The Arno River Basin Authority

The Serchio River Basin Authority

The Po River Basin Authority

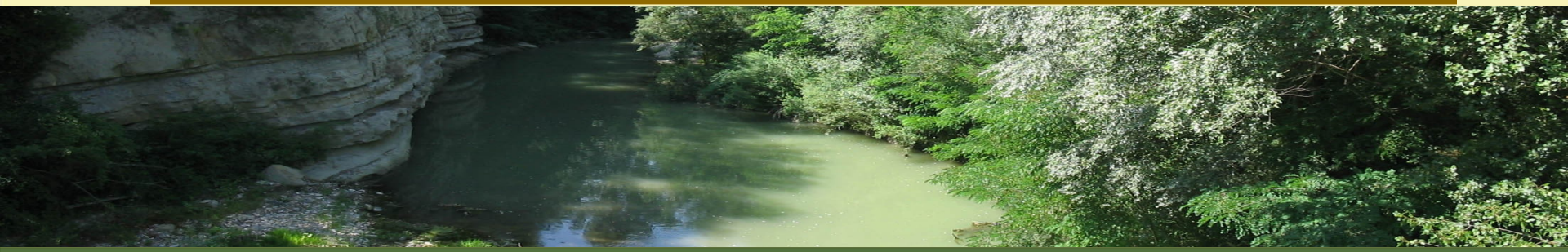
The Liri Garigliano-Volturno Basin Authority

Results of the test activities carried out by the Italian River Basin Authorities: Arno, Po, Serchio, Liri-Volturno-Garigliano

MEETING OF THE EC EXPERT GROUP ON WATER SCARCITY AND DROUGHT - Venice, 13-14 October 2011

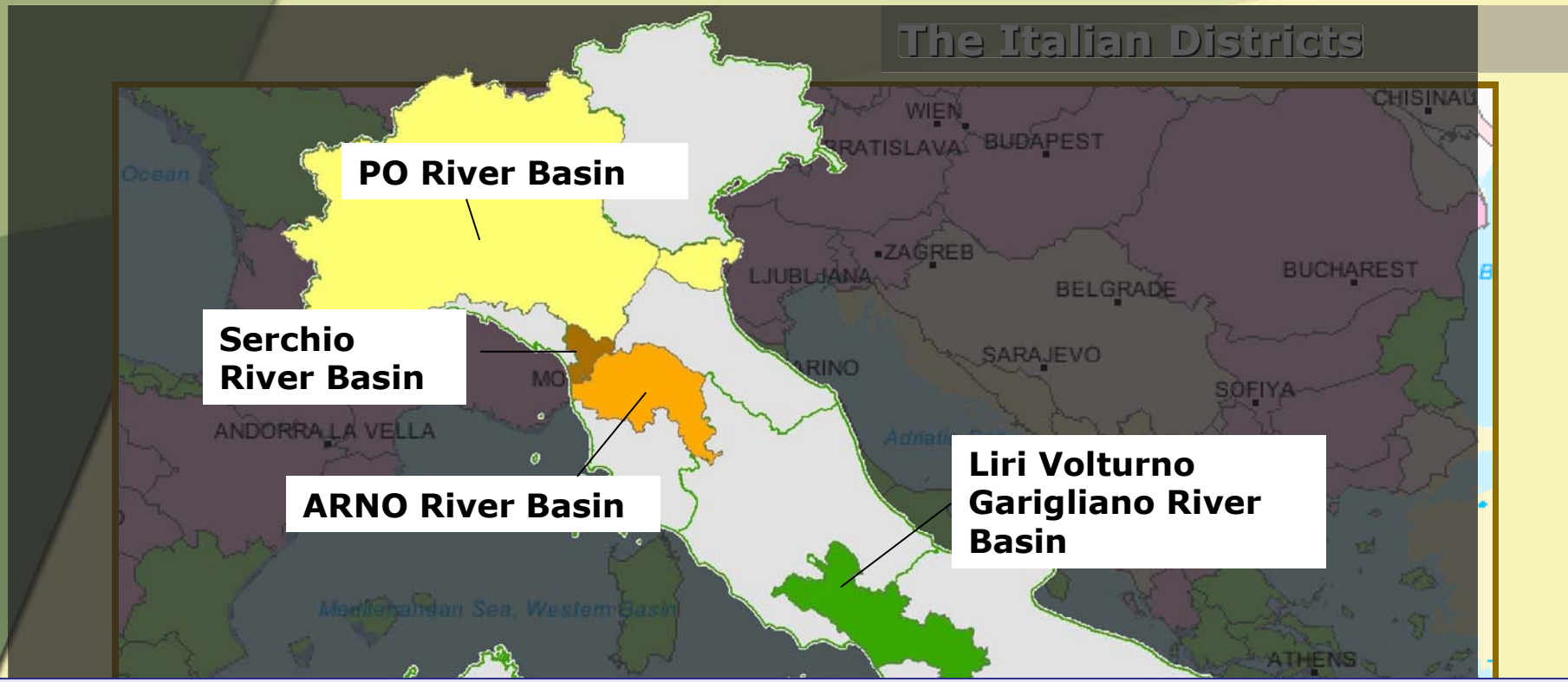
Gaia Checcucci
Segretary General
The Arno River Basin Authority
www.adbarno.it

The Italian Districts



The Italian Districts

The Italian Districts



The Italian River Basin Authorities that are participating to the WS&D Indicators' Test Case Exercise are:

