SOUTH EAST EUROPE
Jointly for our common future

DMCSEE
Drought Management Centre for Southeastern Europe

Programme co-funded by the EUROPEAN UNION

IMPLEMENTATION OF STANDARDIZED PRECIPITATION INDEX - SPI

Joint report

Environmental Agency of Slovenia

2011

DELIVERABLE SUMMARY	
PROJECT INFORMATION	
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Ending date:	31. 3. 2012
Project WEB site address:	[redacted]
Lead partner organisation:	
Name of representative:	
Project manager:	
E-mail:	
Telephone number:	
DELIVERABLE INFORMATION	
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Type (internal or restricted or public):	Internal (draft)
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WP leader:	OMSZ
Activity leader:	EARS
Participating partner(s):	OMSZ, VITUKI, NIMH, AUA, GEORAMA, DHMZ, RHMSS, HI-M, HMS, INEUM
Author:	[redacted]
E-mail:	
Telephone number:	
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Contractual date of delivery to the JTS:	31. 5. 2010
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Introduction

Standardised precipitation index (SPI) has become one of most frequently used tools for drought monitoring throughout the world. Although developed quite recently (McKee has published his first article in 1993 with description of SPI calculation), it has nowadays most wide-spread use in practical drought monitoring. This was one of main reasons to include implementation of the SPI index in DMCSEE project.

SPI is based on statistical techniques, which can quantify the degree of wetness or dryness on multiple time scales. Appropriate time scale should be selected according to typical temporal duration of dry anomaly which causes impacts to society and economy (in short – drought). This scale differs substantially among regions. Usually one, three, six, 12 or even (sometimes) 24-monthly rainfall totals are taken into account and compared to the climatological rainfall records.

Since SPI depends only on precipitation amount, interpretation (mainly connected to its relation to drought impacts) has to be careful. On the first place, SPI requires different interpretations according to its time scale. For example, the 1-month SPI reflects mainly short-term conditions, and its application can be related closely to soil moisture. It can be potentially related to drought stress in certain development stages of crops. The 3-month SPI provides a seasonal estimation of precipitation, typically related to overall crop yield and streamflow conditions of small rivers. The 6- and 9-month SPI indicates medium term trends in precipitation patterns; and the 12-month SPI reflects the long-term precipitation patterns, usually tied to larger stream flows, reservoir levels, and even groundwater levels. Another advantage of the implementation of SPI comes from its standardization, which ensures that the frequency of extreme drought events at any location and any time scale are consistent. A drought event occurs at any time the SPI is continuously negative and reaches an intensity of -1.0 or less. The event ends when the SPI becomes positive. Each drought event, therefore, has a duration defined by its beginning and end and intensity for each month that the event continues. Table 1 represents SPI values and drought classification (according to cumulative probability).

Table 1: Drought classification by SPI value and corresponding event probabilities

SPI value	Classification	Cumulative probability (%)
2.00 or more	Extremely wet	2.3
1.50 do 1.99	Very wet	0.4
1.00 do 1.49	Moderately wet	9.2
0 do 0.99	Mildly wet	34.1
0 do -0.99	Mild drought	34.1
-1 do -1.49	Moderate drought	9.2
-1.50 do -1.99	Severe drought	4.4
-2.00 or less	Extreme drought	2.3

One of the problems might be inconsistent conclusions obtained due to different time lengths of precipitation record are involved in the SPI calculation. The longer the length of record used in the SPI calculation, the more reliable the SPI values will be, especially for long-time-scale SPI values. The use of robust data is desirable in the analysis of the climatic responses of hydrologic processes because of disparities in station records including inhomogeneity and inconsistency of observations in space and time. In order to minimize possible problems with inconsistency, **calibration period as well as basic data treatment has to be standardized.**

Description of data

Meteorological network

Meteorological networks, types of observations and data availability are most important factor of drought monitoring. There are large differences in type and availability of data in the DMCSEE partnership – both due to nature of partner institutions (some are operating national meteorological networks, other have limited access to national data) and due to situation within national meteorological offices in the countries (in some cases there were serious reductions of network and /or automatization of measurements, there are also cases where data is not available in digital form).

In all countries there are some basic types of stations which can be Observers on precipitation stations, among other meteorological parameters defined by standard observation programme, measure precipitation once a day. Meteorological diary is sent monthly to RHMSS. Actual data availability delay in practice is at least one to two months. Data arrive in form of written document and they are not ready for instant use. At this moment, a number of active precipitation stations is about 500.

Observers on climatological stations follow the same program regarding the precipitation as their colleagues on precipitation stations, but proceed with additional measurements according to standard programme for this type of station. Considering possible operative use of these data, the situation is quite similar to this which is described above regarding precipitation stations. Climatological station observation programme is currently carried out on 99 locations.

Synoptic stations mainly involve the same procedure as classical climatological stations (some airport meteorological stations are exceptions), but observers do the measuring more frequently during the day. All synoptic stations in Serbia are now in the regime of hourly measuring and hourly reporting via SYNOP bulletins and GTS in real time. Data received via bulletins from 32 synoptic stations are used for operative activities in the field of agricultural meteorology within RHMSS, including monitoring of moisture conditions (See Table on the page 6). Collected data are daily processed, there is no delay.

By the end of 2009, RHMSS completed the network of automatic meteorological stations (AMS). All automatic stations are situated on the locations – meteorological stations under the authority of the Service and with professional employees. Measuring program on these 28 AMSs cover wind speed and direction, air temperature and humidity, precipitation, air pressure, air temperature on 5 cm above the soil, global radiation and soil temperature in the depths of 5, 10, 20, 50 and 100cm. All data from these stations are near-real time available. However, operation of these stations is still in the testing phase – adjustments are carried out, as well as comparative analyses of these data with data obtained by classical measuring on the same locations.

Data records

Near–real–time data

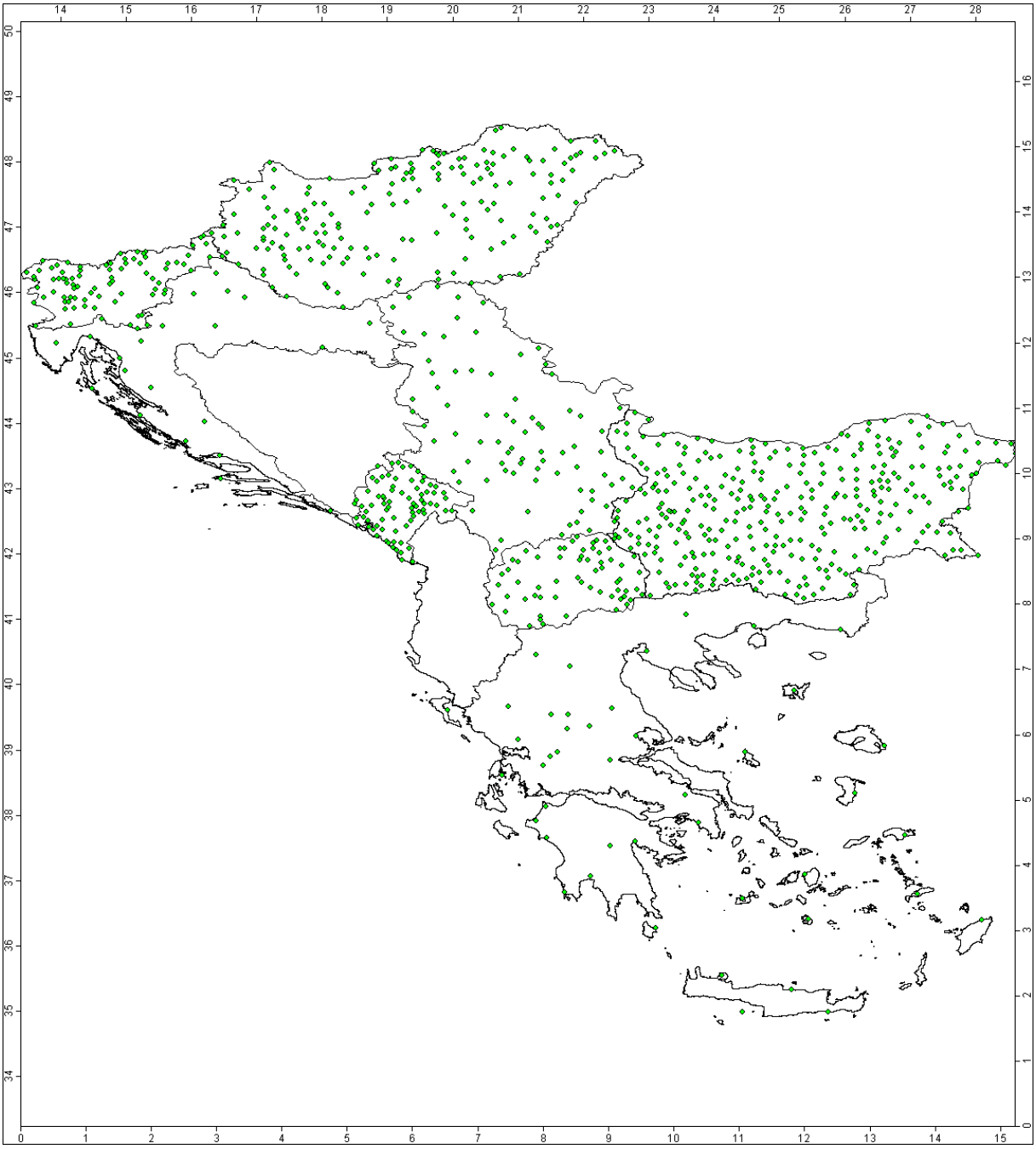
Operative SPI calculations are performed on the basis of daily precipitation data regularly submitted from 29 synoptic stations and statistical parameters derived from historical precipitation data. Complete data for the period 1961-2005 exist for the twenty five stations. For the purpose of statistical parameters calculation, previous interpolation of missing data was carried out in case of three of remaining stations. Regional climate model *(Regionalen Klimamodells* on the basis of *FITNAH*) was used.

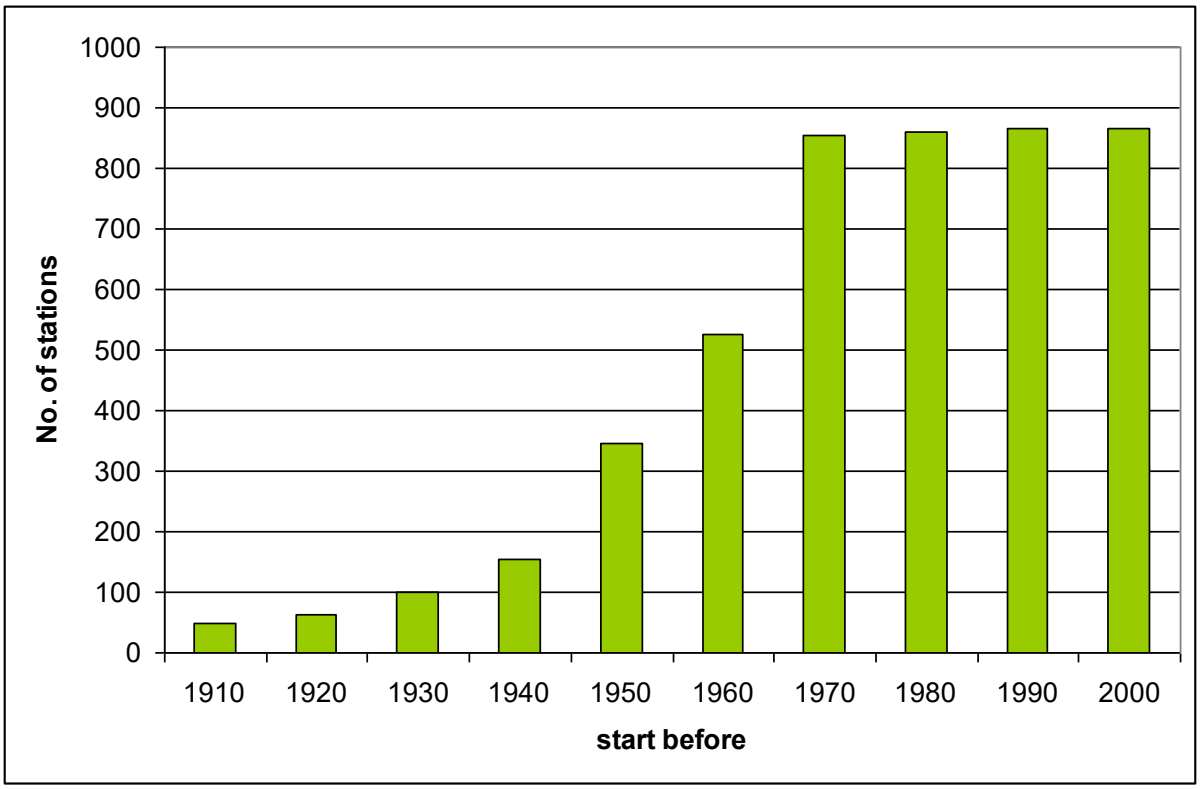
In case of the station Kopaonik (1710m), only all available original data were used-without interpolation. In practice, SPI values obtained for these four stations without complete series of original data are accepted as approximative. They are considered in spatial analyses, but they are not presented individually.

Classical data

Besides the mentioned stations where Synop reporting exists, there are another 39 climatological stations with data record for the period 1961-2000 and additional 5 for the period 1971-2000. Lists of these stations are given in Tables on the pages 7 and 8.

