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APPLICATIONS OF ENVIRONMENTAL INFORMATION SYSTEMS IN HYDROMETEOROLOGICAL FORECAST

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Abstract: *Environmental Informatics, defined as the research and system development focusing on the environmental sciences relating to the creation, collection, storage, processing, modeling, interpretation, display and dissemination of data and information, could be considered one of the best options which provide the expected solutions for the increasing complex expectations of the mankind in the field of ambient protection.*

In a broad sense, hydrometeorology is a border line science linking meteorology - the science of atmosphere - with hydrology - the science of water of the earth and earth's atmosphere.

The purpose of the present paper is to extend the perspectives in studying of Environment Information Systems integrated in the problematic issues reclaimed by the hydrometeorology field. Therefore, during this work paper, we try to give additional explanations for the methodologies and strategies implicated in the evaluation and forecasting processes with a vision in developing future.

According to the real impact of the Environmental Information Systems focuses on the development of new and innovative approaches to the creation, dissemination and applied use of environmental information resources we reemphasize the significant role of EISs in the attractive background of hydrometeorology. Obviously, the importance of the subject of hydrometeorology has become increasingly recognized and it is studied with the help given by the tools develop in this sense, tools that make the importance of Environmental Information Systems to be vital in the context of applied hydrometeorology.

Keywords: *Environmental Informatics, environmental sciences, hydrometeorology*

1. INTRODUCTION

The present era that we are living can be described, without restraint, as the "Information Age" [11, 12]. No matter what area of science and technology we look at, it is more obvious than ever that we are dealing with an 'information overflow' without precedent in the history of humanity [3].

In this context is being clear to everyone that we are dealing also with an 'environmental information overflow'.

Environmental Sciences are no exception to the rule [2], so the recent advances in this field would have been unthinkable, unmanageable and unattainable without the support offered by the computational mathematics and the modern information technology tools, in the sense of Environmental Information Systems or in the large perspective given by the Environmental Informatics [2, 3].

Environmental Informatics (EI) [11], defined as the research and system

development focusing on the environmental sciences relating to the creation, collection, storage, processing, modeling, interpretation, display and dissemination of data and environmental information, could be considered one of the best options which provide the expected solutions for the increasing complex expectations of the mankind in the field of ambient protection.

Also EI with the exceptional help of Environmental Information Systems (EISs) [3], provides the information processing and communication infrastructure to the interdisciplinary and very complicated field of environmental sciences aiming at data, information and knowledge integration, the application of computational intelligence to environmental data as well as the identification of environmental impacts of environmental information technology.

As a part of the Environmental Informatics [11] and also as a branch of meteorology that deals with problems involving the hydrologic cycle, the water budget and the rainfall statistics of storms, the hydrometeorology could be consider, in a broad sense, as a border line science linking meteorology - the science of atmosphere - with hydrology - the science of water of the earth and earth's atmosphere.

However, the perception of this science is often premature and non-unanimous [3,12], factor which makes the boundaries of the hydrometeorology to be not clear-cut and the problems of the hydrometeorology to overlap with those of the climatologist, the hydrologist, the cloud physicist, the weather forecaster and the managers. Much more, this perspective for different specialist to interact makes considerable emphasis which are placed on determining, theoretically or empirically, the relationships between meteorological variables and the maximum precipitation reaching the ground. These analyses often serve as the bases for the design of flood-control and water-usage structures, primarily dams and reservoirs.

Other concerns of both informaticians and hydro-meteorologists include the determination of rainfall probabilities, the space and time distribution of rainfall and evaporation, the recurrence interval of major storms, snow melt and runoff, and probable wind tides and waves in reservoirs.

The whole field of water quality and supply is of growing importance in hydrometeorology and also in the sector of environmental information systems, where the environmental informaticians give the necessary information for shaping, creating and implementation of the sustainable development strategies for local and regional communities.

2. CONSIDERATIONS OF EISs IMPLICATIONS IN HYDROMETEOROLOGICAL FORECAST

2.1 The hydrometeorology – conceptual boundaries and perspectives

The hydro-meteorological science with its relative applications [1] has made strong progress over the last decade at the European and worldwide level. In these conditions appear new modeling tools, post processing methodologies and observational data. The recent European efforts in developing a platform for e-science provide an ideal basis for the sharing of complex hydro-meteorological data sets and tools.

Despite these early initiatives, however, the awareness of the potential of the Grid technology as a catalyst for future hydro-meteorological research (HMR) is still low and both the adoption and the exploitation have astonishingly been slow, not only within individual EC member states, but also on an European scale.

Lately, special attention was given to research, management and control issues whether we refer to environmental pollution, as a whole, whether we talk about risks (hazards) technological or natural and all disturbing elements to the dynamic equilibrium of the environment or with a degree or another of acceptability for the population.

For the development of hydrological forecasts, the necessary basic data are collected the field devices via a network of meteorological and hydrological characteristic points located in the river basins [4, 6]. These

data are transmitted to the dispatcher center where are processed resulting the real characteristics of floods.

