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SVILENGRAD TEST AREA IN SMARTWATER PROJECT

ABSTRACT

In the framework of Smart Water project funded by the call for proposals Prevention and Preparedness 2012 of DG ECHO financial instrument for civil protection support, our team has started a research on the Bulgarian river – Maritza in its part located on the territory of Svilengrad municipality. The project main idea is to implement in the everyday work of the civil protection engineers webGIS tool where flood maps of potential flood scenarios can provide online support in cases of need for the operational teams on the field.

The researchers from Bulgarian Academy of Sciences is working in a consortium with lead partner – province of Padua, Romanian partner – Danube delta national institute for research and development, research committee from university of Thessaly and region of Thessaly. The prepared flood maps will be created with accordance of the EU flood directive 2007/60/EC, which will give compatibility between the results in the consortium field work.

Keywords: SmartWater project, Flood mapping, Svilengrad municipality, Maritsa River.

AKILLI SU PROJESİ KAPSAMINDAKİ SVILENGRAD (HASKÖY) TEST ALANI

ÖZ

DG ECHO (Avrupa Topluluğu İnsani Yardım Bürosu Genel Müdürlüğü)'nun Koruma ve Hazırlık için teklif çağrısının sivil koruma desteğinin finansal araçları tarafından desteklenen Akıllı Su Projesi kapsamında Bulgaristan'daki Maritza Nehri'nin Svilengard (Hasköy) Belediyesi sınırları içerisinde bulunan bölgesinde bir araştırma başlatılmıştır. Projenin ana fikri sivil koruma mühendislerinin günlük işlerinde taşkın haritaları üzerinde webGIS araçları kullanarak olası sel felaketi senaryolarını belirlemesi ve arazide çalışan harekat ekiplerine çevrimiçi destek verebilmesidir.

Bulgaristan Bilimler Akademisi'ndeki araştırmacılar, pilot ortak Danube Delta Ar-ge Ulusal Enstitüsü -Padova İli, Romanya ortağı- ile konsorsiyum kapsamında çalışmışlardır, araştırma komitesi Tesali Üniversitesi ve Tesali bölgesindendir. Hazırlanan taşkın haritaları konsorsiyum arazi çalışmaları sonuçları arasındaki uyumluluğu sağlayacak olan 2007/60/EC sayılı AB taşkın yönetmeliğine uygun olarak üretilmiştir.

Anahtar Kelimeler: AkıllıSu Projesi, Taşkın haritası, Svilengrad (Hasköy) Belediyesi, Maritsa Nehri.

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1. INTRODUCTION

Floods are one of the most devastating natural hazards causing huge damages and human casualties all over the world. European countries in the recent years suffered from floods quite often. Some of the most catastrophic flood events for the last 100 years had happened in the last decade. The response of EU was acceptance of the Directive 2007/60/EC of the European Parliament and Council of the European Union on October 23, 2007 about the assessment and management of flood risks [1]. The Directive establishes a framework for assessment and management of flood risks to reduce the associated adverse effects on human health, environment, cultural heritage and economic activity. With accordance to the Directive the Bulgarian Executive Agency of Civil Defense (EACD) has introduced the following categories of floods, depending on their size, frequency and duration [2]:

1. **Small floods:**

They are characterized by low intensity and frequent recurrence – once in 10-20 years. These are floods bearing the lowest grade of risk (danger). They do not cause damage and do not leave long-lasting traces in the memory of the local population.

2. **Dangerous floods:**

Their characteristics are average intensity and probability of emergence once in 20-40 years. They cause damage to the immediately adjacent to the river agricultural land, buildings and facilities. They pose danger for the people and animals not only in the river valley proper, but also on the flooded river terraces.

3. **Very dangerous floods:**

Their characteristics are high intensity and probability of emergence once in 40-80 years. They cause damages to bridges, water catchments, and embankments along river corrections, adjacent land, buildings and engineering structures. They pose great danger for people and animals along the banks of the river.

4. **Devastating floods:**

Their characteristics include high intensity and probability of emergence once in 80-150 years. They cause great changes in the river course with grave pitting, meander breaking, destruction of banks, retaining walls, heavy damages and destruction of bridges, hydro-engineering facilities, sites situated near the river etc. They cause huge material damages and the peril of people and animals.

