Modern means of monitoring the hydrological regime in the Siret River Basin (Romania)

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ABSTRACT: The hydrometrical monitoring of the water courses represents a major step in apprehending the hydrological regime.
The old systems of monitoring imposed - in special circumstances – great efforts from operators, who sometimes reached exhaustion. For example, a flood in the lower basin of the Siret River extends on a period of even more than a week; meanwhile the gauging station observer must provide recorded data at least three to three hours.
Lately new monitoring programs have been introduced to cover both classical gauging stations, and especially automatic stations which are already installed in the field.
DESWAT Project (Destructive Water) which was conducted with the financial and technical support of USAID (United States Agency for Investment and Development) and USTDA (U.S. Trade and Development Agency) aims to elaborate appropriate recommendations in the field of flood protection, including public information, and modernization of hydrological monitoring network in the Siret River Basin, using the latest technology. Siret Water Administration has currently 82 automatic gauging stations and 35 independent automatic rainfall stations from the DESWAT project. The information collected by the automatic stations represents basic elements for the hydrological forecasting program RFS (River Forecast System).
As a result of the project **"Plan for Prevention, Protection and Mitigation of floods in the Siret River Basin"** (Part I) there were obtained hydrological risk maps for the Siret River and its main tributaries, so that in Part II of the same project to be obtained risk maps for the smaller tributaries. As result of the project, Siret Water Administration also benefited of the hydrologic modelling software ISIS necessary to adjust and update the maps.
The **EASTAVERT Project** will be implemented by the partner institutions for water management in Romania, Ukraine and Moldova, and aims to reduce the vulnerability to flooding of the communities in the border regions by carrying out upgrading works at the hydrological complex Stanca-Costesti, improving the warning system by installing monitoring systems in the Siret and Prut River Basins and increasing the responsiveness of the population through information.

KEY WORDS: river network, automated hydrometrical station, DESWAT, RFS, EASTAVERT

1. Introduction

The hydrometrical monitoring of the water courses represents a major step in apprehending the hydrological regime. The first gauging station in our country was situated on the Danube, at Orsova, in 1838. Starting this year the hydrometrical network developed, so the gauging stations were located both on the Danube and inland rivers. Until 1925 there have been exclusively registered water levels observations on the rivers, but after 1955 the program has been improved. Thus, observations and measurements were made for the air and water temperature, slope area profiles, surface water, water flows, alluvial flow, chemical composition, heavy rains and snow depth, and the system is developing permanently.

As collecting a large amount of data in time, it was decided to organize them into hydrologic syntheses. These syntheses included general laws for the production, development and distribution of the main hydrological phenomena in Romania.

Because, during periods with special events (floods), old monitoring systems required great efforts on behalf of the operators, who sometimes reached exhaustion, and due to the rapidly increasing technology development, the monitoring of the rivers gradually moved from manual to automatic.

Lately, through a series of projects, Siret Water Administration has disposed of both monitoring of the river sectors and data processing programs improvement. At the moment as a result of the **DESWAT** project completion there are available 82 automatic gauging stations and 35 automatic pluviometric stations installed in the field, and a series of software installed on computers in the office. Following the completion of **the first part of the PPPDEI** project (Plan for Prevention, Protection and Mitigation of floods in the Siret River Basin) Siret Water Administration has been provided with the floodability study maps for the Siret River and its main tributaries (Suceava, Moldova, Bistrita, Trotus, Putna and Ramnicu Sarat) and the hydrological modelling software ISIS necessary for any modifications, adjustments or updates needed in time. In **the second part of the PPPDEI** project (which is in progress at the moment) are to be delivered, the longitudinal profile, the cross-sections and the floodability maps for the second, third, fourth and fifth order tributaries (after the Water Cadastre, 1992, the first order being the main course of the Siret River). Since 1st of December, 2013 the **EASTAVERT** project, which has as main objective the prevention and protection against floods in the upper sectors of the Siret and Prut basins, is in progress by implementing a modern monitoring system with automatic stations and modern hydraulic modelling software.

2. The area of investigation

The Siret River is the biggest river in Romania. It springs from the Paleogene flysch of the Ukrainians Carpathians at an altitude of approximately 1238 m (Ujvari, 1972) and drains, within its catchment the central-eastern part of the Eastern Carpathians and a part of the South-Eastern Carpathians, the Moldavian Sub-Carpathians and the northern part of South-Eastern Sub-Carpathians, the Moldavian Plateau and the Lower Siret Plain. The catchment area of the Siret River covers an area of 44 871 km^2 from which 42 890 km^2 in Romania. The total length of this river in Romania is 548 km, while there are another 110 km from its springs to the point it enters Romania.