At the dispatcher center arrive also recorded data on hydraulic structures in the area and after processing, resulting their influence on the hydrological regime. Having available all the data collected, the dispatcher center sets to reach the optimal commands hydro-technical constructions and protection measures required in various sections of the river network. Therefore, construction of a hydro-technical basin shall be the source of information for the hydrologic flow regime changed and beneficiaries of hydrological forecasts for optimal and safe operation.

2.2 The methodology of obtaining and disseminating the hydro-meteorological information. The Water Information Systems (WIS) and its importance

Measurement at the points of, the data are obtained using non-automated and automated processes media [4]. Non-automated resources are common and include the bridegroom, limnigraphes, hydrometers, thermometers, pluviometers, pluviographes.

Resources shall be automated stations equipped with sensors to measure rainfall and temperature main and stations equipped with sensors to measure water levels, rainfall and temperature.

Besides the main sensors at these stations can add sensors to measure other hydro-meteorological factors such as humidity, atmospheric pressure, wind direction and speed, the sunshines, the water equivalent of snow, etc.

Stations are measured at times scheduled by the collection, query cycle is adjustable between 15 minutes and 6 hours to the needs dictated by general hydro-meteorological conditions.

Basic means of systematic dissemination of hydro-meteorological information and forecasts are daily hydro-meteorological bulletin, but besides this, there are special situations or restricted areas, and in this case, we need a special hydro-meteorological bulletin.

The Environmental Information Systems (EISs) consists therefore of all means of collection, transfer, processing and verification of information in the decision-water resources of hardware known as well as all procedures, programs and information processing software, programs related-known means of software.

The Water Information System (WIS), as part of the EIS, include the classic, established based on human operators and automated water information system based on the - component calculation and applied ecuations or functions related to computational mathematics [7, 8].

The concept of information flow in the water includes all ways of gathering, transmission, processing and utilization of information as well as content and frequency.

Such information is divided into two categories [4]:

- slow flow or statistical information;
- fast or operators information flow in real time.

In the water activities decision-making shall be used both types of information [7]. Much of the information flow becomes faster recovery after slow flow information and is stored in so-called statistical databases and others that are not needed in decision-making disappear after a preset time.

Collection, compilation, processing and use of information decision scope selected from water are through specialized units called, "dispatching of the waters" with skills

in line with the country's territorial administrative organization [4, 9].

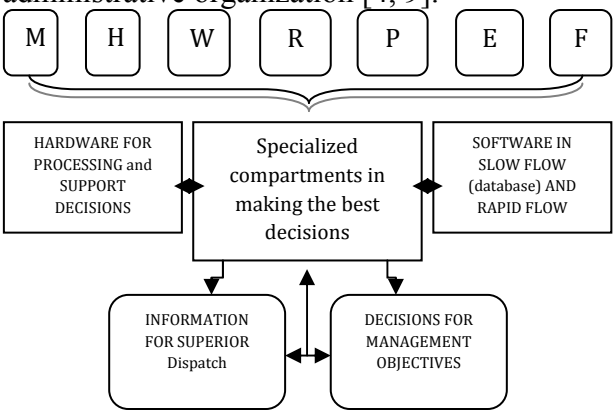

Fig. no. 1. The scheme of WIS-dispatcher

The input information [4] for the Wather Information System (WIS) - dispatcher are characterized by the following categories of data: meteorological (M), hydrological (H), data exploitation of hydrotechnical works (W), issues relating to regulation of water uses (R), the protection of water quality data (P), environmental protection (E), protection against floods and ice (F). The main products of the dispatch information refer to the selection of the higher dispatcher information and decide for dispatcher from managed targets, which shall be added and establish decision-making skills at different levels - which appears to be one of the most complex operations managerial.

In Europe, according to the implication of EIS in hydrometeorology as WIS, a large number of hydrometeorology research projects have been financed by the European Commission in the last years, projects such as:

- HyMeX (Hydrological cycle in the Mediterranean eXperiment, [13]);
- FLOODsite (Integrated Flood Risk Analysis and Management Methodologies, [14]);
- IMPRINTS (Improving Preparedness and Risk maNagemenT for flash floods and debriS flow events, [15]);
- FP6 PREVIEW (Prevention Information and Early Warning, [16]);
- CLIVAR (CLImate VARiability and predictability: a programme of the World Climate Research Programme, [17]);
- FloodProBE (Flood Protection of the Built Environment [18]).

2.3 Prediction of hydrometeorology events with help of EISs. Warnings and hydro-meteorological forecasts

Prediction of hydro-meteorological events relies on hydrological and meteorological forecast models [4, 9] that solve the basic equations that describe the hydrological cycle in the atmosphere. These predictions are based on observational measurements, for example of rainfall and river flow.