5. **Calamitous floods:**

Their characteristics are very high intensity and probability of emergence once in 150-200 years. They cause sharp changes in the river bed – pitting and destruction of old meanders. In the mountain sections the river course carries huge stone blocks of up to and above 2-3 m in size. At the point of exit of the river out of the mountain and into the flat land large, several meters thick torrential cones might emerge, made up of block piles, gravel and sand or sludge. In the flat land end of the river valleys got covered with a thick layer of slime. Hydro-engineering and building facilities and sites, situated along the river banks, such as reservoirs, bridges, roads, barrages, buildings etc. get entirely demolished or gravely damaged. Devastation and catastrophic material damages are inflicted and there are great losses of human life and animals.

This separation of the flood events was the first step in differentiation of the areas along the rivers exposed on risk in Bulgaria in the last three years. The data needed for hydrological analysis had to be collected also with accordance to the flood directive rules adopted in the Bulgarian legislation based on EU Directive 2007/2/EC of the European Parliament and the Council of March 14, 2007 for establishing an infrastructure for spatial information in the European Community (INSPIRE) [3]. This directive obligated building on metadata layers on national level in every EU member state. Bulgaria had, and still has, difficulties in defining the public and private bodies keeping relevant data in correspondence to the directive, but good practices have been taken into consideration. For instance in the frame of research, presented in [4], was given information about large historic flood events along Bulgarian rivers from the period 1935-1957, which is great progress in building the history of the large flood events in Bulgaria. This information is cited here in Table 1.

Table 1. Recorded floods in the period 1935-1957 for some major rivers in Bulgaria (cited from [4])

№	River	Locality of Gage Station	Q_{max} m^3/s	F km^2	MQ_{max} $l/s/km^2$	Date	Q_{max}/Q_0
1	Erma	Trun	180	358	503	22.VI.1948	65
2	Ogosta	Glojene	1120	3112	360	7.XI.1957	62
3	Iskar	Pasarel	420	1035	406	24.V.1937	32
4	Iskar	Kourilo	457	3662	125	24.VI.1948	21
5	Iskar	Oryahovitsa	1514	8366	181	14.I.1938	29
6	Vit	Yasen	534	2407	222	23.VI.1948	38
7	Osam	Gradishte	353	1771	200	17.VI.1955	42
8	Yantra	Vetrentsy	692	476	1455	28.VI.1957	138
9	Yantra	Cholakovtsy	1307	1289	1014	14.VII.1944	143
10	Yantra	Radnevo	1336	6574	203	29.VI.1957	33
11	Rossitsa	Karam	1975	203	9720	28.VI.1939	660
12	Rossitsa	Sevlievo	2755	1084	2542	28.VI.1939	300
13	Rossitsa	Vodolei	1100	1856	592	28.VI.1957	100
14	Vidima	Sevlievo	690	560	1332	28.VI.1939	160
15	Rous. Lorn	Besarabovo	124	2813	44	26.VI.1955	25
16	Provadiiska	Provadia	68.8	1304	53	22.I.1940	75
17	Provadiiska	Sindel	49.9	1856	27	13.II.1956	26
18	Devnya	Devnya	55	182	308	22.I.1940	-
19	Kamchiya	Preslav	626	1010	620	6.XI 1957	118
20	Kamchiya	Grozdevo	428	4857	88	4.V.1937	19
21	Vrana	Kochovo	81.7	380	93	6.III.1954	50
22	L. Kamchiya	Asparouhovo	536	1521	352	17.XII.1953	65
23	Maritsa	Belovo	1014	741	1370	5.IX.1957	117
24	Maritsa	Pazardjik.	895	4126	217	29.VI.1957	45
25	Maritsa	Polatovo	960	5440	176	29.VI.1957	32
26	Maritsa	Plovdiv	1375	8006	171	29.VI.1957	29

