Deliverable D6.11 Functional prototypes of BSC-OS Flood Portals for citizens: Implementation and Evaluation

Title	Functional prototypes of BSC-OS Flood Portals for citizens: Implementation and Evaluation
Creator	Anderja Jonoski (UNESCO-IHE)
Creation date	15.03.2013
Date of last revision	25.03.2013
Subject	The document presents the final design, implementation and evaluation of the two flood-related prototype applications within the BSC-OS aimed for citizens and broader stakeholders, including non-experts. The prototypes were implemented and evaluated for two case studies in Romania on the basis of the conceptual design presented in Deliverable 6.5 (enviroGRIDS_D65).
Status	Final
Type	Word document
Description	Two flood-related demonstrator case studies in Romania have been identified for development of the demonstrator applications of the BSC-OS for citizens and broader stakeholders: the Somes Mare catchment in north-western part of Romania and a stretch of the Danube river (between Braila and Isaccea). Both case studies include observed and modeled data. All spatial and temporal data has been presented in dedicated web-based platforms, by making use of web services based on OGC standards such as WMS, WFS and WaterML 2.0. Web-based user interfaces for accessing and visualization of the data by non-expert stakeholders and citizens have been developed, together with components for providing user feedback. Two dedicated workshops with stakeholders have been carried out in the respective case study areas, during which the applications have been evaluated by the target stakeholders. This report presents the final design, implementation and evaluation of these applications.
Contributor(s)	Andreja Jonoski, Ioana Popescu, Adrian Almoradie, Florin Stoica, Sorin Teodor, Ioan Jelev, Dorian Gorgan
Rights	Public
Identifier	EnviroGRIDs_D611
Language	English
Relation	1. Generic conceptual design of BSC-OS for citizens (enviroGRIDS_D65) 2. First implementation of the BSC-OS portal (enviroGRIDS_D64) 3. Requirements and specifications for the development of BSC-OS Portal (enviroGRIDS_D61)

Abstract:

This document describes the final design, implementation and evaluation of two citizens-oriented demonstrator applications as part of the BSC-OS system that has been developed within the enviroGRIDS project. While most tools included in BSC-OS are aimed at water and environmental professionals, the two applications that are subject of this report are developed specifically for the target group of citizens and broader non-expert stakeholder groups. Two applications have been developed, both related to flooding problems in two case studies in Romania. These applications are entitled "Flood Portals for citizens". The report initially describes the purpose and main objectives of the flood portals and their conceptual design. Two case studies are then described that serve for developing the applications: the mountainous catchment of the Somes Mare River located in north-western Romania and a section of the Danube River between the towns of Braila and Isaccea. Typical flooding problems together with available data and implemented models for simulating flooding in these respective areas are presented. The final design and implementation of the flood portal is subsequently described with all data management components on the server side (using standard web services, such as WMS, WFS and WaterML 2.0) and web-based user interfaces on the client side. Both flood portals have been developed in English and Romanian language. Evaluation of the flood portals during workshops with local stakeholders in Romania is finally presented, followed by conclusions.

Executive Summary

EnviroGRIDs is a 4 year international research project, funded in 2009 by the EU FP7 research programme, which aims to contribute towards development of international cooperation and capacity development for sustainable development in the countries of the Black Sea Catchment (BSC). The project has been set-up in recognition of the need for harnessing the potential of the latest ICT technologies for data collection, storage and sharing, together with latest developments in modeling technologies - in order to deal with the complexities of achieving sustainable development in the region. One significant output of the research carried out within enviroGRIDS is the setting-up of the so called Black Sea Catchment – Observation System (BSC-OS) – a portal which provides access to a set of tools for management and usage of large sets of data and models related to the BSC to be used by different types of users and for different tasks. Although most of the tools available in the BSC-OS portal are aimed at water and environmental professionals, two web applications that are subject of this report have been designed and implemented for broader stakeholder groups and individual citizens. The main objective of these applications has been to demonstrate how latest ICT technologies can be used for developing applications through which water and environment-related information can be provided to these target groups in such a way that they will become more informed about critical issues and support their involvement of these same issues together with the responsible authorities.

