

# Monitoreo de Sequía

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# Programa curso

*Martes, 10 de noviembre*

<b>Sesión 1 09:00-11:00</b>	Presentación “Indicadores de Sequía des Aguas Subterráneas”  Trabajo en la computadora en grupos “Indicadores de Sequía des Aguas Subterráneas”
<b>11:00-11:30</b>	Café
<b>Sesión 2 11:30-13:00</b>	Trabajo en la computadora en grupos “Indicadores de Sequía des Aguas Subterráneas”  Discusión plenaria “Indicadores de Sequía des Aguas Subterráneas”
<b>13:00-14:30</b>	Almuerzo
<b>Visita de campo 14:30-19:30</b>	Visita de un proyecto de recarga de Aguas Subterráneas

precipitation

soil moisture

groundwater

discharge

DROUGHT

variable  
threshold

PROPAGATION



time



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# Drought Identification – Indices: many ways

## Key Indicators For Monitoring Drought

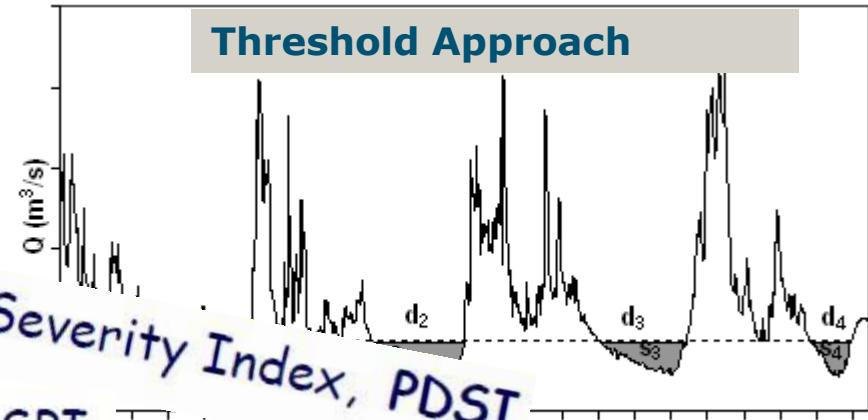
- climate data (precipitation, temperature)
- soil moisture
- stream flow
- ground water
- reservoir and lake levels
- snow pack
- short, medium, and long range forecasts
- vegetation health/stress and fire danger

## Martonne aridity index

- Single index or parameter
- Multiple indices or parameters
- Composite index

## Standardized Precipitation Index, SPI

## Surface Water Supply Index, SWSI



53: 90th percentile  
heat-wave duration

110: Mean-dry spell-length (days)



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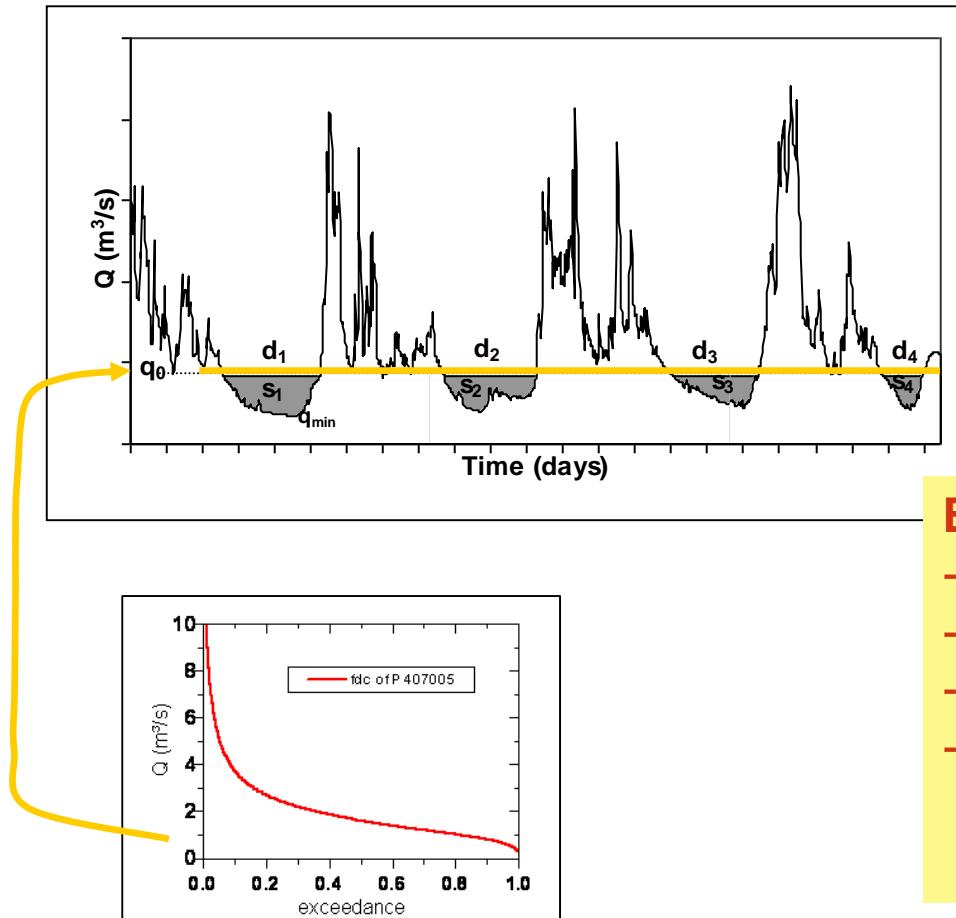
# Drought Identification – Indices: many ways

**Definitional issues, lack of observational data, and the inability of models to include all the factors that influence droughts preclude stronger *confidence* than *medium* in the projections. Elsewhere there is overall *low confidence* .....**

