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NEWADA

"NETWORK OF DANUBE WATERWAY ADMINISTRATIONS"

South-East European Transnational Cooperation Programme

STATUS QUO REPORT ON HYDROLOGICAL ACTIVITIES

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Activity:	3.1 Improve methods, processes and procedures for hydrographical and hydrological activities	
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LIST OF ABBREVIATIONS

EAEMDR	Executive Agency for Exploration and Maintenance of the Danube River
HMS	Hydrometeorological station
AMSL	Above mean sea level
GMT	Greenwich Mean Time
HHM Directorate	Hydrology and Hydrometeorology Directorate
NIMH	National Institute of Meteorology and Hydrology
BAS	Bulgarian Academy of Sciences
QMS	Quality Management System
DC	Danube Commission
MTITC	Ministry of Transport, Information Technology and Communications
VHF	Very High Frequency

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3 SCOPE OF THE DOCUMENT

This document is prepared in within Activity 3.1 of the project – Improve methods, processes and procedures for hydrographical and hydrological activities. According to the Description of works all the project partners have to prepare status quo report on the hydrological activities including information about the hydrological data – how it is elaborated and used, description of the hydrological data series according the water bearing period - dividing it on data in annual regime, in flood and drought regime and by other approaches. It includes also information about the methods of processes – measurements and pre-proceeding of the hydrological data, hydrological forecasting and warning, description of the equipment that is used for the measurements etc.

This report will contribute for the elaboration of a final report for all the countries from the WPL, based on which best practices cases will be identified and know how exchanged.

4 MONITORING NETWORK

4.1. Description of Water Gauging Stations

For the performance of daily meteorological and hydrological observations along the Bulgarian stretch of the Danube River 6 main water gauge stations were situated along it. These are: Novo selo at km 833.6; Lom – at km 743.3; Oriahovo – at km 678.0; Svishtov – at km 554.3; Ruse – at km 496.5 and Silistra – at km 375.5.

Figure 1 - Network of the hydrometeorological stations along the Bulgarian section of the Danube

The first regular meteorological observations for the Bulgarian section of the Danube began in 1866 in the Austrian Consulate in Ruse. The meteorological station at Ruse was established in 1884. It was transformed into hydrometeorological in 1955. The level mark of the zero elevation is 11.80 m according to the Baltica Kronshtad Evaluation System.

The station at Novo selo has been functioning since the 1st of January, 1937. The level mark of the zero elevation is 26.75 m according to the Baltica Kronshtad Evaluation System.

The station at Lom has been functioning since 1st of January, 1911. The level mark of the zero elevation is 22.65 m according to the Baltica Kronshtad Evaluation System.

The station at Oriahovo has been functioning since 15th of March, 1924. The level mark of the zero elevation 21.34 m according to the Baltica Kronshtad Evaluation System.
The station at Svishtov exists from the 1st of January, 1913. The level mark of the zero elevation 14.89 m according to the Baltica Kronshtad Evaluation System.
The Silistra station began its activity as a part of the Romanian Hydrographic Service. It has been operating as a Bulgarian hydrometric station since the 1st of May, 1941. In 1942 measurements of the air and water temperatures were commenced. The level mark of the zero elevation 6.27 m according to the Baltica Kronshtad Evaluation System.

Hydrometeorological station	Longitude	Latitude	AMSL
Novo selo	22°78’	44°15’	49.00 m
Lom	23°13’	43°49’	32.50 m
Oriahovo	23°58’	43°41’	28.85 m
Svishtov	25°21’	43°37’	24.30 m
Ruse	25°52’	43°52’	37.50 m
Silistra	27°15’	44°07’	15.85 m

Table 1 – Geographical coordinates of the hydrometeorological stations

All of these stations are within the Hydrology and Hydrometeorology Department of EAEMDR. The department performs the following main activities:

- All hydrological measurements and the entire complex 24-hour synoptic and meteorological observations on the Danube river;
- Measurements of water levels and temperature;
- Measurements of the velocity of the flow and water quantities;
- Prepare daily, monthly, annual and multi-annual prognosis on the basis of the collected data;
- Process and prepare for dissemination the hydrological data for internal and external exchange.

Figure 2 – Hydrometeorological station in Ruse

4.2. Gauge equipment

In order to measure the water levels the gauge stations are equipped with cast iron gauges which are mounted on the quay walls and are ruled in 2 cm intervals. The HMS in Lom and Ruse are equipped with automatic stations (limnigraphs). It is foreseen the stations in Novo selo and Oriahovo to be equipped with such limnigraphs as well.

Figure 3 - Self-writing water measuring gauge in Ruse

They are also provided with pressure detectors.

Water quantities are measured by a ship that is equipped with hydrometrical propeller OTT – Kempten, and the velocity of the flow - on the basis of the integral method by vessel. Its location is determined by GPS with one-meter precision.

Figure 4 - Hydrometrical propeller OTT – Kempten.

At all the stations the ice occurrence in the river waters is registered. There is no special equipment for defining the ice occurrence, thus this is made taking into account the percentage of water surface that is covered with ice.

The water temperatures are measured with mercury thermometers with a precision of 0.1°C.

