

SASI: AN AUTOMATED REAL TIME SYSTEM FOR HYDROLOGICAL MONITORING

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ABSTRACT

The Italian Hydrological Service's institutional task is that of territory monitoring through a telemeasuring net, called "Surveying and Monitoring National Net", made up of about eight hundred among pluviometer, termometer and hydrometer stations in order to make available, as soon as possible, all about concern rain fall, river hydrometrical height and any other kind of information that can be deducted from the measurements taken. Besides this, the Service also takes wind velocity and direction measurements, as well as air humidity measurements and atmospheric pressure. All of this is done by special equipment located at the Compartmental Office that the Station refers to, which calls each station through etere. The measurement set is coded into one or more files and stored inside an NT Server, placed at the same Office. The total of the NT Servers, one for each of the ten Compartmental Offices, are networked through the ITAPAC geographical net to an NT Server at the General Headquarter. The General Headquarter has developed a program, named SASI, which is able to read, decode, interpret, organize into tables and store the text file realized by the Compartmental Offices computers. A feature of such program creates a user interface so that it can give a real time evaluation of the hydrological events.

1. INTRODUCTION

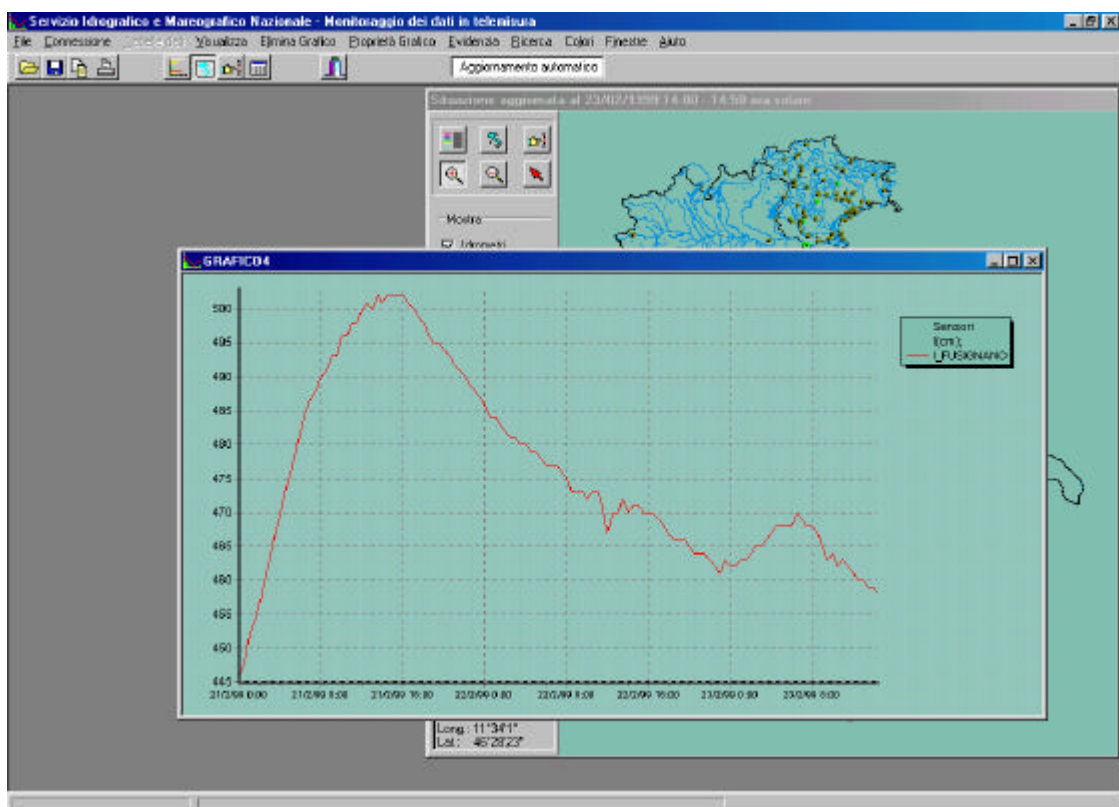
The Italian Hydrological Service's institutional task is that of territory monitoring through a telemeasuring net, called "Surveying and Monitoring National Net", made up of about eight hundred among pluviometer, termometer and hydrometer stations in order to make available, as soon as possible, all about concern rain fall, river hydrometrical height and any other kind of information thart can be deducted from the measurements transmitted from the Stations to the Department of Civil Protection or to other institutions interested in civil protections, like Prefectures, Municipalities and so on.

