

INCREASING THE VALUE OF METEOROLOGICAL OBSERVATIONS FOR WATER RESOURCE MANAGEMENT: THE CASE STUDY OF MONTE BALDO

Michele Costa¹, Alessio Pasetto¹ and Dino Zardi¹

¹ Atmospheric Physics Group, Department of Civil and Environmental Engineering, University of Trento, Trento, Italy
E-mail: foralps@unitn.it

Abstract: Preliminary results are shown from a research work aiming at retrieving, collecting in a data base and analysing measurements from both existing and dismissed weather stations in the area of Monte Baldo (Southern Central Alps). The work aims at producing a climatological analysis to be used, in connection with geological and hydrological input, for the purpose of water management. This activity involved not only researchers, but also local communities, public authorities, stakeholders and end users, providing an appreciable example of coordination and cooperation between many subjects variously responsible of and interested in the use of water resource. Then on the basis of the gathered information, some pro-active proposals were prepared, to be shared with the authorities dealing with the territorial management.

Keywords: *meteorological measurement network, rain gauges, water resource management*

1. INTRODUCTION

The mountain chain of Monte Baldo, in the southern Prealps, lies between the Lake Garda and the Adige Valley (Figure 1). It is about 36 km long and 11 km wide and is composed of a main chain, with an elongated crest about 2200 m high in NNE-SSW direction, and a series of various surrounding elements, such as small ridges, plateaus, steps and natural terraces.

The Baldo chain is composed of two separated bodies: one from Punta San Vigilio till Bocca di Navene (1430 m. a. m. s. l.); and the other the Mt. Altissimo of Nago (2078 m. a. m. s. l.) from Bocca di Navene till Sella di Loppio. The first is not only the widest, but also includes the highest summits among which Punta Telegrafo (2200 m a. m. s. l.), Cima Valdritta (2218 m a. m. s. l.) e Cima delle Pozzette (2132 m a. m. s. l.).

Ranging from 65 m a. m. s. l. of Lake Garda up to about 2200 m a. m. s. l. of its main crest, Monte Baldo displays a remarkable variety of geographical characters and ecosystems, in particular flora, after which it deserved the name of *Hortus Europae* (Garden of Europe). This variety is reflected in its territory, which includes various particular kinds of economic activities, ranging from tourism to industrial and business activities, to mountain houses and alpine meadows for cattle breeding, and some minor ski resorts.

However a limiting factor for most of these activities, as well as for many other mountain areas in the region, is the remarkable deficiency in water resource, a severe restriction for the development of the area. One further problem for the management of such a scarcely available resource is the lack of knowledge (monitoring, database, studies, etc.) about precipitation and its distribution in space and time.

The climate of Monte Baldo shares features typical both of the Po Plain, a large alluvial plain adjacent to the Mediterranean area, and of the Alpine region. Furthermore several various microclimates can be identified from the feet of the mountain (especially on the side facing Garda Lake) up to the highest summits, hosting remarkable samples of biodiversity.

For these reasons Monte Baldo has been adopted as a case study within the project FORALPS (“Meteo-hydrological Forecast and Observations for improved water Resource management in the ALPS”). FORALPS is supported by the European Union with the European Regional Development Funds (ERDF) under the initiative Interreg III B “Alpine Space” (cf. Pasetto *et al.*, 2007).

2. METEOROLOGICAL MONITORING ON MONTE BALDO

From an administrative viewpoint, the northern part of Monte Baldo belongs to the Province of Trento, while the southern one to the Province of Verona. Moreover, as it is clear from Figure 2-right, Monte Baldo is at the border line between the two hydrographic basins of Rivers Adige and Po. The above fact reflects in a remarkably different situation for what concerns the water management. In the southern area there is a severe water scarcity due to natural conditions that cause underground water to flow towards Lake Garda ;

while in the northern area there is a relative abundance of natural springs and water can be stored also for hydroelectric power production (as in the artificial basin of Lake Pra da Stua).