The main relief lines decrease in height from west to east and from north to south. The morphographical and morphometrical features depend on lithology. This way in the Carpathians area, from west to east, there aligns the main morphological units (Atlas of Water Cadastral Survey Romania, 1992; Siret Water Basin Administration, 2005; Roşu & Stoica, 2008; Siret Water Basin Administration, 2009; Siret Water Basin Administration, 2011):

- Volcanic mountains, with massive forms and hard rocks. In this area the runoff is high (15 – 20 l/s/km^2) and the sediment yield is low (0.5 – 0.7 t/ha/yr.).
- Crystalline mountains, also with massive forms, and very high, because of the hard rocks, and with limestone intrusion. The runoff is still high (12 – 16 l/s/km^2) while the sediment yield is low (0.8 – 1.2 t/ha/yr.).
- Flysch Mountains are characterized by a great lithological variability; because of the over thrust layers. Here the runoff has values between 8-14 l/s/km^2, and the sediment yield become high (20 – 25 t/ha/yr. in the South-Eastern Carpathians).

The Sub-Carpathians are located on the eastern part of the Carpathians, characterized by the presence of some depressions bounded by anticline hills. In this area the runoff is between 8 – 10 l/s/km^2, and the sediment yield between 5 – 15 t/ha/an, but there are a lot of variations.

The main relief units from the platform region are the Moldavian Plateau, the Lower Siret Plain and the north-east part of the Baragan Plain. In the plateau, the runoff has values between 2 – 6 l/s/km^2, and the sediment yield between, 2 –5 t/ha/yr. In the plain area the values of the runoff and the sediment yield are much smaller.

3. Methodology

As the article presents the degree of modernization of the hydrometric network, in recent years, by means of the four projects (Project DESWAT, PPPDEI - part I, PPPDEI - part II, EASTAVERT Project) completed or in progress, the research was based on the data retrieved in old sources, the final reports of the developed projects, provided by the Siret Water Administration and the work schedule of the Bureau of Prognosis, Hydrology and Hydrogeology.

To analyse the means and methods of the hydrological regime monitoring it was analysed the evolution of the manual hydrometrical stations, the automatic hydrometrical stations and the modern software used in analysing the raw data from the field (ISIS, RFS, TOPLATS, NOAH etc.).

The graphic of this article was based on the information from the reports of the four projects, provided by of the Bureau of Prognosis, Hydrology and Hydrogeology (the final reports of the projects, print screen – directly from the monitoring, modelling or forecasting programs).

4. Results

Lately, on a background of severe drought and accidental pollution, Romania has been affected by extreme hydrological phenomena – floods (Gaume, 1971; Ujvári, 1972; Podani & Zavoianu, 1992; Selarescu & Podani, 1993; Rosu & Cretu, 1998; Romanescu, 2003; Arduino et al, 2005; Mustatea, 2005; Romanescu, 2005; Stanciu et al, 2005; Gore 2006; Romanescu, 2006; Arghius, 2007; Barredo, 2007; Serbu et al, 2007; Romanian Space Agency, 2008; Mihaila et al, 2009; Olariu et al, 2009a; Olariu et al, 2009b; Romanescu, 2009; Pleşoianu & Olariu, 2010; Obreja, 2011; Romanescu

& Nistor, 2011; Romanescu et al, 2011a; Feyen et al, 2012; Obreja, 2012; Romanescu et al, 2012; Cojoc et al, 2014).

Given that the damage caused by these phenomena generates millions of euro annual losses (Chiriac et al, 1980; Diaconu, 1988; Perry & Combs, 1998; Sankarasubramanian et al, 2001; Godlewska et al, 2003; Konecsny, 2005; Lehner et al, 2006; Strupczewski et al, 2006; Gabitsinashvili et al, 2007; Komma et al, 2007; Teodosiu et al,Cameron, 2007; Tockner et al, 2007; Gaume & Borga, 2008; Zhenmei et al, 2008; Portela & Delgado, 2009; Badaluta-Minda & Cretu, 2010; Olaru et al, 2010; Potcoava et al, 2010; Khatibi, 2011; Neuhold & Nachtnebel, 2011; Zhang et al, 2011), priorities for the policy action of the Ministry of Environment and Climate Change, which is also in line with the recommendations of the European Parliament and Council Directive establishing a framework for Community action in the field of water policy, are the investments in this field in order to reduce these losses.

To achieve this priority objective, the Ministry of Environment and Climate Change is considering the development of some strategies for the necessary investments in the water management field and the development of a hydrological informational system integrated at country level, for the prevention and reduction of the effects of the disasters (flooding, dangerous meteorological phenomena, accidents at hydro-technical constructions, pollution with dangerous substances of the water courses).

The activity within the hydrometrical networks corresponding to the Siret River basin is ensured by the Bureau of Prognosis, Hydrology and Hydrogeology from the Siret Water Administration, headquartered at Bacau. In turn, the Bureau of Prognosis, Hydrology and Hydrogeology is responsible for several hydrological stations: Vatra Dornei hydrological station, Suceava station hydrological station Suha hydrological station, Piatra Neamt hydrological station, Bacau hydrological station, Onesti hydrological station, Focsani hydrological station. Each hydrological station corresponds to a number of hydrometrical stations (Hydrological stations - 7; Hydrometrical stations on rivers and channels - 140; Hydrometrical stations instream channels - 14; Hydrometrical stations/representative basins - 7; Evaporimetrical stations - 8; hydrometrical stations on lakes - 17; Hydro-geological stations - 161) (Table 1).