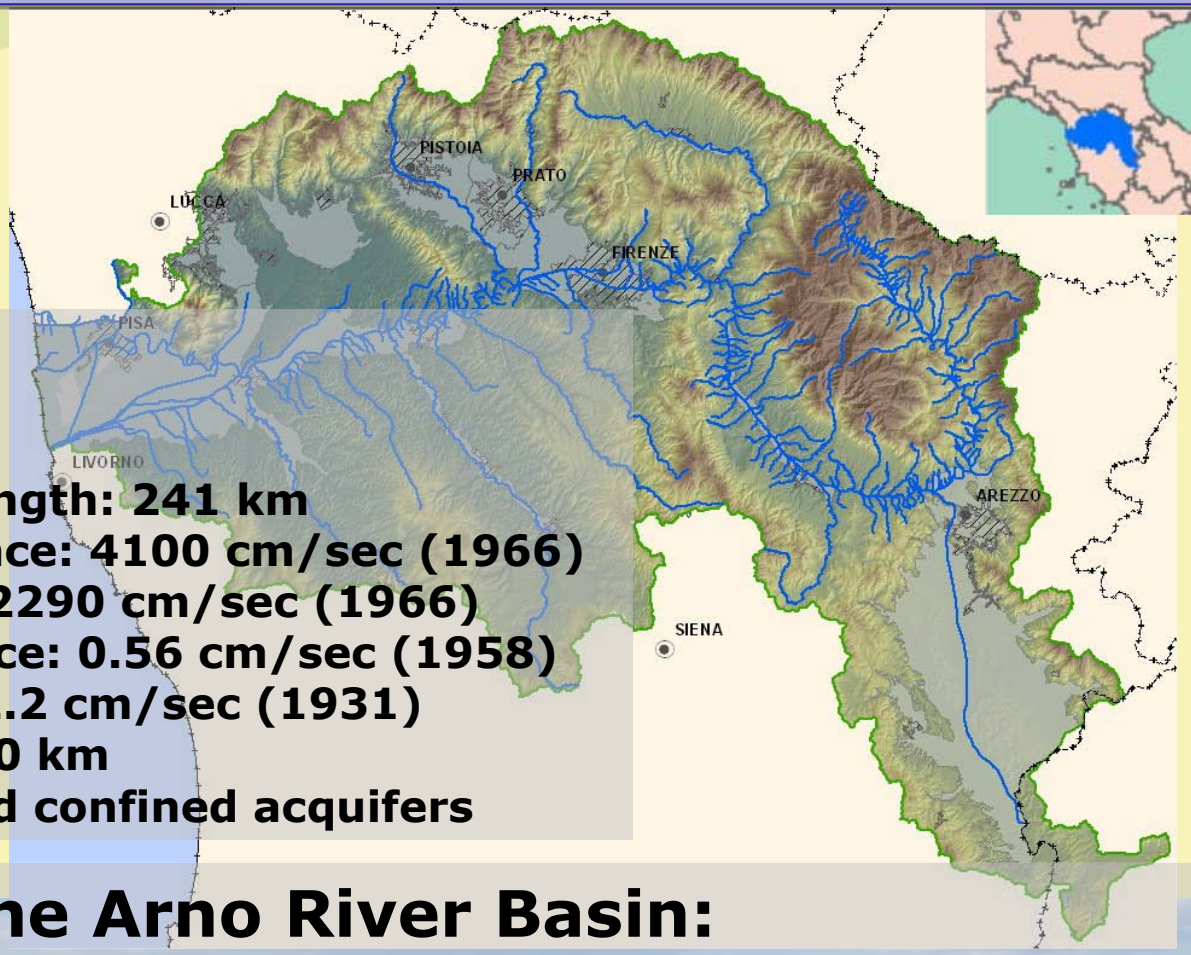
The Arno River Basin Authority

The Po River Basin Authority

The Serchio Pilot Basin Authority

The Liri – Volturno Garigliano Basin Authority

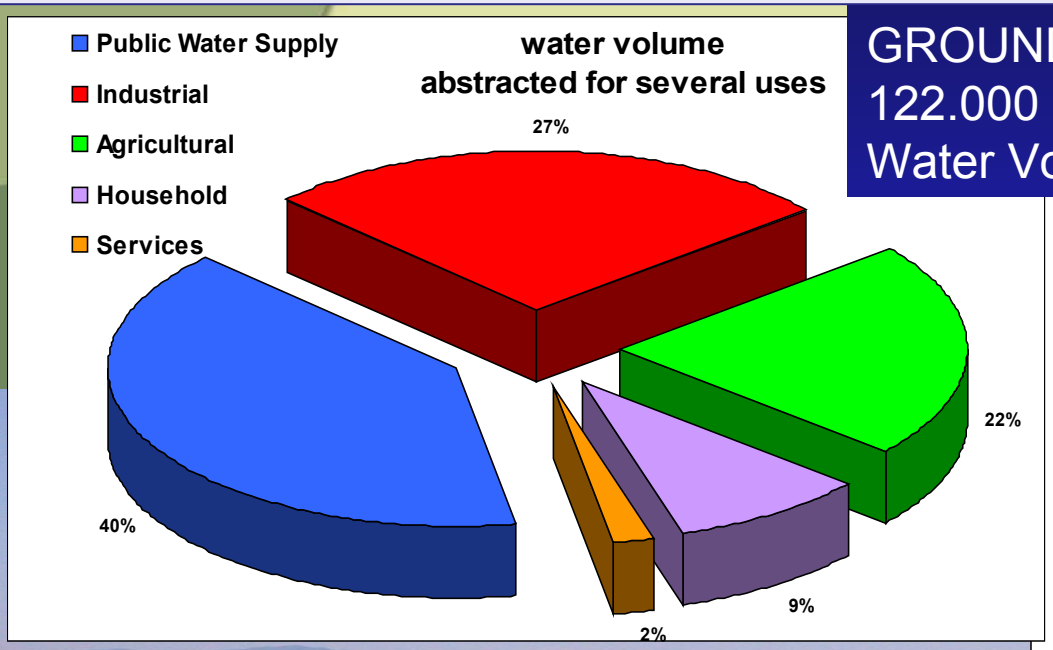
The case of the Arno River Basin



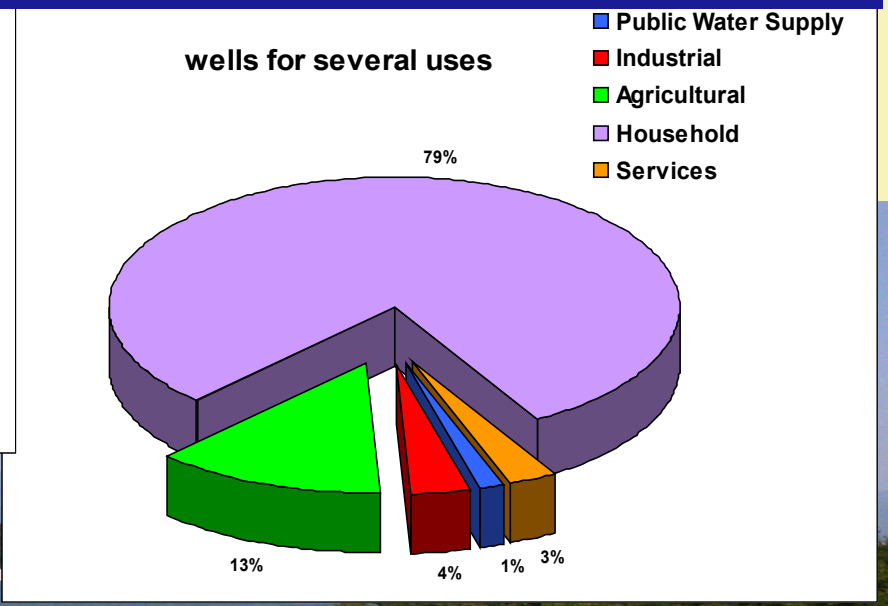
- Basin surface 9.100 sq km
- Main channel (Arno river) length: 241 km
- Maximun discharge in Florence: 4100 cm/sec (1966)
- Maximun discharge in Pisa: 2290 cm/sec (1966)
- Minimun discharge in Florence: 0.56 cm/sec (1958)
- Minimun discharge in Pisa: 2.2 cm/sec (1931)
- Surface water bodies - 24000 km
- Groundwater 17 phreatic and confined acquifers

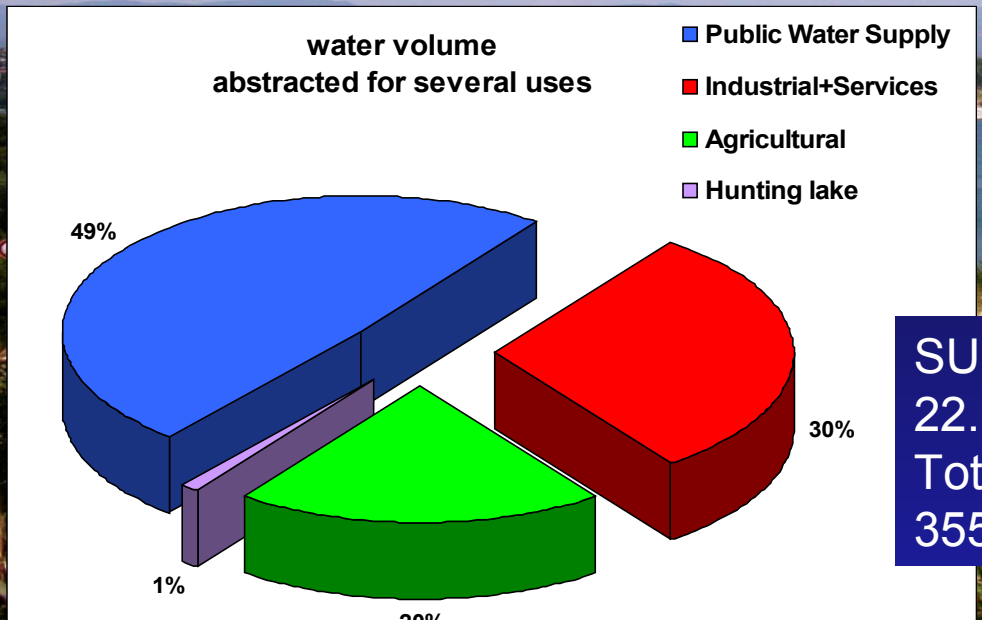
Water Scarcity in the Arno River Basin: The *Water Balance Plan* highlights water criticalities . WS&D mainly occur during the Summer Months (June – September).

Water resources in Arno River Basin



GROUNDWATER ….
122.000 Wells
Water Volume Abstracted / Year: 320 Mcm/Year



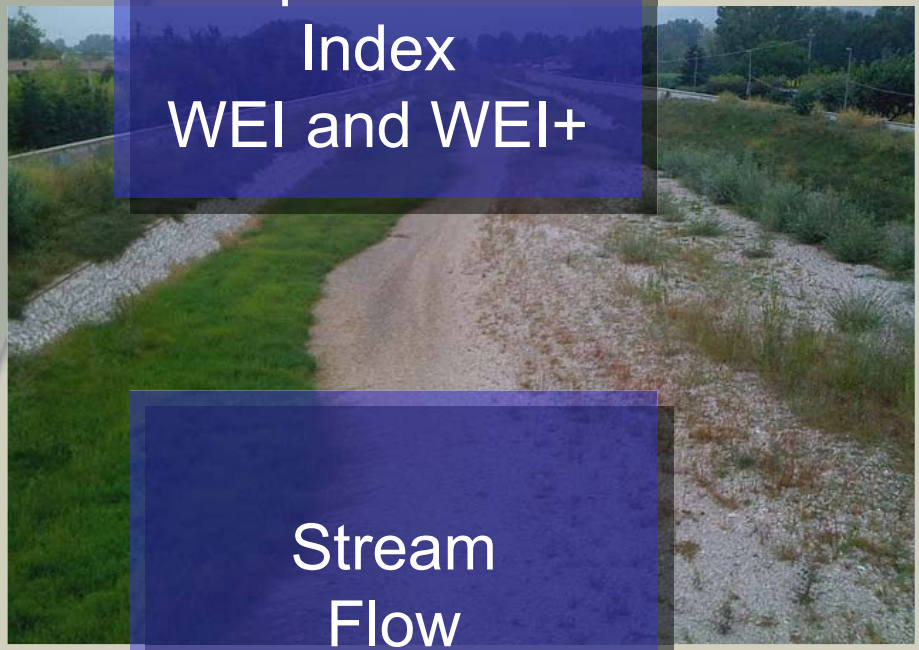


SURFACE WATER ….
22.000 Abstraction Points
Total Water volume abstracted / Year:
355 Mcm

