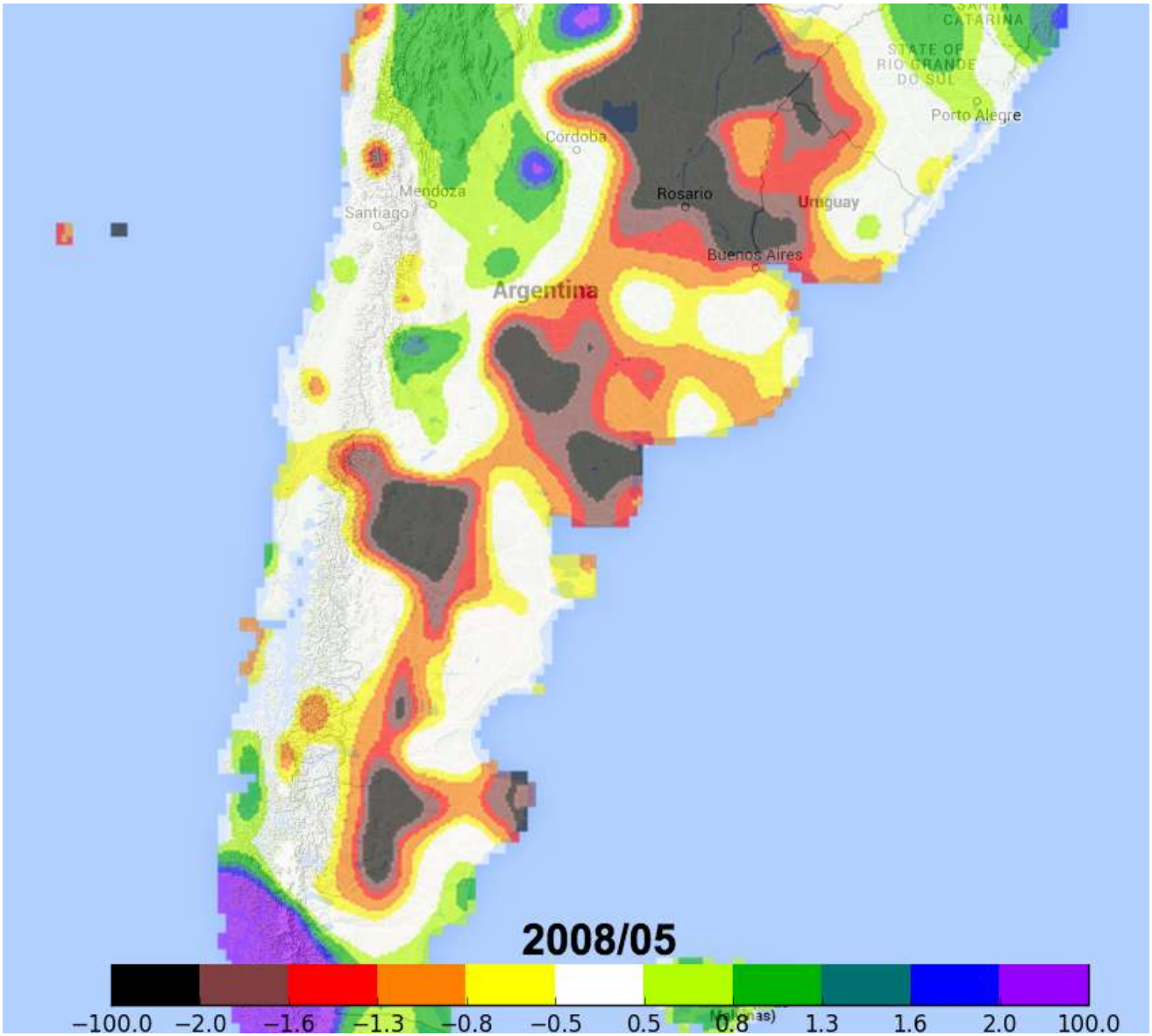
Figure 3.9 Propagation of drought through the hydrological system and the feedbacks to the atmosphere Source: Adapted from NDMC