***From: Executive Summary, Changes in Climate Extremes and their Impacts on the Natural Physical Environment, Chapter 3. Seneviratne et al. (2012), Manage the risks of extreme events and disasters to advance climate change adaptation, IPCC.***



# Threshold approach



**Threshold approach**

- Each drought has:
- onset
  - duration
  - severity (deficit)
  - intensity

Hisdal et al. (2004)



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# Threshold approach

## Threshold level method:

- Original method: Hisdal et al. (2004), Fleig et al. (2006, HESS)
- Arid regions: Van Huijgevoort et al. (2012, HESS)
- Regions with rapid increase in discharge: Beyene et al., (2014, HESSD)
- Changing “normal” due to climate change: Wanders et al. (2014, ESDD)



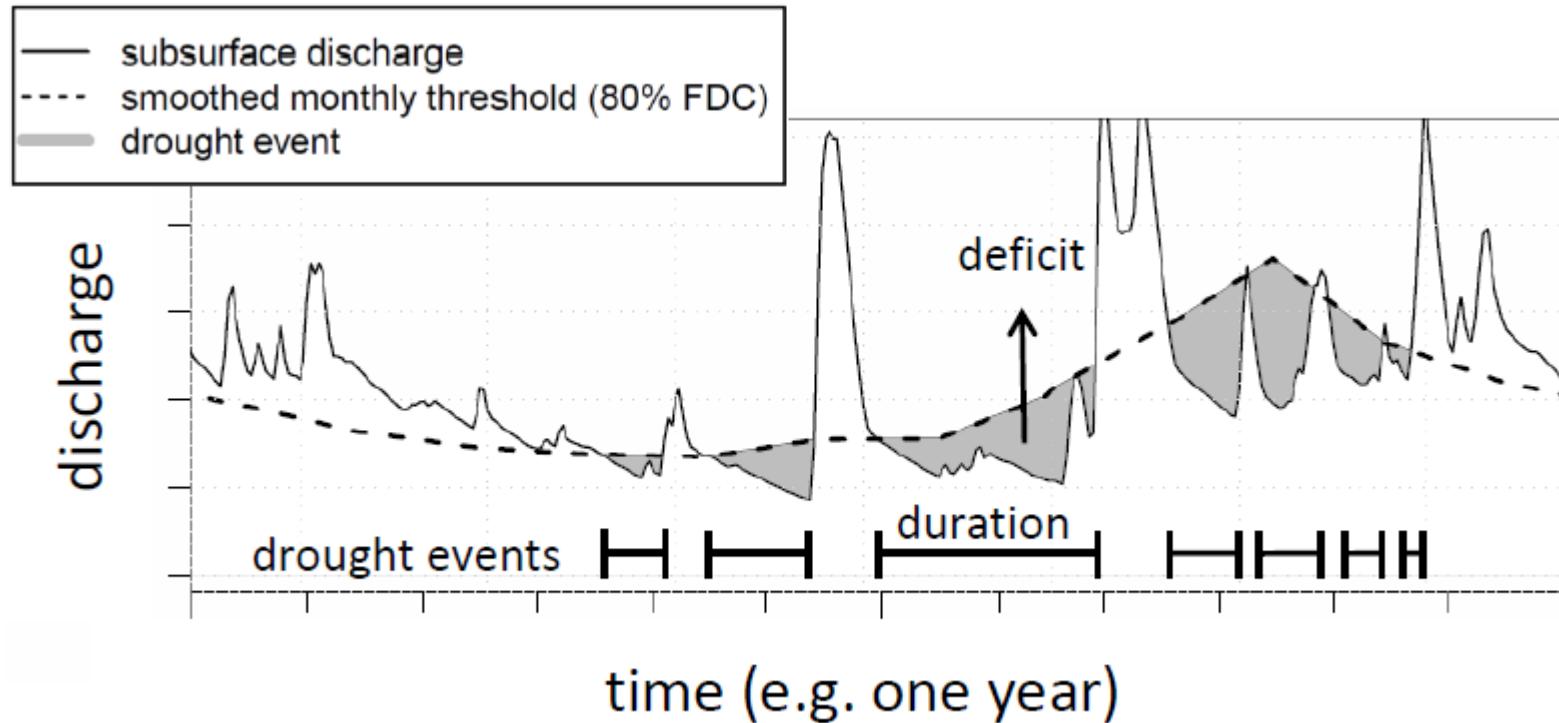
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# Threshold approach



Van Loon, 2015, Wires Water



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# Threshold approach

## Threshold approach

Deficit volume per timestep  $t$ :

$$D[t] = \begin{cases} (\tau_o - X[t])\Delta t & \text{for } X[t] < \tau_0 \\ 0 & \text{for } X[t] \geq \tau_0 \end{cases}$$

Deficit volume for drought  $j$ :