Among around 500 precipitation stations that are operational today, around 400 stations were functioning during the period 1961-2000, and additional near twenty stations were functioning in the period 1971-2000. The lists of these stations are not attached to this document because of several reasons. The number of these stations is considerable and it is necessary to previously carry out more detailed checking of the real availability of historical data on precipitation from these stations. Also, it is assessed that the expectation that current data from these stations could be included in operative calculation of SPI in nearest future is not real. Unfortunately, actual data availability delay in practice is too big at this moment.


14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



Albania

Contact address in Albania: [redacted]

Data from climatological and precipitation stations arrives to the data base with one month delay and is entered manually from paper forms. However, there are **63 climatological and precipitation station with data records starting from 1951** .

Former Yugoslav republic of Macedonia

Contact: [redacted]

Data from regular and precipitation stations arrive to the database with one month delay and are entered manually from paper forms.

There are **12 main meteorological stations, 5 regular and 43 precipitation stations with data records for the period 1961-2009** appropriate for calculation of SPI. All data are available in the monthly records. Main problems are mising and not digitalized data

Greece

Contact: [redacted]

46 meteorological stations are available for SPI calculation. They are automatic and equiped with specialized and experienced personnel. Until 2001 three measurements had been taken, namely at 6:00, 12:00 and 18:00 UTC. These measurements were summed in order to calculate the daily precipitation. After 2001 the observers record measurements every three hours starting from 6:00 UTC (6:00, 9:00, 12:00, 15:00, 18:00, 21:00, 24:00, 3:00 UTC) and the sum of these measurements gives the daily precipitation. All stations transmit synoptic messages over the Global Telecommunication System (GTS) of the WMO. The observers have also to fill in a form on paper with all the measurements and send it monthly to the Meteorological Office.

There are **26** station with records starting in 1961 or earlier and **38** stations starting in 1971 or earlier

Hungary

Contact: [redacted]

The meteorological observing system is equipped with both automatic weather stations (AWSs) and human observers. Number of synoptic station is 29 recently, 14 from them have manual observations as well. Number of QLC stations with limited measuring program is 59 and there are 9 traditional climate stations with volunteers, report twice a month via mail.

Traditional climatic stations and rainfall measure stations are the parts of the station network. Observers on traditional climatic stations send data to the centre in mail where couple of colleagues control and input these data into the INDA system. Number of traditional climate stations decreases significantly because of the automatization. Number of precipitation gauges is more than 500 but their automatization is also planned in the future.

There are together **177** stations with data available from 1951

Serbia

Contact: [redacted]

Complete data since 1961 exist for the 25 synoptic stations. For the purpose of statistical parameters calculation, previous interpolation of missing data was carried out in case of three of remaining stations.

There are another 39 climatological stations with data record for the period 1961-2000 and additional 5 for the period 1971-2000. Among around 500 precipitation stations that are operational today, around 400 stations were functioning during the period 1961-2000, and additional near twenty stations were functioning in the period 1971-2000.

Slovenia

Contact: [redacted]

Professional observers on 13 synoptic stations are sending data daily. However, for SPI calculations it is critical to have long time series. For period 1961–2000 we have data only from 3 stations.

There are 63 precipitation and 2 climatological stations with data available since 1961 and additionally 10 precipitation and 3 climatological stations with data since 1971.

There are **32** automatic stations with classical precipitation record in vicinity for time period at least 1971-2000.

SPI software

The Standardised Precipitation Index (SPI) is widely used for defining and monitoring meteorological droughts. Since its appearance (McKee et al. 1993), it has been extensively used in America (Hayes et al. 1999), Asia (Min et al. 2003), Africa (Rouault and Richard 2003; Ntale and Gan 2003) and Europe (Lloyd-Hughes and Saunders 2002; Domonkos 2003; Bonaccorso et al. 2003; Paulo et al. 2003; Tsakiris and Vangelis 2004; Paulo and Pereira 2007).

Version of SPI software was developed by EARS and presented to project partners. The software works on daily, weekly or monthly time scale.

SPI calculations

Albania

About the SPI index in Lezha (costal station Albania)

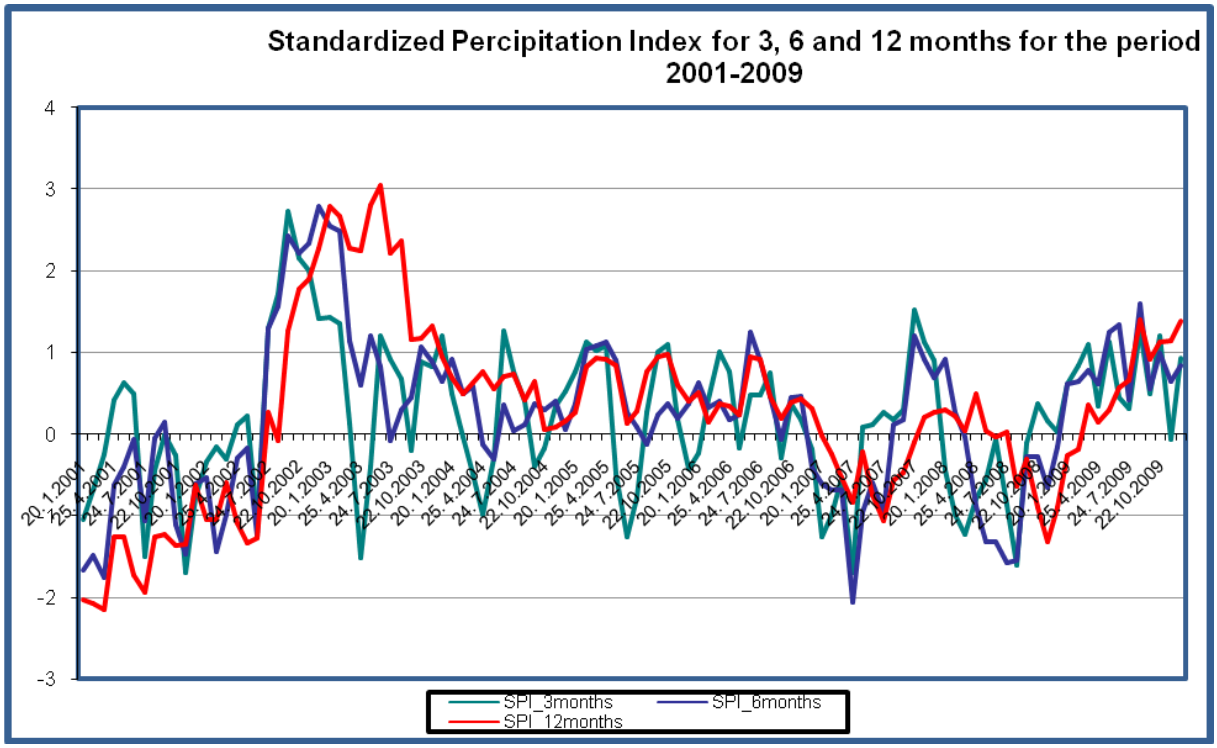
To calculate the SPI index the precipitation monthly series (1951- 2008) is used. The SPI values for one-month (**SPI**1) are tabulated in the table below based on the drought classification by SPI value.

In this table the conclusion of one-month spi calculation is given.

Classification	Extremely wet	Very wet	Moderate wet	Near normal	Moderate dry	Severe dry	Extremely dry
SPI value	>+2	**1.99 -1.5**	**1 - 1.49**	**0.99 - 0.99**	**-1 -1.49**	**-1.5 - 1.99**	**<-2**
%	2.3	3.9	10.5	67.5	7.5	5.2	2.7

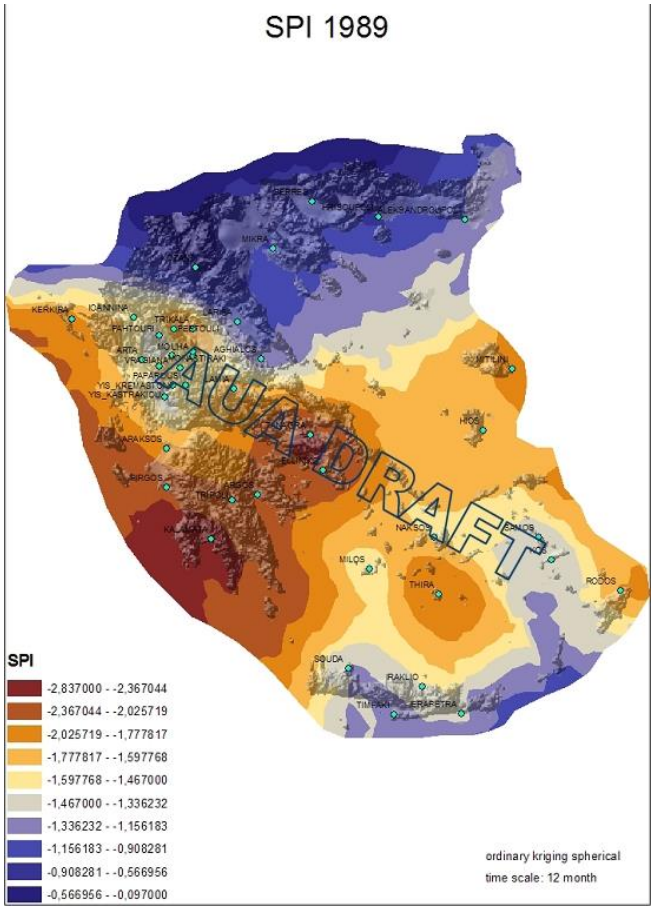
Former Yugoslav republic of Macedonia

Number of stations were used and software provided by EARS was implemented to prepare sample SPI output**.** Figure below shows time series for station Strumica.



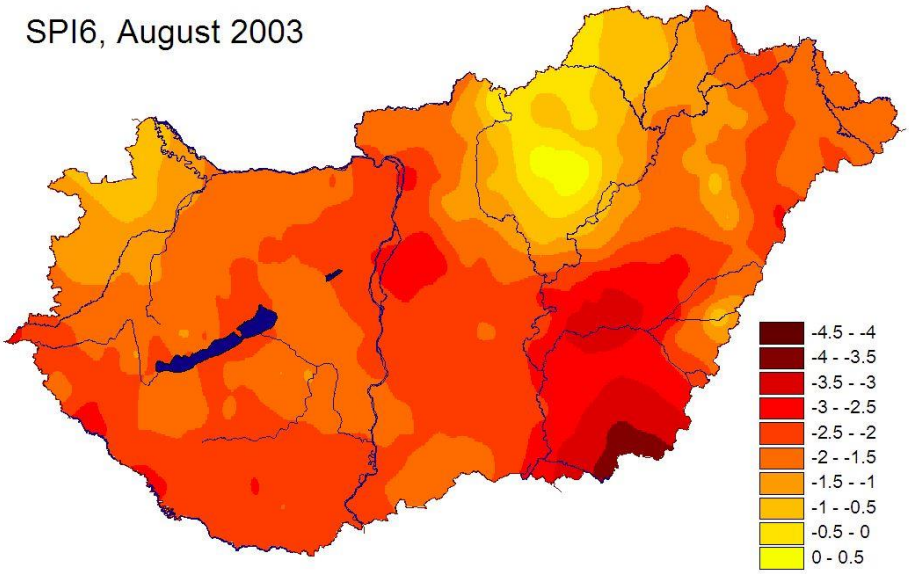
Greece

This is a sample of the SPI 12 index in Greece for the year 1989 were the most extreme drought had been taken place. Software provided by EASR was used.



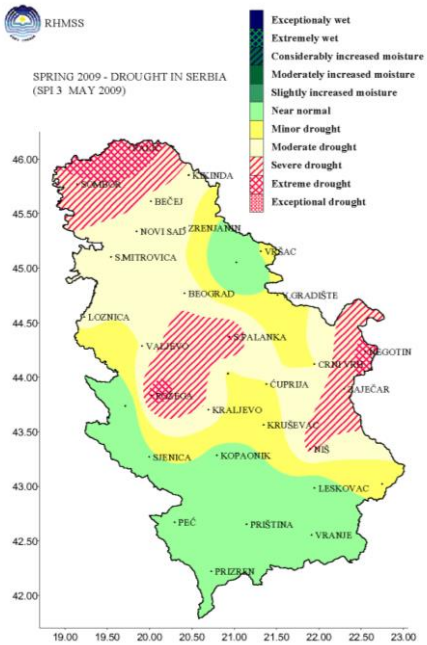
Hungary

The SPI calculator which is offered on the project web page was applied for SPI calculations in Hungary. Mapping performed in MISH Output: Digital map (in lat/lon regular grid) in Arc ASCII format.



