Needs of seasonal weather forecasts for the Italian Electric System

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There are some topics related to the Italian Electric System in which weather plays a certain role as "perturbation" on the management practice, they are:

1. Quality of service regarding faults over lines	influenced by	Severe weather
2. Electric Load requirements	„	Temperature, humidity and cloud cover
3. Fossil fuel supply	„	Precipitation and hydropower availability

Weather forecasts of these variables can help to better manage, in the sense of security and economy, the electric system, but the space-time scale of the predictions must be different.

The first of the previous topics concerns the temporary switch-off of the electric supply on some location due to severe weather as storms, strong wind, intense snowfall. This kind of weather it is not in good relation with the average parameters provided by the actual seasonal forecast.

The second topic is very important for day to day practice. The incidence of weather on electric load demand is about 3% in the north of Italy, but may rise considerably in some particular days, for this reason only short range forecasts are useful.

The third topic is well related to long range forecasts. The principle is that if one can plan to use more hydroelectric energy than the average, in the next months, one can plan to store less oil for thermoelectric power plants or wait to bye it when prices will decrease, or decide to stop plants for maintenance, in any case if it is possible to predict a correct scenario on the availability of the two kind of power production (hydro and thermo), it is possible to manage the system in order to save money.

The hydroelectric production in Italy is about 16% of the total (1997) and the reservoirs are managed on a weekly or seasonal basis. In the electric slang there is a term linked with the meteorological variable: the *hydroelectric producibility*. This quantity is the energy that a power plant can produce at the maximum of its efficiency. So It depends only by the natural inflow to the reservoir connected to that plant. This quantity is computed on a monthly basis and integrated over all the power plants situated on a large area. The monthly producibility prediction, some months in advance, is a very important element in the planning activities of a mixed electric system like the Italian one.

Now it is important to investigate the variables linked with producibility that can be predicted on a monthly time-scale.

A meteorological quantity linked with the monthly producibility is the monthly rainfall over the basin areas. But the link is not only between producibility and rainfall of the same month but also with rainfall of the previous months. For better understand this statement, it is important to analyse some data. The monthly producibility has been computed on some large areas of Italy, two areas over the Alps and one over the Apennines (fig. 1).

Areas

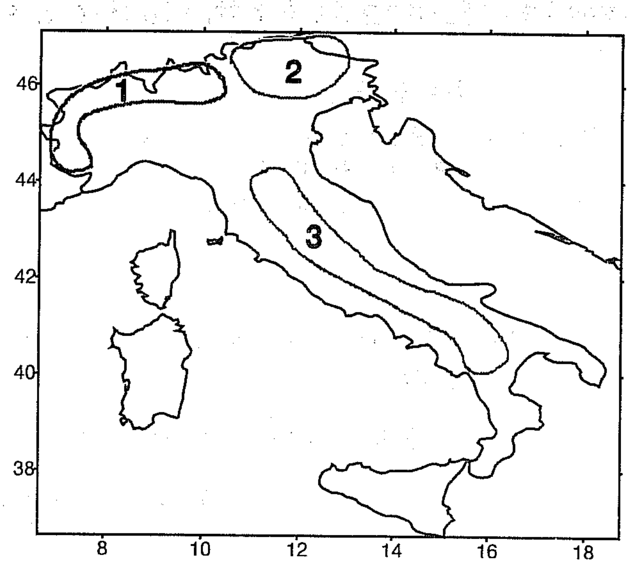


Fig. 1

Fig. 2, 3, 4 show the average producibility for each month and its standard deviation, for the period from 1953 till 1980. Producibility data have been normalised respect to possible power plant variations during this period. Over the same areas the monthly rainfall, averaged over a certain number of stations, most at high altitude have been computed.

As a first analysis, one can examine the matrix built with the correlation coefficient between producibility of the month indicated at the top of the column and the precipitation of the month indicated on the row (fig. 5, 6, 7). Of course the precipitation months are intended to be before or contemporary the producibility month. The highlighted values, shown in the three tables, are higher than 0.5. In the North West Alps (fig.5) the highest values are located around the main diagonal only in fall. In fact in the other periods of the year the effect of the precipitation on the producibility is delayed of some months.

The precipitation in winter, that are much more snowfall, affects the production in summer with the high correlation coefficient of 0.7. There is also some noise due to lower basins also affected by rain. The same effect can be seen on the area n. 2 (North East Alps) in fig. 6. For the area n. 3, the Apennines, the correlation coefficients in fig. 7 have a different behaviour: the highest are on the diagonal during winter, spring and fall, very low in summer. This fact is in accordance with the climatic characteristics of that region (dry summer and rainy cold seasons).

A quite good correlation with spring producibility can be obtained adding the rainfall of many consecutive months, as can be seen in the graph in fig. 8. This graph shows also the sensitivity of producibility to the rainfall amount. In the case of Western Alps is about 4 GWh for every mm., Of course this quantity probably depends on the measurement points used. From this analysis we can conclude that a seasonal precipitation forecast can be useful especially in fall, for the north of Italy. On the contrary, a good snow monitoring can be sufficient to forecast spring and summer producibility. For the rest of the country we need a correct forecast during all the year except in summer. Of course further investigations must be done on the influence of temperature on producibility.

