Standardized Runoff Index (SRI)

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Contents

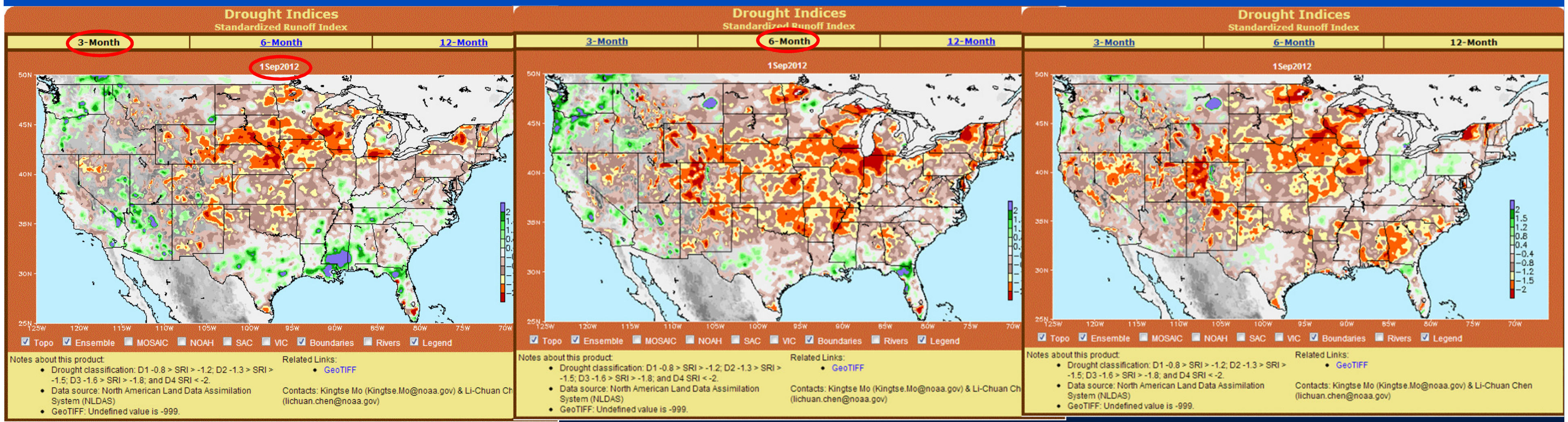
About the SRI - SRI in the world

SRI is a hydrological drought indicator, based on the assessment of the runoff of a given basin.

Spain proposed this indicator to the EG in 2010 in order to include the effects of the natural characteristics of the basins in droughts.

SRI is an internationally recognized and widely used indicator:

The U.S. National Weather Service provides actualized SRI maps, among other indices, in three time scales



National Weather Service
Climate Prediction Center

http://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/sri3.shtml

About the SRI - Methodology

METHODOLOGY

- Same as for the SPI, the SRI is the "*unit standard normal deviate associated with the percentile of hydrologic runoff accumulated over a specific duration*[1]".
- Involves fitting a probability density function (PDF) to a given frequency distribution of monthly runoff for a gauge station.
- The PDF parameters are then used to find the cumulative probability of an observed runoff for the required month and temporal scale.
- This cumulative probability is then transformed to the standardized normal distribution with mean zero and variance one, which results in the value of the SRI.
- The probability density function selected will depended on the data series. Gamma distribution can be used in most European basins, but users can choose other PDF that better fits to their data.

for $0 < H(x) \le 0.5$

$$SRI = +\left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \qquad t = \sqrt{\ln\left(\frac{1}{(H(x))^2}\right)}$$

for $0.5 < H(x) \le 1.0$

$$SRI = -\left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \qquad t = \sqrt{\ln\left(\frac{1}{(1 - H(x))^2}\right)}$$

1. Shukla and Wood, 2008.

SPATIAL AND TEMPORAL SCALES

Spatial scale: Stream gauge stations or surface data built by interpolation.

Temporal scale depends on the characteristics of the basin and the aims of the assessment: Monthly (SR1), Quarterly (SRI3), Annual (SRI12), Seasonal or Interannual (SRI18, SRI24, SRI36).

SOME REMARKS

Gauge stations must be representative of the basin.