The management of this territory, rich in beauties and natural resorts, requires a detailed monitoring of environmental resources. In particular the improvement of the information concerning those resources which depend on weather and climate (such as water, tourism) could significantly improve the economic, social and cultural activities therein.

An analysis of the situation of the meteorological network in the past and the comparison with the actual one is preliminary summarised in the present contribution: a more detailed account will be available in a separate technical report in preparation (Costa, 2007). The network of meteorological stations has been drastically reduced during the last 30 years. A report of the situation is described below.

Looking at the current situation (Figure 2-left) it is clear that nowadays there is a severely inhomogeneous distribution of the weather stations in the area: while the northern part (Trento) is well covered by stations installed by the local institutions, in the southern part (Verona) the only stations remaining were installed and are currently being operated by amateurs in meteorology, interested in specific applications, such as monitoring weather condition for assistance to tourists sailing on Lake Garda, air temperature measurement at the refuges, measurement of precipitation for the botanic garden or evaluation of conditions for optimal observations with telescopes at the astronomical observatory of Novezzina.

It is also quite evident that along the main chain, where orographic factors mostly influence the weather at local scale, there is no meteorological station. The unique exception is the weather station at the refuge Fiori del Baldo (at 1815 m a. m. s. l.), installed and managed by the owner of the refuge. Unfortunately the weather data collected in the territory of Verona are not stored and archived by any local institutions, so there is no way to have a common format and structure of dataset at the moment.

About 30 years ago the meteorological network in Monte Baldo area (Figure 2-right) was really different from the current situation: the National Hydrographic Service was in charge of the management of the hydro-meteorological network in Italy and all the data were collected and archived. During the '70s this role passed to regional Offices that autonomously decided the change, decommitment or substitution of the already present stations.

In particular in the River Adige Valley (East of the Baldo chain) several weather stations were installed and the climatology of the area was well monitored; the measured data was validated, collected and archived in the periodic publication "Annali Idrologici".

In the framework of FORALPS, some of this history database was found and collected; after that, a first elaboration was carried out in order to give contributions to the climatological characterisation of the area (Vicenzi, 2006).

The elaboration has first considered the precipitation set of data directly useful for the water management. Three records of data from as many weather stations, representative of the local territory, were selected for the period 1950-1974: the stations (figure 4) are Spiazzi (south-east part of the Monte Baldo, 930 m a. m. s. l.), San Zeno di Montagna (south west part of the Monte Baldo, 583 m a. m. s. l.) and Malcesine (along the northern Garda Lake coast, 90 m a. m. s. l.).

The dataset analysed is composed of daily precipitation measurements, that were originally aggregated in different temporal scale records: monthly, seasonal and annual records of values.

The comparison of these temporal levels of dataset showed both some similarity and some differences among the stations due to local environmental and orographic conditions.

In particular the annual mean value of precipitation are very similar for the three locations staying between 1000 mm and 1100 mm.

The elaboration of monthly and seasonal data, instead, allowed to point out different trends that are traced to the effect of local meteorological forcing such as the presence of Lake Garda: this water body determines at this scales effects much more evident from the analysis of extreme events such as high precipitation or hail, really frequent in the west part of the Monte Baldo, even at intermediate altitude and originating from the moist atmosphere upon of the lake. The Monte Baldo chain, with its position, looks like an obstacle to the movement of this phenomena that are deviated more frequently to the city of Verona than to the Adige valley.

The analysis, although utilising data from stations not uniformly distributed in the territory and for a short period of measurements, has pointed out the necessity to deeply investigate the local phenomenology in order to give corrects interpretations to the different meteorological situations and utilization of environmental resources.