$$V_j = \sum_1^n D(t)$$



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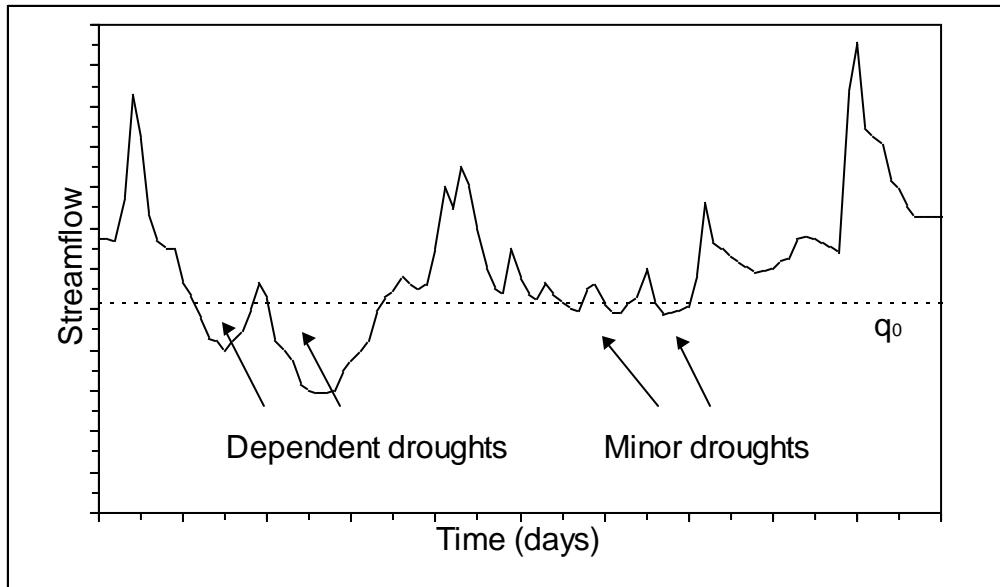


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Yevjevich (1967)  
Hisdal et al. (2004)  
Tallaksen et al. (2009)  
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# Threshold approach

## Threshold approach



- dependent droughts
- minor droughts

### Pooling procedures:

- MA
- IC
- SPA

Hisdal et al. (2004)



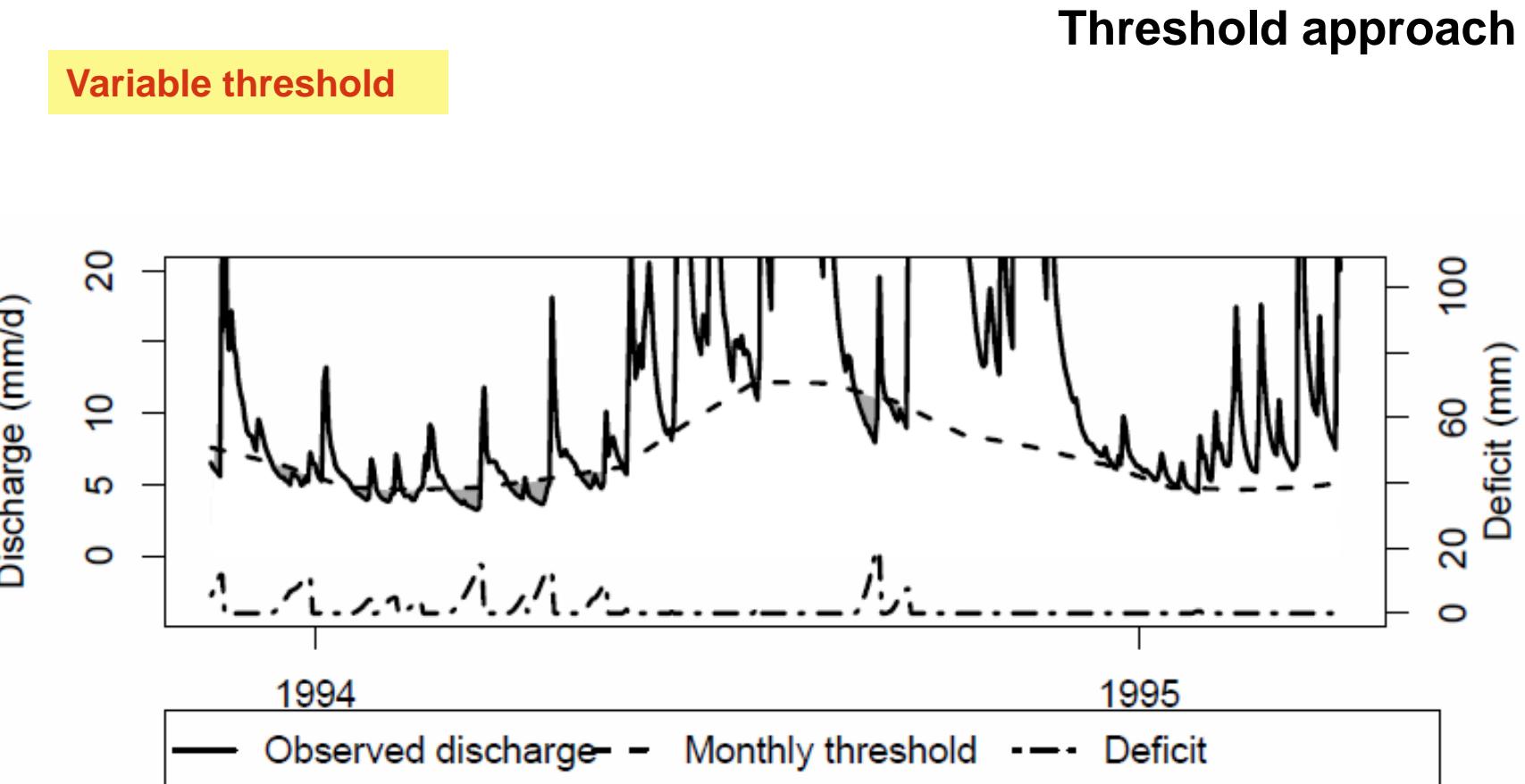
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# Threshold approach



Van Loon et al. (2010)