Tabel 1. Morphometric data of Siret River and its tributaries (from Water Cadastre Atlas of Romania, 1992)

River (main river + tributary)	Length (km)	Elevation (m)		Average slope (‰)	River basin surface (km²)	Average higth (m)	Forest index
		Spring	Confluence				
Siret	647	1238	2	1.7	44871	515	0.37
Upstream Suceava	199	1238	232	3.8	2559	484	0.34
Suceava	173	1200	232	5.8	2652	589	0.35
Upstream Brodina	45	1200	585	16.2	368	994	0.53
Brodina	28	1340	585	26	142	988	0.82
Siret Upstream Moldova	322	1238	178	2.6	7045	479	0.25
Moldova	213	1116	178	4	4299	674	0.53
UpstreamMoldovita	67	1116	537	9	683	1019	0.54
Moldovita	48	1160	537	13	549	915	0.28
Upstream Suha	76	1116	500	9	1325	957	0.67
Suha	34	1270	500	21	356	876	0.79
Upstream Ozana	156	1116	276	5	3057	762	0.60
Ozana	59	1380	276	12	410	683	0.39
Upstream Topolita	168	1116	244	5	3569	739	0.59
Topolita	36	480	244	7	268	430	0.29
Siret Upstream V.Neagra	406	1238	173	2.5	11489	549	0.37
V. Neagra	48	370	173	4	303	304	0.05
Siret Upstream Bistrita	399	1238	134	2.2	12510	526	0.29

River (main river + tributary)	Length (km)	Elevation (m)		Average slope (‰)	River basin surface (km^2)	Average higth (m)	Forest index
		Spring	Confluence				
Bistrita	283	1658	134	5	7039	919	0.60
Upstream Dorna	70	1658	791	14	762	1250	0.75
Dorna	53	1700	791	17	608	1127	0.71
Upstream Bistricioara	156	1658	507	9	2985	1163	0.69
Bistricioara	64	1260	507	12	770	1041	0.66
Upstream Bicaz	182	1658	420	7	4120	1111	0.68
Bicaz	39	1300	420	23	566	1032	0.53
Upstream Tarcau	188	1658	400	7	4709	1101	0.66
Tarcau	33	1230	400	25	392	998	0.93
Upstream Cracau	229	1658	256	6	5671	1042	0.68
Cracau	66	910	256	10	447	567	0.33
Siret Upstream Trotus	483	1238	79	2	20599	642	0.39
Trotus	162	1380	79	8	4456	706	0.54
Upstream Uz	79	1380	321	13	1280	970	0.56
Uz	50	1150	321	17	469	972	0.68
Upstream Tazlau	112	1380	184	11	2848	846	0.59
Tazlau	89	1220	184	12	1104	503	0.46
Siret Upstream Barlad	545	1150	20	1	25965	635	0.44
Barlad	207	347	20	2	7330	211	0.18
Siret Upstream Putna	561	1238	16	1	33307	542	0.37
Putna	153	1490	16	10	2480	520	0.51
Upstream Milcov	132	1490	25	11	1608	700	0.55
Milcov	79	1040	25	13	444	349	0.51
Upstream Ramna	134	1490	22	11	2053	615	0.54
Ramna	66	510	22	29	415	287	0.35
Upstream Ramnicu Sarat	575	1238	13	1	36051	539	0.37
Ramnicu Sarat	137	1260	13	9	1063	294	0.26
Upstream Buzau	627	1238	8	1	37806	520	0.38
Buzau	302	1250	8	4	5264	505	0.38

4.1. Project DESWAT

The project DESWAT (Destructive Water) with financial and technical support of USAID (U.S. Agency for Investment and Development) and the USTDA (U.S. Agency for Development of Trade) aims to develop appropriate recommendations in the field of protection against floods, including public information, as well as modernizing the hydrological monitoring in the Siret River basin, using the latest technology. The DESWAT project also integrates the system of communications and radar from the project SIMIN.

The DESWAT project has made it possible to cover a wide range of applications, with obvious economic benefits:

- prediction of flood occurrence and areas likely to be flooded;
- prediction of chemical pollutants dispersion in the aquatic environment;
- anticipation of severe minimum flow rates that would affect the water supply services;
- prediction of flow and extreme volumes for the proper management of large accumulations;
- control of thermal pollution;
- Commercial applications (maps with areas where the levels exceed the alert thresholds, telephone services with hydrological information, television) which will bring profit from both the fees charged by National Institute of Hydrology and Water Management/National Meteorological Administration and Romanian Waters National Administration.