Pristine conditions: runoff data should not be affected by human activities when ever is possible.

Data series that are affected by human activities should be restored to natural conditions by discounting the abstraction produced upstream the station.

The indicator should be used together with other indicator like SPI, soil moisture, snowpack, groundwater, fAPAR, etc.

About the SRI - Methodology

During the process of discussions of the WS&D EG the SRI methodology has been adapted to European conditions:

eg: Thresholds calculation: Severity thresholds are defined based on the probability of exceeding an observed runoff value, which will have an associated SRI value.

The probabilities selected are:

- **P95% corresponds to SRI = -1.65 → Much drier than normal**
- **P90% corresponds to SRI = -1.28 → Severely drier than normal**
- **P80% corresponds to SRI = -0.84 → Moderately drier than normal**

MS have assessed the indicator on their basins and they have contributed their observations to the implementation of the indicator and drafting the previous versions of the factsheet:

Time scale

Representativeness of the gauge stations

Probability distribution function to be used

Use it in conjunction with other indicators

Comments made in Athens on SRI factsheet

During Athens meeting (Sept 2012) some changes in the factsheet were pointed out in order to the SRI final acceptance in the WS&D indicators pool:

- **To explain clearly that SRI is a hydrological drought indicator that should be used in pristine conditions when ever is possible.**
  - **Restoring runoff to natural regime has to do with the basin abstractions but it is not necessary to understood the entire hydrological cycle in the basin.**
- **To specify that temporal scale used will depend on the basin conditions and the aims of the assessment.**
- **To explain how SRI relates to SPI and other drought indicators.**
- **To modify the thresholds names.**
- **Including a mention on the use of a probability density function other than Gamma distribution.**

Since the meeting in Athens no other comments from MS have been received, therefore no more changes, other than the ones above, are been included in the factsheet.

Last modifications of the factsheet

Pristine conditions – Restoration to natural flow

Entries about "Pristine conditions and restoration of flow to natural regime" have been introduced in points 5 and 6 of the factsheet:

5. Data source and frequency of data collection

The data are provided by Water Agencies, considering relevant and selected stream gauges. At regional level, an aggregation for the data could be considered, according to water resources management concerns.

The indicator can be used with any series of flows, but it is more advisable to use data in pristine conditions in order to avoid the affection caused by human activity.

The frequency of data collection is monthly.

6. Quality Information

a. Strength & weaknesses at data level

Similar to SPI, the quality of the index depends on the quality of the runoff time series. The runoff time series shows a regular checking process (validation of relation level-runoff by contrast with direct runoff-gauges, contrast with data from other sources such as hydrological automatic systems).

Several works (Pruhdomme and, 2007; Lloyd Hughes et al., 2009) assessed hydrological drought from observed streamflow gauges in different European regions. The criteria applied in assessing the representativeness of the stations for large-scale evaluation of hydrological droughts, could be considered.

Additionally, run-off data might be affected by human activity, which would distort the natural trends of a drought. Therefore, when pristine conditions data are not available, it is advisable to use data from hydrological models or restitution to natural conditions (using 'affected' data and existing demands).

This indicator is targeted to be used complimentarily with other indicators, thus errors could be possibly detected during this process as some trends may be illogical to explain.

Although the SRI and SPI are similar when based on long accumulation periods, the SRI incorporates hydrologic processes that determine seasonal lags in the influence of climate on streamflow (Shukla and Wood, 2008). This fact must be taken into account when comparing both indices in which the results don't necessarily go in parallel. Therefore both indicators should be used together.

Special attention to choosing the probability density function (PDF) considered, a poorly adapted distribution may lead to large discrepancies in estimating extreme percentiles (Vidal et al., 2010). Lloyd Hughes and Saunders (2002) found gamma distributions suitable for the larger part of Europe, but users should choose the distribution function that better fits their data series.

As a result, on monthly to seasonal time scales, the SRI is a useful counterpart to the SPI or others indicators for depicting hydrologic aspects of drought.

b. Performance of the indicator

Scoring based on criteria (data availability, clarity, validity, accuracy, sensitivity, capacity of integration with other indicators etc.)

The estimation and interpretation of the indicator, is easy and simple.