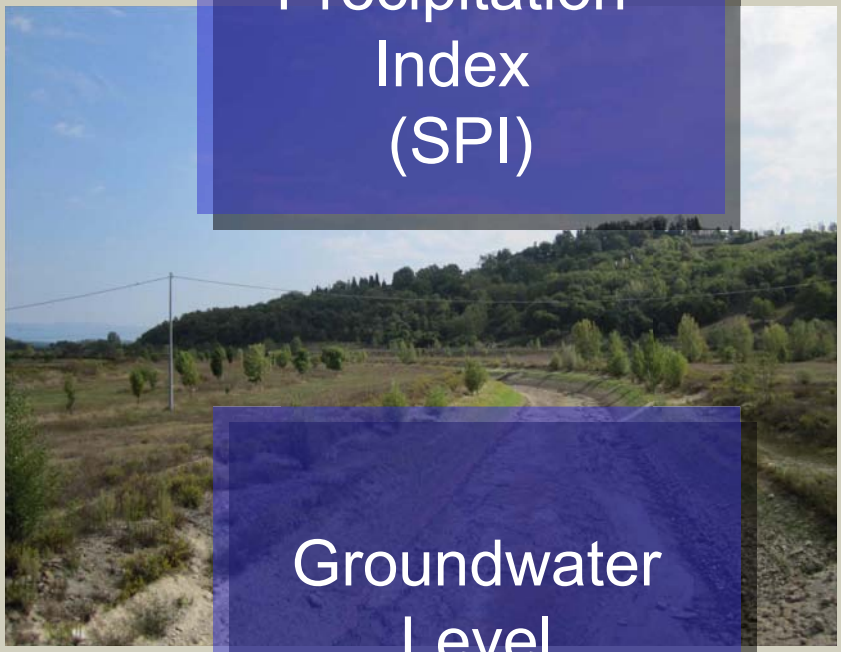
Water Scarcity & Drought:
… the most relevant indicators for the Arno River Basin

Water Scarcity & Drought: … the most relevant indicators for the Arno River Basin

Water Exploitation Index WEI and WEI+



Standard Precipitation Index (SPI)



Stream Flow

Groundwater Level

Water Exploitation Index (WEI) and the WEI+ in Arno River Basin

WEI components	WEI+ components
ABSTRACTION *(Eurostat definition)*	ABSTRACTION *(WISE-SoE definition)*
Excludes hydropower	Includes hydropower
LTAA WATER RESOURCES AVAILABILITY	RENEWABLE WATER AVAILABILITY (RWA)
$P_{LTAA} - Eta_{LTAA} + I_{LTAA}$	P – Eta + I + R – WR (ENV, treaties)

WEI = ABSTRACTION / LTAA WATER RESURCES AVAILABILITY

20%

WEI + = ABSTRACTION / LTAA RENEWABLE WATER AVAILABILITY

21%

Water Exploitation Index (WEI) and the WEI+ in Arno River Basin

WEI components	WEI+ components
ABSTRACTION *(Eurostat definition)* Excludes hydropower	ABSTRACTION *(WISE-SoE definition)* Includes hydropower
LTAA WATER RESOURCES AVAILABILITY $P_{LTAA} - Eta_{LTAA} + I_{LTAA}$	RENEWABLE WATER AVAILABILITY (RWA) P – Eta + I + R – WR (ENV, treaties)

WEI = **20%**

WEI + = **21%**

CRITICALITIES:

The annual basis calculation does not allow the identification of summer water balance deficits

Standard Precipitation Index in the Arno River Basin

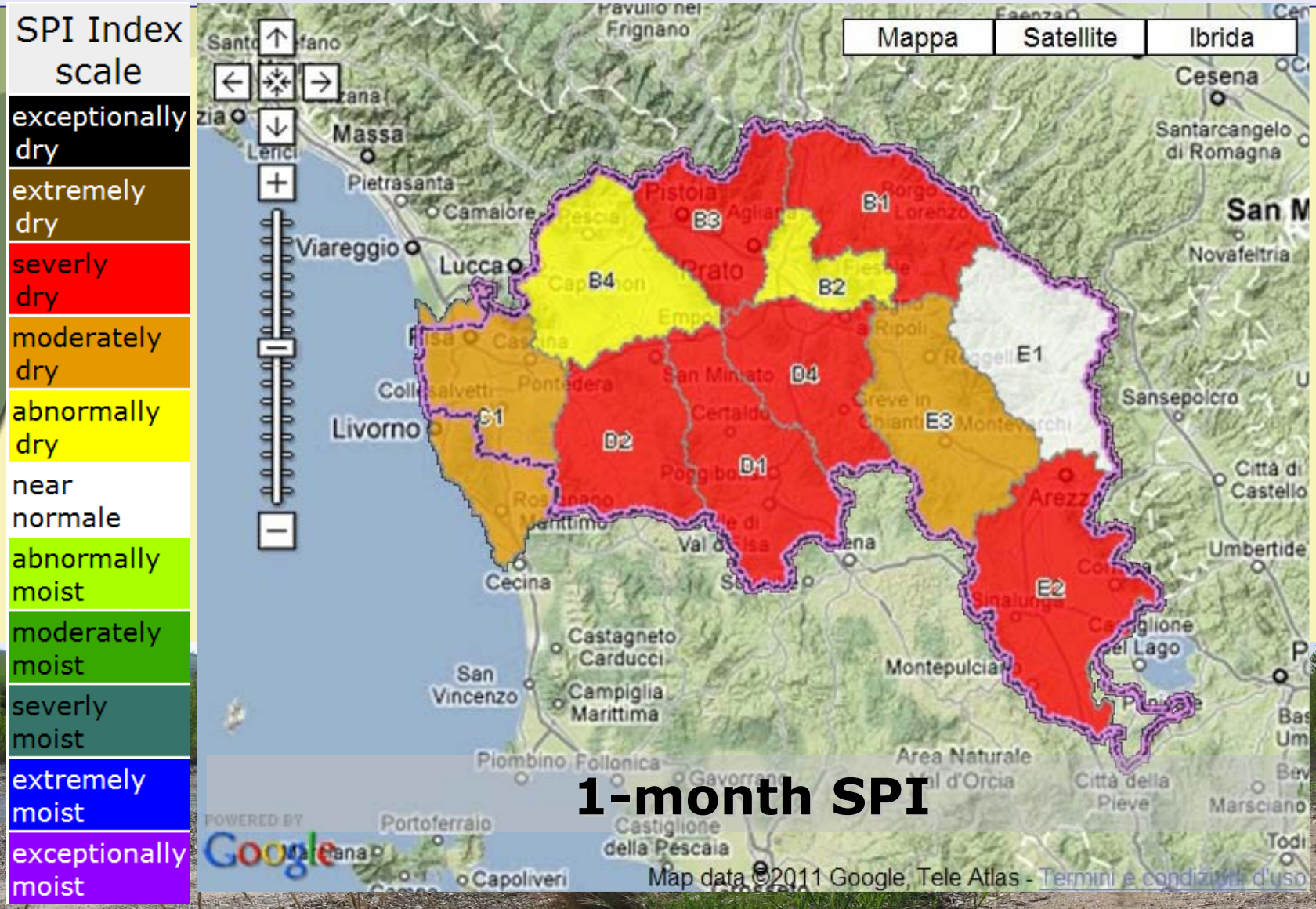
Daily Precipitation Data
from 177 hydro-meteorological stations

Observation of precipitations in 11 sub-basins
Time scales 30, 60, 90, 120 e 180 days

Hystorical series 1951-2010 (60 years)