The DESWAT project maintains the 4 levels of technical and functional organization within the Romanian Waters National Administration. Through the DESWAT project, the hydrological and water management activity has entered a new stage of development and modernization for the following systems:

- The monitoring of the rivers by installing automatic stations with sensors for measuring water levels, rainfall, air and water temperature, as well as the main parameters of water quality;
- The short and medium term hydrological forecast, through the acquisition of the advanced forecasting models and the integration of the Romanian forecasting models VIDRA, CONSUL and UNDA into the forecasting models from the national hydrology platform: the development of the medium and long term hydrological forecast, taking into account various scenarios of evolution of the meteorological situation; assessment of potential damage in the flooded areas in various scenarios, selecting the least adverse scenario.

Starting from 2012, in the Siret River basin were put into operation 82 automatic hydrometrical stations (AHSS) and 35 automatic pluviometric stations (APPS). Each automatic station provides daily (outside the winter period) information on the following parameters: water level, water and air temperature, precipitation, water quality (6 automatic stations). During winter the sensors are removed from the water because they cannot operate under negative temperatures. The AHSS automatic pluviometric stations are decommissioned and listed in winter regime because they have no heater (device necessary to melt snow). Instead, the APPS pluviometric stations are functional during winter as the heater – the device which melts the snow - is turned on and thus can register the amounts of precipitation.

All this information is saved in the HYDRAS3, an application used for both transmit and receive data measured by the sensors from the hydrometrical stations, the pluviometric stations and quality stations; as well as to interpret and process the data in the operative system and beyond. This application displays the measured parameters of automatic station and it also offers the possibility to process these data.

In addition to this application, for interpretation of data are also used: the HBT application (HydroNet Briefing Terminal), the HTN application (HydroThreatNet) and the hydrological interactive forecasting program RFS (RIVER FORECAST SYSTEM).

HydroNet Briefing Terminal application is part of the system HFMS-DESWAT (HYDROLOGICAL FORECASTING AND MODELING SYSTEM-DESWAT) and is available at the Water Management System dispatcher, the dispatchers and forecast centres from the Siret Water Administration, CNPB (National Centre of Hydrological Forecast), Romanian Water National Administration dispatcher and the Ministry of Environment and Climate Change dispatcher.

HydroNet Briefing Terminal is an application designed for viewing and analysing the DESWAT System products. It has an interface easy to interpret and provides real-time information from the hydrometrical stations, meteorological stations, the pluviometric stations and lake stations; and time series type information (hydrographs) for the hydrological forecasting sections. The application also offers radar and radar-derived products from the hydrological models with distributed parameters. All this information is available on the standard Grid format, GIS format, and graphic representation of the hydrograph or typed in text format (Lockheed Martin Romania, 2012).

An important feature of this application is signalling when the defence level is being exceeded at a classical or automated gauging station through an outline of the relevant station - a corresponding threshold exceeded coloured symbol value (yellow – defence level, orange – flooding level, red –

danger level), regardless of whether the value is measured or forecasted by one of the forecasting models.

The HydroNet Briefing Terminal application has an easy to interpret interface and offers (Figure 1):

- ✓ Radar products and derived from radar data;
- ✓ Hydrological models with distributed parameters;
- ✓ Real-time information from different types of stations (meteorological stations, hydrometrical stations, lakes);
- ✓ Time series type information (hydrographs) for the hydrological forecasting sections.

The information is displayed on the standard Grid format, GIS format, and graphic representation of the hydrograph or typed in text format.