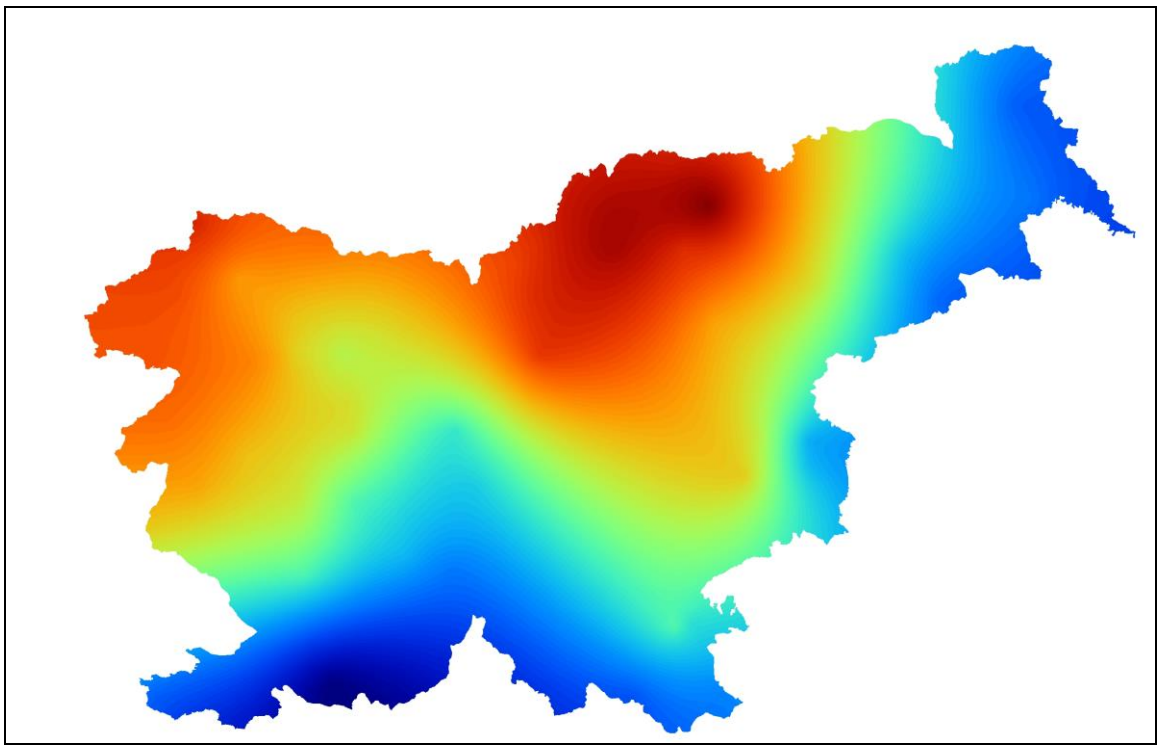
Serbia

Operative SPI calculation in RHMSS is performed by Microsoft Excel sheets and functions. After already mentioned adaptations, full harmonization was achieved with the methodology proposed by EARS within the DMCSEE. An example of comparision of SPI values shows that the differencies betwen calculated values are negligible.



Slovenia

SPI software is entered into SAGA Gis system in order to obtain georeferenced maps.



Result: Map for SPI3 (30.9.2006)

Annex I. Details on available data records

Albania

Meteorological network

Observers on precipitation stations measure precipitation only once a day at 7:00 am. They also measure depth of snow cover and depth of fresh snow and take notes of weather phenomena. All the observers have to fill in a form on paper– a meteorological diary which is sent monthly to Meteorological office. Data is then available with one month delay.

Observers on climatological stations measure precipitation once a day at 7:00 am – regarding precipitation, they follow same program as their colleagues on precipitation stations. In addition to precipitation, they measure temperature and relative humidity three times daily (at 7:00, 14:00 and 21:00 in CET) and note cloudiness amount, visibility, condition of the soil and wind. They also measure daily minimum and maximum temperature. All observers have to fill in a form on paper and send it monthly to the Meteorological Office.

There are only 5 automatic stations, installed near the old one, but they are not really in the good way to use. A real time communication will enable the on-line transmission of the observed information at the central station located at the INEUM.

List of classical stations starting from 1951

Climatic stations

Idmm	name	Start-up
3	Burrel	1951
4	Corovode	1951
5	Cuke	1973
7	Durres- Port	1951
51	Elbasan	1951
9	Erseke	1951
10	Fier	1951
71	Himare	1951
17	Klenje	1957
96	Korçe	1951
21	Kukes A	1951
123	Lezhe	1951
26	Peshkopi	1951
27	Permet	1951
30	Puke	1951
34	Reshen	1971
39	Shkoder A	1951
41	Tirane A	1951

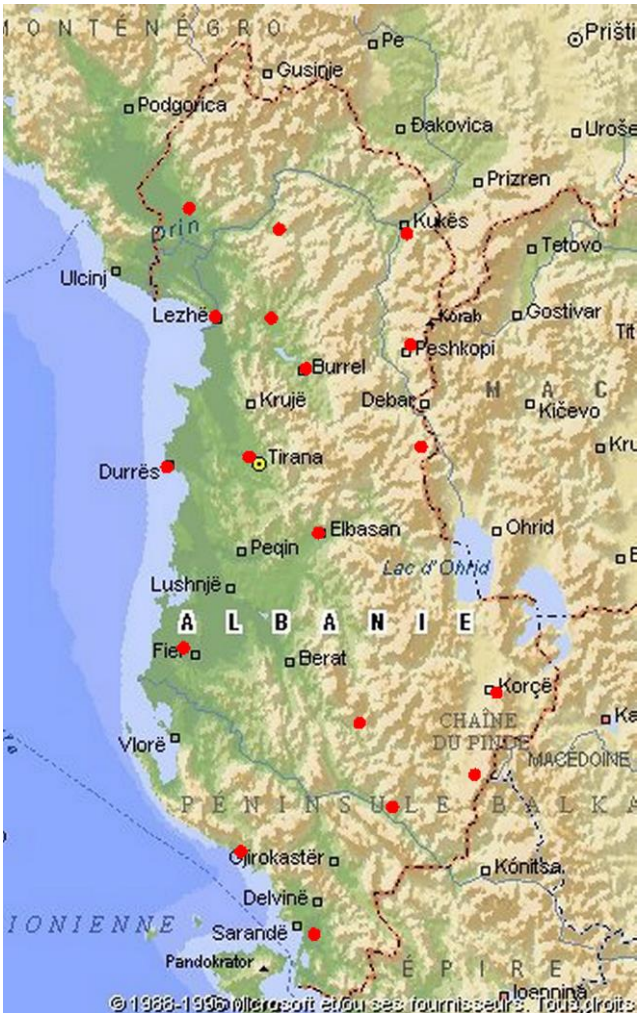
Thermometric stations

Idmm	name	Start-up

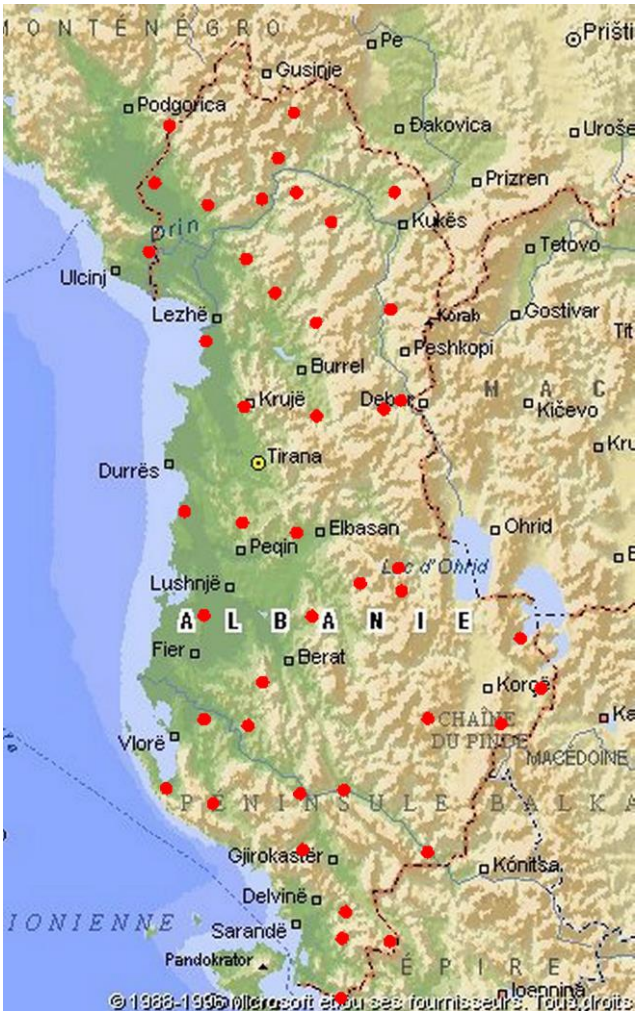
9	Bilisht	1951
10	Bishnice	1960
15	Brataj	1951
22	Cerkovice	1951
9	Carshove	1971
11	Dajc- Bune	1954
32	Dajt	1951
34	Dardhe	1951
39	Dragobi	1951
12	Dushman	1951
14	Fratar	1951
55	Fshat-Klos	1951
62	Gorre	1951
19	Jaroniksht	1951
74	Iballe	1951
25	Kardhiq	1951
85	Kavaje	1951
86	Kelcyre	1951
92	Konispol	1951
93	Koplik	1951
96	Korthpule	1951
100	Kruje	1951
101	Krume	1951
107	Kurbnesh	1951
109	Lajthize	1971
112	Lekbibaj	1974
122	Liqenas	1951
128	Llongo	1961
138	Muzine	1971

143	Orikum	1951
157	Prrenjas	1951
170	Rapsh	1971
178	Selenice	1956
182	Sinje	1951
56	Simon	1951
186	Srtavaj	1951
197	Shtylle	1969
198	Shupenze	1951
199	Tepelene	1951
211	Ura e Shtrnjte	1951
217	Vrap	1951
220	Ylli kuq (Shenkoll)	1951
222	Zalli Kalise	1951
69	Zerqan	1951
186	Srtavaj	1951

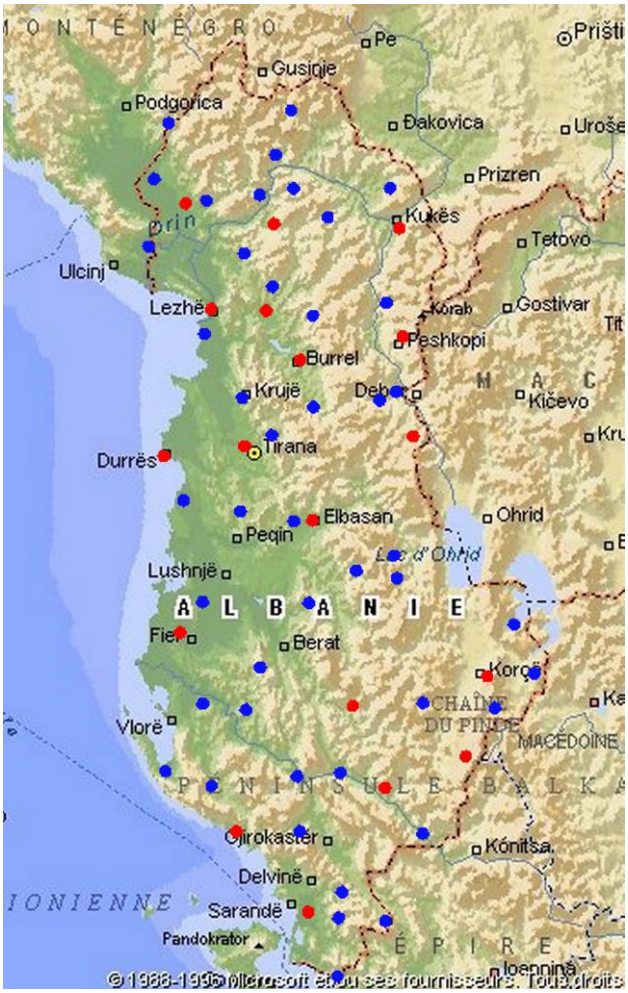
2. Map of climatic stations starting up almost from 1951



3. Map of thermometrical stations starting up almost from 1951


MONTÉNÉGRO
Pe
Priš
Gusinje
Podgorica
Đakovica
Uroše
Prizren
Kukës
Drin
Tetovo
Ulcinj
Lezhë
Korab
Gostivar
Peshkopi
Burrel
Krujë
Debar
Kičevo
Tirana
Durrës
Elbasan
Ohrid
Peqin
Lac d'Ohrid
Lushnjë
ALBANIE
Fier
Berat
Korçë
CHAÎNE DU PINDE
MACÉDOINE
Vlorë
PÉNINSULE BALKA
Gjirokastër
Kónitsa
Delvinë
IONIENNE
Sarandë
Pandokrator
ÉPIRE
Ioannina

4. Map of all classical stations recording precipitation starting almost from 1951



Former Yugoslav republic of Macedonia

Meteorological network

Macedonian meteorological network covers an area of over 25713 km^2. Our climate regime is quite complex and demands optimal conditions of a meteorological network density. The meteorological data are measured at stations of different types: automatic stations, main meteorological stations with professional staff, regular (climatological) stations and precipitation stations with volunteers observers.

Observers on **precipitation stations** measure precipitation only once a day at 7:00 a.m. They also measure depth of snow cover and depth of new snow and take notes of weather phenomena. All the

observers have to write data in a paper form – which is sent monthly to the Meteorological Service. Then data are available by one month delay.

Observers on **regular stations** measure precipitation once a day at 7:00 a.m. Beside depth of snow cover and new one, they measure temperature (daily minimum and maximum) and relative humidity three times daily (at 7:00, 14:00 and 21:00 in CET) and note cloudiness amount, visibility, condition of the soil and wind speed and direction. Some stations also send SYNOP bulletins in real time . All observers have to write data in a paper form and send it monthly to the Meteorological Service.

Main meteorological stations. Sixteen main stations, including 2 airports (24 obs/day), 6 meteorological hail suppression stations 24 obs/day, involve the same procedure as regular (climatological) stations and observers take measures more frequently during the day. They prepare SYNOP bulletins and send them to the GTS in real time. All data are available daily, there is no delay.

Automatic stations. At present there are 6 automatic stations in Macedonia, 2 of them are on the Airports. They measure precipitation, temperature, wind and humidity at least. Some automatic stations have additional sensors (for measurements of global radiation and pressure). Main advantage of automatic stations is availability of measurements in real time and time frequency of measurements (every ten minutes data are obtained).