SPI CALCULATION

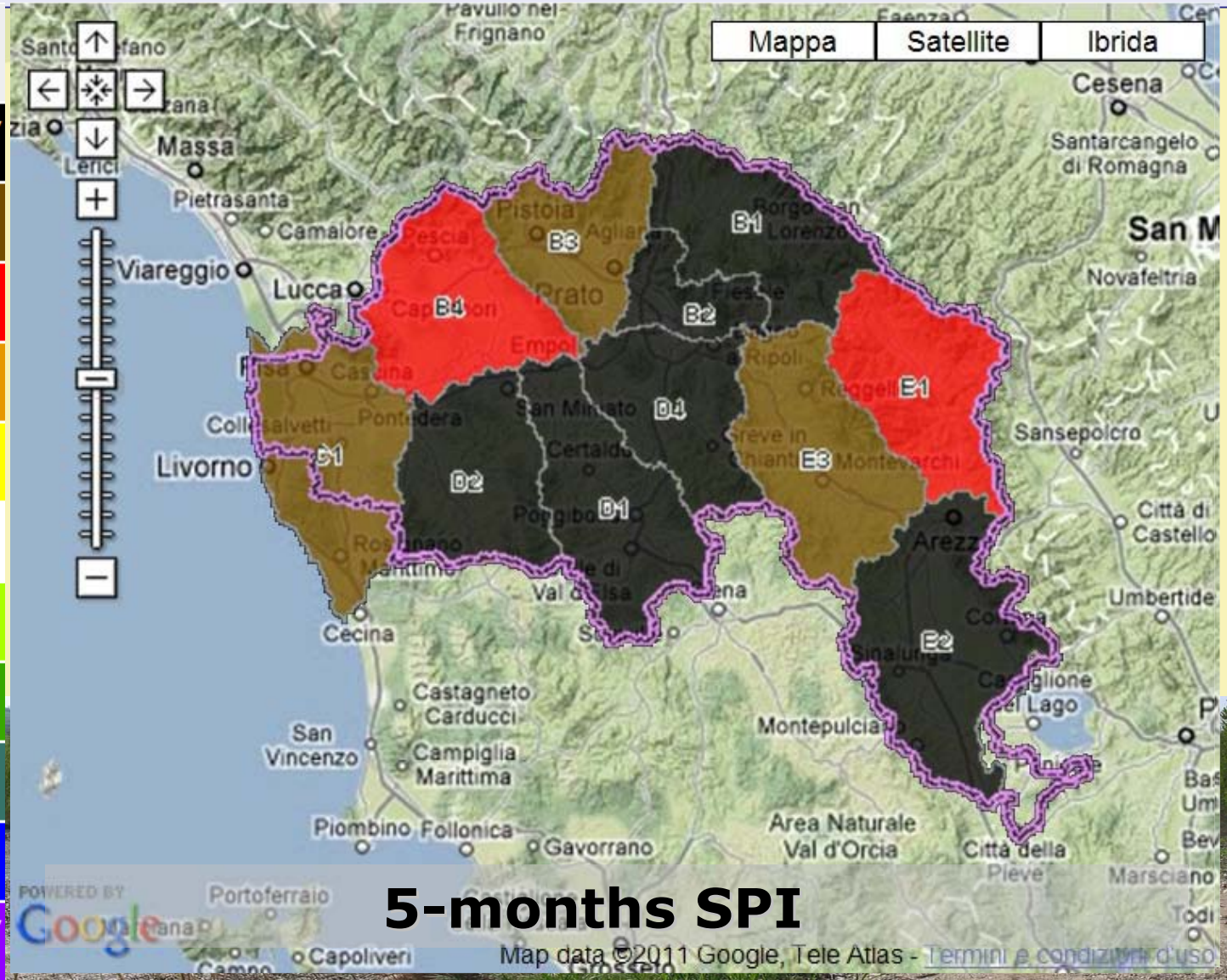
Standard Precipitation Index in the Arno River Basin



Standard Precipitation Index in the Arno River Basin

SPI Index scale

- exceptionally dry
- extremely dry
- severly dry
- moderately dry
- abnormally dry
- near normale
- abnormally moist
- moderately moist
- severly moist
- extremely moist
- exceptionally moist



5-months SPI

"Streamflow" Indicator in the Arno River Basin

Firenze

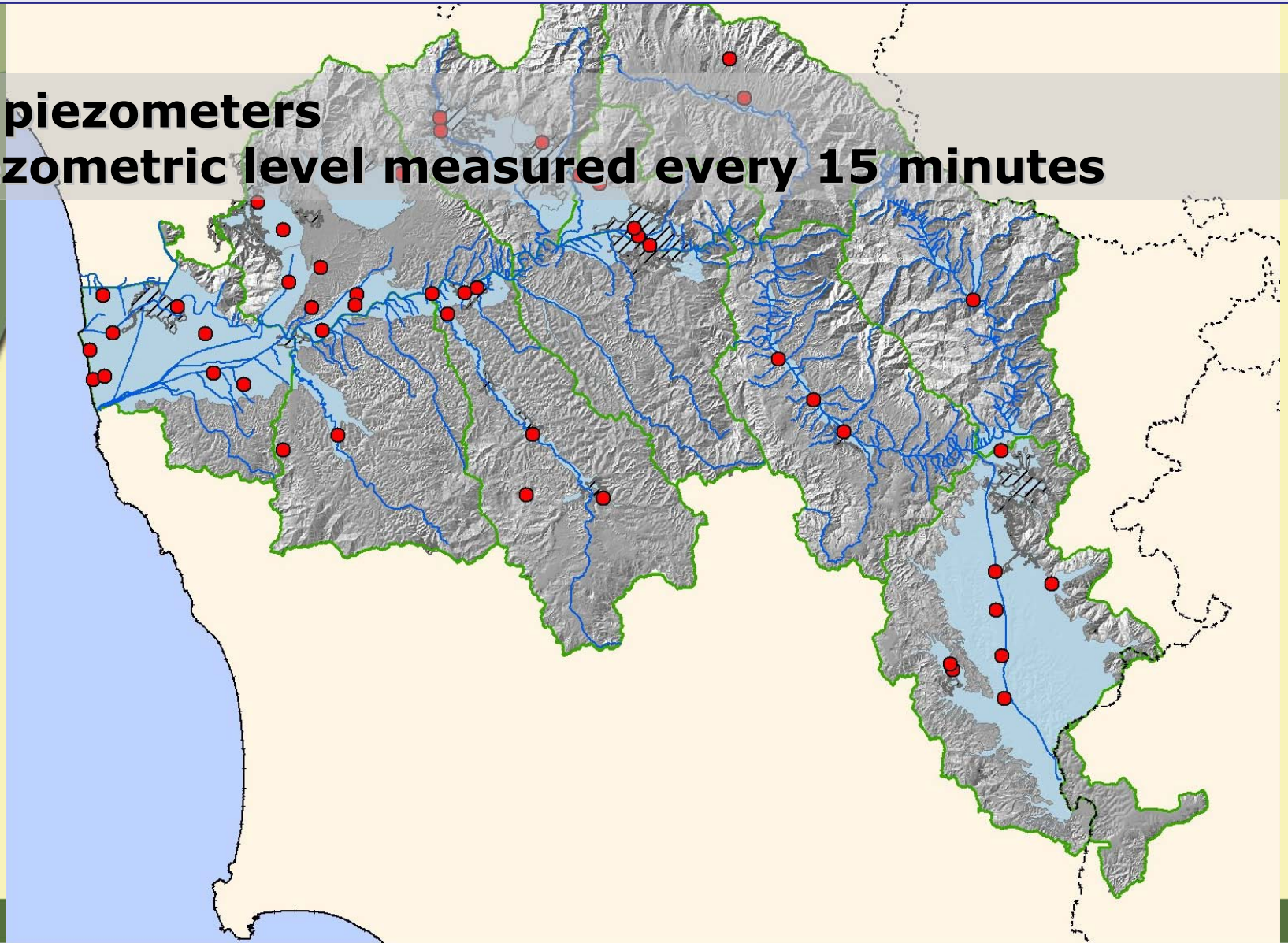
Pisa

Arezzo

121 stream gauges; 12 gauges,located at the end of the main sub-basins, calculate the water level discharge relationship

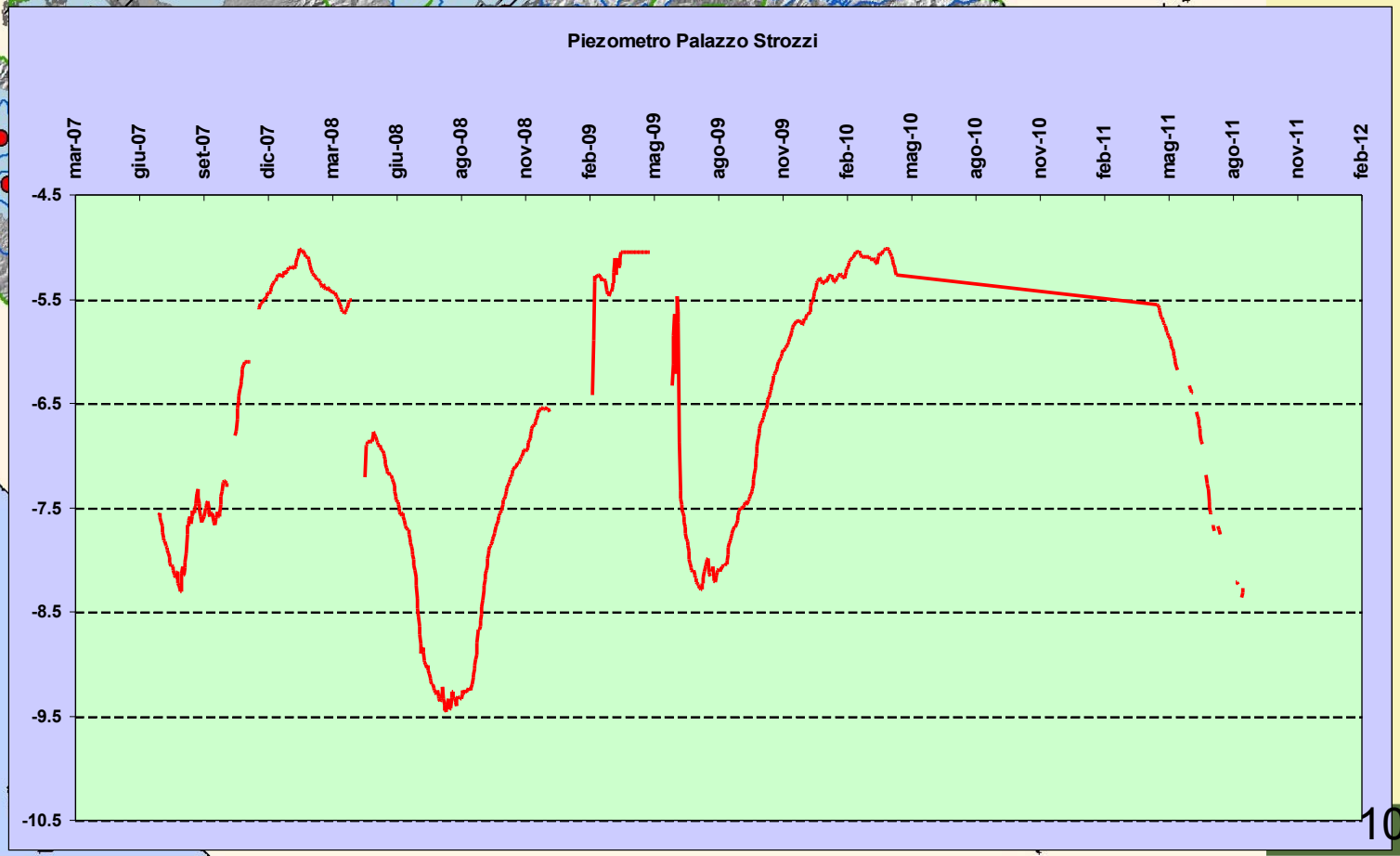
"Groundwater level" Indicator in the Arno River Basin