A very important requirement is that the forecast is geographically correct with regard the side of the Alps. Every meteorologist knows that a period with strong rainfall in northern Europe correspond to a dry period in the South of Alpine region. The consequence is that the spatial resolution of seasonal forecast is a crucial problem, otherwise synoptic information might be combined to rainfall forecast in order to better confine the rainfall pattern. Perhaps the frequency of a certain synoptical pattern can be a better seasonal predictor over the Alps than the average precipitation field.

In conclusion the possibilities offered by the ECMWF seasonal forecast are worth to further investigation for Italian electric system.

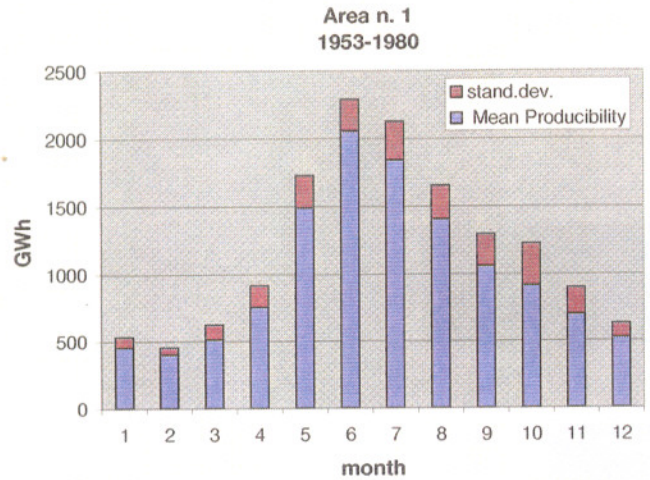


Fig. 2

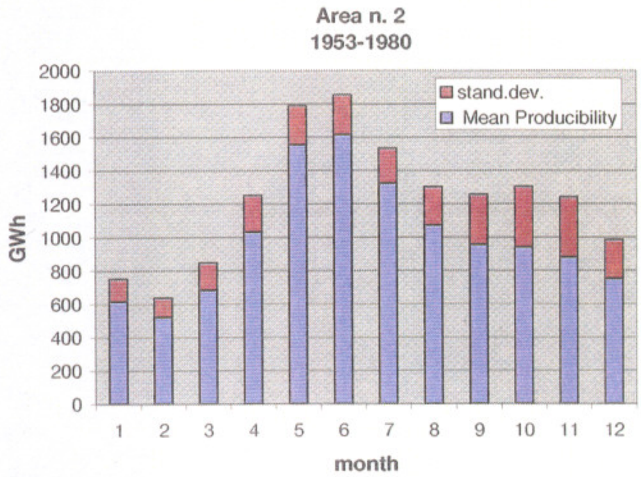


Fig. 3

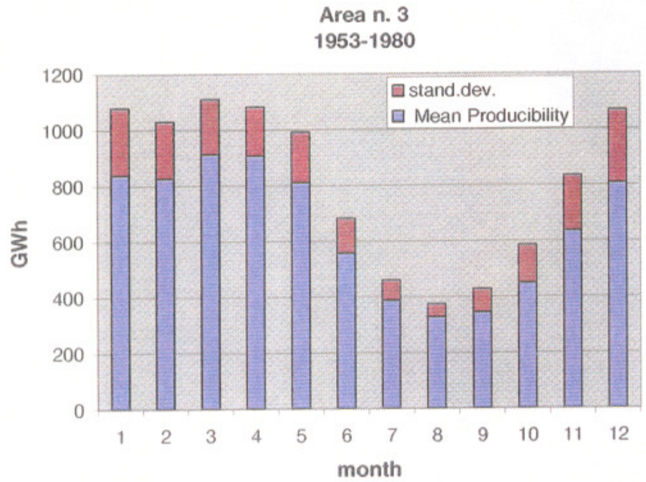
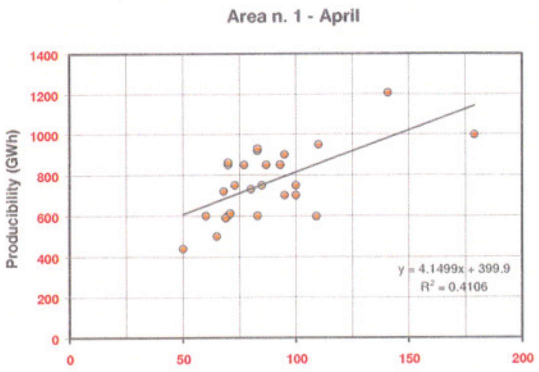