All the parameters and the relevant equipment are presented systematically in the following table:

Measured parameters	Equipment
Atmospheric pressure	Mercury barometer and barograph
Speed and direction of the wind	Wild anemometer
Visibility	By sight
Type and quantity of clouds	By sight
Air temperature	Mercury thermometer
Humidity	Wet and dry mercury thermometer
Type and quality of penetration	Pluviograph and Wild rain gauge
Water level	Iron gauges and automatic stations
Ice appearance	By sight
Water quantities	Hydrometrical propeller
Water temperature	Mercury thermometer

Table 2 – Hydrometeorological parameters and equipment

4.3. Quantity and Quality of Measurements. Elaboration of Data

In order to be ensured good quality and sufficiency of the measurements and the eternal and external transmission of the data all the relevant procedures are developed in accordance with the Quality Management System (QMS).

The water levels are measured at least once a day. At Novo selo and Lom the measurements are performed three times a day due to the big 24-hour fluctuations caused by the working regime of the Hydrotechnical facility “Iron Gates”.

The measurements of the water quantities are performed by the hydrological team within HHM Directorate at least 4 times a year during different water levels.

Measured parameters	Frequency of the measurements
Atmospheric pressure	12 times per day
Speed and direction of the wind	12 times per day and permanently in cases of decreased visibility
Visibility	12 times per day and permanently in cases of decreased visibility
Type and quantity of clouds	12 times per day
Air temperature	12 times per day
Humidity	12 times per day
Type and quality of penetration	Minimum 6 times per day when it is raining
Water level	1-3 times per day; in cases of flood threats more frequently
Ice appearance	Permanently when appear
Water quantities	Minimum 5 times per year
Water temperature	Daily
The hydrological automatic stations in Ruse and Lom register data every 15 min.	
The meteorological automatic stations in Ruse and Lom register data every 5 min	

Table 3 Measured parameters and frequancy of measurents

Hydrological measurements and observations:

The responsible experts from the HMSs at Novo selo, Lom, Oryahovo, Svishtov and Silsitra send the information from the stations to the HMS at Ruse till 07:30 a.m. GMT via email.

The observation of the water levels at the main HMSs and water gauging points is done every day at 07:00 a.m. GMT. In cases of intensive increasing or decreasing of the water level of the Danube, additional observations are done besides the main one - at 13:00 a.m. and 17:00 a.m. When it is necessary they are done at intervals of 1 – 3 hours.

The daily data is registered in the referent journals and is published once a day on the website of the Agency. When there are additional observations the results of them are published in real time.