The two applications have been developed for case studies in Romania. They are both related to issues of flooding and they are entitled “Flood portals for citizens”. In the first case study of the mountainous Somes Mare catchment located in the north-western part of Romania the users are able to access relevant flood-related data (precipitation, temperature, discharges, and flood hazard maps) together with hydrological modeling results of a rainfall-runoff model that simulates the discharge from the catchment. Citizens and other users have been provided with web-based user interfaces for visualizing these data as well as with components for providing user feedback (their own knowledge related to flood issues in the catchment). The second case study is related to flooding problems in the downstream part of the Danube River on a section between the towns of Braila and Isaccea. This part of the river is also known by the local name of Cat’s Bend. The town of Galati is also located in the middle of this section on the left bank of Danube. Both Galati and the large low laying area on the right bank of Danube could be prone to flooding from Danube and especially if the flood peak of Danube coincides with flood peaks of two left tributaries – the rivers Prut and Siret. Such critical situations have been modeled with a hydrodynamic 1D-2D model of the area and scenarios with different coincidence of flood peaks (from the three rivers) have been analyzed. Alternatives without raised dikes and with raised dikes have also been simulated and presented to the stakeholders and citizens via the flood portal for awareness raising and obtaining user feedback.

These applications have been developed by technologies that have been researched and promoted within enviroGRIDS related to development and deployment of web services for delivering geospatial and temporal data. The OGC standards, such as WMS and WFS have been used for delivering the spatial data, and WaterML 2.0 was used for delivering time series data. This has been achieved by utilizing GeoServer on the server side, together with standard web server applications and databases. On the front end the applications have been developed with mapping and graphing components for realizing the required user friendly interfaces. Both flood portals have been developed in English and Romanian language.

The developed applications have also been evaluated by local stakeholders in the case study areas in two dedicated workshops. The evaluation results were quite positive and the stakeholders have shown high appreciation for the approach presented via these two applications. Both the involved authorities (enviroGRIDS partners from Romanian waters) and other stakeholder representatives have indicated the high potential of these kinds of applications for future, potentially more inclusive flood risk management in Romania.

The flood portals for citizens are made accessible via the BSC-OS portal together with other tools developed within the enviroGRIDS research project.

Contents

List of figures

1 Introduction

1.1 Purpose and scope

EnviroGRIDs is a large 4 year international research project funded in 2009 by the EU FP 7 research programme, which aims to contribute towards development of international cooperation and capacity building for sustainable development in the region of the Black Sea catchment (BSC). The project has been set-up in recognition of the need for harnessing the potential of the latest ICT technologies for data collection, storage and sharing, together with latest developments in modeling technologies, - in order to deal with the complexities of achieving sustainable development in the region. The project has several main areas of research activities contributing to this overall goal. The first area is on developing Spatial Data Infrastructures (SDIs) for environmental data by means of which data could be shared and utilized within countries of the BSC region as well across different countries that have shared water and environmental resources. The SDI development is based on latest Web and GRID technologies and on adopted and emerging standards for sharing spatial and temporal data. A second large research area of the project is modeling of hydrological processes on both large and small scales. The large scale modeling is pursued by developing a model of the BSC using the freely available open source Soil and Water Assessment Tool (SWAT), while other diverse tools are used for small scale modeling applications. Research is then pursued in combining these modeling applications with predictive models of possible external drivers (climate change, population growth, land use change, etc) in order to assess impacts on several societal benefit areas (agriculture, energy, ecology, flooding, etc). Through these research activities and selected large and small scale case studies the benefits of all latest ICT technologies are demonstrated and a large number of project partners and stakeholders in the region develop capacity for better coping with many future uncertain factors.