Two automatic stations send data in real time, but from others we take data by computer. All data from automatic weather stations are archived in separate data base.

Data records

Near–real–time data

Professional observers from 14 main stations and 6 meteorological hail suppression stations send data daily, using common data control. Getting the meteorological monthly book we make critical and logical data control which takes one month. For calculation daily SPI we have to compute some years to obtain daily long time data series from those stations (period 1981-1988) .

If we solve this problem we could calculate daily SPI in the future, but this refers only to main stations and not to regular and precipitation stations.

However, we have not a problem with length of data record, our main problems are: data missing, not-computed data and impossibility of using data from automatic weather stations , because of very short period of their establishment.

Classical data

Data from regular and precipitation stations arrive to the database with one month delay and are entered manually from paper forms. However, we select 12 main meteorological stations, 5 regular and 43 precipitation stations with data records for the period 1961-2009 for calculation of monthly SPI index. All data are available in the monthly records.

meteorological stations with precipitation records for calculations of SPI for 1961-2009

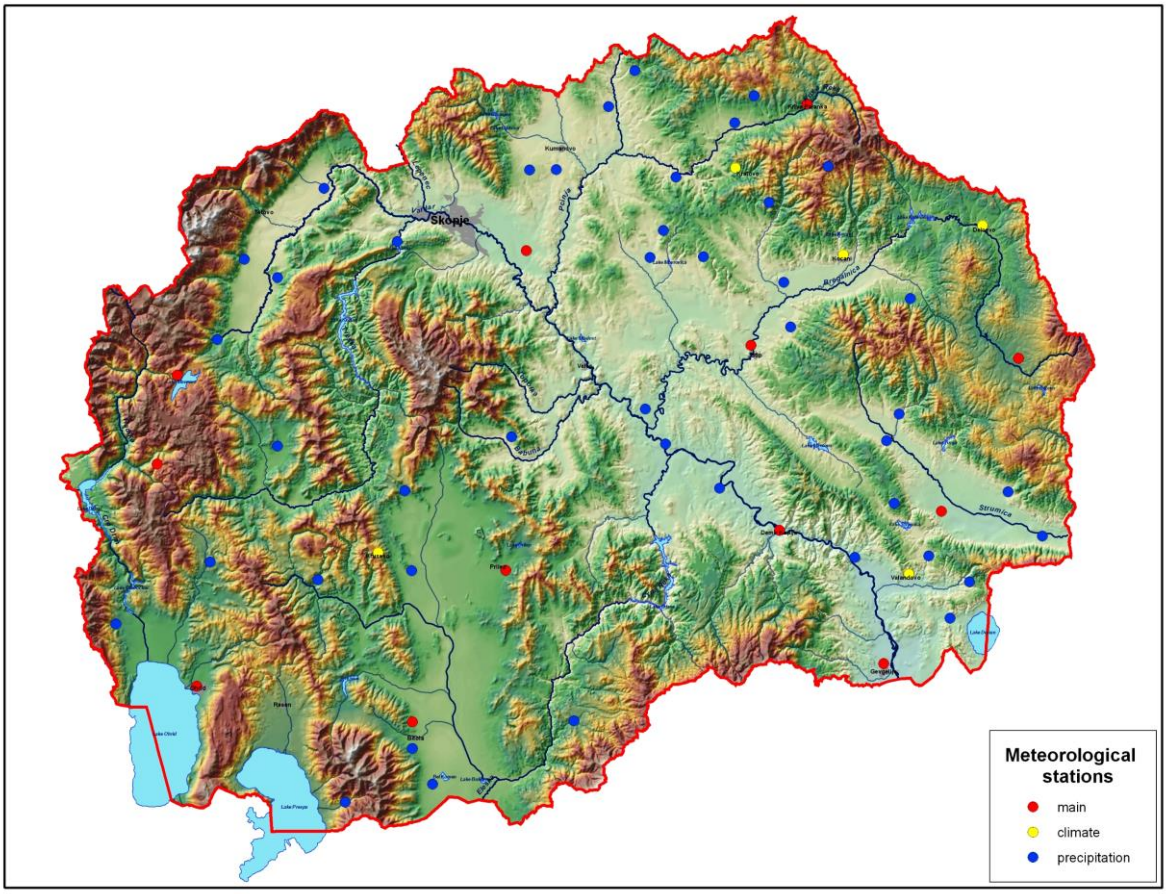
Main stations						
No.	**Station no.**	**Name of station**	Ny	ϕ	λ	**Start-up**
1	597	Gevgelija	57	41°09'	22°30'	1951
2	592	Demir Kapija	126	41°25'	22°15'	1946
3	595	Strumica	224	41°26'	22°39'	1950
4	586	Skopje- Petrovec	232	41°57'	21°38'	1942
5	591	Shtip	326	41°45'	22°11'	1948
6	583	Bitola	586	41°03'	21°20'	1942
Main stations						
No.	**Station no.**	**Name of station**	Ny	ϕ	λ	**Start-up**
7	585	Prilep	673	41°20'	21°34'	1950
8	493	Kriva Palanka	691	42°12'	22°20'	1946
9	578	Ohrid	760	41°07'	20°48'	1946
10	598	Berovo	824	41°43'	22°51'	1949
11	576	Mavrovi Anovi	1240	41°42'	20°45'	1952
12	577	Lazaropole	1332	41°32'	20°42'	1948
Climate stations						
No.	**Station no.**	**Name of station**	Ny	ϕ	λ	**Start-up**
1	953	Valandovo	100	41°19'	22°34'	1952
2	902	Kochani	345	41°55'	22°25'	1951

3	904	Delchevo	630	41°58'	22°46'	1953
4	970	Kratovo	640	42°05'	22°09'	1954
5	582	Krushevo	1230	41°22'	21°15'	1952
Precipitation stations						
No.	**Station no.**	**Name of station**	Ny	ϕ	λ	**Start-up**
1	43	Udovo	75	41° 21'	22° 26'	1945
2	255	Negotino	150	41° 29'	22° 06'	1945
3	154	Nogaevci	160	41° 38'	21° 55'	1947
4	37	Gradsko	164	41° 34'	21° 58'	1945
5	281	Crnichani	200	41° 14'	22° 40'	1947
6	270	Ilovica	290	41° 28'	22° 49'	1948
7	117	Matka	298	41° 57'	21° 18'	1940
8	168	Ularci	300	41° 52'	22° 16'	1947
9	194	Podaresh	320	41° 37'	22° 33'	1947
10	144	Mezdra	345	41° 55'	21° 56'	1952
11	155	Teovo	380	41° 35'	21° 35'	1951
12	274	Smolari	380	41°23'	22° 54'	1946
13	170	Radanje	380	41° 47'	22° 17'	1955
14	195	Kalugjerica	390	41° 34'	22° 31'	1951
15	61	Jancishte	395	42° 03'	21° 07'	1951
16	3	Romanovci	400	42° 05'	21° 42'	1949
17	275	Kosturino	435	41° 21'	22° 37'	1946
18	74	Staro Nagorichani	440	42° 12'	21° 50'	1955
19	143	Dolno Gjugjanci	440	41° 58'	21° 58'	1951
Precipitation stations						
No.	**Station**	**Name of station**	Ny	ϕ	λ	**Start-**

	no.					up
20	277	Organdzali	440	41° 18'	22° 43'	1947
21	81	Shopsko Rudare	460	42° 04'	22° 00'	1954
22	88	Ginovci	470	42° 10'	22° 09'	1948
23	160	Mechkuevci	470	41° 55'	22° 04'	1945
24	78	Umin dol	505	42° 05'	21°38'	1949
25	56	Pirok	525	41° 55'	20° 55'	1947
26	112	Stenche	550	41° 53'	21°00 '	1951
Precipitation stations						
No.	**Station no.**	**Name of station**	Ny	ϕ	λ	**Start-up**
27	267	Rich	580	41° 27'	22° 32'	1946
28	289	Porodin	596	40° 56'	21° 23'	1948
29	68	Zegljane	600	42° 16'	21°54'	1952
30	225	Krivogashtani	608	41° 20'	21° 20'	1948
31	219	Debreshte	650	41° 29'	21° 19'	1948
32	111	Oslomej	683	41° 34'	21° 00'	1948
33	100	Vrutok	691	41° 46'	20° 51'	1953
34	222	Dolenci	700	41° 19'	21° 06'	1946
35	188	Blatec	700	41°50'	22° 35'	1948
36	87	Petralica	720	42° 13'	22° 12'	1948
37	254	Budimirci	740	41° 03'	21° 44'	1947
38	204	Izvor-Kichevski	760	41° 21'	20° 50'	1952
39	286	Bukovo	790	41°00'	21° 20'	1947
40	94	Lesnovo	890	42° 01'	22° 14'	1948
41	10	Sasa	920	42° 05'	22° 23'	1948
42	12	Vevchani	975	41° 14'	20°36'	1947

43	285	Brajchino	1020	40° 54'	21° 10'	1951

Map of Meteorological Stations



Greece

The data are measured in various type of stations, ranging from fully automatic stations to manned automatic stations. Data are provided from the National Meteorological Service, , from the Public Power Corporation S.A. and from the Ministry of Public Works. For the SPI implementation measurements have been used from 46 stations, which are listed in the pertinent tables and presented in the corresponding maps. In the longest time series available precipitation record appears from 1947-2009 at Alexandroupoli and Heraklion meteorological stations . Only 4 stations have provided us data starting after 1980 (Argos, Kastoria, Kos and Chrysoupolis). This is quite an advantage, since the SPI calculation requires long time series on record.

All the 46 meteorological stations that have been used for SPI calculation are automatic with specialized and experienced personnel in data recording. Until 2001 three measurements had been taken, namely at 6:00, 12:00 and 18:00 UTC. These measurements were summed in order to calculate the daily precipitation. After 2001 the observers record measurements every three hours starting from 6:00 UTC (6:00, 9:00, 12:00, 15:00, 18:00, 21:00, 24:00, 3:00 UTC) and the sum of these measurements gives the daily precipitation. All stations transmit synoptic messages over the Global Telecommunication System (GTS) of the WMO. The observers have also to fill in a form on paper with all the measurements and send it monthly to the Meteorological Office.

Greece – list of available stations

ID	Station	Latitude	Longitude	Altitude (m)	Type	Timeseries	Measured elements
1	Alexandroupoli	40 51'	25 56'	3	Automatic-manned	1947-2009	Temp-Precip
2	Heraklion	35 20'	25 11'	39	Automatic-manned	1947-2009	Temp-Precip
3	Pyrgos	37 40'	21 26'	12	Automatic-manned	1948-2009	Temp-Precip
4	Elliniko	37 54'	23 45'	15	automatic-digital	1948-2009	Temp-Precip
5	Araxos	38 08'	21 25'	12	Automatic-manned	1949-2009	Temp-Precip
6	Kerkyra	39 37'	19 55'	4	Automatic-manned	1949-2009	Temp-Precip
7	Larissa	39 39'	22 26'	74	automatic-digital	1949-2009	Temp-Precip
8	Ioannina	39 40'	20 51'	484	Automatic-manned	1950-2009	Temp-Precip
9	Milos	36 44'	24 26'	165	Automatic-manned	1950-2009	Temp-Precip
10	Trikala	39 33'	21 46'	110	Automatic-manned	1952-2009	Temp-Precip
11	Kozani	40 17'	21 47'	626	Automatic-manned	1955-2009	Temp-Precip
12	Lesvos	39 04'	26 36'	5	Automatic-manned	1955-2009	Temp-Precip
13	Naxos	37 06'	25 23'	10	Automatic-manned	1955-2009	Temp-Precip
14	Rodos	36 24'	28 05'	12	Automatic-manned	1955-2009	Temp-Precip
15	Agchialos	39 13'	22 48'	15	Automatic-manned	1956-2009	Temp-Precip

16	Lamia	38 51'	22 24'	17	Automatic-manned	1956-2009	Temp-Precip
17	Serres	41 05'	23 34'	34,5	Automatic-manned	1957-2009	Temp-Precip
18	Tympaki	35	24 26'	7	Automatic-manned	1959-2009	Temp-Precip
19	Chania	35 33'	24 07'	152	Automatic-manned	1959-2009	Temp-Precip
20	Monastiraki			390,2	Automatic-manned	1960-2009	Temp-Precip
21	Tanagra	38 19'	23 33'	140	Automatic-manned	1960-2009	Temp-Precip
22	A.Fragista	38 57' 45''	21 36' 26''	725,3	Automatic-manned	1960-2009	Temp-Precip
23	Ardanovo			357	Automatic-manned	1960-2009	Temp-Precip
24	Thessaloniki	40 31'	22 58'	5	Automatic-manned	1960-2009	Temp-Precip
25	Plastira	39 19' 15''	21 45' 47''	801,2	Automatic-manned	1961-2009	Temp-Precip
26	Santorini	36 25'	25 26'	34	Automatic-manned	1961-2009	Temp-Precip
27	Tavropos	39 20' 53''	22 05' 57''	793,8	Automatic-manned	1963-2009	Temp-Precip
28	Kastraki	38 46' 11''	2123' 31''	74,8	Automatic-manned	1964-2009	Temp-Precip
29	Kremasta	38 53' 36''	21 29' 47''	801,2	Automatic-manned	1964-2009	Temp-Precip
30	Pertouli	39 32'	21 30' 53''	801,8	Automatic-manned	1964-2009	Temp-Precip
31	Ierapetra	35	25 44'	10	Automatic-manned	1964-2009	Temp-Precip
32	Kythira	36 16' 48''	23 6'	321	Automatic-manned	1964-2009	Temp-Precip
33	Andravida	37 54' 36''	21 16' 48''	10	Automatic-manned	1967-2009	Temp-Precip
34	Methoni	36 49' 48	21 42'	34	Automatic-manned	1967-2009	Temp-Precip
35	Tripoli	37 32'	22 24'	652	Automatic-manned	1967-2009	Temp-Precip
36	Lymnos	39 54' 36''	25 13' 48''	5	Automatic-manned	1968-2009	Temp-Precip
37	Skyros	38 57' 36''	24 28' 48''	28	Automatic-manned	1970-2009	Temp-Precip
38	Kalamata	37 04'	22 06'	11	Automatic-manned	1971-2009	Temp-Precip
39	Aktion	38 36' 36''	20 45' 36''	4	Automatic-manned	1973-2009	Temp-Precip
40	Chios	38 21'	26 09'	4	Automatic-manned	1974-2009	Temp-Precip