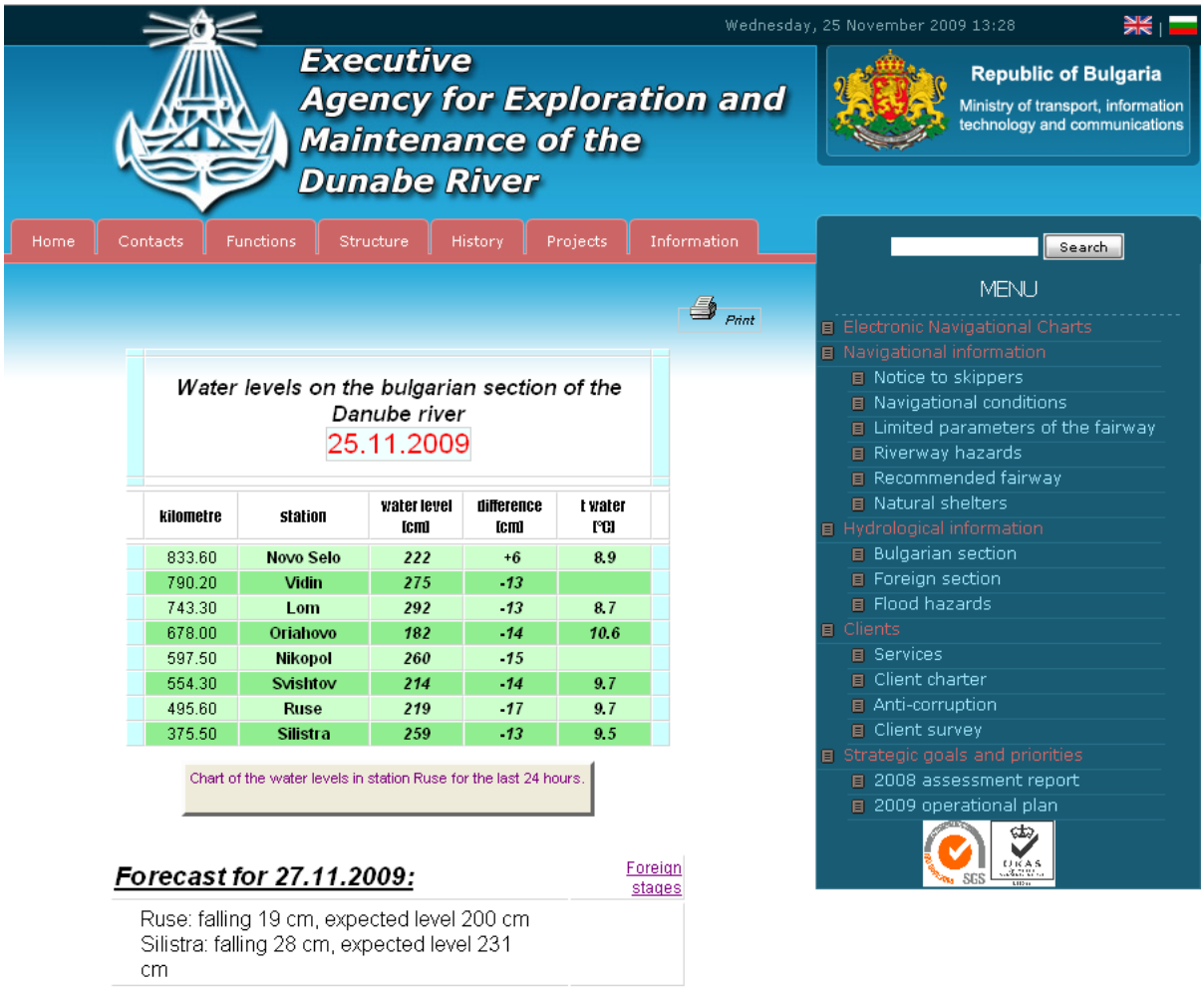

Figure 5 Water level information ot the website of EAEMDR

At the stations where there are limnigraphs the data from them is compared with the data from the iron gauges. When there is difference more than 2-3 cm, the limnigraph is set to the correct data from the iron gauges.

During low waters (when the level is under the bottom end of the iron gauge) and high waters (when the level is above the upper end of the iron gauge) the measurements are done with a mounted beforehand temporary gauge.

Measurements of the flow velocity and water quantities

The measurement of water quantities are done at the main hydrometric profiles, critical for the navigation and the secondary branches of the islands in order to be set the relation between water quantities and water levels, to be indicated the discharge of the waters in the relevant branches, the characteristics of the water flow and its development.

The number of the verticals is defined in compliance with the width of the river (or the branch). And the distance between them should not exceed 1/7th from the width of the river flow.

In order to be achieved higher precision of the measurements it is recommended and preferably this distance not to exceed 40 – 50 m (for the main profiles) and 15-20m in the secondary branches.

The verticals at the left and right banks are done as near as possible to the riverbank (depending the draught of the vessel). The adjacent verticals should not lie remote from those at the banks due to the fact that the average velocity intensively increases from the riverbank to the midstream. The acceptable maximum error in the measurements is ± 5%.

The measurements are postponed if the meteorological conditions are not favourable.

There is a detailed procedure for defining the distances between the verticals and for the measurements of the depths that the responsible experts are obliged to follow. This procedure is in accordance with the QMS.

The measurement of the velocity at the fairway are done at different water levels in order to be defined the average speed of the flow in the different sections of the river. They are done on every 5 km at a depth 1m and with duration minimum 100 seconds.
Al the data from the measurements are registered in the following table:

НА „ПРОУЧВАНЕ И ПОДДЪРЖАНЕ НА РЕКА ДУНАВ" ИКод: ФК-15.001
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ПРОУЧВАТЕЛЕН КАРНЕТ

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Дата			H =					
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Figure 6 Table for measurement results

All the information is permanently stored in HMS Ruse.

Meteorological observations and preparation of information:

The synoptic observations are done 10 minutes before the following time (GMT) (without shifting to summer time) – 12:00a.m, 03:00 a.m., 06:00 a.m., 09:00 a.m., 12:00 p.m., 01:00 p.m, 18:00 p.m., 21:00 p.m., following the procedure and the guidance from the National Institute for Meteorology and Hydrology. The ciphering of the information is performed with the Synop programme, developed by the NIMH – BAS, and is sent to the responsible meteorological expert in NIMH.
Climate observations are done at 05:00 a.m., 12:00 a.m. and 19:00 p.m. (GMT), the procedure for their proceeding and dissemination is the same.

There are special registers where the responsible expert from NIMH enters the data from the meteorological observations. At the beginning of every month these registers are sent to the EAEMDR and permanently stored in the HHM Directorate

4 HYDROLOGICAL CONDITIONS

4.4. Regime and Operative Data

The Bulgarian stretch of the Danube, which is part of the Lower Danube, is along the right bank of the river starting from the outfall of the Timok river and reaching the city of Silistra downstream the Danube with total length of 471 km. This is the northern border of the Republic of Bulgaria with the Republic of Romania. The river in this section is typical lowland river, it becomes shallower and broader and has a big seasonal difference of water levels – more than 9 m. Steep sediment walls, in some places up to 150 m, characterise the Bulgarian river bank. The catchment area of the river increases with 105 000 km² 43 000 km² from which are in the Bulgarian sector (the Predbalkan Mountains, the north slopes of the Balkan Mountines and a part of the Rila Mountain).