27	Maritsa	Purvomai	1050	12729	83	11.I.1955	14
28	Maritsa	Svilengrad	2285	20837	110	11.XII.1941	23
29	Mutivir	Sersemkale	210	162	1070	5.IX.1957	175
30	Chepinska	Varvara	333	885	376	29.VI.1957	46
31	Topolnitsa	Poibrene	176	904	195	29.VI.1957	28
32	Topolnitsa	Lesichevo	750	1617	464	5.IX.1957	81
33	Stryarna	Bahya	165	833	178	2.XII.1956	-
34	Arda	Prileptsy	1885	1900	993	2.XII.1956	63
35	Varbitsa	Djebel	2620	1149	2280	9.I.1956	137
36	Tundja	Banya	360	2234	161	9.I.1956	20
37	Mesta	Kremen	521	1511	345	24.V.1937	54
38	Struma	Rugdavitsa	343	2195	164	13.II.1956	36
39	Struma	Mar.Pole	1000	10243	93	10.I.1955	14
40	Dragovishtitsa	Goranovtsy	867	570	1532	9.VII.1940	98
41	Bistritsa	Sovolyano	116	257	452	28.VI.1957	52
42	Djerman	Doupnitsa	432	396	1090	31.VII.1953	100
43	Stroumeshtitsa	Mitinovo	285	1893	150	3.XII.1947	25

The flood events listed above and the floods which occurred in August 2005 and March 2006 in Elhovo region along the Maritsa and Tundja Rivers have shown that Bulgaria is also very affected from these extreme natural events and research projects in the field of systems for early warning and civil protection reactions will be of great benefit for the local population situated along the areas of high risk.

2. FLOOD HAZARD MAPPING in BULGARIA. STATE of THE ART

The contingency planning incorporated in the Smart Water webGIS tool background for the civil protection engineers of Svilengrad municipality is treating floods as a complex process that could be supported within the development of an integrated methodological approach. We will summary the core functions foreseen for the Bulgarian test case area:

1. The state of the art for the flood hazard mapping for Svilengrad municipality has been based on the existing official maps that are published on both sites of Fire Fighting & Civil Protection Directorate of the Ministry of Interior and Basin Directorate, Ministry of Environment and Water in Bulgaria [5], [6]. These maps were developed on the basis of historical and prognosis flooding data in 2012 for the territory of whole Bulgaria. An example for the area of Svilengrad and Maritsa River is shown on Fig.1. For better accuracy another set of simulations has to be done only for the area of Maritsa River in the segment Svilengrad municipality, by using hydrological model with 5, 10, 50, 100, 500 and 1000 years of time step for high wave propagation of the water in critical conditions. This is needed in the framework of Smart Water project because the borders between Bulgaria, Greece and Turkey are situated on the territory of Svilengrad municipality. The final uploaded flood hazard map scenarios in the webGIS decision support tool will give better precision and response by the civil protection authorities in cases of dangerous flood events.

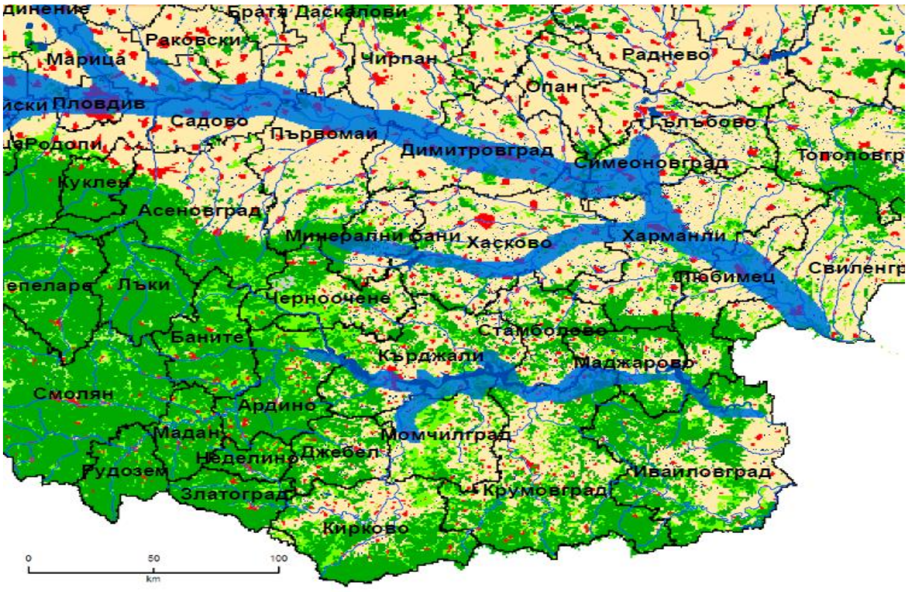

Figure.1. An example of a flood hazard map zones (blue zones) of Maritsa river for the area of Svilengrad. The data is retrieved from [6].