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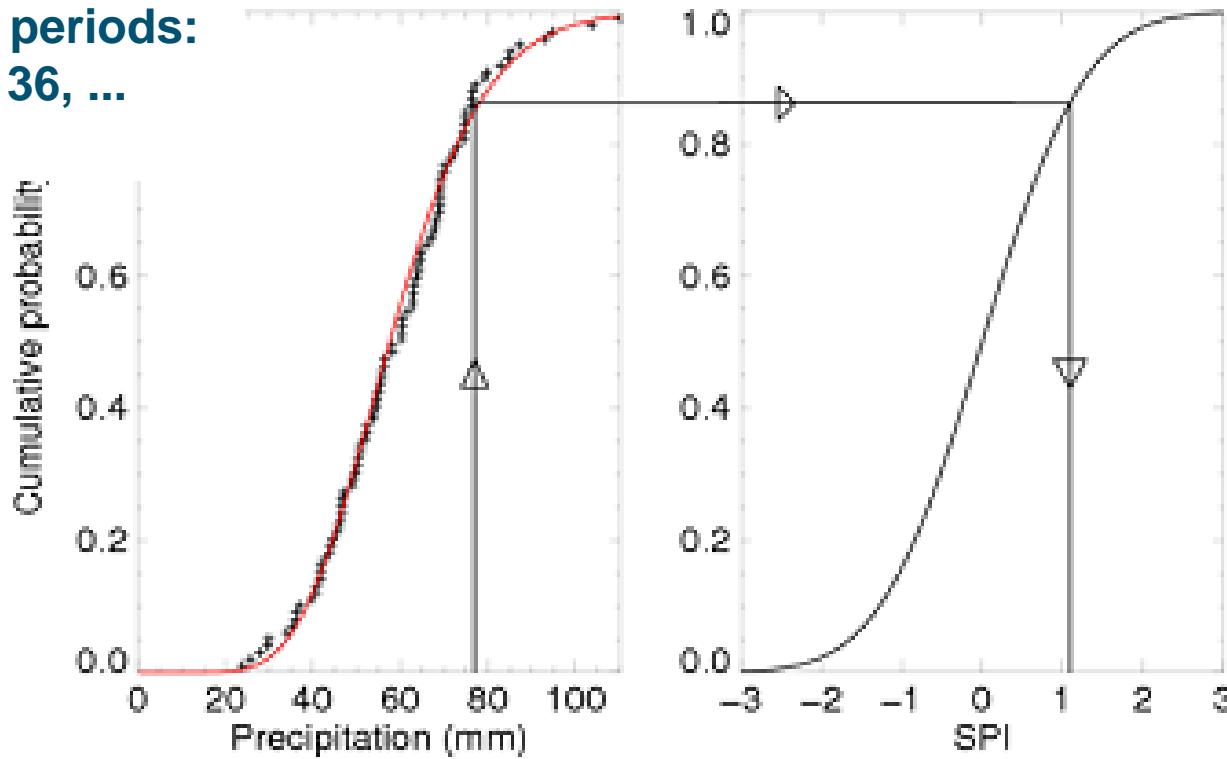
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# Standardised indices

**SPI = Standardized Precipitation Index**

For various  
accumulation periods:  
1, 3, 6, 12, 24, 36, ...  
months



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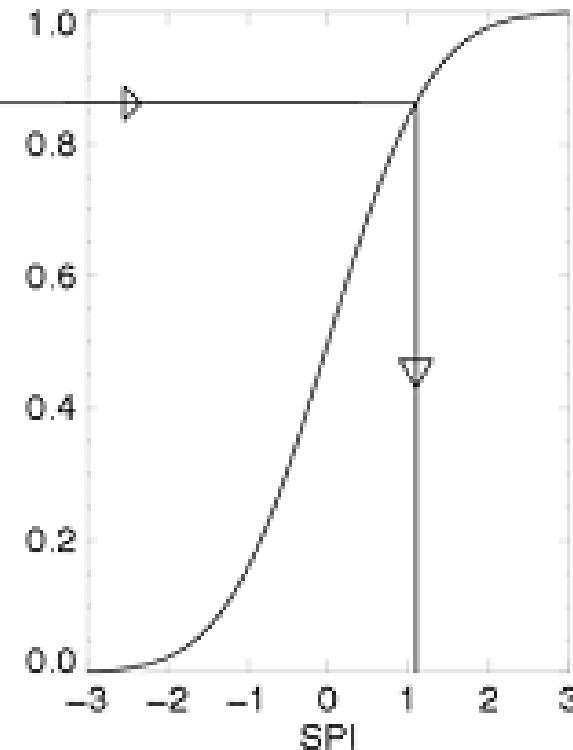
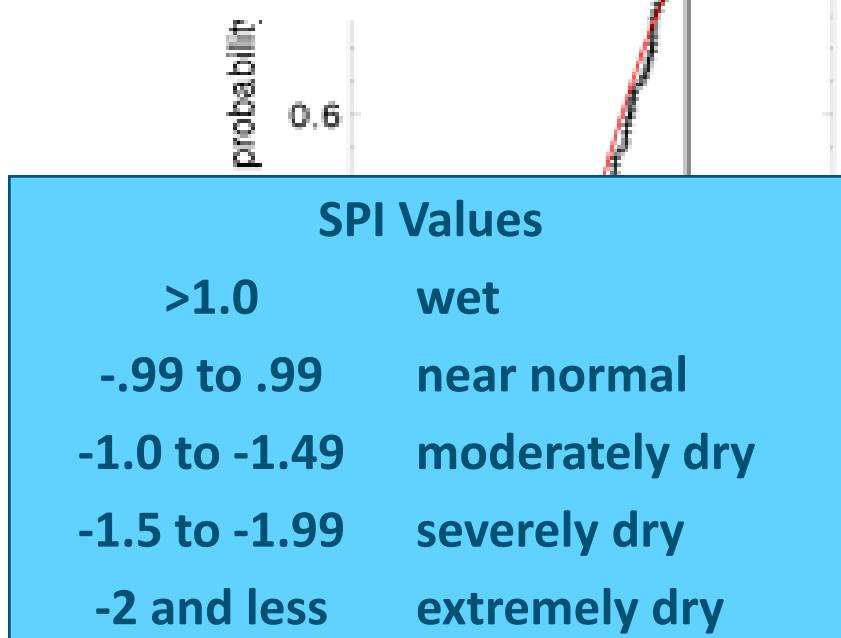
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# Standardised indices