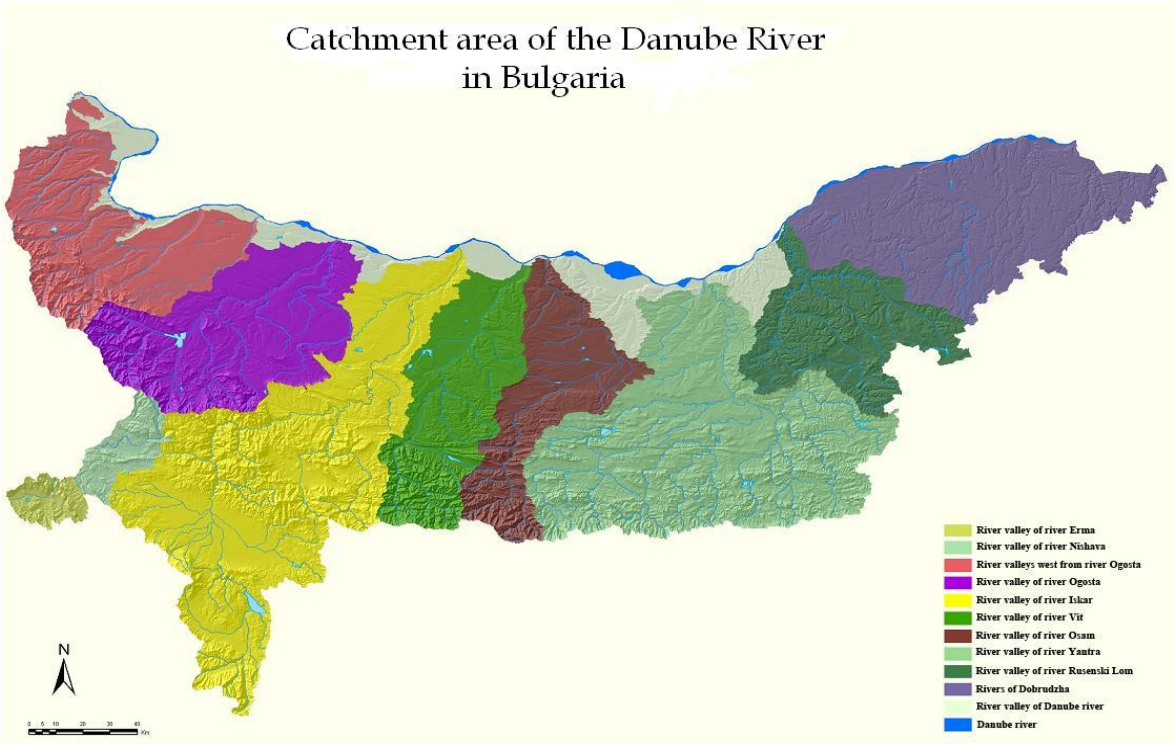

Figure 6 - Catchment area of the Danube in Bulgaria

River	km²
Erma and Nishava	1137
Ogosta and west fro Ogosta	8193
Iskar	8634
Vit	3228
Osam	2838
Yantra	7862
Rusenski Lom	2950
Dobrudza rivers	2357
Danube	5638
Total	42837

Table 4 Catchment area of the Danube in km²

The influence of the local meteorological conditions, the existing soil types through which river passes, the riverbed configuration, the increase and decrease of the water and hard flow, the different river flow velocity influenced by the water formations, the hydrotechnical facilities and other natural forces and human factors define the active hydromorphological processes of the river in this section. As a result of their activity the riverbed constantly changes its geometrical and hydrological parameters (situation of the midstream, direction and velocity of the flow, structure of the flow, terrain shapes in the riverbed, etc.).

The average multi-annual quantity of the sedimentation for the Danube River within the section from Novo selo (km 833.6) to Silistra (km 375.5) is presented in the following table:

Distance km	833.6	786.9	743.3	678.7	624.2	596.3	554.3	553.2	493.1	379.6	375.5
River width m	840.0	800.0	1100	680	900	810	1100	1100	810	880	850
1956 1970	1189.7	1441.5	1247.3	1576.0	985.2	1191.2	1587.7	1270.8	1407.9	1704.7	1686.8
1971 1984	581.6	769.6	791.6	901.6	621.0	845.3	1052.8	771.2	859.4	728.2	1147.5
1985 2005	276.1	109.0	444.2	429.8	288.6	327.8	599.4	431.3	441.7	437.7	713.0

Table 5 Average multi-annual quantity of the sedimentation for the Danube River within the section from Novo selo (km 833.6) to Silistra (km 375.5)

The changes in the water quantities and water temperature of the Danube within the same section are as follows:

Period	Water quantity at Novo selo	Water temperature at Novo selo	Water quantity at Silistra	Water temperature at Silistra	Increase of the water quantity in the section	Increase of the water temperature in the section
Year	*m³/s*	*°C*	*m³/s*	*°C*	*m³/s*	*°C*
1940-1981	5815.38	12.10	6384.12	12.53	568.74	0.42
1982-2005	5348.00	12.73	5812.08	13.36	464.08	0.63
1940-2005	5645.42	12.33	6176.11	12.83	530.68	0.50
Increase in the section	464.67	0.60	610.12	0.80	-145.45	0.21

Table 6 Water quantities and water temperature of the Danube River within the section from Novo selo (km 833.6) to Silistra (km 375.5)

