Valuations on Historical Series of Precipitations in Piedmont (NW Italy)

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The study of the precipitations deserves great attention because being part of a recent past, it allows us to analyze in detail the variations which have occurred and their causes. In order to correctly assess these variations, it is necessary to have complete and homogeneous series (Eischeid et al., 1995, 2000, Alexandersoon et al., 1997).
In this report, we have studied the daily pluviometric series in Piedmont. For each site we have analyzed and compared the co-located series belonging to ARPA Piedmont (Regional Agency for the Environmental Protection) and SIMN (Hydrographic and Marigraphic National Service). Then we have reconstructed the monthly series and we have applied the homogeneity test SNHT, analysing trends.

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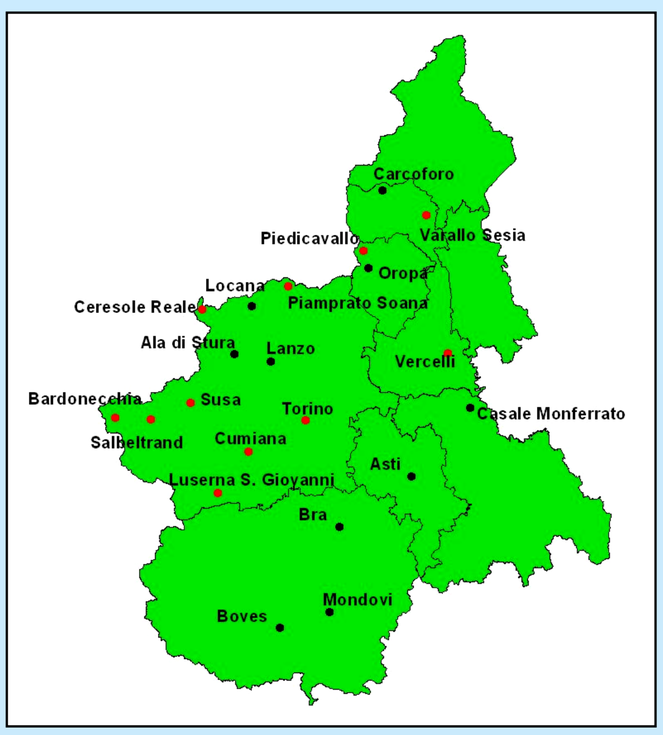
COMPARISON AND SELECTION

In the direct comparison between the daily pluviometric series, for each year and both the series we have neglected the values missing in at least one station. For each year we have computed the monthly, seasonally and annual coefficient of correlation during the period of overlapping of the measurements. In order to estimate whether the compared series admit the same distribution, we have applied the Kolmogorov-Smirnov test to the series concerning amount of monthly precipitations. We have computed the series of the ratios between the two station values, according to the formulations here reported:

$$R = \frac{P_{rain,SIMN}}{P_{rain,ARPA}}$$

For each new series, a statistical analysis has been carried out. All the series of the precipitation, in the period of overlapping, admit very high correlation coefficient. The direct comparison points out that for eleven of twenty-one locations the recording rain gauges of these stations measure the same amount of rain.



STATION	SIMN E (m)	ARPA E (m)	D (m)	P (years)
Ala di Stura (TO)	1013	1006	70	1993-2003
Asti (AT)	152	117	2350	1998-2003
Bardonecchia (TO)	1350	1353	850	1991-2003
Boves (CN)	590	575	1782	1988-2003
Bra (CN)	290	285	5	1993-2003
Carcoforo (VC)	1150	1290	2525	1997-2003
Casale M. (AL)	113	118	20	1988-2003
Ceresole R. (TO)	2260	2304	920	1996-2003
Cumiana (TO)	290	327	2800	1988-2003
Lanzo (TO)	540	580	2250	1989-2003
Luserna S. G. (TO)	476	475	760	1988-2003
Mondovì (CN)	555	422	390	1993-2003
Oropa (BI)	1180	1186	5	1990-2003
Piamprato S. (TO)	1550	1555	760	1988-2003
Piedicavallo (BI)	1050	1040	180	1996-2003
Salbertrand (TO)	1031	1010	1250	1991-2003
Susa (TO)	510	520	813	1990-2003
Torino (TO)	269	240	830	1990-2003
Locana (TO)	2410	2365	250	1987-2003
Varallo S. (VC)	453	470	2040	1990-2003
Vercelli (VC)	135	132	1360	1994-2003

Table I: Meteorological stations analyzed, E= elevation (m a.s.l.) SIMN stations, E= elevation (m a.s.l.) ARPA stations, D = distance (m) and P = period of overlapping of the measurements. In red are indicated sites where the meteorological station measure the same amount of rain during of overlapping.

Figure 1: Map of meteorological station analyzed. Red points indecate sites where the meteorological stations measure the same amount of rain during of overlapping period.