Last modifications of the factsheet

Temporal Scale

The comment about "Temporal scale" has been introduced in the point 3 of the factsheet:

Previous versions

3. Temporal scale

Monthly

Actual version

3. Temporal scale

Several scales are possible depending of the basin characteristics and the aims of the study: Monthly (SR1), Quarterly (SRI3), Annual (SRI12), Seasonal or Interannual (SRI18, SRI24, SRI36).

In general, short scales, like monthly and quarterly scales, are useful in small and non-artificially regulated basins, while longer scale, annual and interannual, are more suitable for larger basins with a complex hydrological cycle, or watersheds with artificial storage. Anyhow, temporal scale must be selected depending on the characteristics of the basin and the purpose for which to use the indicator.

Last modifications of the factsheet

SRI related to SPI and other indicators

The relationship of the SRI with the SPI and with other indicators have been introduced in two points of the new factsheet:

Key message

Even though the availability of water in watersheds mainly depends on rainfall, information on other components of the hydrological cycle, such as runoff, improves insight into the situation of the basin in relation to drought. Increasing the knowledge about the dynamics of flows in European basins, will improve the knowledge of plausible trends of hydrological drought events in order to take appropriate measures both to conserve aquatic ecosystems and minimize impacts on water uses. The streamflow, as a component of the hydrological cycle, is related to infiltration, ground water dynamics, superficial runoff, soil moisture, etc., therefore time-response of runoff against precipitation will depend on the characteristics of the basin: size, complexity, artificial regulation, etc.

So far SPI has been used in many places as the sole indicator of drought, but as described above, other elements of the hydrologic cycle, as runoff, must be considered to obtain a more complete understanding of the basin in terms of drought. After the analysis of some streamflow indicators, SRI has been chosen as a suitable indicator for hydrological drought since the methodology is sufficiently contrasted (since is based on SPI), it is easy to apply, the results are suitable and easy to be interpreted and it can be applied in a wide rage of basins. SRI takes into account, in addition to precipitation, other elements of the hydrologic cycle that are relevant in many basins and are difficult to be modeled, thus it is convenient to consider SRI as a complement of SPI.

6. Quality Information

a. Strength & weaknesses at data level

Similar to SPI, the quality of the index depends on the quality of the runoff time series. The runoff time series shows a regular checking process (validation of relation level-runoff by contrast with direct runoff-gauges, contrast with data from other sources such as hydrological automatic systems).

Several works (Pruhdomme and, 2007; Lloyd Hughes et al., 2009) assessed hydrological drought from observed streamflow gauges in different European regions. The criteria applied in assessing the representativeness of the stations for large-scale evaluation of hydrological droughts, could be considered.

Additionally, run-off data might be affected by human activity, which would distort the natural trends of a drought. Therefore, when pristine conditions data are not available, it is advisable to use data from hydrological models or restitution to natural conditions (using 'affected' data and existing demands).

This indicator is targeted to be used complimentarily with other indicators, thus errors could be possibly detected during this process as some trends may be illogical to explain.

Although the SRI and SPI are similar when based on long accumulation periods, the SRI incorporates hydrologic processes that determine seasonal lags in the influence of climate on streamflow (Shukla and Wood, 2008). This fact must be taken into account when comparing both indices in which the results don't necessarily go in parallel. Therefore both indicators should be used together.

Special attention to choosing the probability density function (PDF) considered, a poorly adapted distribution may lead to large discrepancies in estimating extreme percentiles (Vidal et al., 2010). Lloyd Hughes and Saunders (2002) found gamma distributions suitable for the larger part of Europe, but users should choose the distribution function that better fits their data series.

As a result, on monthly to seasonal time scales, the SRI is a useful counterpart to the SPI or others indicators for depicting hydrologic aspects of drought.

b. Performance of the indicator

Scoring based on criteria (data availability, clarity, validity, accuracy, sensitivity, capacity of integration with other indicators etc.)

The estimation and interpretation of the indicator, is easy and simple.