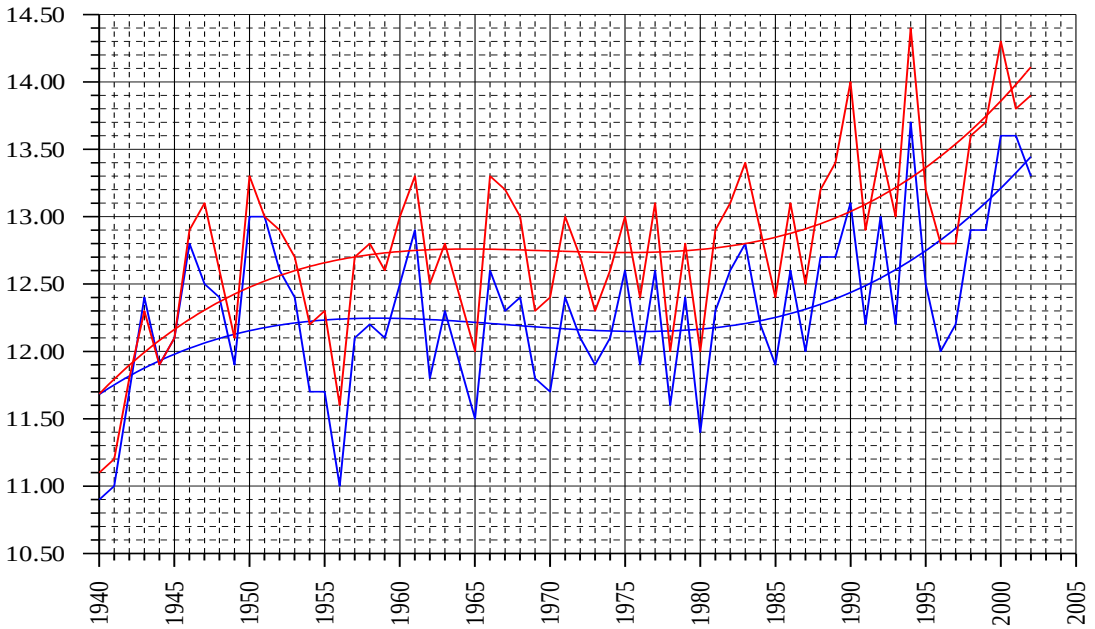

Figure 7 Changing of the water temperature of the Danube

Some conclusions from these figures:

- Discharge series – there is a decrease of the discharge series due to the less precipitations in the Bulgarian and Romanian Danube catchment areas;
- Water temperature – water temperature increased due to the global warming. At the beginning of the section this is with 0.63º C and within the section – with 0.21º C;
- The quantity of the sedimentation at Novo selo decrease during the period 1974 – 2005 in comparison with the period before 1974 r with 913 kg/s. Within the section it was observed significantly less decrease – only 62 kg/s. This lead to the intensification of the erosion processes.

4.5. Discharge series

The quantities, coming from the main Bulgarian Danube tributaries - the rivers Erma, Nishava, Ogosta, Iskar, Vit, Osam, Yantra, and Rusenski Lom, are very small and don't have significant influence on the water levels. Together with the Romanian tributaries, they form about 7% of the discharge of the Danube. The major amount of water quantities, coming from the tributary rivers, is formed in the Upper and Middle Danube and the big feeders Sava, Drava, Tisa and Velika Morava.

During low and average water periods, the water quantities in the upper Bulgarian – Romanian section are directly dependant on the mode of operation of the Hydrotechnical complex Iron Gates and are characterised with large daily fluctuation. In some cases the differences between the water levels registered at 8 a.m. and the midnight water levels are more than 1 m.

The maximum water quantity at Ruse is registered in 2006 and is 15685 m³/s while the average maximum water quantity was 10878 m³/s.

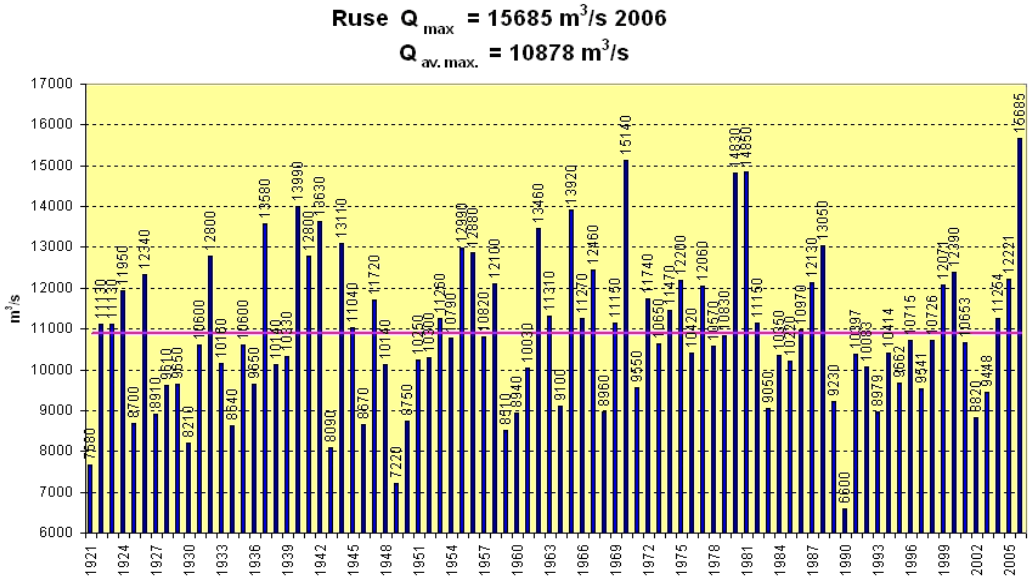

Figure 8 Water quantities at Ruse, 2006

4.6. Designed data

The data collected from the relevant measurements and observations is processed from the responsible experts within EAEMDR. Based on the received results curves for the speed, the duration and other parameters of the water levels are elaborated. Annual key curves for the water quantities are made as well. The curves are drowned using the method of least squares.