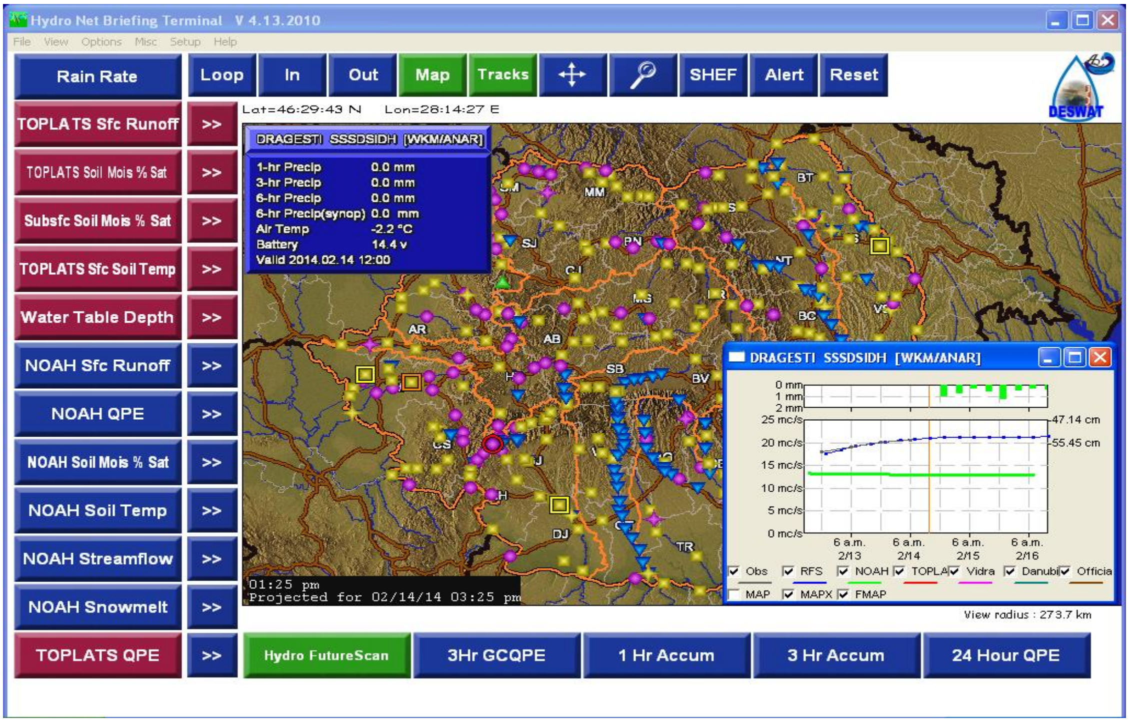

Figure 1. The HydroNet Briefing Terminal application interface. Information about the gauging station Dragesti from the Siret River. (Print screen taken after the Prognosis Centre, Bacau).

The application also offers the possibility to visualize the products generated by the hydrological models with the distributed parameters implemented within the project DESWATS: TOPLATS and NOAH. These two models use the latest meteorological information provided by the numerical meteorological forecast model ALADIN, run by the National Meteorological Administration, the values of precipitation from the field, temperature and air humidity, solar radiation and other variables, and provide products to forecast the evolution of the hydrological parameters on a grid network with a spatial resolution of 1 km.

There are two basic modes operation for both distributed models:

- LDAS mode (Land Data Assimilation System-data assimilation system) which represents an update every 30 minutes to the status of the model parameters according to new information received (principally estimated precipitation trends based on radar);

- FCST mode (Forecast-the forecast), which generates every 6 hours, the prognosis for the anticipation of 48 hours for different hydrological parameters (based on the state parameters at the time of initiating the cycle of forecasting and using the prognostic information from the numerical meteorological model ALADIN).

NOAH model runs at the national level, while TOPLATS runs on certain sub basins and only during the warm season.

The HydroThreatNet is part of the HFMS-DESWAT (HYDROLOGICAL FORECASTING AND MODELING SYSTEM-DESWAT) and is available at the Hydrological Forecasting Centres within Siret Water Administration and at the National Centre of Hydrological Forecast within the National Institute of Hydrology and Water Management.

HydroThreatNet is an application for viewing and analysing the DESWAT System products. It has an easy to interpret interface, but more complex than the HydroNet Briefing Terminal. The application provides real-time information from the hydrometrical stations, meteorological stations, pluviometric stations and lakes; and time series type information (hydrographs) for the hydrological forecasting sections. The application also offers radar and radar-derived products from the hydrological models with distributed parameters. All this information is available on the standard Grid format, GIS format, and graphic representation of the hydrograph or typed in text format (Lockheed Martin Romania, 2012).

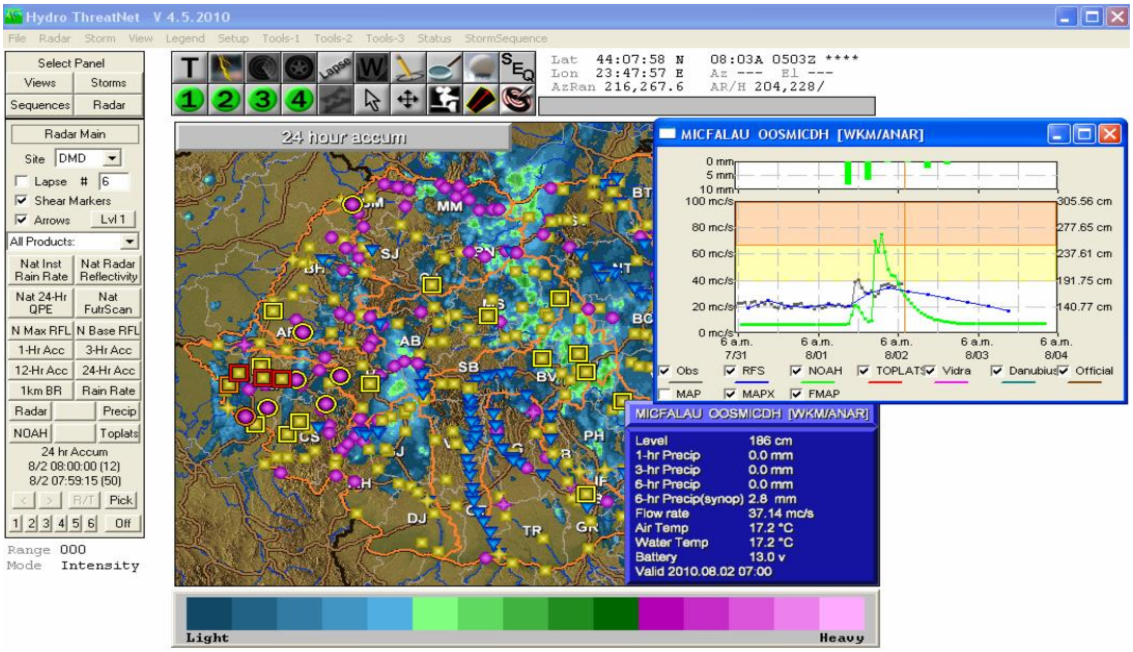

Figure 2. The HydroThreatNet application interface. Information about a gauging station from the Olt River Basin (image taken after the National Prognosis Centre, Bucharest).