51 piezometers
Piezometric level measured every 15 minutes



"Groundwater level" Indicator in the Arno River Basin

51 piezometers
Piezometric level measured every 15 minutes



"Water Scarcity & Drought" Indicator in the Arno River Basin

Indicator	Scale	Focus	Data Availability	Comment
Relevant Water Stress Indicator (RWSI) = Percent of Total Freshwater Abstracted over the total Renewable Water Availability RWSI = ABS / RWA	RBD, Site specific	WS&D	Data are available **(RWA = P – Eta + I – EF + R)**	Assessment in progress
Water Exploitation Index (WEI) and the WEI+ Total Water Abstraction / Renewable Water Availability	RBD	WS&D	Data are available in the Water Balance Plan RWA = Internal Flow (D) + Actual External Inflow (I) + Returned Water (R) - Water Requirements (WR)	Assed. The annual basis calculation does not allow the identification of Summer droughts.
Water Use per sector	Site specific	Water exploitation	Data available in the RBMP	Assessed

"Water Scarcity & Drought" Indicator in Arno River Basin

Indicator	Scale	Focus	Data Availability	Comment
Snowpack	Regional, site specific	Climate change	Not Relevant	Not relevant
Ground water level	Regional, Site specific	Water exploitation and subsidence	Yes	There is a need to increase the number of monitoring stations
Standardized Precipitation Index (SPI)	Sub basin	WS&D	Yes	Versatile indicator both for the temporal and the spatial scale Useful. Easily comparable with other indicators and indexes if calculated taking into consideration rainfalls at sub-basin scale

"Water Scarcity & Drought" Indicator in the Arno River Basin

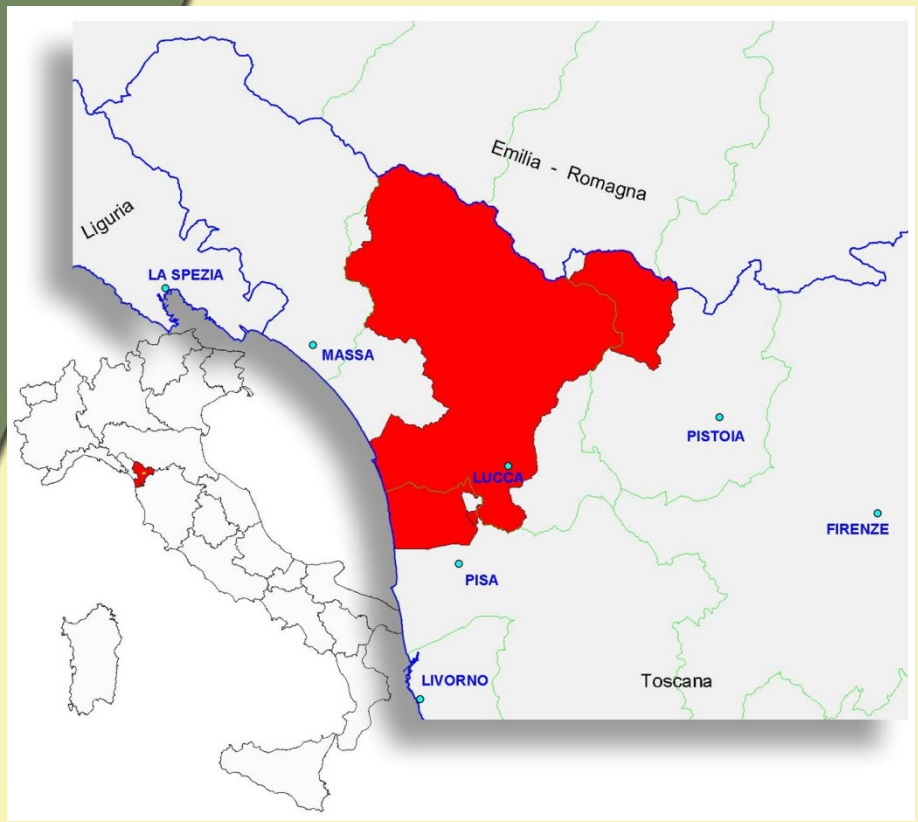
Main Issues:

The annual basis calculation of the WEI and WEI+ does not allow the identification of Summer Droughts.

Indicators should be referred to Summer Droughts and clustered at an appropiate scale (most significant sub-basins).

WS&D Indicators should be compared in order to outline the situation in a complete and reliable way

The case of the Serchio River Basin



Area = 1600 Km2	
Popolazione	
295000	ISTAT-2004-2008
1 Regioni	Toscana
Comuni	36
ATO	3

Data Availability Survey for Water Scarcity and Drought Indicator system (WSDiS)

1) **Data about *water resources availability*, *water abstraction by source*, *water use by sector* (data from *WQ Reporting Tool**)**

1) ***Relevant socio-economic and environmental indicators***

* developed for this purpose of the WISE-SoE#3 Water Quantity Reporting 2009

Data reported by the *Serchio Pilot River Basin*

Country: IT/Italy
Responsible: Segreteria Tecnica
Email: segreteria@bacinoserchio.it
Remarks:

Overview of the data reported so far

Region code	Region name	Region type	Water balance	Water abstraction	Water use	Wells	Reservoirs	Streamflow st.	Precipitation st.
ITD	Serchio	RBD	YES	YES		18	13	20	58

Water balance

Region: Code ITD | Name Serchio | Type RBD

Hydrometeorological parameters | Water storage | Returned water | Reused water | Desalinated water | Other additional water resources

Clear table — Volume in hm3

	Areal Precipitation	Pot. Evapotranspiration	Act. Evapotranspiration	Internal flow
Month 1 (Jan)				
Month 2 (Feb)				
Month 3 (Mar)				
Month 4 (Apr)				
Month 5 (May)				
Month 6 (Jun)				
Month 7 (Jul)				
Month 8 (Aug)				
Month 9 (Sept)				
Month 10 (Oct)				
Month 11 (Nov)				
Month 12 (Dec)				
Annual				
Wet Season				
Dry Season				
LTAA	2237,2	765,81	749,81	1487,39

Data available (rapidly)
as long term annual average (LTAA).
Annual data are (very often)
much more difficult to elaborate

Water balance

Region: Code ITD | Name Serchio | Type RBD | Yea

Hydrometeorological parameters | Water storage | Returned water | Reused water | Desalinated water | Other additional water resources

Clear table — Volume in hm3

	Snowpack	Changes in reservoir storage	Changes in groundwater storage
Month 1 (Jan)			
Month 2 (Feb)			
Month 3 (Mar)			
Month 4 (Apr)			
Month 5 (May)			
Month 6 (Jun)			
Month 7 (Jul)			
Month 8 (Aug)			
Month 9 (Sept)			
Month 10 (Oct)			
Month 11 (Nov)			
Month 12 (Dec)			
Annual			
Wet Season			
Dry Season			
LTAA	0	0	0

Data not available

Relevant Socio-economic and Environmental Indicators

Questionnaire answers

Responsible Authority		Autorità di Bacino Serchio
Sub Unit		Distretto Idrografico del Fiume Serchio
Area [km2]		1.565
Indicator	**Population**	2
	Economy	4
	Land use	5
	Infrastructure	8
	Quality -	6
	Education and	0
	Responses	0
TOTALE		25

Criticalities

Some population data are not available:

-Seasonal workers in the tourism sector (which are not permanent residents)

-Nights spent at hotels, etc.