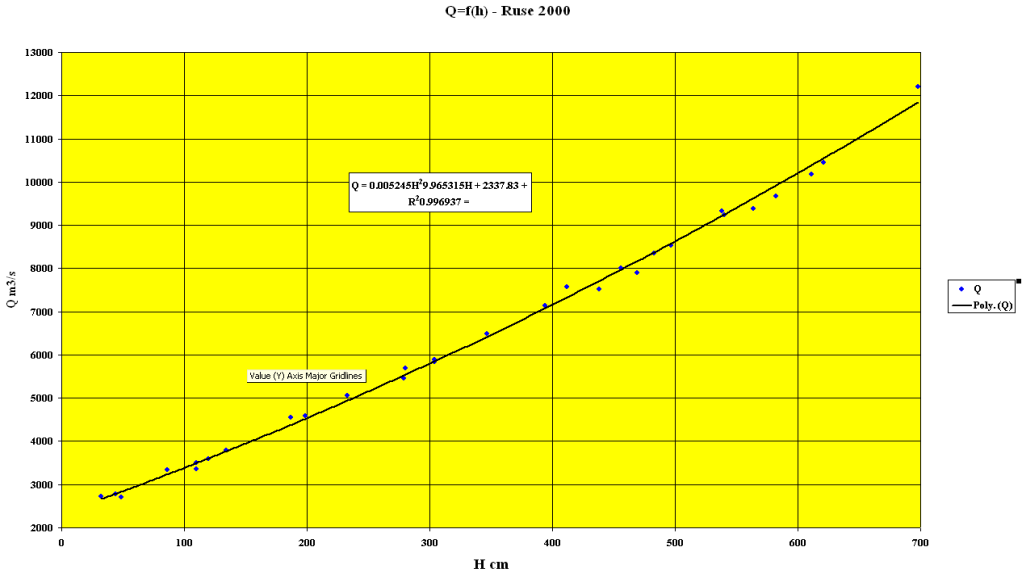

Figure 9 Water quantities curve at Ruse, 2000

Trend assessment and alteration of the key curves during the time is also done.

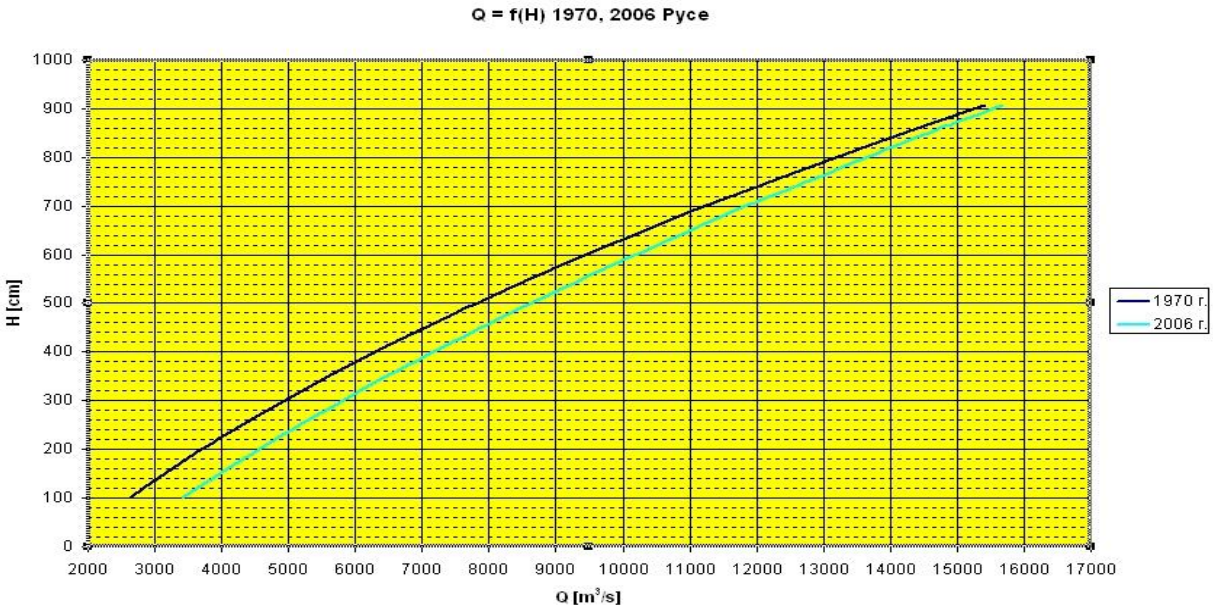

Figure 10 Alteration of the key curves at Ruse

It is obvious from the picture above that the trend for the period after construction of the Hydrotechnical complex Iron Gates is shifting the curve to right, especially during the periods of law waters.

The data that has been checked for mistakes and processed is stored on a digital bearer in ASCII and xls formats in EAEMDR which is the data owner. It is submitted to interested users upon request following the procedure, determined by the Ministry of Transport, Information Technology and Communications.