Last modifications of the factsheet

Thresholds names

Severity levels: Severity thresholds are defined based on the probability of exceeding an observed runoff value, which will have an associated SRI value. This values are:

- Much drier than normal: is the runoff value exceeded 95% of the time, which corresponds to SRI = -1.65
- Severely drier than normal: is the runoff value exceeded 90% of the time which corresponds to SRI = -1.28, and
- Moderately drier than normal: is the runoff value exceeded 80% of the time which corresponds to SRI = -0.84.

Fig. 1. Stream gauges considered for the estimation (SRB).

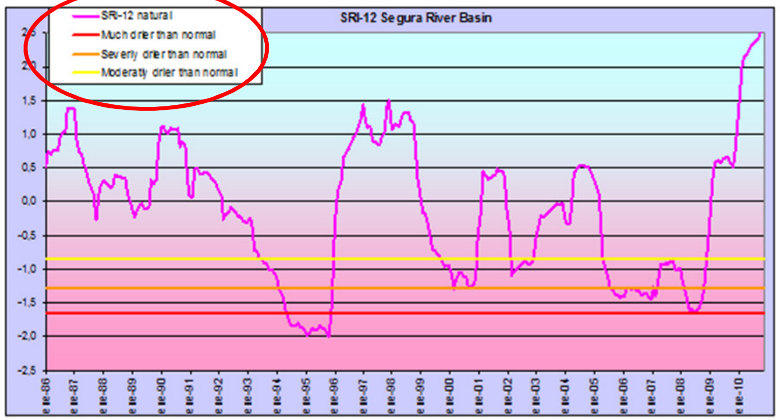


Fig. 2. SRI-12 performance in the Segura River Basin (SRB).

Severity threshold names have been modified in the last version of the factsheet:

Previous version		Actual version
Extreme drought	→	Much drier than normal
Sever drought	→	Severely drier than normal
Moderate drought	→	Moderately drier than normal

Last modifications of the factsheet

Probability Density Function

1. Indicator

McKee et al. (1993) select the Gamma distribution for fitting monthly precipitation data series, and suggest that the procedure can be applied to other variables relevant to drought, e.g., streamflow or reservoir contents. Although it is perfectly possible to use other statistical distributions when they fit better to the observations. The SRI can be computed the same way as the SPI (Standardized Precipitation Index), except for being based on the monthly-mean runoff time series.

6. Quality Information

a. Strength & weaknesses at data level

Similar to SPI, the quality of the index depends on the quality of the runoff time series. The runoff time series shows a regular checking process (validation of relation level-runoff by contrast with direct runoff-gauges, contrast with data from other sources such as hydrological automatic systems).

Several works (Pruhdomme and, 2007; Lloyd Hughes et al., 2009) assessed hydrological drought from observed streamflow gauges in different European regions. The criteria applied in assessing the representativeness of the stations for large-scale evaluation of hydrological droughts, could be considered.

Additionally, run-off data might be affected by human activity, which would distort the natural trends of a drought. Therefore, when pristine conditions data are not available, it is advisable to use data from hydrological models or restitution to natural conditions (using 'affected' data and existing demands).

This indicator is targeted to be used complimentarily with other indicators, thus errors could be possibly detected during this process as some trends may be illogical to explain.

Although the SRI and SPI are similar when based on long accumulation periods, the SRI incorporates hydrologic processes that determine seasonal lags in the influence of climate on streamflow (Shukla and Wood, 2008). This fact must be taken into account when comparing both indices in which the results don't necessarily go in parallel. Therefore both indicators should be used together.

Special attention to choosing the probability density function (PDF) considered, a poorly adapted distribution may lead to large discrepancies in estimating extreme percentiles (Vidal et al., 2010). Lloyd Hughes and Saunders (2002) found gamma distributions suitable for the larger part of Europe, but users should choose the distribution function that better fits their data series.

As a result, on monthly to seasonal time scales, the SRI is a useful counterpart to the SPI or others indicators for depicting hydrologic aspects of drought.

b. Performance of the indicator

Scoring based on criteria (data availability, clarity, validity, accuracy, sensitivity, capacity of integration with other indicators etc.)

The estimation and interpretation of the indicator, is easy and simple.

References about the PDF that can be used, other than Gamma distribution, can be found in various places.