The National Hydrological Service is formed by the General Headquarter, located in Rome at the Department for National Technical Services and ten Compartmental Offices spreadout all over the Italian territory. More precisely, the ten Compartmental Offices are: Venice with its three Separated Sections in Udine, Padova e Stra; Parma with its three Separated Sections in Torino, Milano e Sondrio; Catanzaro with its Separated Section in Potenza; Pisa with its Separated Section in Firenze; Bologna, Pescara, Bari, Napoli, Roma, Genova.

As we already have said, the “Surveying and Monitoring National Net” makes mainly pluviometer, termometer and hydrometer measurements, but it also takes wind velocity and direction measurements, as well as air humidity measurements and atmospheric pressure. All of this is done by a special equipment, called DAS, located at the Compartmental Office which the Station refers to, that calls each station through etere. The measurement set taken from the Stations is coded into one or more than one files and memorized inside an NT Server, placed at the same Office. The total of the ten NT Servers, one for each Compartmental Office, are networked through the ITAPAC geographical net to an NT Server at the General Headquarter. The General Headquarter has developed a program, named SASI, which is able to read, decode, interpret, organize into tables and memorize the text file realized by the Compartmental Offices computers and another program, called RealTime, that creates a user interface so that it can give a real time evaluation of the hydrological events.

2. DESCRIPTION OF THE SYSTEM SASI

The project's main idea is to realize an application that integrates the functionalities of the existing software to let a rapid and easy access to tele-measured, real time data and historical data in order to put the user in the most favourable condition for taking decisions regarding the alarming of local and/or central institutions such as Civil Protection, Compartments, Municipalities and Prefectures in case of hydrological risk.



Example of a graphical representation of hydrometrical height.

Another requisite to be pursued is the program's portability (at least for the compartmental's net computers), in order to allow different users, such as Compartments or Civil Protection's offices, to access the data base in the same way, avoiding therefore misunderstanding on a situation due to the different manner of presenting data which would anyway happen if various instruments were adopted.

A more concrete consequence coming out from this integration of is that one to realize a faster execution speed and not to require a use of hardware resources which office computers do not possess; this brings some limitation to the new functions that the application should do, which is not an handicap when one bears in mind that the final aim is, at least up to date, that of a fast and friendly data base access for a hydrological real time monitoring.

The General Headquarter has developed a program, named SASI, which is able to read, decode, interpret, organize into tables and memorize the text file realized by the Compartmental Offices computers and another program, called RealTime, that creates a user interface so that it can give a real time evaluation of the hydrological events. The Real-Time program works as follows: it creates a vectorial geographical map on which is put each single station and the measurements from each station are presented both in a numerical and in a graphic format, may it be a line or an hystogram, and the memorized data are in addition visualized as a table. The program gives at last information on the connection status between the peripheral NT server and the central one, in terms of data updating. Finally, the program may represent a starting point for successive developments and extension s aiming to integration with other data base, like the Geological Service and Dikes Service data base, and also for different employments from the present project's ones. This requires as mandatory a detailed decription of the source code, of the algorithms involved and anything that may be useful to this regard or simply to the program maintenance itself.