An important feature of this application is signalling when the defence quotas is being exceeded at a classical or automated gauging station through an outline of the relevant station - a corresponding threshold exceeded coloured symbol value (yellow – defence quota, orange – flooding quota, red – danger quota), regardless of whether the value is measured or forecasted by one of the forecasting models.

The HydroThreatNet application has a more complex interface compared to HydroNet Briefing Terminal application (HBT) and offers (Figure 2):

- ✓ Real time information from the measurement networks (Romanian Water National Administration, National Meteorological Administration etc.);
- ✓ Radar products and derived from radar data;
- ✓ Hydrological models with distributed parameters;
- ✓ Time series type information (hydrographs) for the hydrological forecasting sections.

The information is both in text format, and in graphical representation. The main menu of the application provides access to the HTN commands that allow the use of the improved functions of the application; some of them are not being used in the operative mode.

The application also offers the possibility to visualize the products generated by the hydrological models with the distributed parameters implemented within the project DESWATS: TOPLATS and NOAH. These two models use the latest information on rainfall, soil moisture, air temperature, water temperature, solar radiation and other variables, and provide information on the hydrological parameters that characterize a given region.

There are two basic modes operation for both distributed models (Lockheed Martin Romania, 2012):

- LDAS mode (Land Data Assimilation System-data assimilation system) which represents an update every 30 minutes to the status of the model parameters according to new information received (principally radar data);
- FCST mode (Forecast-the forecast), which generates every 6 hours, 48 hour prognosis for different parameters (based on the state parameters at the time of initiating the cycle of forecasting and using the prognostic information from the numerical meteorological model ALADIN).

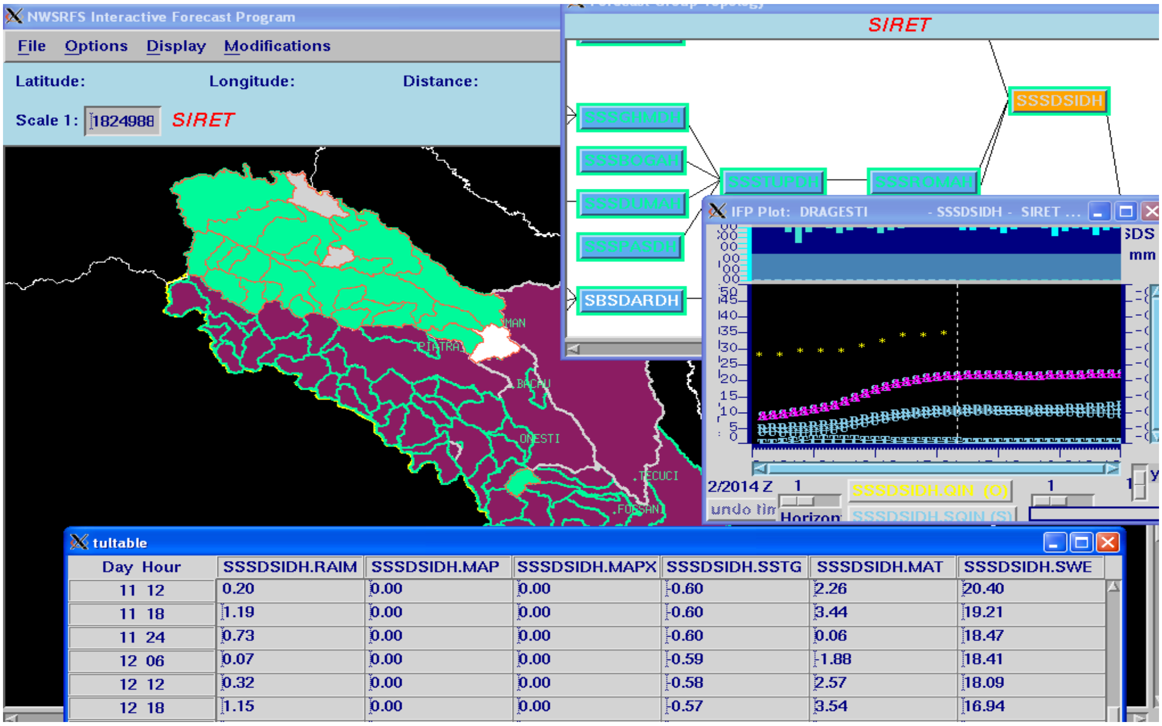

Figure 3. The RFS program interface. Information about the gauging station Dragesti from the Siret River. (Print screen taken after the Prognosis Centre, Bacau).