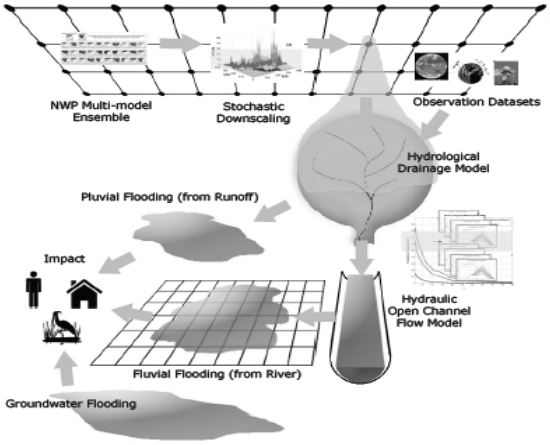

Fig. no. 2. Implication of EISs in hydrometeorological science area

In recent years [1], the quantity and complexity of the tools and data sets, as well as drawings, diagrams and charts making software, has increased dramatically for the next three reasons.

- ✓ remote sensing observations from satellites and from ground-based radars provide complete three-dimensional coverage of the atmospheric and land surface state, vastly increasing the quantity of data;
- ✓ forecasting methods combine multiple numerical weather prediction and hydrological models through stochastic downscaling techniques to quantify the uncertainty in the forecast;
- ✓ is increased recognition of the need to understand the entire forecasting chain, from observations through to civil defense response, resulting in complex workflows able to combine different

data sets, models and expertise in a flexible manner.

All the hydro-meteorological observations, forecasting methods and other prediction and models combine and develop, in a sense or another, tools given by Environmental Information Systems giving birth to a new science, of perspective, named Hydro-Meteo-Informatics.

Hydro-Meteorological Research is closely linked to operational forecasting. Researchers rely on data archives maintained by operational agencies and increasingly make use of operational modeling and simulating environmental informatics tools.

In establishing the basic hydrological forecasts, we have the following objectives:

- determine the data to be measured and collected, including the information from hydro-technical works amending the flow regime;
- establishment of computational methods, including the mathematical modeling operational;
- the endowment with the adequate computer equipment;
- ensuring a reliable informational system and the defense plans and operating regulations associated for taking of appropriate measures.

The hydrological prognosis is, in principle, through modeling, which is a research path of complex phenomena.

Application of hydrological models could have physical or mathematical dominant composition, as follows:

- ✓ representing the laws of the basin hydrologic (rainfall-runoff models) used for forecasting and generalizations;
- ✓ chronological simulation data strings to complete the measurements and observations of short duration, to which is added the transfer information, and extrapolation and interpolation of hydrological temporal and spatial parameters.

Another type of forecasting, which requires a detailed research and enjoys particular attention to, is the long-term hydro-meteorological forecast [6]. This may be based on water reserves of the basin, the water supply network of riverbeds or established statistical methods.

2.4 Environmental Information Systems applications in hydrometeorology forecast

Although international agencies like the United Nations or the European Commission (EC), national government organizations, and local authorities increasingly ask for globally certified management tools to deal with extreme events of precipitation and floods, the scientific community is still reduced to the ability to communicate *scenes* to urban, regional and national decision makers [5].

Unfortunately, the hydro-meteorological *scenes* are typically both information-light and emotion-heavy with a *degraded* view at scientific data and environmental information.

Important prerequisites of such abilities are observed data, formally sound models to supplement them, the reliable access to distributed data archives and interoperable computational technologies with respect to the Environmental Information Systems.

Without the support of an adequate information and communication infrastructure such, an undertaking will be difficult if not impossible [9].

As for scientific hydro-meteorological workflows the visualization instruments have to deal with an increasing amount of data generated by modeling tools and more sophisticated acquisition instruments.

3. CONCLUSIONS

In the context of the present era, perceived as the "Information Age", where is more obvious than ever that we are dealing with an 'information overflow' without precedent in the history of humanity, the importance of Environment Information Systems [12] is more than vital [11].

The perspective of Environmental Information Systems (EISs) [10] especially in solving many environments problems [2, 3], such as the problematic issues reclaimed by the hydrometeorology area – in accordance with this work paper - (prediction, prognoses, modeling and simulation models of floods [6], information dissemination to the public etc) [8] brings the idea that all this aspects must be integrated with the environmental information elements related to sustainable development.

Meteorologists, hydrologists and engineers have long recognized the value of hydro-meteorological data and more importantly the rainfall data for hydrologic analyses [5]. Thus, application and analysis of meteorological data for the solution of hydrologic problems has precisely come to be known as the science of hydrometeorology.

In engineering hydrology dealing with design and operation of water resource projects, the subject of hydrometeorology occupies a central position. Obviously, the same importance of the subject of hydrometeorology has become increasingly recognized [7, 8] even in the field of environmental protection engineering or in the environmental informatics area, and it is now studied not only by hydrologists and engineers but also by students from many different disciplines, with the help given by the tools develop in this sense, tools dedicated to EI [3] that make the importance of Environmental Information Systems to be essential in the context of applied hydrometeorology.

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