RECONSTRUCTION

For the new 11 precipitation series that have been operating with continuity during 56 years, from 1951 to 2006, we have reconstructed monthly amounts to fill gap (no missing data). We have chosen four different methods of spatial interpolation (Eischeid et al., 1995; Eischeid et al., 2000).

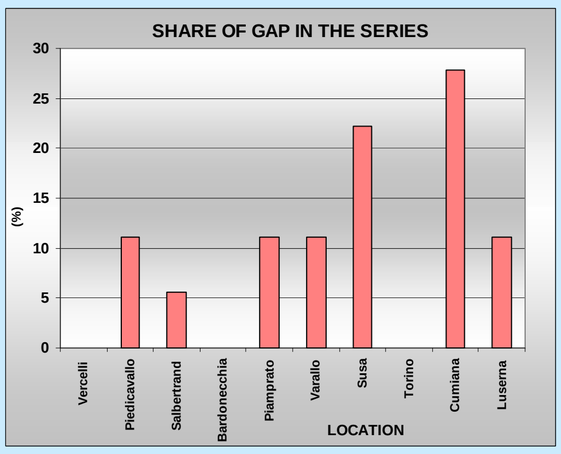


Figure 3: Percentage of present gaps in the series of the selected localities.

The selection of the value, than fill the gap, has been executed choosing the highest coefficient of correlation between the original series and the reconstructed series obtained with different methods.
The correlation coefficients vary between 0.61 and 1.

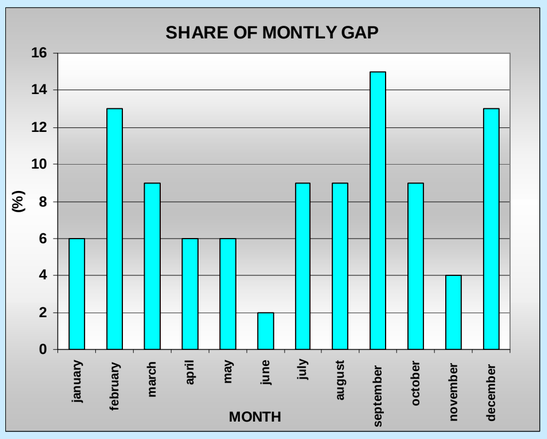


Figure 2: Share of recostructed gaps in the months.

These are defined as:
1) NR normal ratio method;
2) IDW simple inverse distance weighting;
3) MLR multiple linear regression;
4) MED median of the previous three method.

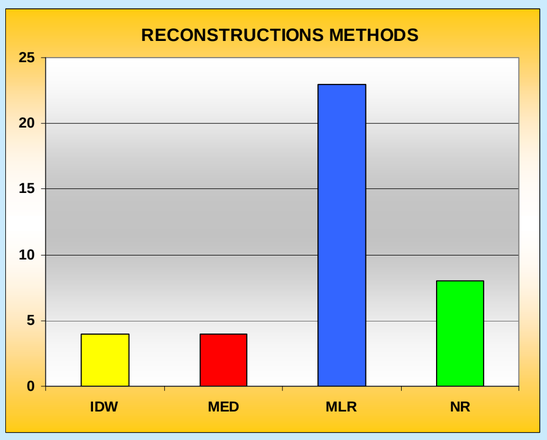


Figure 4: The number of times that a particular interpolation method is used.

TREND

We have calculated the trends of the annual series of the precipitation and the rainy days (Table 3) for the selected locations. To verify of the trends for the period (1951-2006), the Mann-Kendall test (Hipel et al., 2005) was applied with 95% confidence interval.

	PRECIPITATION		RAINY DAYS	
STATION	τ	P	τ	P
Bardonecchia	-0.05	0.61	0.02	0.84
Cumiana	-0.06	0.51	-0.24	0.01
Luserna S. G.	-0.09	0.35	-0.11	0.25
Piamprato S.	0.01	0.96	-0.03	0.73
Piedicavallo	0.08	0.38	0.18	0.05
Salbertrand	-0.12	0.19	-0.12	0.20
Susa	-0.20	0.03	-0.01	0.89
Torino	-0.06	0.52	-0.24	0.01
Varallo S.	-0.10	0.27	-0.08	0.39
Vercelli	-0.07	0.46	-0.22	0.02

For the greater part of the analyzed series the test has not detected a statistically acceptable trend. For the precipitation annual series the Mann-Kendall test has identified only two trend, in the location of Piedicavallo and Piamprato Soana, while, for the annual rainy days series, only three trend, in the location of Cumiana, Torino and Vercelli.

Table 3: Results of tend analysis, applying the Mann-Kendall test for the annual series of precipitation and rainy days. Level of confidence 95% -> p_0 = 0.05, level of probability of the null hypothesis -> p.