## SPI = Standardized Precipitation Index

For various  
accumulation periods:  
1, 3, 6, 12, 24, 36, ...  
months



# Standardised indices

## Standardized Precipitation Index, SPI

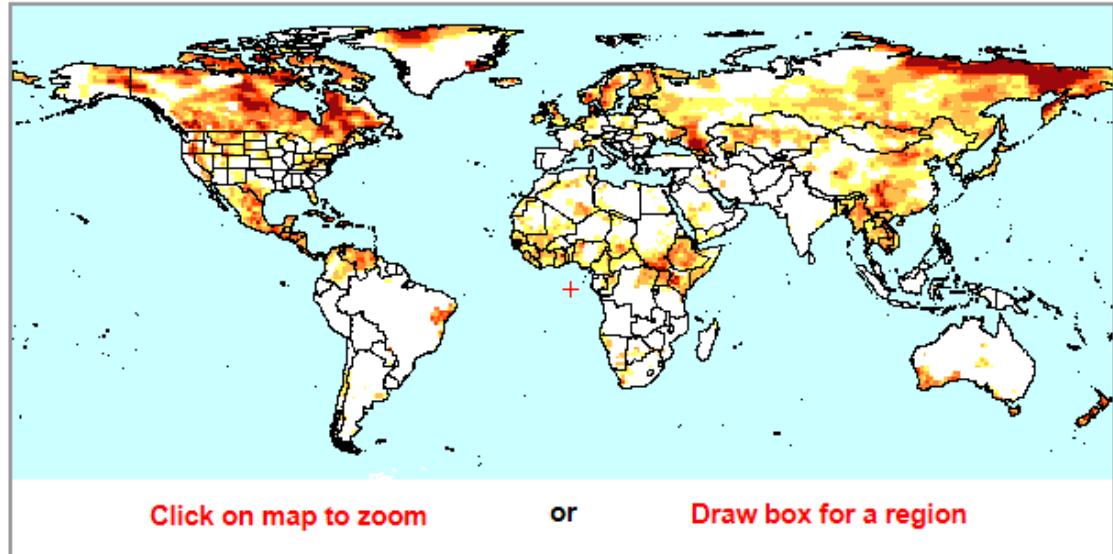
SPI – 1 month

UCL

### Global Drought Monitor

April 2013

Data updated on the 16th of each month



0 9200 18400 27600 36800 km

Drought Severity

Minor Drought

Moderate Drought

Severe Drought

Extreme Drought

Exceptional Drought

Population in the current view under exceptional drought: 57,377,000



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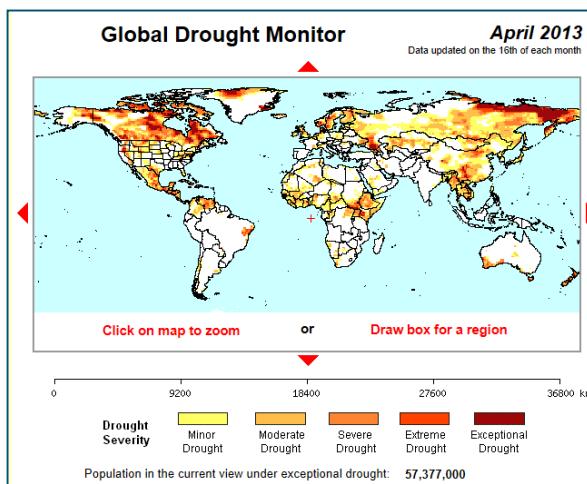
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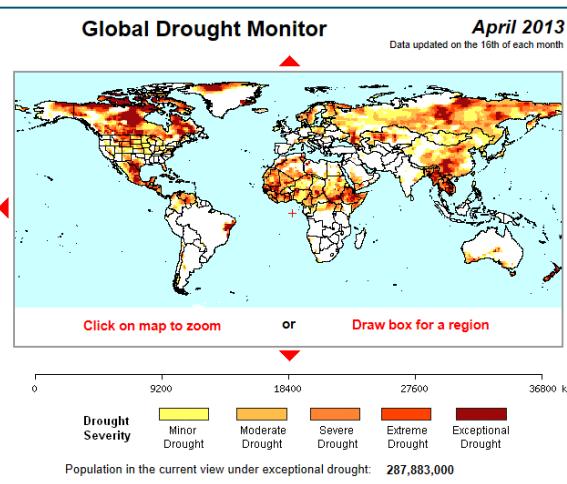
# Standardised indices