Propagation of Drought Through the Hydro-Ecological System – Argentina Drought 2008-2009

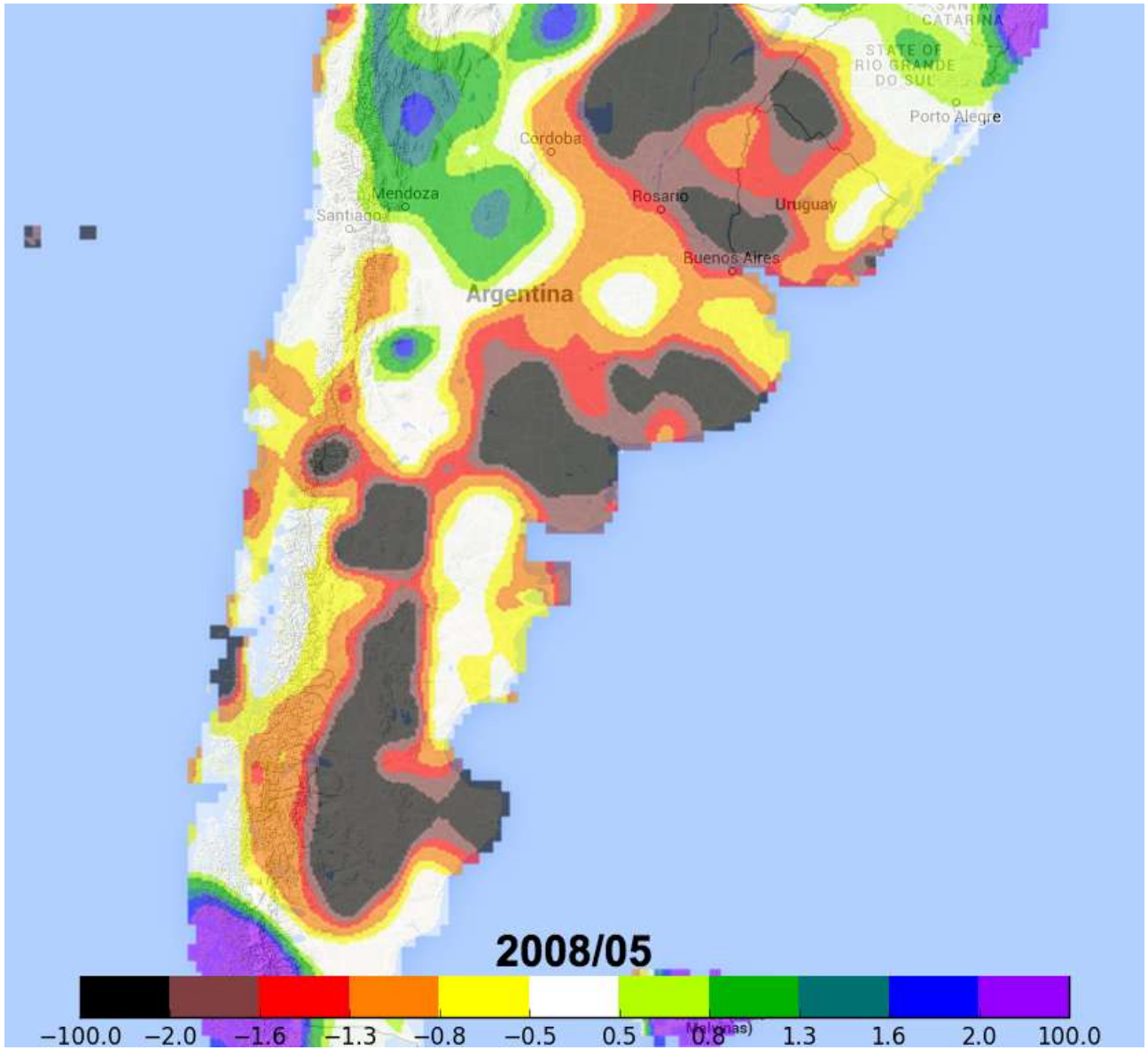


Example of propagation of drought

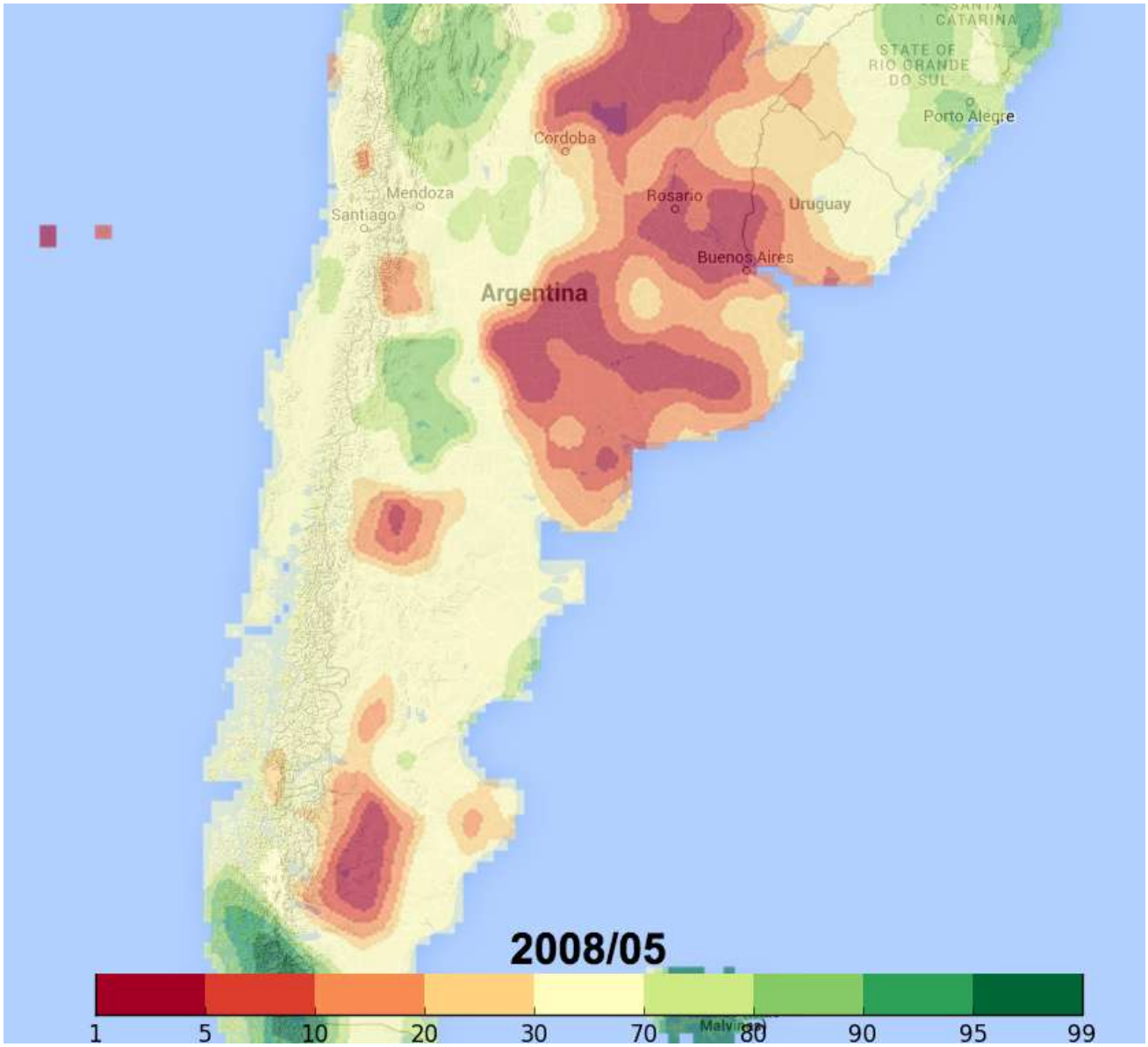