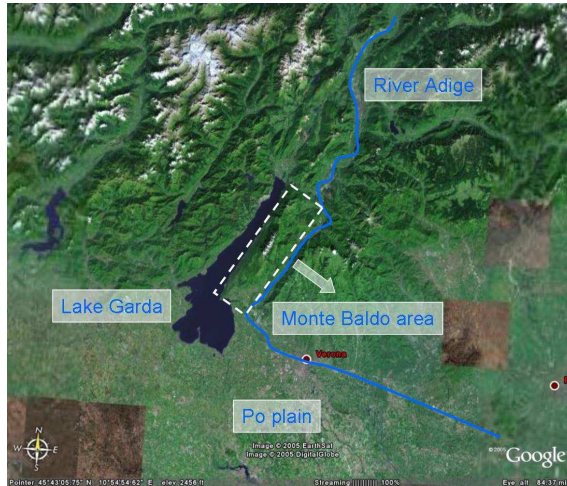


Figure 1: Overview of Monte Baldo, a “balcony” in the Prealpine chain facing the Po Plain.

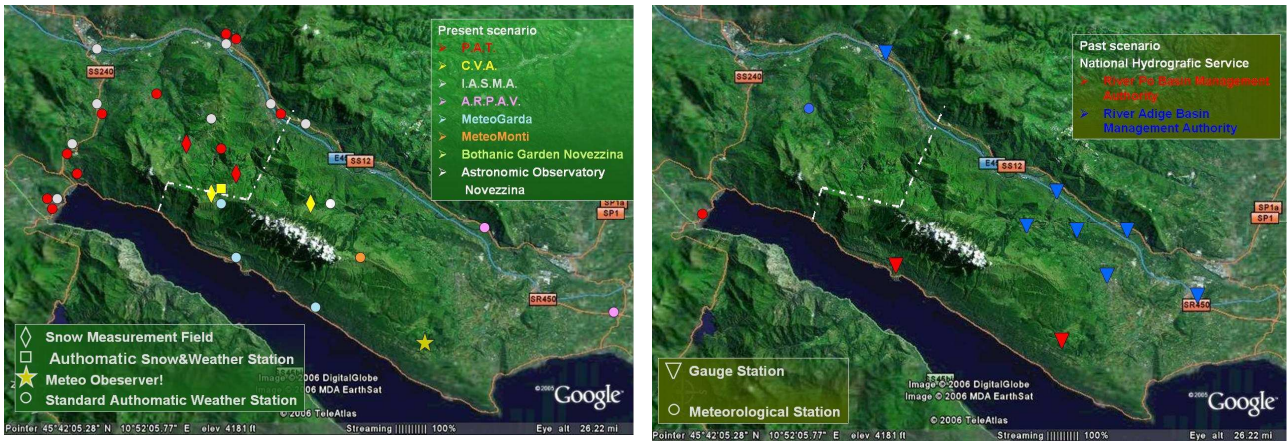


Figure 2: Left: Present state of the weather station network on Monte Baldo. Right: Past state of the weather station network on Monte Baldo

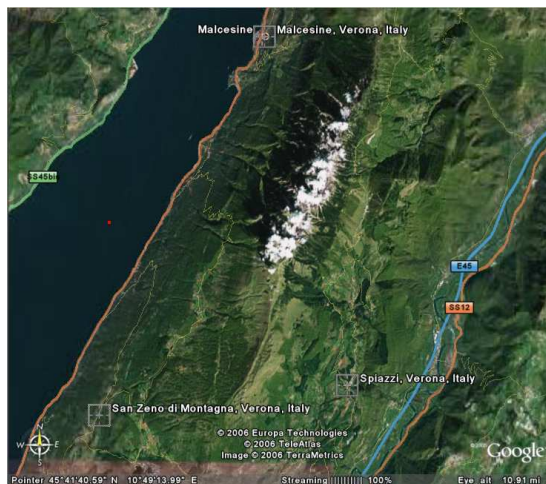


Figure 3: Localization of the three rain gauge used for the study

3. CONCLUSIONS

Thanks to the EU Project FORALPS a considerable amount of meteorological information pertaining to the monitoring of Monte Baldo and its possible applications has been collected and described. In particular an analysis of the hystoric path of the monitoring activity has been recovered; the study has permitted to localize and gather a lot of data and metadata, till now unknown also to local population.