1. The flood hazard mapping in general uses hydrological models that are developed on the basis of terrain data with accuracy of 5-10 cm. The currently public available data for Bulgaria from satellite information is with accuracy 30-90 m (ASTER GDEM - 30m and STRM3 - 90m) and the one from topographic maps reaches 3-10 m (1:5000 ~ 3m; 1:25000 ~ 10m). The mathematical background of the flood prognosis is nicely shown by the Saint-Venant equations and the descriptions in Fig.2. The numerical integration gives 1D propagation which is the easiest case in simulation's plane:

$$\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = 0$$

$$\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right) + gA(So - Sf) = 0$$

Where:

Q - flow (m^3/s)
A - cross section area (m^2)
q - lateral inflow ($m^3/s/m$)
x - longitudinal channel distance (m)
t - time (s)
g - gravitational acceleration (m/s^2)
So- bed slope; Sf- friction slope

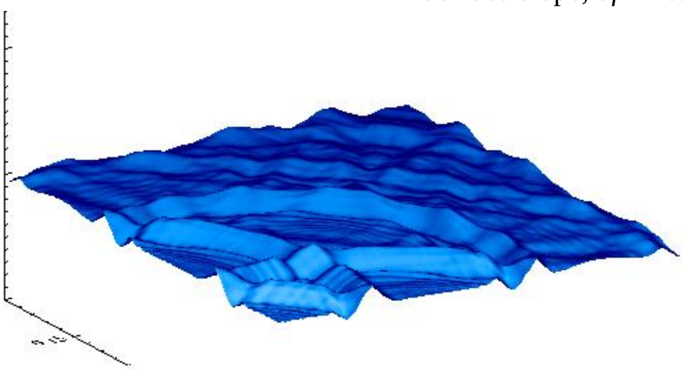

Figure 2. Saint-Venant equations shallow water model graphical interpretation example. The figure is retrieved from [7].

Practical commercial software solutions for achieving of 1D and 2D successful modelling are the Halcrow ISIS [8] and DHI Group MIKE [9] products. Bulgarian territory has been successfully modeled for 163 zones from the ReSAC Company and the Agency for Sustainable Development and Euro Integration [10]. An example of a flooding hydrological model for the area of Svilengrad and Maritsa river water level dynamic change from 1 to 5 meters of high wave water discharge with vertical relief accuracy of 5 m. This is shown on Fig.3:

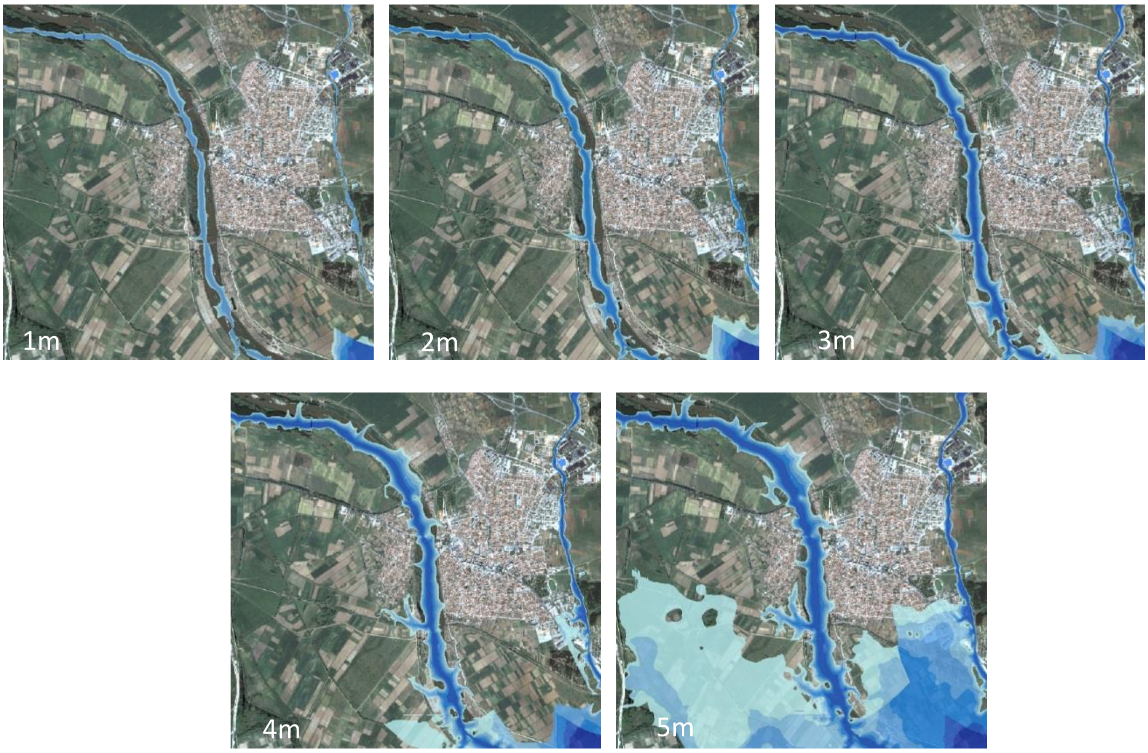

Figure 3. An example of a flooding hydrological model for the area of Svilengrad and Maritsa river water level dynamic change from 1 to 5 meters with relief vertical accuracy of 5 m. The data is retrieved from [10].

Evidently, because of the lack of enough accurate data the developed maps need adjustment when it comes to operational implementation for civil protection decision support tool as it is planned in Smart Water project.

3. PROJECT SMART WATER INSIDE LOOK

The project Smart Water has technical specifications which are oriented to the civil protection engineers, who could apply field response for the population in risk by having webGIS tool that could support their decision making in cases of large flood events. The test areas are river sections defined for each project partner and the Bulgarian region is on the territory of municipality Svilengrad. The end user needs for the test cases cover the following types of information for the river monitoring:

- Distance from water level to river bank side
- Flooding areas
- Speed and direction of the water
- Water blades
- A series of maps of predefined and variable flood scenarios, with greater frequency for the selected test case area provided in an information layer (i.e. raster images) corresponding to the information required by the civil protection units, where the reliability of forecasts is the main focus.

- A set of data in the form of graphs, tables, or files for download will be also available for the identified critical levels.

- For each simulation and for each point, the maximum water height independently from the moment, when it is reached, will display immediate worst scenario situation possible from the given initial conditions.

The standard WMS interface will be applied for displaying the hydrological model outputs on the webGIS platform. The maps in raster format like JPEG or PNG will give opportunity for punctual queries for the users. The cartographic data will be provided in alphanumeric information related to the predetermined number of positions along the route of the monitored water course, deemed to be especially critical. The identification of the strategic locations and data supply will have geomorphologic and hydrodynamic sets, where will be included DEM (Digital Elevation Model) for the catchment basin, ortophoto images for better justification of land use, meteorological data for precipitations and additional climatic conditions, along with water level discharges and topology of the river levees for the simulated areas. On Fig. 4 is given the structure of the information flow that the webGIS platform will have implemented in its last version.

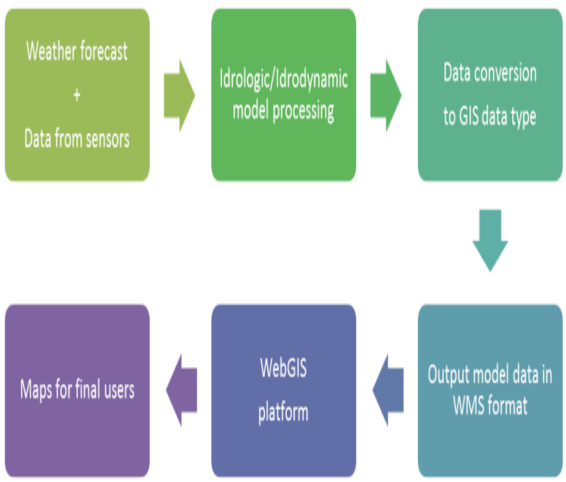

Figure 4. Information flow as it will be implemented in the webGIS tool that will be the result of Smart Water project.

4. CONCLUSIONS

The project duration is two years during which our team has as a goal to implement all required specifics of the EU Directive 2007/60/EC for flood monitoring. Smart Water project is a helpful tool which can improve significantly the civil protection decision support on the field and it is a good example of interdisciplinary work on international level.

AKNOWLEDGEMENTS

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