## Standardized Precipitation Index, SPI

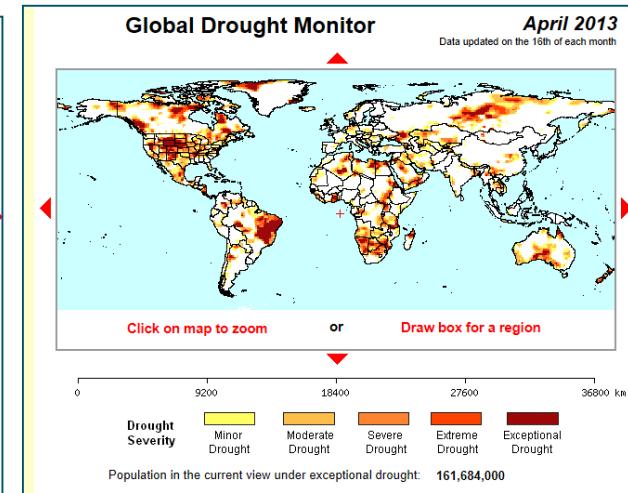
SPI – 1 month



SPI – 3 months



SPI – 12 months



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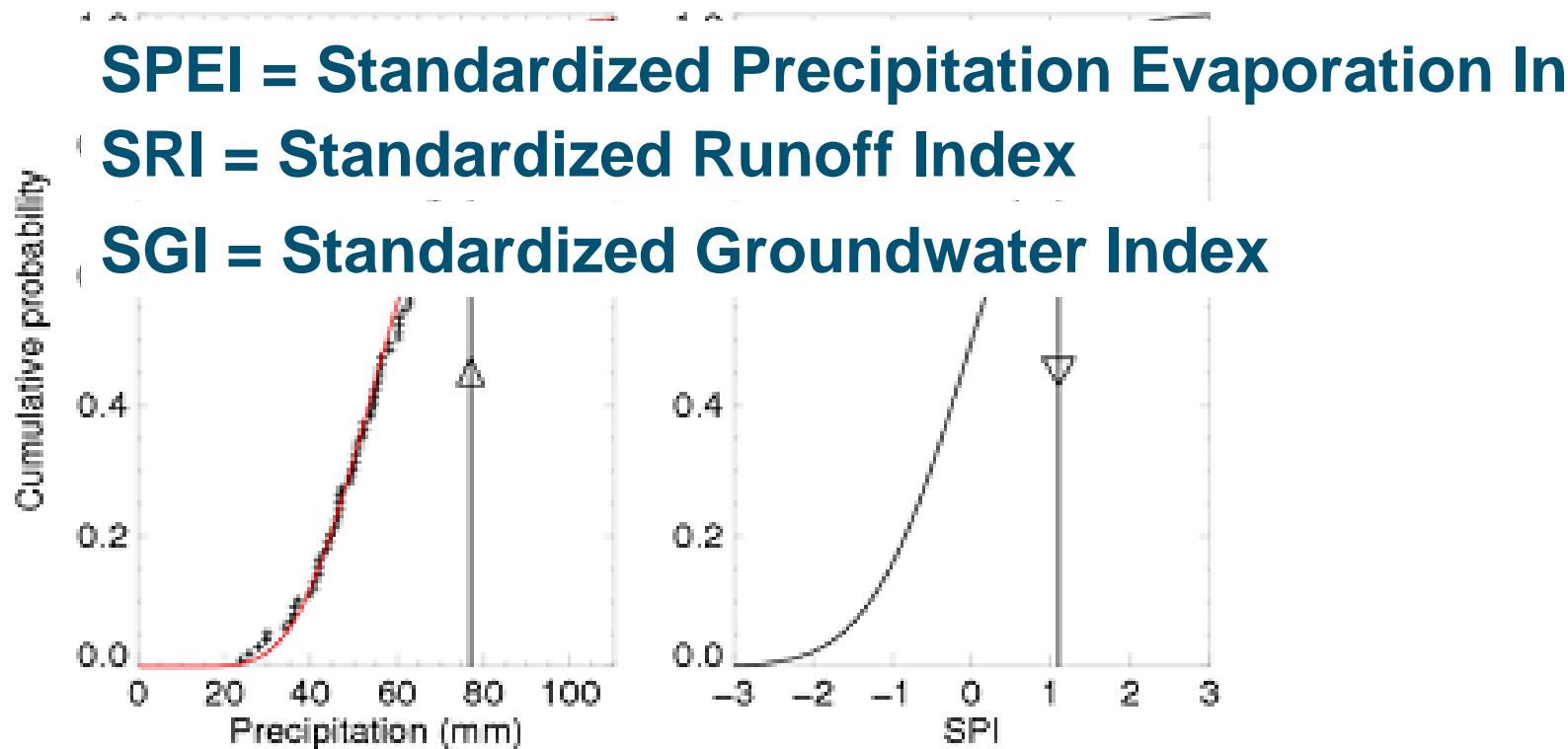
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# Standardised indices