The **RIVER FORECAST SYSTEM** program – Interactive Forecast Program is a conceptual hydrological model with global parameters, and in the normal operating conditions of the system DESWAT – RFS, the input data (rainfall, temperatures, flow rates, ALADIN meteorological forecast) is automatically transferred, on a regular basis, to the forecast program and the user (the prognosis hydrologist) can run the application in interactive mode, using a set of instructions (Lockheed Martin Romania, 2012).

The program provides a meaningful forecast for a period of 4 days, indicating a trend of the flows for a period not exceeding 10 days. Depending on the season the parameters taken into account are different: precipitation, snow cover, soil saturation, air temperature, the upstream flow, propagation time, etc.

4.2. PPPDEI (Plan for Prevention, Protection and Mitigation of floods in the Siret River Basin) – part I

The objectives and program of the Directive on the Assessment and Management of Flood Risk 2007/60/EC are the following:

- ✓ 2011: preliminary assessment of the flood risk;
- ✓ 2013: hazard and risk maps;
- ✓ 2015: plans for the flood risk management;
- ✓ After 6 years: reviews/updates of the maps and plans (similar to the Water Framework Directive).

The first part of the **Plan for Prevention, Protection and Mitigation of floods in the Siret River Basin** comprises the floodability study maps, the databases and the associated computational tools, the scenarios on the critical points for the SIRET River and its first order tributaries. The first part of the project was completed in May last year (2013).

At the present time Siret Water Administration has been delivered:

- the floodability maps - level A 1:2000 (413 km^2 derived from 2D modelling for 68,3 km river, topographic sections, aerial photographs/LiDAR)
- the floodability maps - level B 1:10000 (3.127 km^2 derived from 1D modelling for 773km river, topographic sections, aerial photographs/LiDAR)
- the hydrographic map of the Siret River Basin 1:50000 (28.000 km2 – the whole basin – floodability maps including 5.000 km^2 aerial photographs/LiDAR)
- simulation of land-use planning scenarios in critical areas in the Siret River Basin
- Software (ISIS – modelling program from Halcrow England, GIS – Geographic Information Systems) and the database of the project.

The 1D and 2D hydrodynamic modelling was possible on the base of the ISIS modelling program, delivered by Halcrow, England. For the 1 D model there were necessary: the river cross sections and the DTM – major riverbed (measurement and maps) – hydro technical constructions; the calibration has been realized at the level of the year 2005 (the year with the highest recorded values) - based on the level/flow values and the major difference between them (Halcrow, 2012).

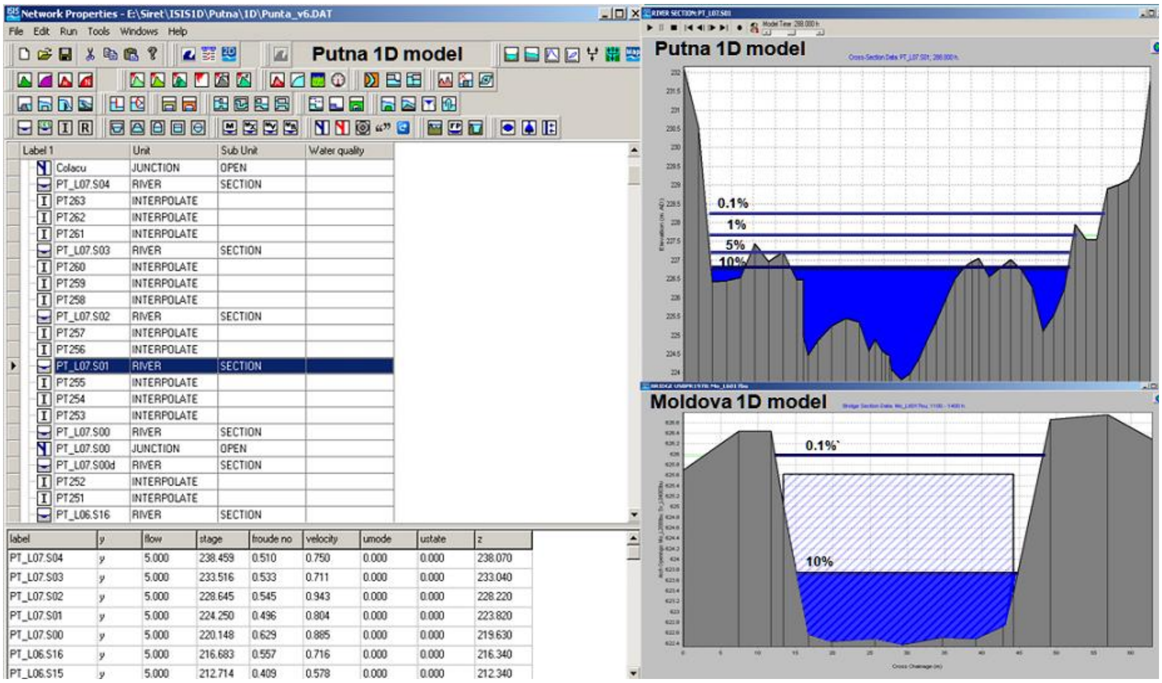

Figure 4. ISIS modelling program interface. The longitudinal profile of Putna River and two cross sections, one on Putna River and the other on Moldova River.