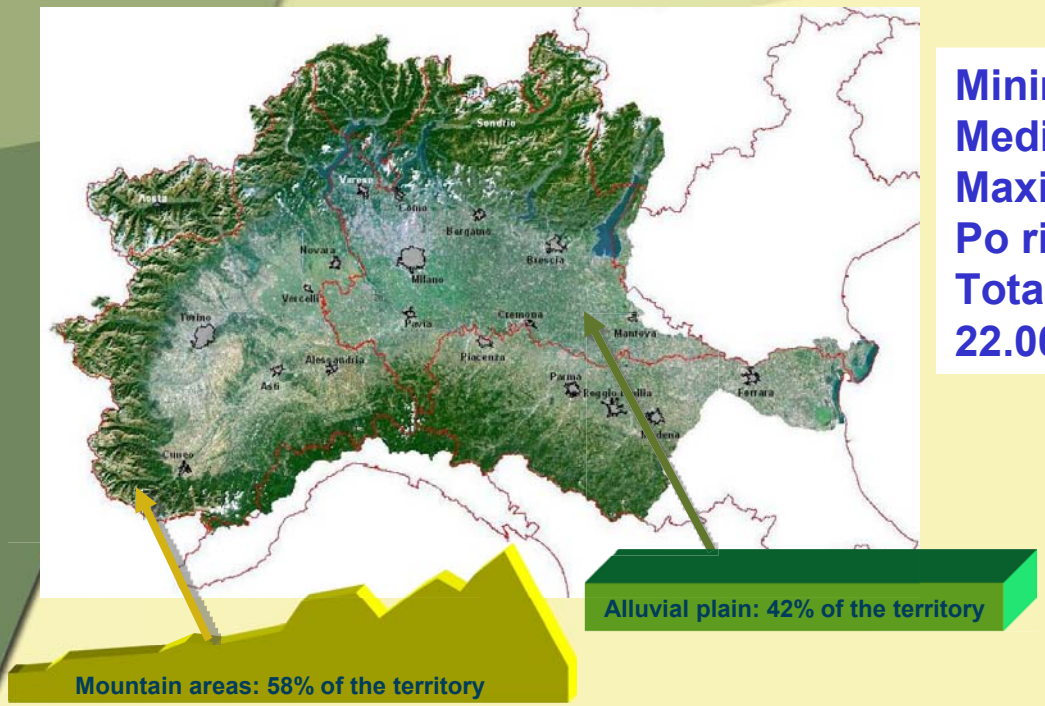
***Economic data (incomes per sector, losses due to drought, public expenditures, investments for water infrastuctures, etc.) are difficult to collect**

WS&D INDICATORS

Indicator	Scale	Focus	Data Availability	Comment
Relevant Water Stress Indicator (RWSI) = Percent of Total Freshwater Abstracted over the total Renewable Water Availability RWSI = ABS / RWA	RBD, Site specific	WS&D	Problems: external inflow and returned water are difficult to assess **(RWA = P – Eta + I – EF + R)**	WS&D indicator , that can be used in mapping water scarcity, water exploitation,and for monitoring and management purposes at local level
Water Exploitation Index (WEI) and the WEI+ Total Water Abstraction / Renewable Water Availability	RBD	WS&D	Problems: external inflow and returned water are difficult to assess **RWA = Internal Flow (D) + Actual External Inflow (I) + Returned Water (R) - Water Requirements (WR)**	WS&D , focused on water scarcity. Comparison between LTAA results very useful (i.e. 1971-2010; 2000-2010)
Water Use per sector	Site specific	Water exploitation	Not available	Useful for assessing exploitation, for monitoring and management purposes at local level

Indicator	Scale	Focus	Data Availability	Comment
Snowpack	Regional, site specific	Climate change	Problems: real time monitoring and assessment	Long term average of maximum annual snowpack in winter seasons could be more appropriate
Ground water level	Regional. Site specific	Water exploitation and Subsidence	Yes	A LTAA as reference period could be more appropriate for changes assessment
Standardized Precipitation Index (SPI)	Spatial scale appropriate to the station density	WS&D	Yes	Versatile indicator both for temporal and spatial scale Note: reference period. Compare the **recommended reference period** (i.e. 1971-2010) with the last 10 years (i.e. 2000-2010) in order to accommodate changes in the precipitation regime and to better assess actual rainfall figures

The case of Po River Basin

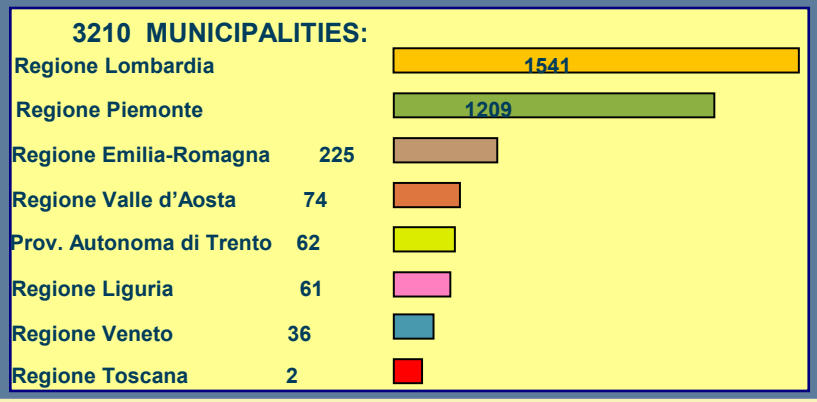


Minimum daily flow rate 168 m /s
Medium daily flow rate 1500 m /s
Maximum daily flow rate 10.300 m /s
Po river course length 652 km
Total length of "natural rivers" network: 22.000 km

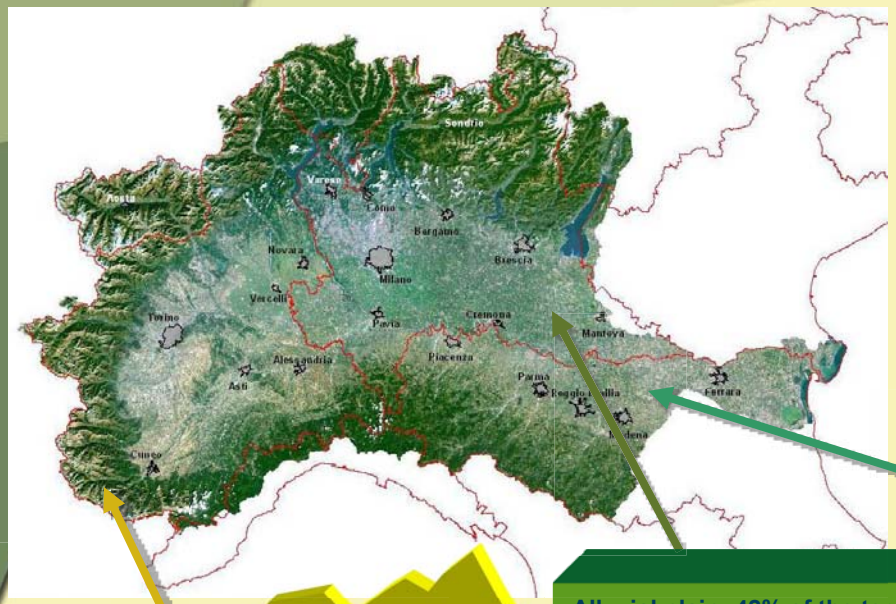
Area = 74.700 Km (of which 4000 outside Italy)

Population: 17.000.000

Regions: 7



The case of Po River Basin



Minimum daily flow rate 168 m /s
Medium daily flow rate 1500 m /s
Maximum daily flow rate 10.300 m /s
Po river course length 652 km
Total length of "natural rivers" network: 22.000 km

GDP : 40% OF THE NATIONAL GDP

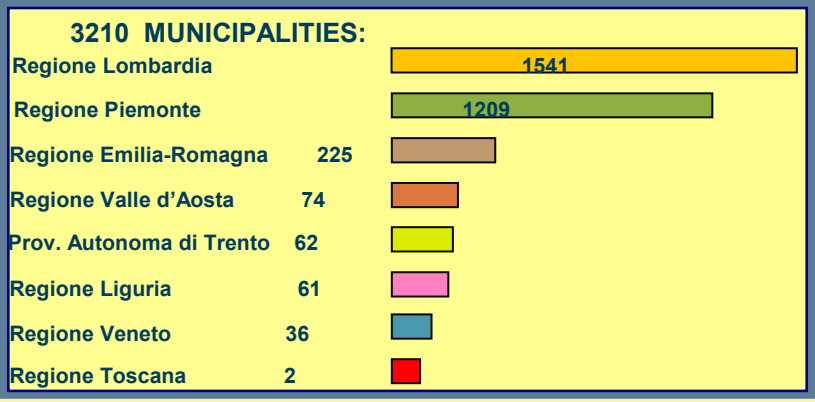
Alluvial plain: 42% of the territory

Mountain areas: 58% of the territory

Area = 74.700 Km (of which 4000 outside Italy)

Population: 17.000.000

Regions: 7



1) Water Resources Availability, Water Abstraction by source, Water Use by sector – PO RIVER BASIN AUTHORITY

Water resources availability: very long daily streamflow and precipitation series (since 1925...).