Fig. 4

Fig. 8



Area n. 1

Precipitation \ Producibility	1	2	3	4	5	6	7	8	9	10	11	12
1	0.15	0.1	0.28	0.11	0.22	**0.69**	**0.7**	**0.53**	0.08	-0.01	-0.15	-0.14
2	0	0.22	0.38	0.32	0.21	0.38	0.32	0.13	0.02	0.05	0.08	0
3	-0.1	-0.01	0.12	0.23	0.33	0.41	0.29	0.38	0.14	-0.13	-0.08	0.02
4	0.19	0	0.12	0.13	0.22	-0.09	-0.05	0	-0.15	-0.08	0.1	0.15
5	-0.04	-0.01	0.04	-0.13	0.37	0.42	0.48	0.46	0.22	-0.09	-0.03	0
6	0.02	0	-0.25	-0.24	0.07	0.15	-0.01	-0.12	-0.11	-0.26	0	0.08
7	0.15	0.21	0.32	0.03	0.04	0.15	0.06	0.02	0.24	0.34	0.14	0.14
8	0.26	0.3	0.39	0.06	0.22	0.13	0.2	0.25	**0.61**	0.43	**0.51**	0.44
9	0.23	0.32	0.32	0.34	0.08	0.09	0	-0.01	**0.76**	**0.52**	0.38	0.28
10	0.47	0.46	**0.54**	0.25	-0.05	0.22	0.28	**0.5**	0.08	**0.83**	0.45	**0.54**
11	0.3	0.21	0.03	0.27	0.47	-0.04	-0.05	-0.09	-0.08	-0.04	**0.55**	0.42
12	0.46	**0.67**	**0.54**	0.28	0.24	0.11	0	0.06	-0.05	0.34	0.09	0.48

Fig. 5

Area n. 2

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.42	0.46	**0.59**	0.15	**0.51**	0.48	**0.59**	**0.51**	0.01	0	-0.18	-0.19
2	0.05	**0.56**	0.43	0.02	0.31	0.22	0.19	0.16	0.1	0.03	0.14	0
3	-0.18	-0.05	0.26	0.45	0.49	**0.5**	0.22	0.24	0.08	-0.21	-0.16	0.02
4	-0.21	-0.1	-0.06	0.15	0.05	-0.15	0.13	0	-0.06	-0.15	-0.21	-0.11
5	-0.14	0.06	-0.17	-0.03	0.17	0.38	0.36	0.32	-0.02	-0.49	-0.17	-0.13
6	-0.32	-0.37	-0.52	-0.49	-0.35	0.24	0.06	-0.09	-0.13	-0.36	-0.32	-0.1
7	0.38	0.19	0.14	-0.11	-0.05	-0.07	0.07	0.06	0.26	0.28	0.15	0.33
8	-0.03	-0.01	0.04	-0.14	0.06	-0.15	-0.25	**0.53**	**0.52**	0.11	0.38	0.23
9	0.11	0.32	0.12	0.02	-0.09	-0.24	-0.06	0.09	**0.81**	0.49	0.38	0.28
10	0.46	0.14	0.39	0.06	-0.17	0.36	0.09	0.13	0.14	**0.6**	0.22	0.43
11	0.27	0.1	0.02	0.46	0.22	0.04	-0.12	0.12	0.02	-0.11	**0.57**	0.4
12	**0.51**	0.38	0.26	0.11	0	0.05	-0.01	-0.14	0.11	0.34	0.17	**0.68**

Fig. 6

Area n. 3

	1	2	3	4	5	6	7	8	9	10	11	12
1	**0.69**	**0.53**	0.19	0.3	0.39	0.43	0.33	0.33	0.12	-0.07	-0.14	-0.12
2	-0.09	**0.58**	0.43	0.22	0.23	0.11	0.23	0.29	0.13	0.05	-0.3	-0.21
3	**0.57**	0.18	**0.69**	0.49	0.12	-0.08	0.21	0.11	0.11	0.18	0.15	0.31
4	0.12	0.05	-0.24	**0.62**	**0.55**	0.18	0.21	0.14	0.18	-0.04	-0.09	0
5	-0.16	0.12	0.2	0.04	0.2	0.19	0.09	0.11	-0.05	-0.18	-0.22	0.01
6	0.13	0.3	0.28	-0.3	-0.07	0.24	0.23	0.31	0	0.1	0.08	0.35
7	0.08	-0.06	0.03	-0.14	-0.29	-0.24	0.33	0.32	0	0.35	0.23	0.37
8	0.02	0.23	0.19	0.05	0.16	0.15	0.14	0.03	0.31	0.08	-0.08	0.14
9	0.29	0.07	-0.18	-0.04	0.09	-0.07	-0.15	-0.14	**0.81**	0.26	-0.02	0.1
10	-0.04	-0.31	0.17	0	0.03	0.02	-0.01	-0.03	0.29	**0.71**	0.04	0.2
11	0.35	0.31	0.04	-0.12	0.01	0.23	0.37	0.43	0.17	0.02	0.49	0.34
12	**0.56**	0.36	0.3	0.23	0.02	0.34	0.44	**0.5**	0.44	0.18	0.12	**0.7**

Fig. 7