4.3. Project EASTAVERT

The project EASTAVERT runs between the partner water management institutions in Romania, Ukraine and Moldova and aims to reduce the vulnerability to floods for the communities in the border areas: by carrying out upgrading works on the hydrological Complex Stanca-Costesti; by improving the warning system through the installation of monitoring systems in the Siret and Prut Rivers Basins and by increasing the responsiveness of the population through information (MMSCR, 2013).

The project has 24 months duration and it started in December 2013. The main objectives of the project are the protection of the border areas in the upper Siret and Prut River Basins against the flood risk, other natural dangerous hazards of water cycle and accidental pollutions and reducing the environmental, economic and social vulnerability of targeted localities from the border region against flood risk.

The partners in the project are:

Part 1 – Ministry of Environment and Climate Change
Part 2 – Prut and Barlad Water Administration
Part 3 – Siret Water Administration
Part 4 – National Institute of Hydrology and Water Management
Part 5 – Moldavia Waters Agency
Part 6 – Prut and Nistru Water Resource Administration, Ukraine
Part 7 – Chernovtsy Regional Centre for Hydrometeorology
Part 8 – Scientific and technical Centre for regional and intersocial issues of the environment and conservation of resources „Eco Resources”

The specific objectives of the project are (MMSCR, 2013):

- Ensuring of a high quantitative monitoring level of the Siret and Prut River Basins, including the main hydraulic infrastructures as Stanca Costesti Dam and Reservoir for prevention and protection against floods and accidental pollution events.
- Reducing the environmental, economic and social vulnerability of targeted localities from the border region between the Republic of Moldova and Romania against flood risk by enhancing the functional capacities of the Hydro-technical Complex “Stanca-Costesti”.
- Elaboration of the maps representing the flooded areas during the historical flood events in the Siret and Prut River Basins, of the hazard and vulnerability maps at an adequate scale (using the high-resolution satellite images) and of the risk maps for Siret and Prut River Basin.
- Providing of the River Basin Plan for the protection against ice-floods, hydrological drought, accidents occurred at the hydro technical constructions and accidental pollutions for the Siret and Prut River Basins.
- Improving the warning system by a better common forecasting procedures and modelling.
- Increasing the reaction capacity by a better data and forecasts dissemination, public information about flood hazard and risk and a common exercise, testing the hydrological information system.

As a result of these actions the local authorities in the areas with high vulnerability to flooding or pollution will be better protected and will also be ensured better protection of the areas of cultural heritage, and natural history.

Upon completion of the project will be installed 24 automated monitoring stations in Ukraine and 2 in Romania. The two automatic monitoring stations in Romania will be installed at Ripiceni and Stanca-Costesti. There will also be assigned 8 dispatchers, of which 5 to Prut Water Administration (Iasi, Botosani, Vaslui, Galati, Stanca - Stanca-Costeşti) and 3 to Siret Water Administration (Bacau, Piatra Neamt and Suceava). At the national level it will be assigned a dispatcher in Bucharest.

There will also be assigned 3 forecasting centres: in Iasi, Bacau and Bucharest. The forecasting centres will use a new methodology for prognosis and a new forecasting model at the level of the basin. The new technology aims to increase the response time for flood protection measures downstream the border with Ukraine.

5. Conclusions

The old systems of monitoring are less efficient because of to the slower rate of efficiency, great efforts on behalf of the operators, who in the case of dangerous phenomena are needed to make measurements and to transmit them sometimes hourly.

The new monitoring programs recently introduced are much more co-operative and offer the possibility of real-time processing of the data thus more rapidly having forecasts and therefore effective decision making in critical moments.

At the moment there are available 82 hydrometrical automatic stations and 35 pluviometric automatic stations installed in the field, and a series of software installed on the computers in the office, all available after completion of the DESWAT project. These automatic stations make possible the monitoring in real time of the evolution of the levels, and with the help of hydrological forecasting RFS program (by adjusting the daily input parameters in the program) can provide forecasts and flood simulations.

The PPPDEI project, part I (**Plan for Prevention, Protection and Mitigation of floods in the Siret River Basin**) delivered the floodability maps for the Siret River and its main tributaries (Suceava, Moldova, Bistrita, Putna and Ramnicu Sarat) and the modelling software necessary for any modifications, adjustments or updates needed in time.

In the second part of the PPPDEI project are to be delivered the cross-sections, the longitudinal profiles and the floodability study maps for 39 rivers framed in the areas with significant risk of flooding from the Flood Directive.

Upon completion of the EASTAVERT project will be installed 2 automated monitoring stations in Romania, at Ripiceni and Stanca-Costesti. There will also be assigned 8 dispatchers, of which 5 to Prut Water Administration (Iasi, Botosani, Vaslui, Galati, Stanca - Stanca-Costesti) and 3 to Siret Water Administration (Bacau, Piatra Neamt and Suceava). At the national level it will be assigned a dispatcher in Bucharest.

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