Servizio	Racino	Data/ora	Quota	Località	Comune	Provincia	Compartimento	Tabella	Amministrativa
L_Diga_di_Cobona	Tenere	23/2/99 14:00	119	Cobona	Orvieto	TR	RM	PS_ROMA	SIMN-URBIO
L_ANDOLA	Ghivovola	23/2/99 14:30	30	Andola	Andola dell'Emilia	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_MARECCHIA_PALTRONE		23/2/99 14:30						PS_BOLOGNA	
L_PALTRONE_Mandato	Sareggia	23/2/99 14:30	37	Paltrone	Andola dell'Emilia	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_PALTRONE_Sareggia	Canale di Bonifica	23/2/99 14:30	37	Paltrone	Andola dell'Emilia	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_IMPIANTO_FORDELLI_Lavino	Lavino	23/2/99 14:30	28	Impianto Forcelli	Sala Bolognese	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_IMPIANTO_FORDELLI_Canale	Sareggia	23/2/99 14:30	35	Forcelli	Sala Bolognese	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_IMPIANTO_FORDELLI_Mandato	Lavino	23/2/99 14:30	28	Impianto Forcelli	Sala Bolognese	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_SOSTEGNO_Canale	Pieno	23/2/99 14:30	24	Sostegno	Sala Bolognese	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_SOSTEGNO_Reno	Pieno	23/2/99 14:30	24	Sostegno	Sala Bolognese	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_PRAICCHIA	Pieno	23/2/99 14:30	627	Pracchia	Pracchia	PT	BO	PS_BOLOGNA	SIMN-URBIO
L_BAGNETTO_Mandato	Pieno	23/2/99 14:30	23	Bagnetto	Castello D'Agole	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_BAGNETTO_Canale	Pieno	23/2/99 14:30	23	Bagnetto	Castello D'Agole	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_BAGNETTO_Reno	Pieno	23/2/99 14:30	23	Bagnetto	Castello D'Agole	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_Podemonza	Mediana Livinina	23/2/99 14:00	23	Podemonza	Podemonza	PN	VE	PS_MAGVE2	Registrazione all
L_CORRECCIO_Silvio	Correchio	23/2/99 14:30	23	Correchio	Inole	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_OPERA_RENO	Pieno	23/2/99 14:30	25	Opera Reno	San'Agostino	FE	BO	PS_BOLOGNA	SIMN-URBIO
L_MASSAROLO	Galano	23/2/99 14:30	14	Massarolo	Medicina	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_CADONE	Servena Abbadesse	23/2/99 14:30	17	Cadone	Malaberga	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_FOSGAGLIA_Ponero		23/2/99 14:30						PS_BOLOGNA	
L_FOSGAGLIA_Canale		23/2/99 14:30						PS_BOLOGNA	
L_Mogliano_Veneto	Bosco Scolante	23/2/99 14:00	0	Mogliano Veneto	Mogliano Veneto	TV	VE	PS_MAGVE2	Registrazione all
L_Ariano_Marano_Equo	Tenere Ariano	23/2/99 14:00	310	Mariano Equo	Roma	RM	RM	PS_ROMA	G.E.TEVEVE
L_ARCONVEDGIO	Canale Navile	23/2/99 14:30	29	Arconveglio	Bologna	BO	BO	PS_BOLOGNA	SIMN-URBIO
L_SECCINO_SALTO	Canale Napoletano	23/2/99 14:30	30	Il Salto	San'Agostino	FE	BO	PS_BOLOGNA	SIMN-URBIO
L_SALTO		23/2/99 14:30	1499					PS_BOLOGNA	

Example of a table data representation.

3. FUTURE DEVELOPMENTS

The system SASI can be easily improved by adding new features for assisting people dedicated to monitoring services. The features that we aim to add to the system SASI are described in the following paragraphs.

3.1 The Isohyet Calculus and Visualization

A standard way to visualize the precipitations during a period of time and in a determined area is that of the isohyet. To calculate an isohyet, approximate procedures are used, which allow to obtain results depending on the observation and processing method, even if with a relative small number of measurements. These calculations may be done by taking as a reference a reticulum with a sufficient number of points to let a fast elaboration and assigning to it a mean value among those of the nearer stations contained in each circular sector centered in the point itself. The application has, among its possible developments, the possibility of calculating the isohyet for an area chosen by the user and for a selected period of time containing some data, and of visualizing the result over the available cartography.

3.2 The Use of Scale for the Water Flow Calculus

A very significant information that characterizes a fluvial section is its deflusso scale: it puts into correspondence the hydrometric height, measured from the river bottom, to the water flow in that section. To realize such scales are necessary observations and measurements at different heights, in different year periods and under various conditions; these scales can be modeled anyway with a family of functions dependent on two parameters. The application can therefore be expanded in order to give the river water flow, once a data base table has been filled in with the parameters of the portate scales for the different sensors.

3.3 The Realization of a Hydrometric Sensor Reticulum and the Analysis of the Water Flood

Some of the hydrometers are localized on the same river, one being at hill and the other down stream. This information, which is something different from information on their position and on their belonging station, is very important for the sensor correct geographical location and the data interpretation. By having this information, is possible to make a reticulum, a tree representation to be more precise, in which the data are organized and the application can utilize these data to control and forecast the behaviour of the basins, like the passing of the wave flood, the calculus of the concentration time and in general the monitoring of risk situations.

3.4 The Inclusion of Meteorological Chart

For a more effective monitoring is foreseen the use of meteo charts, beyond the use of the georeferenced sensors' data. For this purpose, one can use both visible field charts, infrared field charts, and charts of the water steam contained in the atmosphere. The application needs that the data be in some graphic format, such as a bitmap realized by decoding the information sent from a satellite to a receiver, and that these data be stored in the Service server making them therefore available through the local net.

3.5 The Dikes Data Visualization

A new important vision is the visualization of the information relative to the dikes over the national territory and under the supervision of the Dikes Service; the dikes themselves might be underlined on the chart using an appropriate symbol to take them into account in the evaluation of risk situations and critical events. Such information as the artificial basin size, the normal and maximum filling percentage, the total height, the water flow during the opening period, the administrative information and so on, are stored in another database and will be accessible straightforward from the chart where the dikes and sensors are represented.

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