Example 2: Indicator Testing:

In order to check whether the indicator could be applied in Europe with the current available data without new investment, to verify if the indicator works properly and identifies the existence of drought in the different basins and to evaluate how well the indicator fits other indexes and historical data, an assessment of the indicator was carried out in nine countries and 11 river basins: Morava RB (CZ), Odra RB (PL), Paimionjoki and Kokemaenjoki RB (FI), Slovenia, Thames RB (UK), Po and Arno RB (IT), Leitha/Raab/Rabnitz RB (AT), Meuse RB (NL) and Segura RB (ES).

Fig. 4. European countries that have participated on the SRI assessment.

The results were compared with historical data and with other indicators, such as SPI or other local drought indices. The conclusions of this evaluation are:

On Data Availability

- Most of the MS could apply the indicator on their basins with the existing data. The data series used have good quality and are long enough.
- In most cases, MS used data from gauging stations. Data from hydrological models could be used by most MS without a great investment of money and time.
- An important issue is the representativeness of the gauge stations in the basins.

On the Applicability:

- The calculation procedure is good and easy to carry out. Also it is sufficiently contrasted since it is the SPI methodology. The SRI methodology in general delivers feasible results and can be easily used with the available data.
- The Gamma distribution is a probability distribution function that can be used in most of the European basins, but users can choose other PDF that better fits to their data series.

On the Performance

Conclusions

- The SRI has been assessed in 11 European basins and MS have agreed in that this can be a useful indicator, together with other indices, to identify drought periods in Europe.
- Comments and feedback from MS have been included in the factsheet, which latest version is available in CIRCABC.
- If no other comments or observations are done we propose this indicator to be accepted in the European Pool of Drought Indicators.
- Further development can be done on thresholds and on assess the indicator in different types of basins (e.g. snow-fed or rain-fed basins).

Drought Hazard and Water Scarcity Risk Maps

Bases for discussion

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Background

Drought Risk Maps in the Mandate for the EG on WS&D

the purposes of the DRM are: *"…, together with WS&D indicators, establish drought phases and structural water scarcity, applied recommended measures included in the DMP report, and minimize WS&D socio-economic and environmental impacts…"*

Task nº 5 of the Mandate says: *"Support the creation of Drought Risk Maps, through commonly agreed methodology and scales".*

- **The Mandate talks about drought risk maps but at the same time expresses the need to "establish structural water scarcity" which is directly related to impacts.**
- **The added value of the risk maps over the status maps are the Hazard and Vulnerability concepts. Risk can't be understood without taking into account Impacts.**

Background

Main Goals of Drought Risk Maps

To determine the probability of drought occurrence.

To define water demands or consumptions existing in the European basins.

To evaluate the impacts that a drought of a given intensity can produce on population and environmental water demand.

To identify measures at a local, basin, national and European scale to mitigate the impacts of a drought.

To generate usable maps that can be used by water managers, stakeholders and public to implement measures for a sustainable water management.

References

- **Floods Directive (Directive 2007/60/CE on the assessment and management of flood risks):**

  "flood risk means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event".

  Risk = probability of occurrence * adverse consequences

- **Other references:**

  1. **UNDP (United Nations Development Program): how a good Drought Risk Management and a good early warning system can reduce drought impacts. Drought risk is directly associated with impacts of a drought.**
  2. **Australian Government : "The Bureau's seasonal outlooks are general statements about the probability or risk of wetter or drier than average weather over a three-month period".**
  3. **Spanish White Book on Water (MIMAM, 2000). Studied how two IPCC scenarios (1 and 2) would affect river flows in 2030, helping to generate water scarcity risk maps ranging from low-use, temporary-scarcity and structural-scarcity scenarios.**
  4. **ClimWatAdapt and SCENES projects: For this project maps of future water use, under the IPCC scenarios, have been developed.**

Concepts

Definitions accepted by the EG WS&D:

- **Drought**: "is a natural phenomenon. It is a temporary, negative and severe deviation along a significant time period and over a large region from average precipitation values (a rainfall deficit), which might lead to meteorological, agricultural, hydrological and socio-economic drought, depending on its severity and duration."
- **Water Scarcity**: "is a man-made phenomenon. It is a recurrent imbalance that arises from an overuse of water resources, caused by consumption being significantly higher than the natural renewable availability. Water scarcity can be aggravated by water pollution (reducing the suitability for different water uses), and during drought episodes."