**SPI = Standardized Precipitation Index**

For other variables



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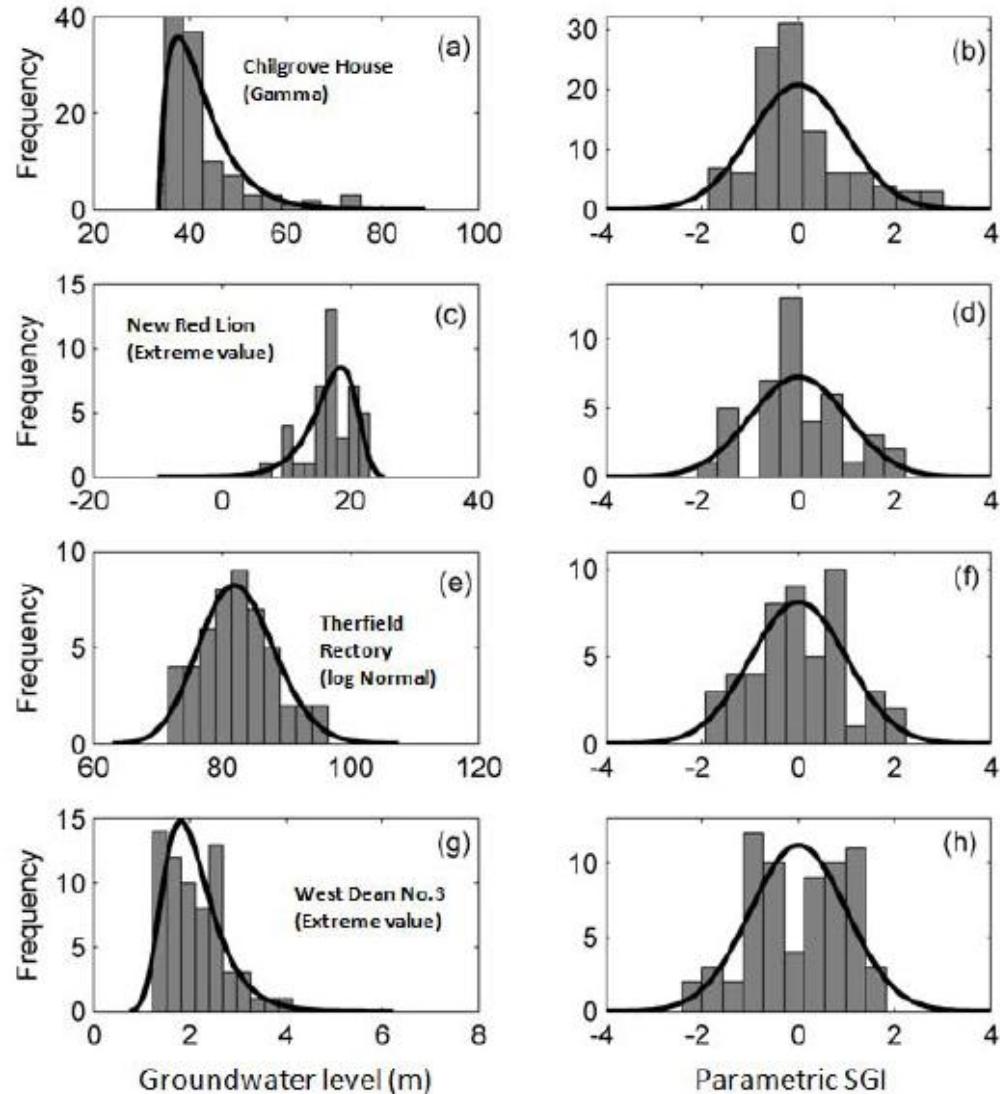
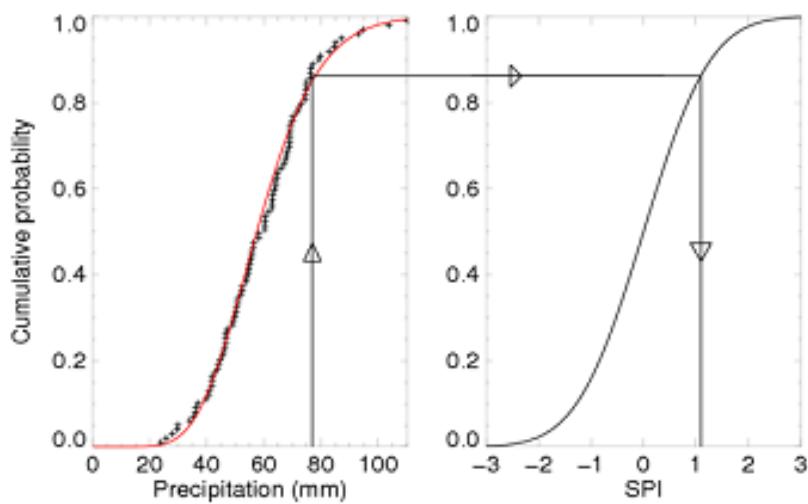


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# Standardised indices

**SGI = Standardized Groundwater Index**



Bloomfield & Marchant, 2013, HESS



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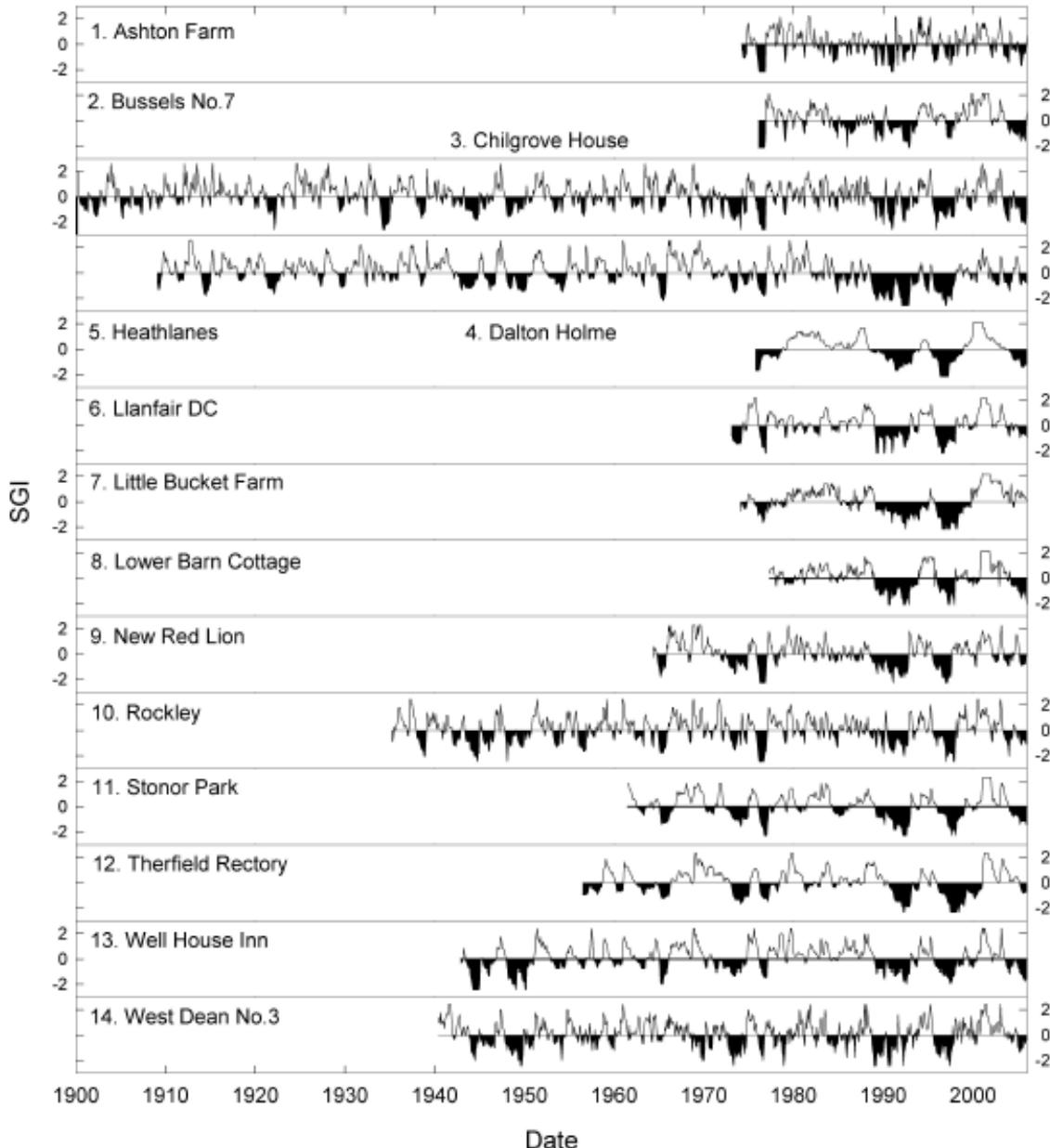
# Standardised indices