SPI (3 month) Index



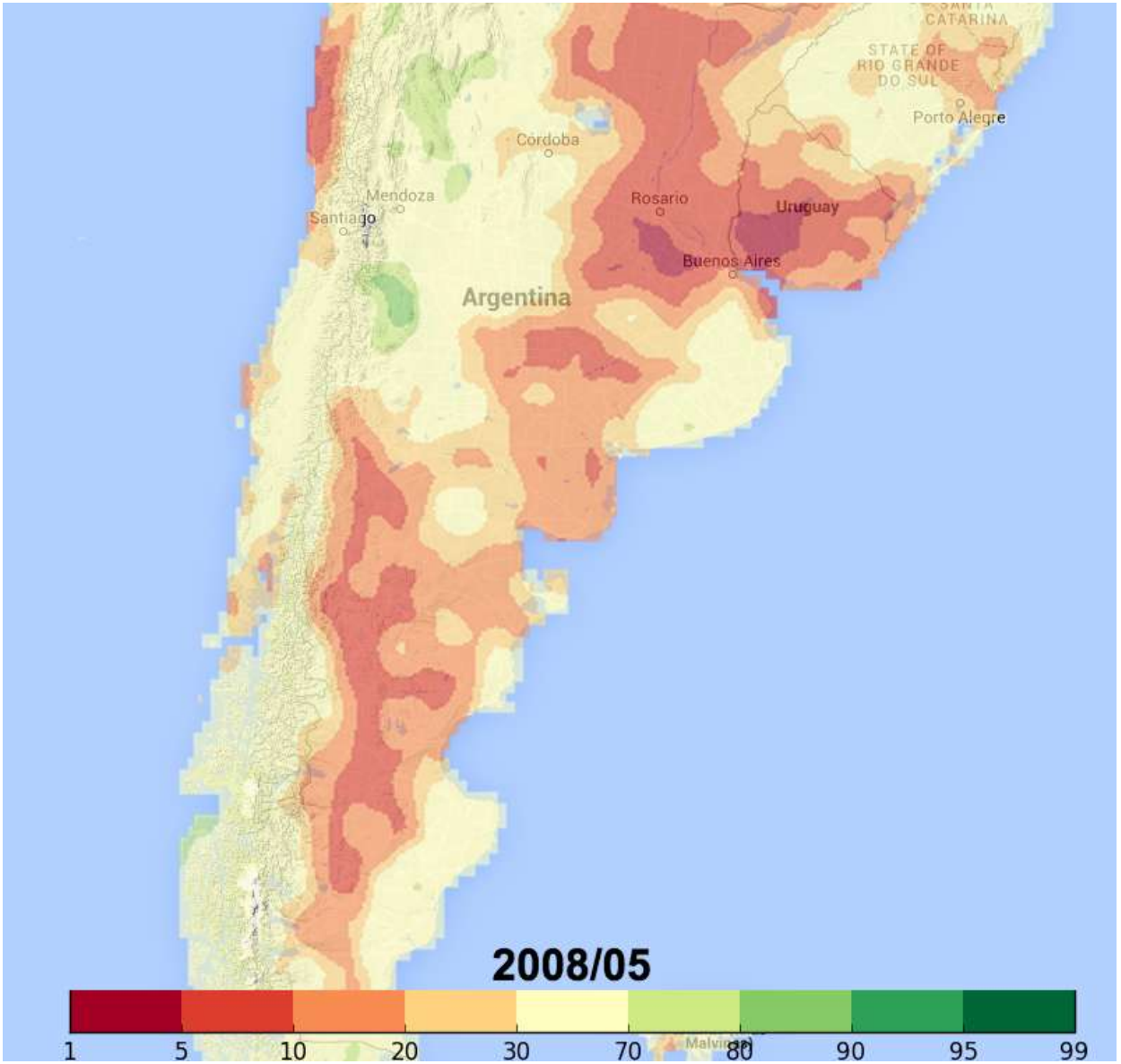
SPI (6 month) Index



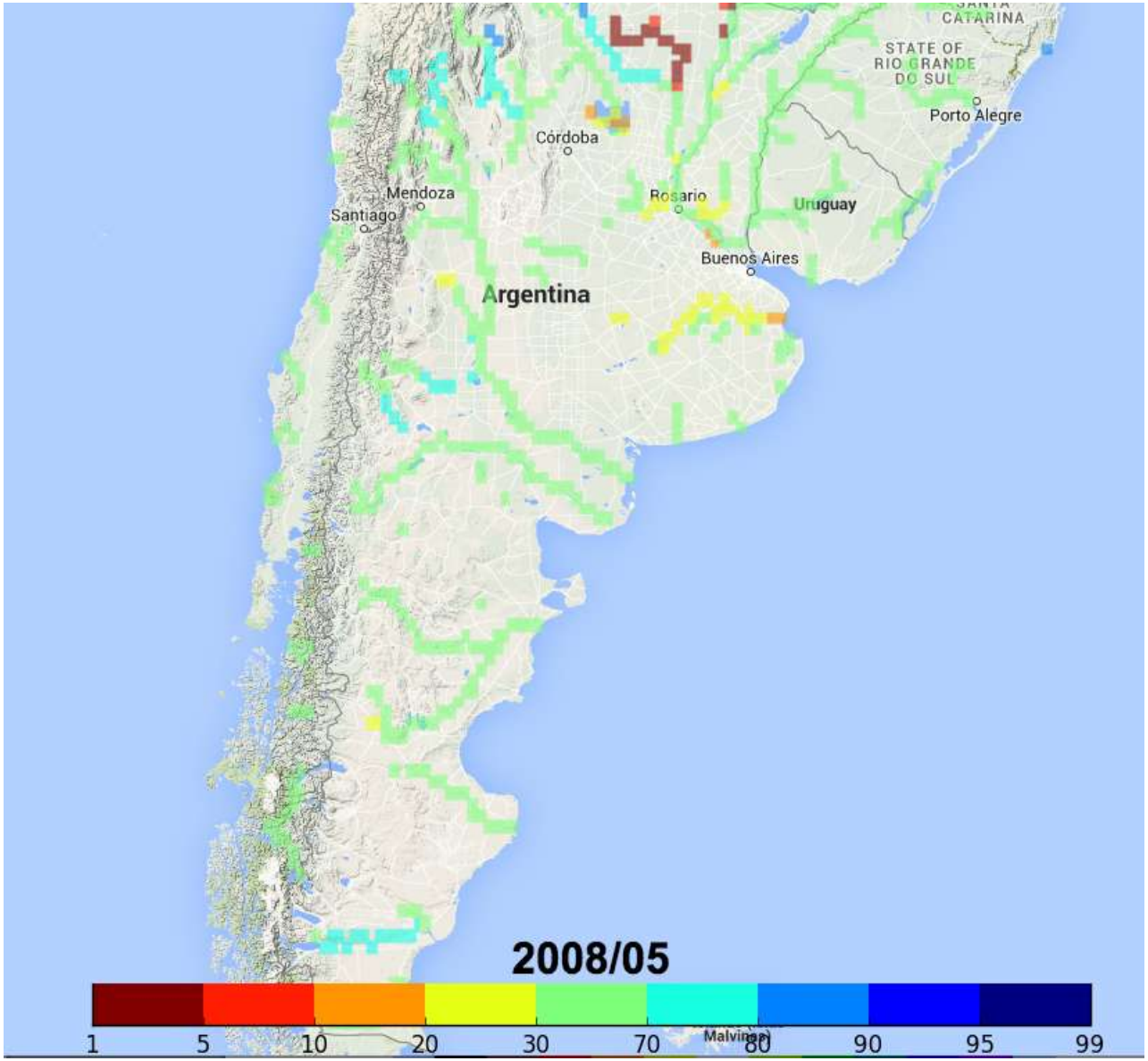
Soil Moisture Index



Vegetation Index



Streamflow Index



Questions and Discussion