Floods Directive

"Flood Risk means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event".

Risk = Hazard * Vulnerability

Flood and drought are natural phenomenon with an associated probability of occurrence, whose impact depends on the place and the time when they occur.

Other concepts

HAZARD

It is the probability of occurrence of a given intensity Flood/Drought phenomena.

It describes a natural phenomenon,

it is not related to the consequences or impacts

*

VULNERABILITY

It's the potential impact of a drought event on people and the environment in a given location/basin.

Effects would be more or less intensive depending on the characteristics of the location/basin.

- Frequency: Nº of times that an event occur,
- Duration: Nº of weeks/months/years that the event lasts, and
- Severity: intensity of the event.

Probability can be

- low, for extreme events,
- medium, return period ≥ 30 years, and
- high, for events with lower return periods.

Other concepts

Risk

Related to water scarcity.

Adverse effects caused by drought on the people, human activities and environment.

Water scarcity depends on human activity, it's impacts are related to human activity and environment.

Risk Maps (RM)

- RM Should show the potential adverse consequences of a given intensity drought event on population and the environment.
- These maps should be used to identify European basins with structural water deficit that can be aggravated during drought periods.

Drought Management Plans

- It should establish the measures that have to be taken in case of a concrete drought event, at a local and basin level.
- DMP are focused on immediate management issues.
- They should be developed under the umbrella of RBMPs.
- RM can support the development of DMPs by identifying the RBDs or parts of them where the development of a DMP is more necessary.

Possible Methodologies to be developed

1. **FLOODS DIRECTIVE (FD 2007/60/EC) METHODOLOGY**

   1.1. Drought risk maps methodology (Stepwise approach)

2. **WATER SCARCITY INDICATOR METHODOLOGY**

3. **STATUS MAPS METHODOLOGY**

   - **This methodology has been abandoned since it does not fit into the concepts of risk, hazard and vulnerability of the Flood Directive.**

Possible Methodologies to be developed

1. FLOODS DIRECTIVE (FD 2007/60/EC) METHODOLOGY (1/2)

Possible Methodologies to be developed

1. FLOODS DIRECTIVE (FD 2007/60/EC) METHODOLOGY (2/2)

Floods Directive distinguishes between Hazard and Risk maps

Risk = Hazard * Vulnerability

HAZARD MAPS = drought maps (probability of occurrence a drought with a certain intensity).

RISK MAPS = consequences of a given intensity drought.

Floods and droughts are different phenomena:

- **Consequences of floods only appear in a concrete area of the territory while consequences of droughts can happen any where.**
- **Floods are developed in a short period of time (hours) while droughts can last months or even years.**
- **Finally in floods events only the flow parameter is involved while droughts can be depicted using different parameters (precipitation, flow, soil moisture, snowpack, etc.).**

Possible Methodologies to be developed

1.1. Drought risk maps methodology (Stepwise approach)

This methodology has been developed following the discussion and comments of the EG during the Athens meeting (September 2012).

It is a variation of the Flood Directive's methodology, using drought parameters and it's characteristics for assessing risk.

DROUGHT MAPS

Based on the probability of occurrence of a drought event of a given intensity

Probability is calculated from the temporal series of a variable (precipitation, runoff, soil moisture, etc) depending on the characteristics of the basin and the drought indicator chosen.

The drought event should be defined in terms of hazard: frequency, duration and severity

DEMAND MAPS

Demand can be difficult to calculate at the EU level

A simplified dataset can be used (e.g. consumption data from main sectors).

Forecasts of demand data can be used to evaluate future drought risk to analyze climate change impacts.

Overlap

DROUGHT RISK MAPS

Possible Methodologies to be developed

Strengths:

- Both methods are coherent with the Floods Directive.
- Drought indicators accepted by the EG WS&D can be used.
- One or more drought indicators (of the CIS indicator set) can be used.