These objectives has been obtained through the creation of a multilevel network of contacts in the Monte Baldo area; composed of end users, stakeholders, local institutions and decision makers interested in the improvement of the meteorological monitoring of the area.

The results have dimonstrated that this improvement is indispensable and could have positive effect in the development of the area due to some principal reasons:

- application of this improved knowledge to the provision of water resource and protection of the territory from natural hazard, through a complete hystoric database and a current good network of measurements. This issue is heavily required by the new company (AGS) that since year 2005 has the responsibility to unify and to make more efficient the water provision system in the Baldo area;
- specific economic activities that could advantage from detailed present and historyc meteorological information, i.e. development of touristic economy during both in the summer season with meteorological information for operators and tourists and in the winter season, with powerful of ski resort through utilising artificial snowing production;
- protection of the environmental treasures of the area, through a deep knowledge, required by the local communities and associations devoted to the increase in value of the territory;
- study of the mountain meteorology particularly sensitive to the effect of climate change.

The work of recovering as many information as possible carried out in the framework of the project FORALPS and its subsequent analysis should be a sample of the richness an utility of these information that should be maintained not only for the present but also for the future, especially in such a delicate mountain environment, where human activities can produce significant impacts.

Acknowledgements:

The Authors thank:

- *the Azienda Gardesana Servizi(AGS) and the Comunità Montana del Baldo for providing various documents and information concerning Monte Baldo;*
- *prof. Alberto Carton, Department of Geography, University of Padova, for many fruitful discussions;*
- *Centro Valanghe in Arabba for providing the data;*
- *The Italian National Environmental Agency (APAT) for sharing preliminary results of the “Progetto Annali”;*
- *The organisers of the initiatives “Baldofestival”, “Meteogarda” and “Meteomonti” and the members of the club “Circolo Astrofili Veronesi”;*
- *The owners of the refuge Rifugio Fiori del Baldo for providing data from their private weather stations;*
- *The Authority “Autorità di Ambito Territoriale Ottimale” of Verona for useful discussions and directions.*

REFERENCES

- Pasetto, A., S. Serafin, D. Zardi, 2007: The project FORALPS: contributions for a wise management of water resources form meteorology and climatology, Proceeding of the 29th International Conference on Alpine Meteorology (ICAM2007), Chambéry (France), 4-8 June 2007.
- Bissoli, C., 2005, Valutazione della risorsa eolica in area alpina [Evaluation of wind resource in an Alpine area], Dissertation for the First Degree in Environmental and Land Planning Engineering (Supervisors D. Zardi and M. de Franceschi), Faculty of Engineering, University of Trento (in Italian).
- Costa, M., 2005, Caratterizzazione meteorologico-climatica della catena del Monte Baldo [Meteorological and climatological characterisation of Monte Baldo], Dissertation for the First Degree in Environmental and Land Planning Engineering (Supervisors: D. Zardi and M. de Franceschi), Faculty of Engineering, University of Trento (in Italian).
- Costa, M., 2007, Assessment of costs and benefits deriving from improved meteo-hydrological information: the case study of Monte Baldo, FORALPS Technical Reports.
- Turri, E., 1999, Il Monte Baldo, CIERRE Edizioni (in Italian).
- Vicenzi, M., 2006, Analisi di serie di misure di precipitazione relative al Monte Baldo per il periodo 1950-1974 [Analysis of precipitation measurements in Monte Baldo region for the period 1950-1975], Dissertation for the First Degree in Environmental and Land Planning Engineering (Supervisors D. Zardi, A. Pasetto and M. Costa), Faculty of Engineering, University of Trento (in Italian)