41	Arta	39 10'	21	10,5	Automatic-manned	1976-2009	Temp-Precip
42	Samos	37 42'	26 55'	7	Automatic-manned	1978-2009	Temp-Precip
43	Argos	37 36'	22 47'	11	Automatic-manned	1981-2009	Temp-Precip
44	Kastoria	40 27'	21 16' 48''	604	Automatic-manned	1981-2009	Temp-Precip
45	Kos	36 48'	27 06'	129	Automatic-manned	1982-2009	Temp-Precip
46	Chrysoupoli	40 54'	24 36'	5	Automatic-manned	1985-2009	Temp-Precip

Map of 46 stations:

List of stations with time series before 1960:

N	Station	Longitude	Latitude	Altitude (m)	Timeseries
1	Alexandroupoli	25 56'	40 51'	3,0	1947-2009
2	Heraklion	25 11'	35 20'	39,0	1947-2009
3	Pyrgos	21 26'	37 40'	12,0	1948-2009
4	Elliniko	23 45'	37 54'	15,0	1948-2009
5	Araxos	21 25'	38 08'	12,0	1949-2009
6	Kerkyra	19 55'	39 37'	4,0	1949-2009
7	Larissa	22 26'	39 39'	74,0	1949-2009
8	Ioannina	20 51'	39 40'	484,0	1950-2009
9	Milos	24 26'	36 44'	165,0	1950-2009
10	Trikala	21 46'	39 33'	110,0	1952-2009
11	Kozani	21 47'	40 17'	626,0	1955-2009
12	Lesvos	26 36'	39 04'	5,0	1955-2009
13	Naxos	25 23'	37 06'	10,0	1955-2009
14	Rodos	28 05'	36 24'	12,0	1955-2009
15	Agchialos	22 48'	39 13'	15,0	1956-2009
16	Lamia	22 24'	38 51'	17,0	1956-2009
17	Serres	23 34'	41 05'	34,5	1957-2009
18	Tympaki	24 26'	35	7,0	1959-2009
19	Chania	24 07'	35 33'	152,0	1959-2009

Map of stations with time series before 1960:

List of stations with time series after 1960:

N	Station	Longitude	Latitude	Altitude (m)	Timeseries
1	Monastiraki			390,2	1960-2009
2	Tanagra	23 33'	38 19'	140,0	1960-2009
3	A.Fragista	21 36' 26''	38 57' 45''	725,3	1960-2009
4	Ardanovo			357,0	1960-2009
5	Thessaloniki	22 58'	40 31'	5,0	1960-2009
6	Plastira	21 45' 47''	39 19' 15''	801,2	1961-2009
7	Santorini	25 26'	36 25'	34,0	1961-2009
8	Tavropos	22 05' 57''	39 20' 53''	793,8	1963-2009
9	Kastraki	21 23' 31''	38 46' 11''	74,8	1964-2009
10	Kremaston	21 29' 47''	38 53' 36''	801,2	1964-2009
11	Pertouli	21 30' 53''	39 32'	801,8	1964-2009
12	Ierapetra	25 44'	35	10,0	1964-2009
13	Kythira	23 6'	36 16' 48''	321,0	1964-2009
14	Andravida	21 16' 48''	37 54' 36''	10,0	1967-2009
15	Methoni	21 42'	36 49' 48	34,0	1967-2009
16	Tripoli	22 24'	37 32'	652,0	1967-2009
17	Lymnos	25 13' 48''	39 54' 36''	5,0	1968-2009
18	Skyros	24 28' 48''	38 57' 36''	28,0	1970-2009
19	kalamata	22 06'	37 04'	11,0	1971-2009
20	Aktion	20 45' 36''	38 36' 36''	4,0	1973-2009
21	Chios	26 09'	38 21'	4,0	1974-2009
22	Arta	21	39 10'	10,5	1976-2009

23	Samos	26 55'	37 42'	7,0	1978-2009
24	Argos	22 47'	37 36'	11,0	1981-2009
25	kastoria	21 16' 48''	40 27'	604,0	1981-2009
26	Kos	27 06'	36 48'	129,0	1982-2009
27	Chrysoupoli	24 36'	40 54'	5,0	1985-2009

Map of stations with time series after 1960:

Hungary

The NOS system is an observation network system equipped with both automatic weather stations (AWSs) and human observers.

Recently we use two types of AWSs: MILOS and QLC. Both are installed to produce data in every 10 minutes. The measuring program of MILOS AWSs is larger, therefore they are used at the synoptic stations. Data of many synoptic stations are part of the international data exchange. Number of synoptic station is 29 recently, 14 from them have manual observations as well. Number of QLC stations with limited measuring program is 59 and there are 9 traditional climate stations with volunteers, report twice a month via mail.

Traditional climatic stations and rainfall measure stations are the parts of the station network. Observers on traditional climatic stations send data to the centre in mail where couple of colleagues control and input these data into the INDA system. Number of traditional climate stations decreases significantly because of the automatization. Number of precipitation gauges is more than 500 but their automatization is also planned in the future.

The data flow contains three levels: all types of data get into the local database then into data base centers and finally into the database of Hungarian Meteorological Service (Current Late Database, CLDB). Except the manual observations, measurements and data recording, the system works automatically. Data observed or measured by the human observers get into the local database through a graphic user interface in controlled form. Data of AWSs are recorded to the same database.

Each MILOS and QLC stations are involved in the NOS. Therefore, the data flow between the NOS levels works as a database-database connection and operates periodically. There are several dedicated collecting stations, which can connect stations of the lower level in their region, collect and store their data until forwarding to the higher level. Recently the connection between the collecting stations and the CLDB builds up in every hour, new data arrive in CLDB and information referring to errors can be sending back to local databases.

Fig. 1. Surface measurement network of the Hungarian Meteorological Service

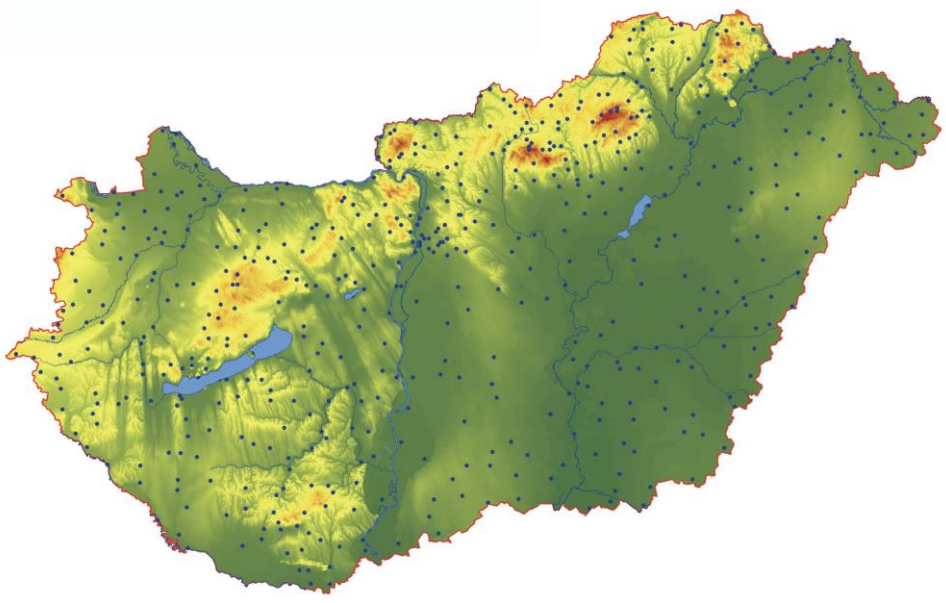


Fig. 2. Traditional precipitation gauges network at OMSZ

In climate studies homogenity of dataseries is of primary importance. Since SPI calculation based on long time data series, homogenity of the used precipitation data is necessary. Therefore only homogenized daily and monthly precipitation amounts are used for SPI calculations in Hungary.

No.	name	lambda	fi	Elevation/m
1	Sopron	16.65	47.71833	118
2	Fertőszentmiklós	16.88	47.58	135
3	Szombathely	16.64778	47.19833	201
4	Felsőszölnök	16.19	46.88	282
5	Mosonmagyaróvár	17.26667	47.89167	121
6	Ravazd	17.76667	47.51667	162
7	Pér	17.8	47.61667	133
8	Beled	17.11667	47.46667	133
9	Bakonyszentkirály	17.88333	47.36667	281
10	Kemenesszentmárton	17.16667	47.3	133
11	Kerta	17.26667	47.16667	141
12	Bakonybél	17.73333	47.25	267
13	Városlőd	17.65	47.15	295
14	Herend	17.75	47.13333	342
15	Türje	17.1	46.98333	153
16	Sümeg	17.28	46.98	178
17	Nagyvázsony	17.7	46.98333	269
18	Keszthely	17.23333	46.76667	112
19	Balatonkeresztúr	17.36667	46.7	121
20	Marcali	17.42	46.58	130
21	Mernye	17.82	46.5	169
22	Iharos	17.1	46.35	196
23	Rinyakovácsi	17.6	46.28333	177
24	Márianosztra	18.86667	47.86667	231
25	Kápolnásnyék	18.68333	47.23333	115
26	Balatonalmádi	18.01667	47.03333	110
27	Siófok	18.04083	46.91083	108
28	Tab	18.02	46.73	178
29	Pincehely	18.43333	46.68333	114
30	Tengelic	18.71667	46.53333	120
31	Gölle	18.01667	46.45	147
32	Szálka	18.63333	46.28333	168
33	Pécs	18.23278	46.00583	203

34	Pásztó	19.7	47.91667	180
35	Budapest	19.02806	47.51111	145
36	Tápiószele	19.88	47.33	106
37	Kecskemét-kült	19.75	46.91	114
38	Kalocsa	19.1	46.51	93.6
39	Baja	19.01667	46.18333	113
40	Felsőszentiván	19.18	46.2	133
41	Miskolc	20.77556	48.09583	233
42	Bogács	20.53333	47.9	186
43	Poroszló	20.64778	47.64472	90
44	Fegyvernek	20.53	47.27	91
45	Túrkeve	20.74	47.11	85.9
46	Cibakháza	20.2	46.96667	92
47	Kunszentmárton	20.28333	46.85	89
48	Kondoros	20.78	46.77	89
49	Szeged	20.01667	46.3	89
50	Karcsa	21.8	48.31667	107
51	Nyíregyháza	21.7	47.98333	141
52	Téglás	21.68	47.72	145
53	Hajdúszoboszló	21.38	47.45	97
54	Debrecen	21.61083	47.49028	108
55	Méhkerék	21.45	46.78	94
56	Battonya	21.01667	46.28333	104
57	Nyírmada	22.19	48.07	131
58	Vásárosnamény	22.31667	48.13333	115
59	Szentgotthárd	16.30833	46.90833	312
60	Kisrákos	16.5	46.86667	270
61	Pinkamindszent	16.48333	47.03333	205
62	Lenti	16.53333	46.61667	165
63	Letenye	16.71667	46.43333	150
64	Hagyárosbörönd	16.7	46.91667	205
65	Felsőrajk	16.99167	46.68333	159
66	Csurgó	17.1	46.26667	147
67	Zalacsány	17.1	46.8	124
68	Kehidakustány	17.1	46.85	125
69	Zalavár	17.16667	46.66667	122
70	Ötvös	17.16667	47.03333	155
71	Rajka	17.2	48	130
72	Vízvár	17.23333	46.08333	125

73	Csorna	17.25	47.61667	117
74	Balatonújlak	17.38333	46.68333	110
75	Mesztegnyő	17.43333	46.5	140
76	Tapolca	17.45	46.88333	125
77	Barcs	17.45	45.95	107
78	Kup	17.45	47.25	212
79	Nagybajom	17.5	46.4	164
80	Lengyeltóti	17.65	46.66667	148
81	Úrkút	17.63333	47.08333	400
82	Farkasgyepű	17.625	47.20833	400
83	Somogytúr	17.78333	46.7	151
84	Tihany	17.9	46.91667	106
85	Bálványos	17.95	46.78333	200
86	Hetvehely	18.05	46.13333	150
87	Súr	18.03333	47.36667	242
88	Bakonya	18.08333	46.08333	236
89	Szakcs	18.11667	46.55	192
90	Komárom	18.11667	47.75	112
91	Várpalota	18.13333	47.2	161
92	Iregszemcse	18.18333	46.68333	165
93	Füle	18.25	47.05	173
94	Lepsény	18.25	47	119
95	Alsószentmárton	18.31667	45.78333	92
96	Kurd	18.31667	46.45	123
97	Lajoskomárom	18.29167	46.83333	122
98	Szakály	18.38333	46.53333	116
99	Tatabánya	18.45	47.53333	202
100	Gyermely	18.64167	47.60833	190
101	Bikács	18.66667	46.68333	108
102	Tordas	18.75	47.35	120
103	Vámosmikola	18.79167	47.975	126
104	Paks	18.84167	46.575	97
105	Nógrád	19.05	47.9	236
106	Szentendre	19.06667	47.66667	119
107	Drégelypalánk	19.05	48.05	154
108	Dunaharaszti	19.08333	47.35	105
109	Bácsbokod	19.15	46.11667	118
110	Tolmács	19.11667	47.93333	196
111	Fülöpszállás	19.23333	46.81667	98