Surface water: very good data avaliability since 2000 also for features ET, PET, Qi, Qo, Reservoir, etc.

Groundwater: poor information, with disomogeneus cover over the basin and over time.

Criticalities

1. Most of the data are collected, calculated or provided by the "Drought early warning system" for the Po basin. Data format don't match with WISE_SoE request, so programmer's time is requested to update system procedures.
2. Groundwater data collection requires planning actions and network design.
3. Need of a reference-platform at the district level.

Water abstraction by source and water use by sector: data collected in "Regional Water Protection Plans", developed in 2004, and transmitted to Po River Basin Authority for the development of RBMP.

Criticalities

1. Need of a "shared procedure" to be defined to organize and activate data transfer.
2. Data are updated to the Regional Water Protection Plans pubblication. The updating procedures and timing are up to regional services and not coordinated one to each other.

2) Relevant socio-economic and environmental indicators – PO RIVER BASIN AUTHORITY

Questionnaire answers

Responsible Authority		Po River Authority
Sub Unit		Po District
Area [Km^2]		74.700
Indicators (nr. avaliable)	Population	3 (7)(*) of 10
	Economy	2 (13) of 17
	Land use	8 (1) of 9
	Infrastructure	2 (3) of 6
	Quality-environment	4 (6) of 10
	Education and awareness	0 (2) of 3
	Responses	1 (7) of 8
Total:		20

(*)(nr. In brackets: different aggregation/data availability to be verified)

Criticalities

- Data collected by ISTAT- National Statistics Insitute, or INEA- National Institute for Agrarian Economy, aggregated on Municipalities'/Provinces'/Regions' boundaires, often not directly suitable for river district.
- Lack of technicians and experts in data managing and analysing.
- In some cases, lack of data, and also of monitoring networks.

Po: "Water Scarcity & Drought" Indicators

Indicator	Scale	Focus	Data Availability	Comment
Relevant Water Stress Indicator (RWSI) = Percent of Total Freshwater Abstracted over the total Renewable Water Availability RWSI = ABS / RWA	RBD	WS&D	**Variable updating.** **DB managed by provinces.** **Data only concerning "annual licensed withdrawal", not measured!**	From Regional Water Protection Plans A systematic data flow from Regional Water Protection Plans to Basin Authority is not enabled.
Water Exploitation Index (WEI) and the WEI+ Total Water Abstraction / Renewable Water Availability	RBD	WS&D	Variable updating. DB managed by provinces. Data only concerning "annual licensed withdrawal", not measured!	From Regional Water Protection Plans A systematic data flow from Regional Water Protection Plans to Basin Authority is not enabled.
Water Use per sector	RBD	Water exploitation	Pubblished in RBMP, Not regurarly upodated at the district scale.	Data collected by ISTAT- National Statistics Insitute, or INEA- National Institute for Agrarian Economy

Po "Water Scarcity & Drought" Indicators

Indicator	Scale	Focus	Data Availability	Comment
Snowpack	Subbasin	Drought monitoring	Since 2000, not immediatly avaliable (to be extracted from DEWS System)	
Ground water level	Local	Water exploitation and subsidence	Not avaliable	Local data availability (Milano province)
Standardized Precipitation Index (SPI)	RBD	Drought monitoring	Avaliable 1,3,6,12,24 months. Long timeserie.	
Streamflow	RBD	Drought monitoring	Avaliable	Based on this indicator, calculation of secondary return period for drought spells (variables: duration and intensity)
Fraction of absorbed Photosynthetically Active Radiation	--	--	no	

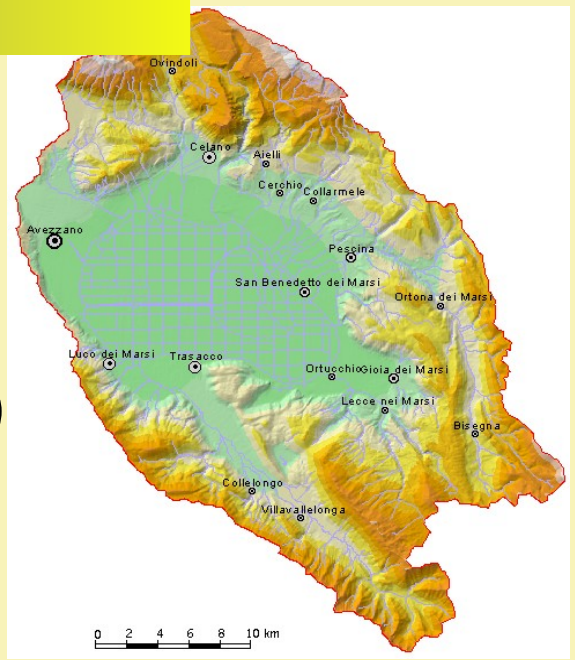
The case of The Liri Garigliano Volturno River Basin

Administrative data:

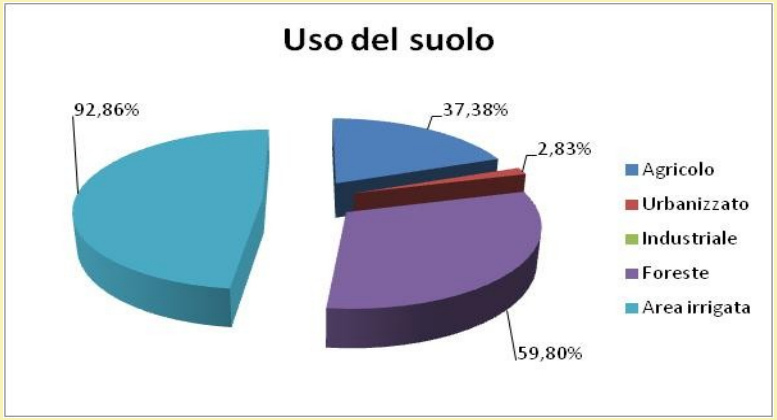
Municipalities located in the Fucino basin (a) and in the Fucino Plain sub-basin (b):

27 comuni (a)	23 comuni (b)
98.732 abitanti (a)	93.304 abitanti (b)
954,1 km² (a)	861,53 km² (b)
1 A.T.O. competente 4 Comunità Montane 1 Consorzio di Bonifica	

FUCINO Basin



Land use:



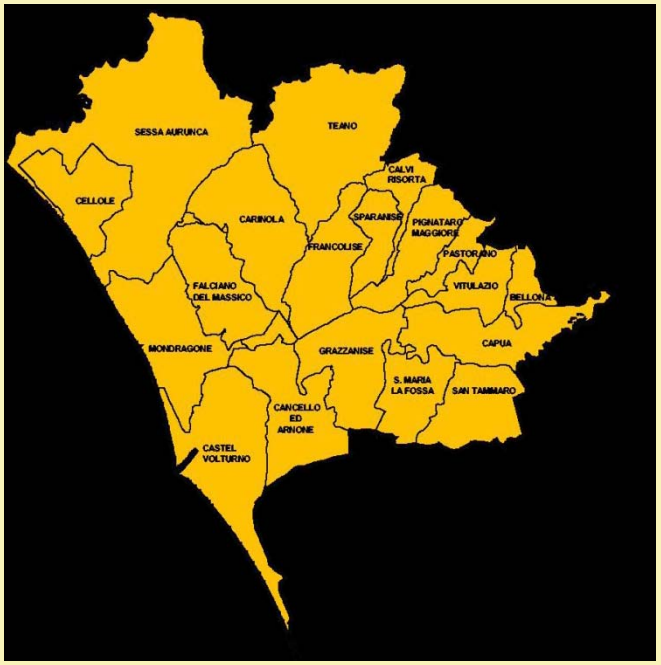
Other data:

Wells	748
Springs:	320
Operating Waste Water Treatment Plants:	19
Waste Water Treatment Plants- under construction:	3
Discharges	78

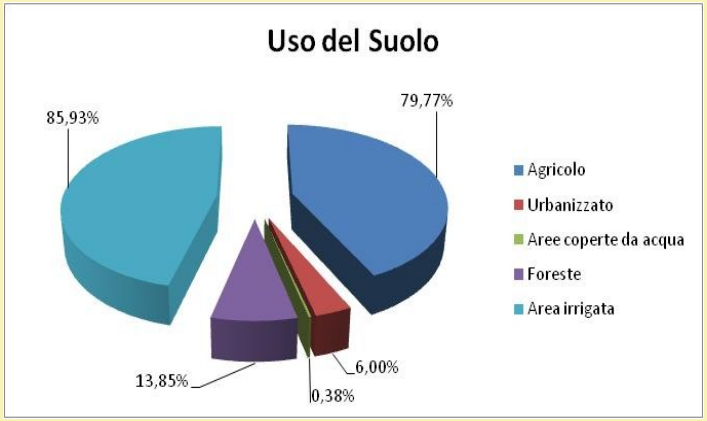
LOWER VOLTURNO BASIN

Administrative data:

Region:	Campania
Province:	Caserta
Basin:	Volturno
Basin Surface:	886 SqKm
Municipalities:	19
Inhabitants since 2005:	180684
Consortium of Municipalities (ATO):	1



Land use:



Other data:

Wells:	1520
Springs:	112
Surface Water Monitoring:	72
Groundwater Monitoring:	56
Waste Water Treatment Plants:	21

Data Availability in LGV Pilot Areas (Lower Volturno Basin, Fucino Basin)

The Volturno River Basin has drafted a water balance plan taking into consideration its whole territory (surface water and groundwater catchments). It includes an estimation of environmental flows (MVF), using an hydrological/environmental methodology and a microhabitats methodology for some relevant river sections.