**SGI =**  
**Standardized**  
**Groundwater**  
**Index**

Bloomfield & Marchant,  
2013, HESS



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# Drought Identification – Indices: how?

Needs data!

Input time series (observed or modeled):

- precipitation (f);
- soil moisture (s);
- recharge (f);
- groundwater head (s);
- groundwater discharge (f)
- streamflow (f)



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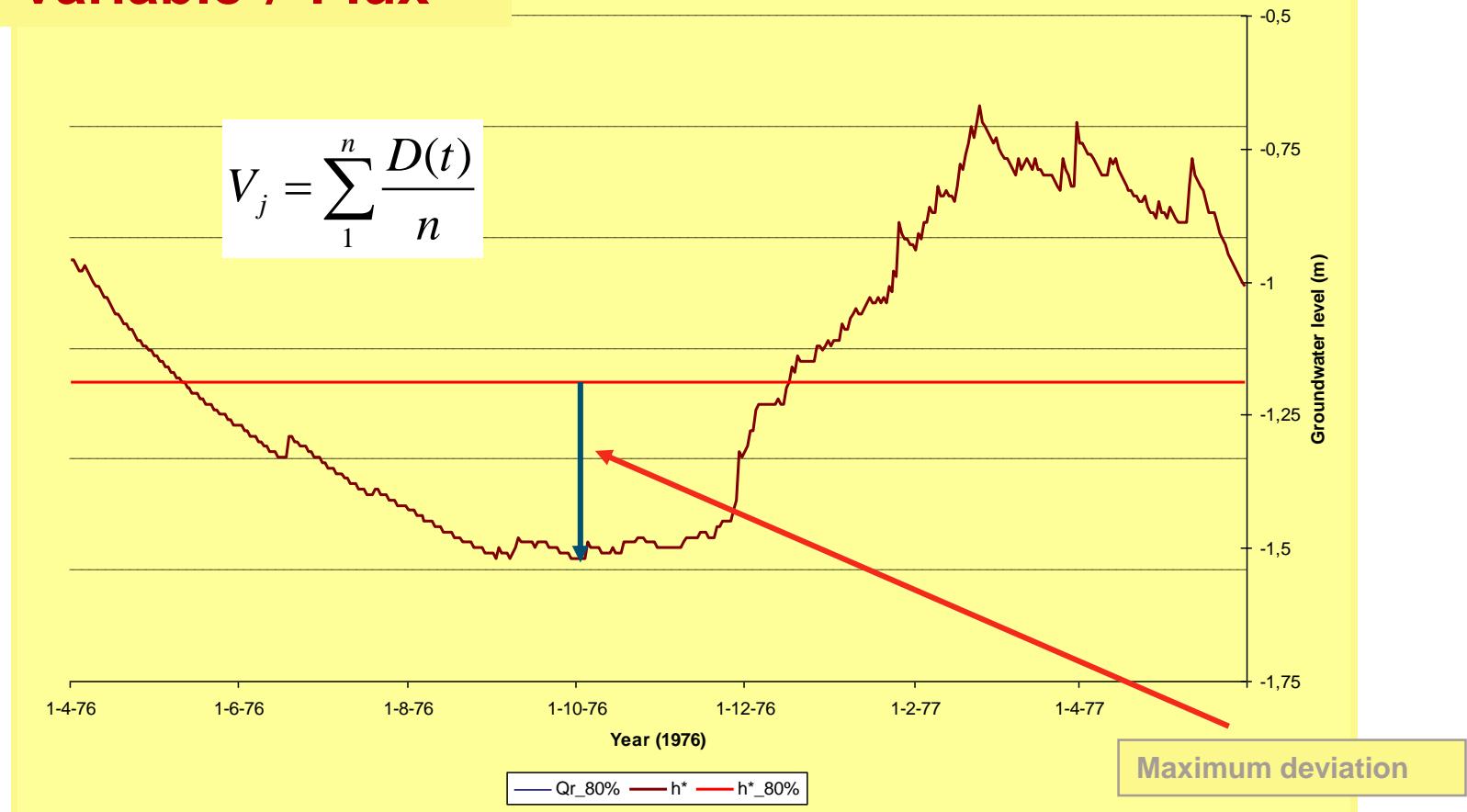
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# Threshold approach

**State variable ≠ Flux**

**Threshold approach**



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Hisdal et al. (2004)

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