5 EXTREME FLOWS AND FLOOD DISASTERS

5.1. Floods regime

During a flood danger the number of gauge stations is increased. The water level observations are performed on an hourly base and at the automatic stations this is a permanent process. Updated information regarding the river water levels is distributed through the EAEMDR website, e-mails, fax transmissions and telephone calls. A permanent connection is supported with the Civil Defense authorities, the aquaculture

organizations that are responsible for the dykes' maintenance and the Regional governments of the Danube regions.

During March 2006 there were extremely high water levels in the Bulgarian section of the Danube river. The reached maximum levels lead to flooding of many cities, villages and industrial areas. These extreme levels were caused from the combination of the snow melting and precipitations in the catching area of the Middle and Upper Danube.

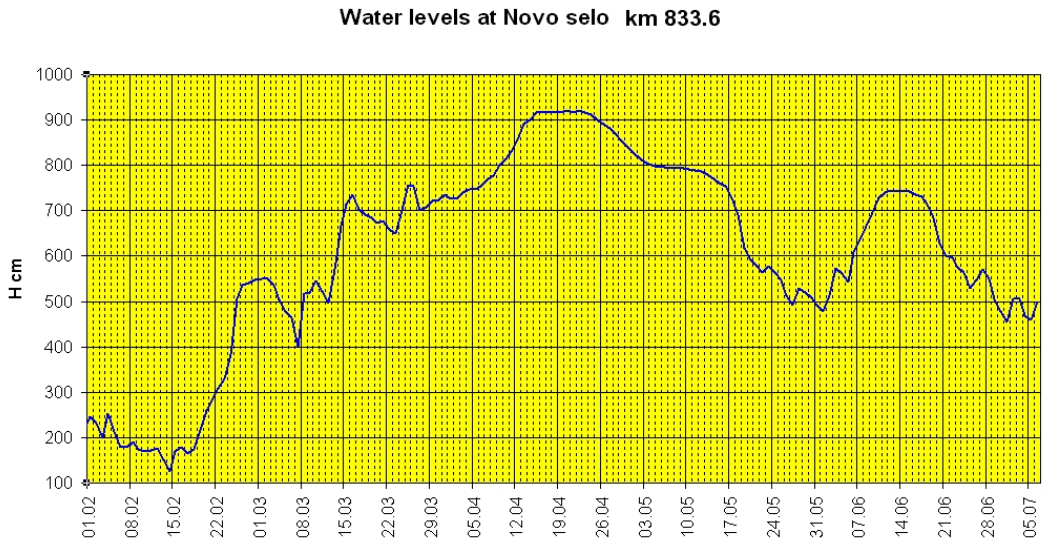

Figure 11 Water levels at Novo selo

Figure 12 The flood in Ruse, 2006

If there is a danger of ice phenomenon EAEMDR performs the following activities:

- Observation of the ice conditions, the water temperature and water levels in the Bulgarian section of the river and receiving and analyzing the information coming from the other Danube riparian countries on a daily basis.
- Based on that prepares forecasting for the next 3 days for the ice occurrence
- Keep communication and coordination of all the relevant activities with AFDJ – Galati, Romania
- When there is a danger of flooding for cities, villages and industrial areas the Agency provide a team for 24 hours observation in its HMSs.
- 24 hours informational center is organized as well

5.2. Drought regime

During low water level periods, the depth and draft speed measurements are performed closer to each other and more frequently in the areas that are critical for navigation. The Agency website contains daily updated data about the fairway parameters and its current status. Information for the critical for the navigation points is published as well.

6 HYDROLOGICAL FORECASTING AND WARNING

6.1. Forecasting services

On the EAEMDR website (http://www.appd-bg.org), there is an access to the following information free of charge:

- Hydrometeorological bulletin;
- Flood hazard warnings;
- Real-time picture of water levels on the river;
- Navigational bulletin;
- Critical sections;
- Recommended fairway;
- Natural shelters.

Detailed information for every measured parameter also is provided upon request and in compliance with the requirements set by the MTITC

6.2. Meteorological Forecasting

NIMH elaborates a two-day meteorological forecast for the Bulgarian section of the Danube River and submits it to the EAEMDR. The forecast is disseminated in Bulgarian language through the Agency website and via e-mails to skippers, media and other interested users.

6.3. Hydrological Forecasting

On the basis of the collected data daily, monthly, annual and multi-annual prognosis are prepared. Daily forecasting of the expected water levels is done for Ruse and Silistra. These are short term forecasts – concerning the next two days. Every Wednesday a weekly forecast is done for the expected tendency in water levels change and the expected highest and lowest water levels for Ruse and Silistra.

6.4. Forecasting Methods

Water levels are forecasted through the flowing speed based on the data received from the gauge stations (not only the Bulgarian ones). The forecasts made by our Serbian and Hungarian colleagues are also used.

6.5. Dissemination of Information

The information is disseminated through the Internet – it is published on the websites of the NIMH and EAEMDR and is broadcasted through the Bulgarian National Radiostation as well.

7 TRANSBOUNDARY COOPERATION

7.1. Exchange data among the countries

The exchange of information among the countries is performed daily following the recommendations of the Danube Commission. The data about the water levels and

water temperature is disseminated ciphered according to the Recommendations for providing hydrological information for the navigation along the Danube River, DC 1997. Prognosis for the water levels and the parameters of the fairway is disseminated as well.