The Water Balance Plan contains:

1. ***Indentification of water bodies in order to define "control" volume:***
   - ***sub-basin on the basis of their meaningfulness (e.g. river junctions, important control section, relevant contribution from groundwater, ecc.);***
   - ***groundwater bodies, on the basis of their hydrogeological features.***
1. ***Estimation of upstream contribution***
2. ***Estimation of real evapotranspiration volume***
3. ***Estimation of infiltration volume***
4. ***Estimation of natural stream inflow***
5. ***Estimation of usable stream inflow (Minimum Vital Flow-MVF)***
6. ***Estimation of total water demand, related to use***
7. ***Evaluation of water abstraction by source***
8. ***Evaluation of water use by sector***

Data Availability in LGV Pilot Areas (Lower Volturno basin, Fucino basin)

The LGV Basin has availability of the following data:

- water availability
- water abstraction by source
- water use by sector

LGV Basin is also facing some problems regarding data collection:

- Update of hydrological data time series
- Information on water abstractions by source

Socio-economic data (Lower Volturno basin, Fucino basin)

Usually socio-economic data are not collected and analyzed at basin or sub-basin spatial scale.

Population and economic data are available in ISTAT reports.

Other data on:

- land use
- infrastructure
- quality – environment
- responses

should be available at annual scale.

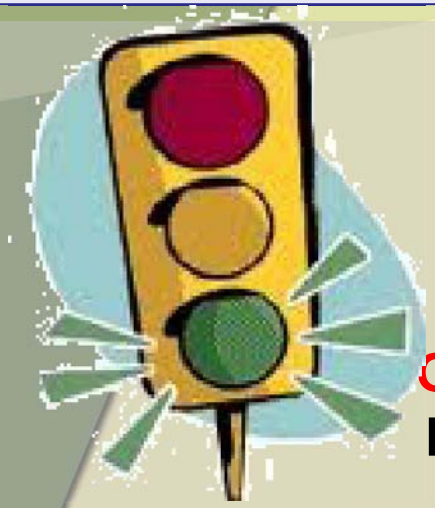
Indicators (Basso Volturno basin, Fucino basin)

Proposed indicator	AdB LGV experience/evaluation:	Criticalities:
Relevant Water Stress Indicator (RWSI) RWSI = ABS / RWA	RWA could be difficult to assess, expecially when it must take into account water exchanges between neighboring groundwater catchments (contribution included in External Inflow). Moreover, available data are not easy to disaggregate at monthly scale. .	The criticalities in RWSI adoption seem to be: • *ABS assessment for groundwater;* • *Temporale scale: monthly scale;* • *Metrics: LTAA.*
Water Exploitation Index (WEI) and WEI+	Main Problems: Actual Inflow Evaluation, in order to estimate the volumes deriving from water exchange between neighboring groundwater bodies; • Assessment of returned water, expecially in order to calculate the volume generated by water losses. Other Parameters are available at yearly scale	The criticalities in WEI+ adoption seem to be: •groundwater; •water losses •Temporale scale: monthly scale •Metrics: LTAA.
Water use per sector	Problems in identifying water uses by sector. These problems are related to past water abstraction licenses due to lack of information. .	The criticalities in Water Use per Sector seem to be: •Data availability for water abstractions licensed in past; •Services sector uses.

Indicators (Basso Volturno basin, Fucino basin)

Proposed indicator	AdB LGV experience/evaluation:	Criticalities:
Snowpack	Data unavailability for snowpack, because of an inadeguate monitoring system. Remote sensing data could be a solution, but don't allow the identification of time series for the previous period of analysis.	The criticalities in Snowpack adoption seem to be: • Data availability, because of no monitoring system ; • In case of remote sensing monitoring, there are no data available to define previous time series.
Groundwater level	LGV Basin experienced the lack of information on groundwater level because of an inadeguate monitoring program/system. Difficulties to define time series.	Groundwater level: • Data availability, because no monitoring system ; • Time series not homogeneous and complete.
Standardized precipitation indez (SPI)	Rainfall data are available at daily and monthly scale, then statistical analysis for SPI calculation can be performed.	The criticalities seem to be: • Improvement of hydrological variables monitoring system.
Streamflow (Q)	Streamflow is a suitable indicator, also considering its easy implementation. .	The criticalities in SPI adoption seem to be: • Q(h) function not updated; • Decrease in the streamflow gauges number.
Fraction of Absorbed Photosynthetically Active Radiation	Indicator could be meaningful, if used jointly with other indicators as SPI. Anyway, it also seems to be influenced by other pressures on vegetation (pests, desease, ecc.).	•Influenced by pressures not related to WS&D. •Need of joint analysis with other index.

"Water Scarcity & Drought" Indicator: Conclusions



Abstractions for the different uses: available for the most relevant uses

Groundwater level: relevant, generally available indicator
Monitoring stations are not located on the whole territory

SPI good data availability,extended time series.
Already in use in some areas

Streamflow data are available for the most relevant sub-basins

All Italian River Basin Authorities have tools to analyse and manage WS&D that allow a good reaction to WS&D issues

"Water Scarcity & Drought" Indicators:Conclusions

WEI and WEI+ The annual basis calculation does not allow the identification of Summer Droughts, Parameters:External Inflow, Returned Water and Water Requirements - are difficult to assess

Groundwater level poor and dishomogenous information in some of the River Basins

In some cases **population data** are not available: Seasonal workers in the tourism sector (which are not permanent residents, nights spent at hotels, etc.

Snowpack difficult to retrieve and not relevant

All Indicators should be referred to Summer Droughts and clustered at an appropiate scale (most relevant sub-basins).Indicators should be compared in order to outline the real situation in a complete and reliable way.

ISPRA ‘s project for the linkage “Osservatori”

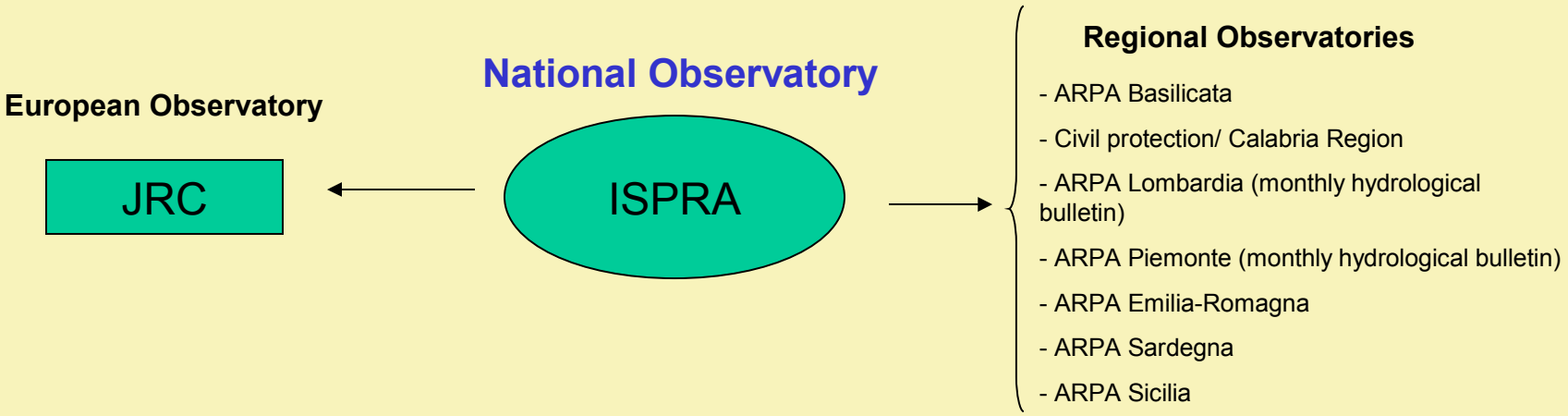
The existing system

Presently it is possible to download from the ISPRA’s webpage images of the monthly bulletin of SPI (calculed for 3, 6, 12 and 24 months) on 4 areas (Italy, Mediterranean basin, EU territorial cooperation area CADSES* and Europe) since December 1989.

This bulletin is updated monthly and calculated on the basis of the precipitation reanalysis of NCEP.

The pages are available in Italian and English.

Also the regional observatories and the European observatory EDO developed by JRC are linked up.



http://www.isprambiente.gov.it/pre_meteo/siccitas/index.html

*Central, Adriatic, Danubian and South- East European Space

ISPRA ‘s project for the linkage “Osservatori”

Designed project

A link enabling easy access to all systems at different level is under construction.

This project will permit the data confrontation and integration and an in-deep analysis in case of WS & D events occurred locally.