112	Vecsés	19.28333	47.4	120
113	Váchartyán	19.25	47.73333	139
114	Nézsa	19.28333	47.83333	230
115	Mohora	19.35	47.98333	192
116	Izsák	19.36667	46.8	106
117	Galgagyörk	19.38333	47.75	175
118	Galgaguta	19.35	47.85	180
119	Becske	19.38333	47.9	230
120	Valkó	19.48333	47.56667	169
121	Nógrádszakál	19.53333	48.18333	203
122	Karancskeszi	19.7	48.16667	198
123	Karancsalja	19.75	48.13333	242
124	Ásotthalom	19.78333	46.2	115
125	Ecséd	19.78333	47.73333	157
126	Gyöngyöspata	19.78333	47.81667	202
127	Mátraverebély	19.78333	47.98333	185
128	Ruzsa	19.76667	46.31667	110
129	Salgótarján	19.78333	48.1	280
130	Salgótarján	19.86667	48.13333	450
131	Parádsasvár	19.98333	47.91667	356
132	Abony	20	47.18333	95
133	Erdőkövesd	20.1	48.05	204
134	Vécs	20.16667	47.81667	139
135	Recsk	20.11667	47.93333	172
136	Mindszent	20.18333	46.51667	86
137	Jászladány	20.16667	47.36667	90
138	Bükkszenterzséb	20.175	48.05833	195
139	Kübekháza	20.28333	46.15	82
140	Szolnok	20.2	47.125	89
141	Erdőtelek	20.31667	47.68333	112
142	Eger	20.36667	47.95	185
143	Tiszaroff	20.44167	47.4	90
144	Füzesabony	20.41667	47.75	113
145	Dédestapolcsány	20.475	48.18333	214
146	Bükkzsérc	20.51667	48	360
147	Mezőkövesd	20.58333	47.81667	116
148	Gádoros	20.58333	46.66667	90
149	Kács	20.61667	47.96667	200
150	Varbó	20.61667	48.15	210

151	Kunhegyes	20.63333	47.36667	92
152	Szin	20.65833	48.49167	155
153	Csanádpalota	20.71667	46.25	95
154	Bódvaszilas	20.73333	48.53333	182
155	Tiszadorogma	20.86667	47.68333	94
156	Csárdaszállás	20.93333	46.86667	85
157	Szikszó	20.93333	48.2	124
158	Tiszadob	21.16667	48.01667	107
159	Taktaharkány	21.13333	48.08333	98
160	Szeghalom	21.18333	47.01667	91
161	Görbeháza	21.23333	47.81667	91
162	Vésztő	21.26667	46.93333	90
163	Biharnagybajom	21.23333	47.2	93
164	Tiszalök	21.38333	48.01667	100
165	Zsáka	21.43333	47.13333	97
166	Komádi	21.5	47.01667	92
167	Hajdúdorog	21.5	47.8	111
168	Hajdúböszörmény	21.5	47.68333	124
169	Kenézlő	21.55	48.2	104
170	Körösszakál	21.6	47.03333	98
171	Kemecse	21.8	48.06667	104
172	Nagykálló	21.83333	47.86667	130
173	Létavértes	21.88333	47.38333	117
174	Kék	21.88333	48.1	101
175	Gégény	21.95	48.15	99
176	Mándok	22.18333	48.31667	113
177	Csaroda	22.46667	48.16667	112

Table 1. List of the stations used for SPI calculations. Stations No. 1-58 are stored from 1901 to 2009 in our database; the rests are available in interval 1951-2009.

Serbia

Meteorological network

Meteorological network in Serbia covers an area of over 88,000 square km. There are more than six hundred meteorological stations which are delivering data to Republic Hidrometeorological Service of Serbia on regular basis. Different types of stations exist. Thirty five synoptic stations (including airport meteorological stations) with 24 observations per day have professional observers. All other stations are automatic or involve outsourced collaborators.

Observers on precipitation stations, among other meteorological parameters defined by standard observation programme, measure precipitation once a day. Meteorological diary is sent monthly to RHMSS. Actual data availability delay in practice is at least one to two months. Data arrive in form of written document and they are not ready for instant use. At this moment, a number of active precipitation stations is about 500.

Observers on climatological stations follow the same program regarding the precipitation as their colleagues on precipitation stations, but proceed with additional measurements according to standard programme for this type of station. Considering possible operative use of these data, the situation is quite similar to this which is described above regarding precipitation stations. Climatological station observation programme is currently carried out on 99 locations.

Synoptic stations mainly involve the same procedure as classical climatological stations (some airport meteorological stations are exceptions), but observers do the measuring more frequently during the day. All synoptic stations in Serbia are now in the regime of hourly measuring and hourly reporting via SYNOP bulletins and GTS in real time. Data received via bulletins from 32 synoptic stations are used for operative activities in the field of agricultural meteorology within RHMSS, including monitoring of moisture conditions (See Table on the page 6). Collected data are daily processed, there is no delay.

By the end of 2009, RHMSS completed the network of automatic meteorological stations (AMS). All automatic stations are situated on the locations – meteorological stations under the authority of the Service and with professional employees. Measuring program on these 28 AMSs cover wind speed and direction, air temperature and humidity, precipitation, air pressure, air temperature on 5 cm above the soil, global radiation and soil temperature in the depths of 5, 10, 20, 50 and 100cm. All data from these stations are near-real time available. However, operation of these stations is still in the testing phase – adjustments are carried out, as well as comparative analyses of these data with data obtained by classical measuring on the same locations.

Data records

Near–real–time data

Operative SPI calculations are performed on the basis of daily precipitation data regularly submitted from 29 synoptic stations and statistical parameters derived from historical precipitation data. Complete data for the period 1961-2005 exist for the twenty five stations. For the purpose of statistical parameters calculation, previous interpolation of missing data was carried out in case of three of remaining stations. Regional climate model *(Regionalen Klimamodells* on the basis of *FITNAH*) was used.

In case of the station Kopaonik (1710m), only all available original data were used-without interpolation. In practice, SPI values obtained for these four stations without complete series of original data are accepted as approximative. They are considered in spatial analyses, but they are not presented individually.

Classical data

Besides the mentioned stations where Synop reporting exists, there are another 39 climatological stations with data record for the period 1961-2000 and additional 5 for the period 1971-2000. Lists of these stations are given in Tables on the pages 7 and 8.

Among around 500 precipitation stations that are operational today, around 400 stations were functioning during the period 1961-2000, and additional near twenty stations were functioning in the period 1971-2000. The lists of these stations are not attached to this document because of several reasons. The number of these stations is considerable and it is necessary to previously carry out more detailed checking of the real availability of historical data on precipitation from these stations. Also, it is assessed that the expectation that current data from these stations could be included in operative calculation of SPI in nearest future is not real. Unfortunately, actual data availability delay in practice is too big at this moment.

List of stations with near-real-time data delivery

Near–real–time data				*Operative SPI calculation*	*AMS existed in addition*
Synoptic stations					
	WMO no.	**name**	**comment**		
1	13067	PALIČ		√	√
2	13160	SOMBOR		√	√
3	13168	NOVI SAD RIMSKI ŠANČEVI		√	√
4	13170	BEČEJ	**Agr. company st.**	√	
5	13173	ZRENJANIN		√	√
6	13174	KIKINDA		√	√
7	13180	BANATSKI KARLOVAC		√	√
8	13183	VRŠAC	**Civil airport st.**	√	
9	13262	LOZNICA		√	√
10	13266	SREMSKA MITROVICA		√	√
11	13269	VALJEVO		√	√
12	13272	BEOGRAD SURČIN	**Civil airport st.**		
13	13274	BEOGRAD OBSERVATORIJA		√	√
14	13278	KRAGUJEVAC		√	√
15	13279	SMEDEREVSKA PALANKA		√	√
16	13285	VELIKO GRADIŠTE		√	√
17	13289	CRNI VRH KOD BORA		√	√
18	13295	NEGOTIN		√	√

19	13367	ZLATIBOR		√	√
20	13369	SJENICA		√	√
21	13370	POŽEGA		√	√
22	13376	KRALJEVO		√	√
23	13378	KOPAONIK		√	√
24	13382	KURŠUMLIJA			√
25	13383	KRUŠEVAC		√	√
26	13384	ĆUPRIJA		√	√
27	13387	NIŠ AERODROM	**Civil airport st.**		
28	13388	NIŠ		√	√
29	13389	LESKOVAC		√	√
30	13392	ZAJEČAR		√	√
31	13397	DIMITROVGRAD		√	√
32	13489	VRANJE		√	√

Active classical stations with time records for 1961- 2000

Synoptic stations		*1961-2000*				
Idmm	**clim. no.**	**name**	Hs	φ	λ	**Start-up**
	674	PALIĆ	102	46º 06’	19º 46’	1945
	1610	SOMBOR	88	45 47	19 05	1949
	1654	NOVI SAD RIMSKI ŠANČEVI	84	45 20	19 52	1948
	1730	BEČEJ	75	45 37	20 04	1945
	1742	ZRENJANIN	80	45 24	20 21	1948
	1712	KIKINDA	81	45 51	20 28	1948
	2631	LOZNICA	121	44 33	19 46	1951
	2603	SREMSKA MITROVICA	81	44 58	19 38	1946
	2655	VALJEVO	176	44 17	19 55	1946
	2712	BEOGRAD OPSERVATORIJA	132	44 48	20 02	1887
	2775	KRAGUJEVAC	197	44 02	20 56	1948
	2755	SMEDEREVSKA PALANKA	122	44 22	20 57	1948
	2813	VELIKO GRADIŠTE	82	44 45	21 31	1945
	2963	NEGOTIN	42	44 14	22 33	1947
	3624	ZLATIBOR	1028	43 44	19 43	1950
	3655	SJENICA	1038	43 16	20 01	1946
	3710	POŽEGA	310	43 50	20 02	1952
	3734	KRALJEVO	215	43 43	20 42	1945
	3861	KURŠUMLIJA	382	43 08	21 16	1951
	3832	KRUŠEVAC	166	43 34	21 21	1946
	3802	ĆUPRIJA	123	43 56	21 22	1946
	3855	NIŠ	201	43 20	21 54	1947

	4805	LESKOVAC	230	42 59	21 57	1948
	3901	ZAJEČAR	144	43 53	22 17	1946
	3974	DIMITROVGRAD	450	43 01	22 45	1947
	4835	VRANJE	432	42 29	21 54	1945
Climate stations						
Idmm	**clim. no.**	**name**	Hs	φ	λ	**Start-up**
	2614	ŠABAC	80	44° 46'	19° 41'	1945
	1700	SENTA	80	45 56	20 05	1945
	1641	BAČ	85	45 24	19 15	1955
	1653	BAČKI PETROVAC	85	45 22	19 34	1948
	2802	BELA CRKVA	90	44 54	21 25	1945
	3801	JAGODINA	115	43 59	21 19	1949
	1602	ALEKSA ŠANTIĆ	120	45 56	19 20	1955
	2723	RADMILOVAC	130	44 45	20 35	1947
	2662	LJUBOVIJA	170	44 11	19 23	1953

***Climate stations** - continuation*						
Idmm	**clim. no.**	**name**	Hs	φ	λ	**Start-up**
	3834	ALEKSINAC	180	43 33	21 41	1953
	3735	VRNJAČKA BANJA	235	43 37	20 54	1948
	3810	REKOVAC	251	43 52	21 06	1949
	3863	PROKUPLJE	266	43 14	21 36	1949
	3604	BAJINA BAŠTA	270	43 58	19 34	1956
	4900	VLASOTINCE	271	42 58	22 08	1948
	2652	KRUPANJ	280	44 22	19 23	1958
	3931	KNJAŽEVAC	281	43 34	22 16	1953
	3825	SOKOBANJA	300	43 39	21 51	1946
	2864	ŽAGUBICA	314	44 12	21 47	1946
	4910	PREDEJANE	318	42 50	22 08	1949
	3840	ALEKSANDROVAC	360	43 27	21 04	1946
	2765	ČUMIĆ	366	44 08	20 49	1958
	3963	PIROT	370	43 09	22 36	1947
	3851	BLACE	395	43 18	21 18	1958
	4844	BUJANOVAC	400	42 27	21 47	1948
	4853	PREŠEVO	410	42 18	21 40	1949
	3841	BRUS	440	43 23	21 02	1961
	3731	IVANJICA	465	43 25	20 14	1953
	3972	BABUŠNICA	495	43 04	22 26	1958
	3763	NOVI PAZAR	545	43 08	20 31	1951
	3722	KAONA	570	43 43	20 25	1949
	3842	JASTREBAC	575	43 26	21 23	1947

	2764	RUDNIK PLANINA	700	44 08	20 31	1956
	4942	BOSILJGRAD	730	42 30	22 28	1947
	3765	BLAŽEVO	880	43 14	20 56	1961
	3736	GOČ	990	43 33	20 51	1953
	4773	DRAGAŠ	1060	42 04	20 39	1952
	4922	VLASINA	1260	42 44	22 21	1946
	4815	KUKAVICA	1442	42 39	21 58	1953
Precipitation stations						
Among precipitation stations that are operational today, around 400 were functioning during the period 1961-2000 - according to available evidence						