Weaknesses:

- Selection of the drought indicators:
  - The Indicator/s should be selected depending on the characteristics of the basin and the type of demands in it (e.g. rain-fed agriculture can be affected by SPI, while urban demand that depends on surface water can be affected by SRI).
  - Since these indicators are statistical distributions, indicator values in different basins are not comparable. These indicators only detect anomalies from the average of their own data series.
  - To make them comparable droughts must be defined in terms of number of consecutive month in which the indicator/s selected give a high intensity drought, and then calculating the probability of occurrence of a drought.
  - Other comparable indicators would be those based on absolute variables, as Annual Average Runoff or Runoff/km^2, etc.
- Historical droughts should be taken into account by generating specific maps on this issue.
- It's not easy to identify the demand areas that depend on the area/basin that is suffering a drought.
- Historical and current demand data can be difficult to obtain.
- It is difficult to assess the impacts in terms of "human health, the environment, cultural heritage and economic activity."

Possible Methodologies to be developed

2. WATER SCARCITY INDICATOR METHODOLOGY (1/2)

Calculate WEI+ Time series

$$WEI = \frac{Abstractions - \mathrm{Re}\,turns}{Water\,\mathrm{Re}\,sources - \Delta Sart}$$

↓

Determine the WEI+ threshold that can not be exceeded (WEI+_Limit)

% of Water Requirements (EWR) compared to Available Resources

↓

Count the number of time steps (months or year) where WEI+ threshold is exceeded, and obtain its percentage.

Based on the probability of exceeding WEI+_Limit a number of years

↓

Calculate Water Scarcity Risk

↓

Draw Water Scarcity Risk Map

Red	Extreme: WEI+ value is exceeded more of the 50% of the years
Dark orange	High: WEI+ value is exceeded between the 30 and the 50% of the years
Light orange	Medium: WEI+ value is exceeded between the 10 and the 30% of the years
Yellow	Low: WEI+ value is exceeded between the 5 and the 10% of the years
Green	Null: WEI+ value is exceeded between the 0 and the 5 % of the years

Possible Methodologies to be developed

2. WATER SCARCITY INDICATOR METHODOLOGY (2/2)

Strengths:

- It uses a water scarcity indicator that has been selected by the EG WS&D for the European pool of WS&D indicators, so all MS are likely to use it in a medium term.
- WEI+ is useful to describe water scarcity,
- Management is related to water scarcity more than to drought, and
- It is ready to provide 'risk maps'.

Weaknesses:

- It might be a bit simplistic.
- It inherits all the uncertainties of WEI+: data availability, thresholds, Water Requirements issues...
- Considering water demand as a stable variable it's assumed that there are no changes in population growth or in water consumption. The indicator should be more flexible and permit the use of other consumption options. Another question is how to predict the variation of water demand according to different types and length of Drought.
- Some MS argue that WEI+ should not be considered as the basis for Drought risk map methodology, but for Water Scarcity risk map methodology.
- It adds a new threshold issue. Establishing low-medium-high levels can be difficult and would depend on the basins characteristics.

Conclusions and baseline for further developments

- **Flood Directive definition of Risk has been suggested since is an adequate concept, therefore previous methodologies, that don't fit in it, have been abandoned (e.g. Status maps methodology).**
- **There are two different approaches suggested: Flood Directive vs. water scarcity indicators methodology. The first one is related with drought risk while the second one have to do with water scarcity and management.**
- **Drought, as a natural phenomenon, is not a risk per se.**
- **The Risk concept can-not be understood without taking into account impacts. Risk can be considered as the relation between the probability of occurrence of natural phenomena (hazard) and the impacts of these phenomena (vulnerability).**
- **Drought can be measured using CIS drought indicators Set, but for this purpose drought should be defined as the number of consecutive months in which the indicator gives a high intensity drought.**
- **It is not easy to achieve an standardization of the risk maps methodology, base on FD, at a European level: The number and type of the drought indicators selected will depend on the characteristics of the RBDs and the degree of certainty to be achieved with the analysis.**
- **Drought impacts are related to water consumption, water use and water demand.**
- **Due to the difficulty of estimating water demand in the RBD, other water use dataset can be used: e.g. most important consumption in the RBD, water use estimation, etc. Changing the demand dataset could simplify the implementation of the risk maps in each RBD, but also risk maps would be more heterogeneous throughout EU.**
- **Risk maps should be practical management tools and risk forecasting should permit using data from IPCC Scenarios.**