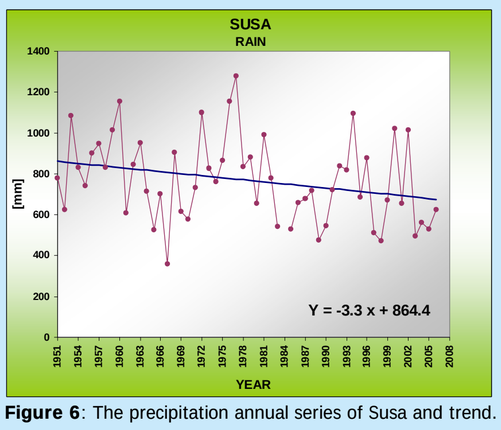


Figure 6: The precipitation annual series of Susa and trend.

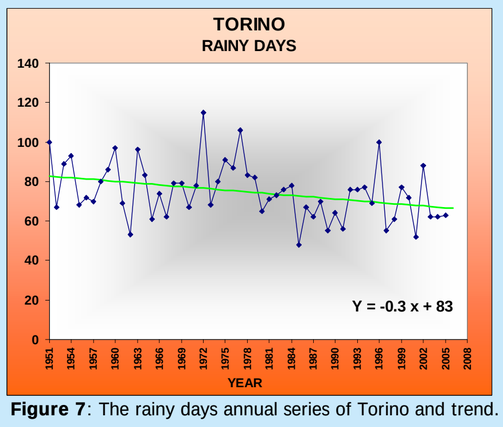


Figure 7: The rainy days annual series of Torino and trend.

Work in progress
We are estimating the monthly and seasonal trend and, thanks to the spectrum analysis method, we will determine the correctly statistics proprieties of interannual fluctuations in precipitation and quantify their correlation on large-scale.

HOMOGENIZATION

We have applied the Standard Normal Homogeneity Test (SNHT) (Alexandersoon et al., 1997) to the series.
This method allows to estimate and individuate the gradual or sudden change of the average value of a particular series comparing it to the reference series which has been obtained by evaluating the result of the adjacent series and that are considered homogeneous.

$\{Y_i\}_{i=1,\ldots,n}$ the candidate time series

$\{S_i\}_{i=1,\ldots,n}$ the reference time series

we define $\{Q_i\}_{i=1,\ldots,n}$ where $Q_i = Y_i / S_i$

The test is applied to the standardized series

$\{Z_i\}_{i=1,\ldots,n}$ where $Z_i = (Q_i - \overline{Q}) / \sigma_Q$

σ_Q the n – 1 weighted standard deviation

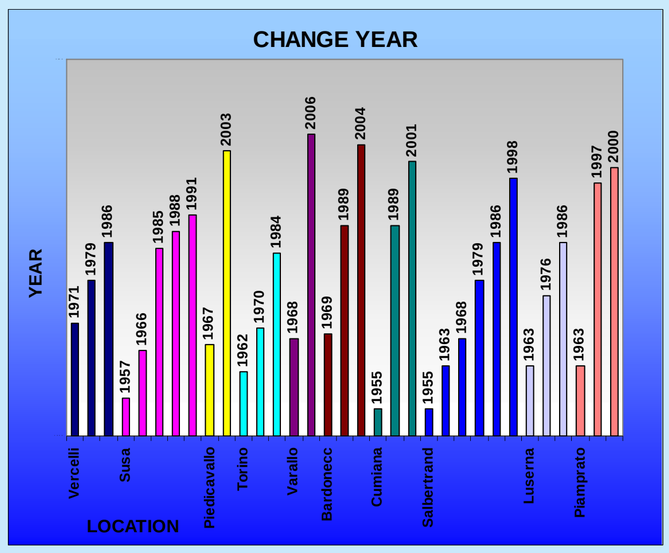


Figure 5: Years in which the discontinuity has been identified from the SNHT test.

LOCATION	MEDIUN VALUE OF THE CORRECTION FACTOR
Bardonecchia	0.99
Cumiana	1.11
Luserna S. Giovanni	0.90
Piamprato Soana	0.96
Piedicavallo	0.91
Salbertrand	0.94
Susa	0.98
Torino	1.05
Varallo Sesia	0.96
Vercelli	0.94

Table 2: Medium values of the correction factor characterized from the test in the series.

Null hypothesis, series is homogeneos

$$H_0 \quad : \quad Z_i \in N(0,1)$$

Alternatuve hypothesis, shift at the point a

$$H_1 \quad : \quad \begin{Bmatrix} Z_i \in N(\mu_1,1); i \in \{1,\ldots,a\} \\ Z_i \in N(\mu_2,1); i \in \{a+1,\ldots,n\} \end{Bmatrix}$$

In the series analyzed we have not identified a dishomogeneous years in common in the locations. Many years have been identified in an only series, others in two stations and only the year 1963 and the year 1986 have been evidence in three series (Salbertrand, Luserna, Piamprato) at the same time.