Active classical stations with time records for 1971 - 2000

(only stations in addition to the 1961-2000 list)

Synoptic stations *1971-2000*						
Idmm	**clim. no.**	**name**	Hs	φ	λ	**Start-up**
	1861	VRŠAC	82	45º 09'	21º 19'	1965
	2711	BEOGRAD SURČIN	96	44 49	20 17	1966
	2865	CRNI VRH KOD BORA	1037	44 07	21 57	1966
Climate stations						
Idmm	**clim. no.**	**name**	Hs	φ	λ	**Start-up**
	2871	BAGRDAN (VOJSKA)	113	44º 05'	21º 13'	1969
	3961	BELA PALANKA	291	43 13	22 19	1962
	3744	JOŠANIČKA BANJA	555	43 23	20 45	1965
	4950	TRGOVIŠTE	600	42 22	22 05	1969
	3770	KARAJUKIĆA BUNARI	1165	43 06	20 06	1969
Precipitation stations						
Near twenty today active precipitation stations were functioning in the period 1971-2000 in addition to those which were functioning in the period 1961-2000						

Other classical stations in operative SPI calculation

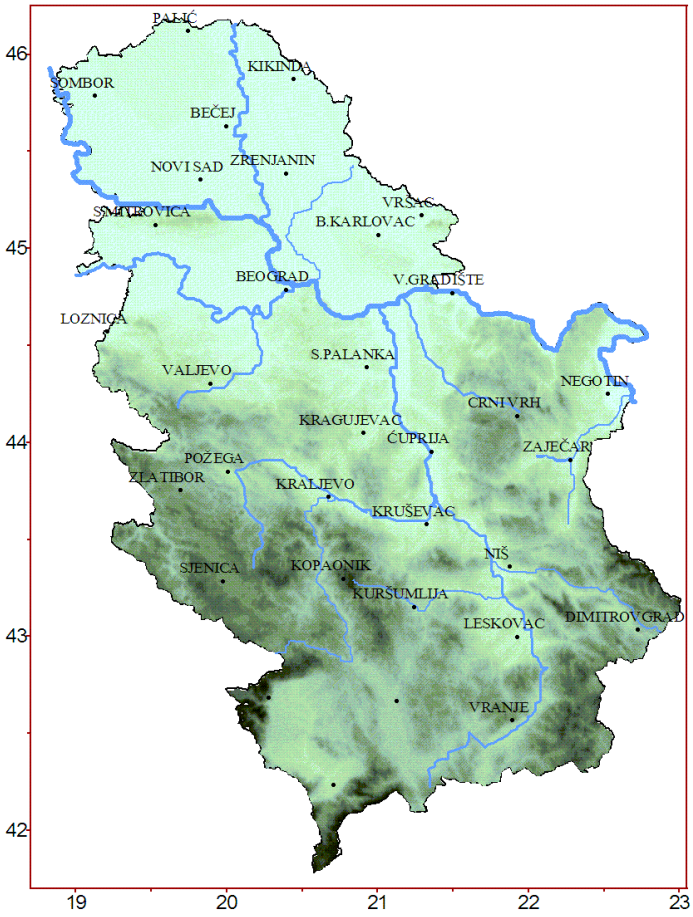
Synoptic stations						
Idmm	**clim. no.**	**name**	Hs	φ	λ	**Start-up / Period**
	1800	BANATSKI KARLOVAC	89	45º 03'	21º 02'	1986
	3755	KOPAONIK	1710	43 17	20 48	1967-73, 1980-

Comment: Respectabe historical meteorological data archive exist for three old synoptic stations on the territory of Autonomous Province Kosovo and Metohija, which is under the administration of UN (see Table below)

Synoptic stations						
Idmm	**WMO no.**	**name**	Hs	φ	λ	**Period**
	473	PEĆ	498	42 40	20 18	1949-1998
	477	PRIZREN	402	42 13	20 44	1949-1998
	481	PRIŠTINA	573	42 39	21 09	1949-1998

Map with stations with operative SPI calculations – Serbia

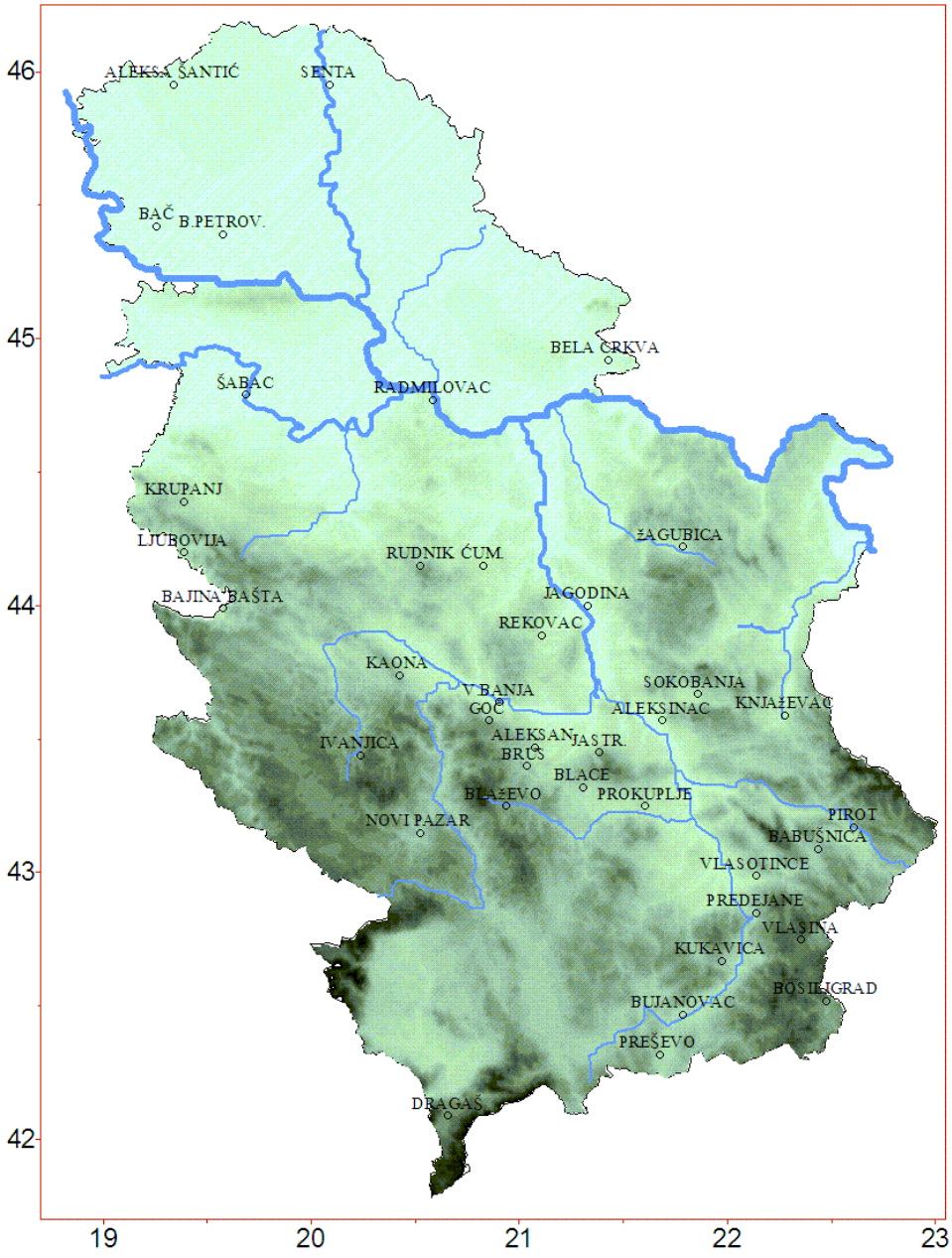
(All are synoptic stations)



Note: It is expected that station Kuršumlija will be added to the operative calculation SPI scheme very soon, as thirtieth synoptic station.

Map with active climate stations with time records for 1961- 2000

(Stations without SYNOP reporting)



Slovenia

Observers on precipitation stations measure precipitation only once a day at 7:00 am. They also measure depth of snow cover and depth of fresh snow and take notes of weather phenomena. All the observers have to fill in a form on paper– a meteorological diary which is sent monthly to Meteorological office. Data is then available with one month delay.

Observers on climatological stations measure precipitation once a day at 7:00 am – regarding precipitation, they follow same program as their colleagues on precipitation stations. In addition to precipitation, they measure temperature and relative humidity three times daily (at 7:00, 14:00 and 21:00 in CET) and note cloudiness amount, visibility, condition of the soil and wind. They also measure daily minimum and maximum temperature. With some adjustments, it is possible to calculate ETP using Penmann-Monteith formula for data measured on these stations. Some stations also send SYNOP bulletins in real time to the Global Telecommunication System (GTS). All observers have to fill in a form on paper and send it monthly to the Meteorological Office.

Synoptic stations involve the same procedure as classical climatological stations, but observers take measures more frequently during the day (however, only at airports measurements are being made over 24 hours). They prepare SYNOP bulletins and send them to the GTS in real time. All data is available daily, there is no delay.

Automatic stations differ substantially to other, "classical" measurements. There is no delay, data is sent in real time to the data base. However, automatic stations are unable to record atmospheric phenomena and there are periods with missing data due to weather-related accidents (struck by lightning, strong wind, broken communications, ice, high snow, etc).

Currently there are 50 automatic stations in Slovenia, fairly well-equipped (precipitation, temperature, wind and humidity measurements at least). Some automatic stations have additional sensors (for measurements of global radiation, visibility, present weather, cloud height, etc.). Main advantage of automatic stations is availability of measurements in real time and time density of measurements (half-hourly data is obtained, precipitation is sampled every 5 minutes).

Data records

Near–real–time data

Professional observers on 13 synoptic stations are sending data daily. However, for SPI calculations it is critical to have long time series. For period 1961–2000 we have data only from three stations.

Data obtained in near real time can be enhanced by records from automatic stations. However, the problem with length of data record is evident – automatic stations have data records, available in data base, of length only few years.

We have tried to mitigate this problem with combined use of current data from weather stations and historical datasets from classical stations. The combinations were chosen subjectively, according to proximity and similarity of climate regime. For specific location we have then combined information on the rainfall for the period of at least thirty years and near-real-time data for the last three years.

If we couldn't found appropriate classical station with long enough data that is close enough to automatic station we did a combination of multiple stations, corresponding to those two conditions.

Classical data

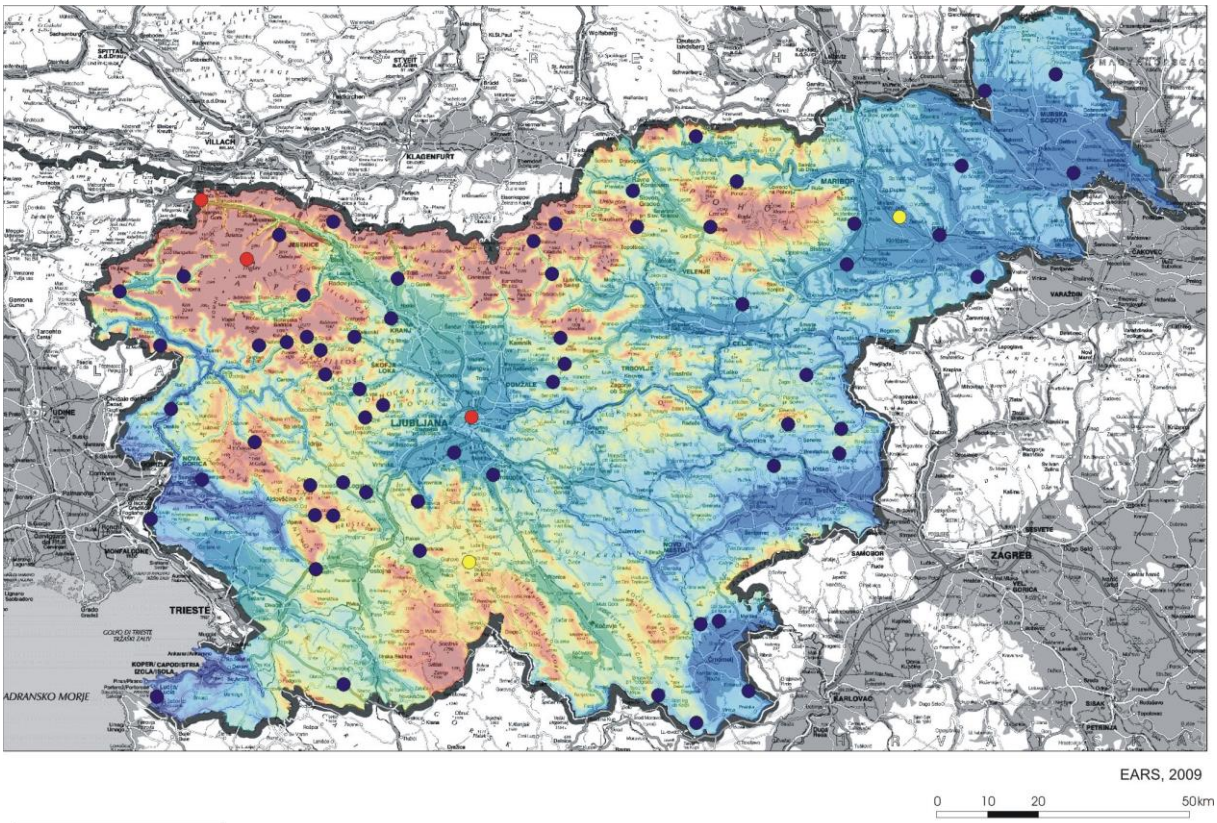
Data from climatological and precipitation stations arrives to the data base with one month delay and is entered manually from paper forms. However, there are 65 climatological and precipitation station with data records for period 1961-200 and 78 stations with data records for 1978-2000. All data is available in daily records.