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hhxx  00068  0407
42070  22  20233  55  10015  50101
42073  22  20295  55  10024  50094
42075  22  20170  55  10024  50118
42078  22  20173  55  10065  50103
42080  22  10168  55  10072  50108
42083  22  00189  55  10078  50105

hyfor  00068
42080  22  80175  00507  80189  00607
42083  22  80185  00507  80188  00607

hhxx  00068  0407
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77  05700  05680  29999
77  05680  05640  29910
77  05640  05600  29910
77  05460  05440  29912
77  05250  05220  29915
77  04760  04740  19914
77  04580  04550  19910
77  04260  04240  29910
77  04070  04020  19915
77  03950  03900  19915
```

Figure 13 Way of ciphering the data

7.2. Navigation

There is a daily connection with the Romanian authorities and an exchange of navigational conditions data in the common river section according to the Agreement between the Bulgarian and the Romanian governments regarding the fairway maintenance and improvement in the Bulgarian – Romanian section of the Danube River. According to that Agreement Bulgaria is maintaining the section between river kilometers 375 and 610 and Romania is maintaining the section between river kilometers 610 and 845. Each country submits information about the navigational conditions in the section that it is maintaining and is obliged to maintain and improve them. According to this Agreement a Bulgarian - Romanian Commission for fairway maintenance and improvement was established. The Commission has regular sessions twice a year as they are held on a successive base on the territory of each country.

The mutual exchange of information and documents is done according to the Regulations for Organization and Work of the Joint Bulgarian – Romanian Commission.

7.3. Inventory of Data Transmission

The information is transmitted via e-mail and telephone connection and is also published on the Agency website – www.appd-bg.org

Every month the NIMH issues monthly hydrometeorological bulletin where an overview of the main processes and phenomena from a meteorological, agrometeorological, hydrological and ecological point of view for the whole country is made. The information in it facilitates the assessment of the influence of these phenomena and processes in the different fields of the economics and public life, for decision making and increasing of the economical benefit. This bulletin is available at the website of the NIMH: http://www.meteo.bg .

Information about the daily status of the Bulgarian rivers and weather forecast for hydrological purposes is available also on the website of the NIMH http://hydro.meteo.bg/indexen.html

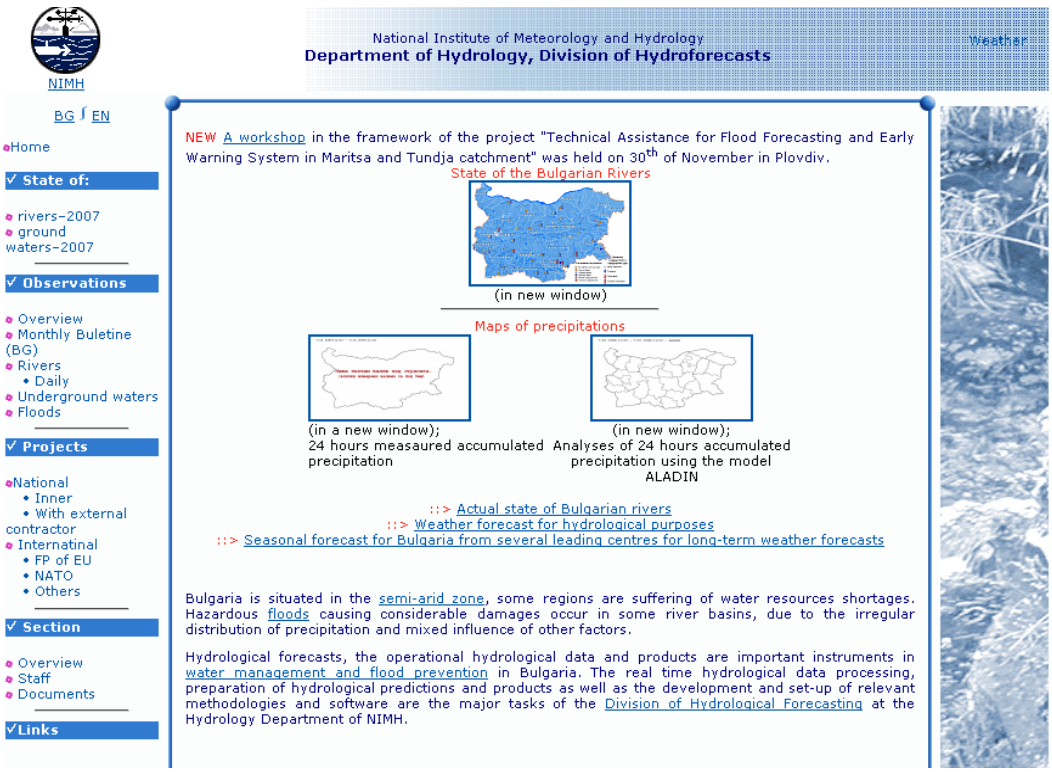

Figure14 NIMH website

The NIMH provides also detailed information upon request.

7.4. Communication System

Radiotelephone 3rd VHF Channel, telephone number +359 82 823 799 and the Internet. The e-mail address of the HHM directorate is: dhhm@appd-bg.org .

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