Slovenia – list of classical stations with time records for 1961-2000

Synoptic stations			
Idmm	**climatological no.**	**name**	**Start-up**
123	48	KREDARICA	1.1.1955
134	51	RATEČE - PLANICA	1.1.1949
460	192	LJUBLJANA - BEŽIGRAD	1.1.1948
Climate stations			
Idmm	**climatological no.**	**name**	**Start-up**
388	158	NOVA VAS NA BLOKAH	1.6.1956
782	309	STARŠE	1.4.1959
Precipitation stations			
Idmm	**climatological no.**	**name**	**Start-up**
33	12	ZGORNJA BESNICA	1.3.1938
41	16	POLJANE V POLJANSKI DOLINI	25.8.1960
46	18	LESKOVICA	1.8.1945
58	21	DAVČA	1.7.1945
59	22	ZGORNJA SORICA	1.1.1961
65	23	ŽELEZNIKI	1.1.1945
77	29	TRŽIČ	1.1.1947
88	35	JAVORNIŠKI ROVT	7.10.1952
102	40	ZGORNJA RADOVNA	1.1.1955
107	42	GORJUŠE	1.1.1961
149	56	SOČA	1.7.1947
163	60	ŽAGA	1.12.1955
168	62	LIVEK	14.11.1947
183	69	RUT	1.9.1953
187	70	PODBRDO	1.7.1947
203	78	MRZLA RUPA	7.1.1948
208	81	ČRNI VRH NAD IDRIJO	6.8.1947
226	89	MORSKO PRI KANALU	1.1.1950
250	99	ŠEMPAS	1.8.1947
263	104	OPATJE SELO	24.10.1955
291	118	SEČA	1.1.1957
314	127	PODGRAD PRI ILIRSKI BISTRICI	1.10.1945
354	141	RAZDRTO	1.1.1950
361	144	PODKRAJ	1.2.1952

362	145	HRUŠICA PRI COLU	1.1.1961
364	146	HOTEDRŠICA	3.12.1953
367	147	LOGATEC	1.1.1924
373	149	POKOJIŠČE	1.1.1957
391	160	CERKNICA	1.1.1961
446	184	LUČINE	1.1.1947
449	186	ČRNI VRH NAD POLHOVIM GRADCEM	1.1.1947
463	195	ČRNA VAS	1.2.1951
469	199	ŽELIMLJE	20.12.1956
509	215	MORAVČE	1.1.1950
514	216	ZGORNJE LOKE PRI BLAGOVICI	1.1.1947
515	217	ZGORNJI TUHINJ	1.1.1961
533	224	LOŽICE	21.8.1953
534	225	ŽUSEM	1.1.1961
541	228	PODSREDA	1.10.1949
543	229	SROMLJE	23.3.1955
573	238	VELIKI TRN	1.1.1961
609	253	SEMIČ	1.1.1961
616	255	CEROVEC	1.1.1949
627	258	ADLEŠIČI - GORENJCI	1.9.1946
630	259	SINJI VRH	1.8.1945
633	260	PREDGRAD	1.5.1946
669	269	VOJNIK	1.1.1949
694	278	LUČE	1.1.1961
696	279	SOLČAVA	1.6.1946
705	282	KOPRIVNA	24.6.1958
723	288	KOTLJE	1.6.1950
729	291	ZGORNJI RAZBOR	1.12.1946
768	304	ČREŠNJEVEC	1.1.1947
776	308	FRAM	1.7.1945
816	319	PODLIPJE	1.6.1955
831	322	MISLINJA	1.1.1947
838	324	RIBNICA NA POHORJU	15.11.1946
871	335	CANKOVA	1.7.1953
884	339	KADRENCI	1.1.1961
897	343	PTUJ	1.1.1961
902	345	CIRKULANE	1.1.1961
917	351	SREDNJA BISTRICA	1.12.1946
936	356	KANČEVCI	22.11.1946

Map of classical stations with precipitation record 1961-2000



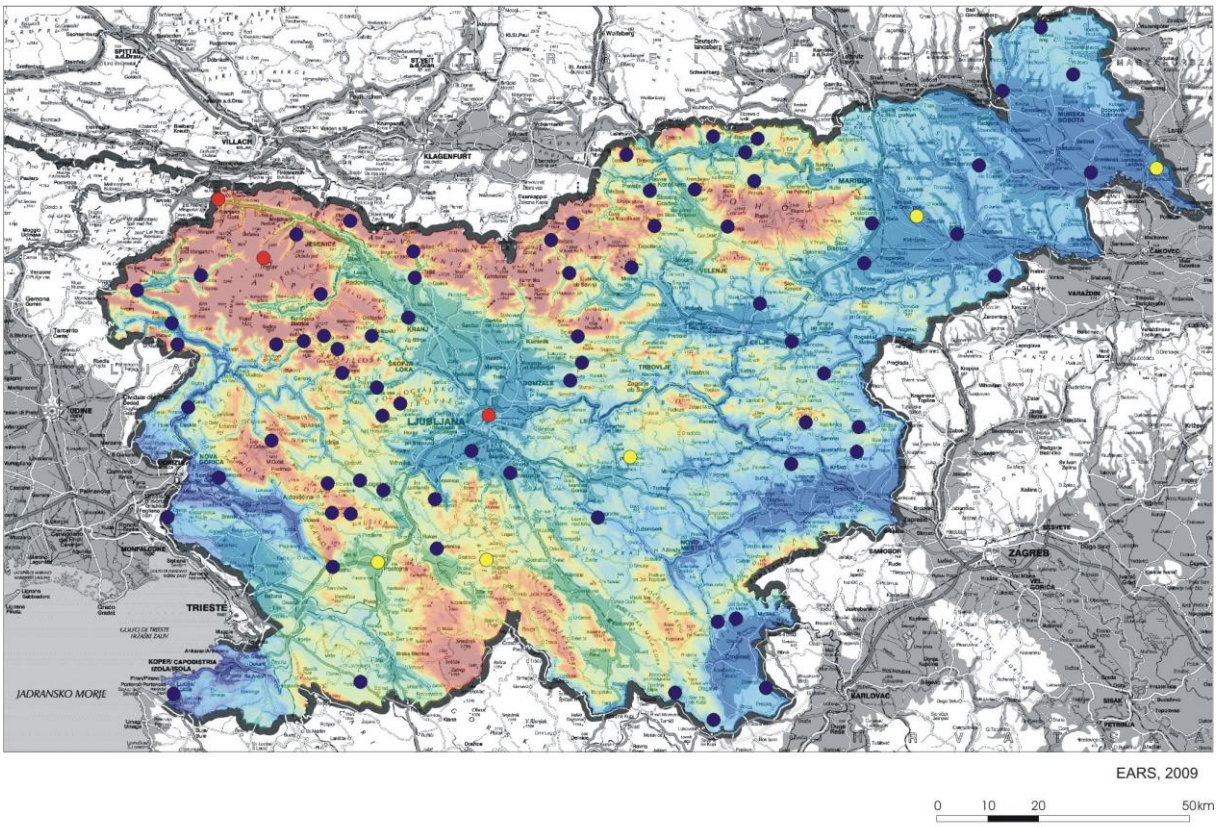
Slovenia – list of classical stations with time records for 1971-2000

(only stations in addition to the 1961-2000 list)

Climate stations			
Idmm	**climatological no.**	**name**	**Start-up**
344	136	POSTOJNA	25.3.1961
488	205	SEVNO	1.5.1961
924	352	LENDAVA	17.1.1962
Precipitation stations			
Idmm	**climatological no.**	**name**	**Start-up**
76	28	PODLJUBELJ	28.5.1963
173	63	KOBARID	1.1.1971
587	244	FUŽINA	1.1.1962

654	266	ŠENTJUR	1.6.1966
683	275	RADEGUNDA	1.3.1961
720	286	STROJNA	27.5.1967
1717	316	REMŠNIK	6.6.1963
810	317	KOZJI VRH	1.9.1966
835	323	SLOVENJ GRADEC – GRADIŠČE	1.6.1963
940	358	MARTINJE	1.4.1964

Map of classical stations with precipitation records 1971-2000



Slovenia – list of automatic stations with matching nearby classical stations having data records for period (at least) 1971-2000

.

Automatic stations		*Matching near by stations*				
ID	**Name**	**Idmm**	**climatological no.**	**Name**	**start-up**	**the end**
1605	JESENICE NA DOLENJSKEM	559	87	KAPELE	17. 11. 1946	31. 1. 1999
1857	AJDOVŠČINA – DOLENJE	260	102	SLAP	7. 8. 1968	31. 12. 2006
1888	SUHA	39	15	ŠKOFJA LOKA	18. 8. 1947	30. 6. 2007
1824	BILJE	246	87	ZALOŠČE	1. 1. 1961	30. 12. 1992
1828	LJUBLJANA – BEŽIGRAD	460	192	LJUBLJANA – BEŽIGRAD	1. 1. 1948	
1838	MARIBOR – LETALIŠČE	782	309	STARŠE	1. 4. 1959	
1839	ŠMARTNO PRI SLOVENJ GRADCU	826	87	ŠMARTNO PRI SLOV.GRADCU	1. 4. 1957	31. 12. 1993
1841	RADENCI	872	336	RADENCI	1. 7. 1962	31. 12. 2000
1849	PORTOROŽ – LETALIŠČE	291	118	SEČA	1. 1. 1957	
1859	PTUJ – TERME	897	343	PTUJ	1. 1. 1961	
1866	POSTOJNA	344	136	POSTOJNA	25. 3. 1961	
1868	BOVEC – LETALIŠČE	162	59	PLUŽNA	17. 11. 1947	31. 5. 1994

1869	PODČETRTEK – ATOMSKE TOPLICE	537	226	PODČETRTEK	13. 8. 1955	3. 1. 2002
2215	CERKLJE – LETALIŠČE	571	87	BREGE	17. 11. 1953	10. 11. 1992
2217	BORŠT PRI GORENJI VASI	446	184	LUČINE	1. 1. 1947	
2299	LENDAVA	924	352	LENDAVA	17. 1. 1962	
2372	SOTINSKI BREG	940	358	MARTINJE	1. 4. 1964	
2286	LITIJA – GRBIN	490	206	LITIJA – GRBIN	1. 1. 1961	31. 12. 2005
1822	NOVA GORICA	250	99	ŠEMPAS	1. 8. 1947	
1860	GAČNIK	861	331	POLIČKI VRH	1. 6. 1966	14. 4. 2008
2216	ŠKOCJAN	279	87	MATAVUN	1. 1. 1925	31. 12. 1993
2252	KOPER	289	116	STRUNJAN	1. 6. 1954	30. 11. 2003
1821	RATEČE – PLANICA	134	51	RATEČE – PLANICA	1.1.1949	
1820	KREDARICA	123	48	KREDARICA	1.1.1955	
2210	KRVAVEC	11	3	KRVAVEC	15. 8. 1973	

Automatic stations	***Matching near by stations***

ID	name	Idmm	climatological no.	Name	start-up	the end
2213	LESCE	87	34	RADOVLJICA	20. 10. 1954	31. 12. 1978
		981	403	LESCE	1. 1. 1979	
1855	ISKRBA	423	174	KOČEVJE	5. 6. 1951	
		424	174	KOČEVJE	21. 9. 1989	
		425	174	KOČEVJE	11. 11. 1993	
1834	ČRNOMELJ – DOBLIČE	627	258	ADLEŠIČI – GORENJCI	1. 9. 1946	
		625	257	ČRNOMELJ – DOBLIČE	17. 5. 1988	
2471	CELJE – MEDLOG	665	268	CELJE – LOKROVEC	25. 2. 1961	31. 10. 1962
		666	268	CELJE – MEDLOG	1. 11. 1962	10. 11. 1965
		667	268	CELJE – LEVEC – LETALIŠČE	11. 11. 1965	25. 10. 1976
		668	268	CELJE	26. 10. 1976	19. 3. 2008
1842	MURSKA SOBOTA – RAKIČAN	932	355	MURSKA SOBOTA – RAKIČAN	1. 1. 1956	30.6.1971
		933	355	MURSKA SOBOTA – RAKIČAN	1.7.1971	18.6.1985
		934	355	MURSKA SOBOTA – RAKIČAN	19. 6. 1985	
1832	NOVO MESTO	602	249	NOVO MESTO – KANDIJA	1. 1. 1952	24. 3. 1961

		603	249	NOVO MESTO – GOTNA VAS	25. 3. 1961	
		604	249	NOVO MESTO	4. 12. 1972	
2250	ILIRSKA BISTRICA – KOSEZE	321	129	ILIRSKA BISTRICA	1. 1. 1957	17. 6. 1969
		322	129	ILIRSKA BISTRICA	18. 6. 1969	9. 3. 1973
		323	129	ILIRSKA BISTRICA	10. 3. 1973	11. 10. 2000
		198	76	VOJSKO	23. 11. 1958	16. 11. 1993
		199	76	VOJSKO	17. 11. 1993	

Map of real-time automatic stations with belonging classical stations with (at least) 1971-2000 precipitation records