The project is also aiming at developing useful tools that can support various tasks needed for the above mentioned research and practice. Such tools are made available within one portal – the Black Sea Catchment – Observation System (BSC-OS portal - http://portal.envirogrids.net/). The development of the BSC-OS is part of the Works Package No. 6 (WP6) of the enviroGRIDS project. Most of the tools that are made available via the BSC-OS portal are aiming to support various water and environment professionals. Available tools include the Geoportal (for searching, discovering and accessing data from the BSC), GreenLand (for satellite image processing on the Grid), gSWAT (for calibrating and executing SWAT models on the Grid), eGLE (for developing, and managing teaching materials – contributing to the Virtual Training Center of enviroGRIDS), BASHYT (a decision support tool primarily based on SWAT models) and GEOSS (access to enviroGRIDS services registered in GEOSS).

Within Task 6.3 belonging to WP6 of enviroGRIDS it was also envisaged to develop web-based demonstrator applications for citizens and broader non-expert stakeholders, which will show how the technologies for distributing geospatial and temporal data combined with modeled results can be used for information dissemination and sharing among water authorities, professionals and broader stakeholder groups and citizens. Such applications could open possibilities for involvement of these broader stakeholder groups in critical water-related management issues, such as flooding.

This report presents the outcomes of the development of these two web applications for citizens. Partners from UNESCO-IHE (Delft, the Netherlands), Somes-Tisza Directorate of Romanian Waters (Cluj-Napoca, Romania), INHGA of Romanian Waters (Bucharest, Romania) and UTC (Cluj-Napoca, Romania) developed jointly the applications for two case studies in Romania. The first case study is the mountainous catchment of the Somes Mare River in north-western Romania, and the second case study is on a section of the Danube River between Braila and Isaccea (upstream of the Danube Delta). In both cases the main issue addressed was flooding. Consequently models and data relevant for flooding in these respective areas were included in the applications. Although there are differences in the two applications in terms of the nature of flood generation, types of data and the respective models, they are also similar in many respects and both of them have been entitled “Flood portals for citizens”.

The flood portals are web-based applications that include flood-related data provided by the authorities (Romanian waters) used and combined with model results, all of which are presented via user interfaces in a simple and intuitive way for broad stakeholder groups. Web based mapping and graphing components are extensively used for developing these interfaces. All the relevant data are provided from the back end using SDI-like solutions that have been researched and promoted within the enviroGRIDS project (web services solutions, based on OGC standards, such as WMS, WFS and WaterML 2.0). Because the applications were for local case studies in Romania, both flood portals have been developed in English and Romanian language. The Romanian version of the portals was necessary for purposes of demonstrating and testing the flood portals during workshops with local stakeholders.

The scope of this report is to present the final design, implementation and evaluation (by the stakeholders) of the two flood portal applications. Initial ideas about the two demonstrator case studies and the conceptual design of the citizens applications have been reported mid-way through the enviroGRIDS project in the deliverable enviroGRIDS_D65. This report will present only connecting information to the material presented in this deliverable, primarily regarding the conceptual design on which the final design and implementation of the flood portals was based. Some modifications in the target issued addressed by the applications and in the final design and implementation (as compared with those proposed in enviroGRIDS_D65) will also be presented. For other issues related to the generic conceptual design of these applications the readers are advised to access enviroGRIDS_D65.

1.2 Document structure

This document is structured in 6 chapters. Chapter 1 (this chapter) outlines the broad objectives and main research areas of the enviroGRIDS project, the purpose of developing flood portal applications for citizens as envisaged in WP6 and the scope this document. Chapter 2 gives a brief description of the BSC-OS Flood portal applications and their objectives, together with their initial conceptual design. In chapter 3 the two case studies selected for developing the demonstrator applications are introduced by their characteristics, objectives, modeling approaches and available data that were used for model development and deployment on the flood portals. The final design and implementation of the flood portals is given in Chapter 4, together with their linking to the BSC-OS Portal. Chapter 5 presents the evaluation of the flood portals during the workshops with local stakeholders in terms of structure of the workshops, forms used for evaluation, and obtained results. Finally, Chapter 6 presents brief conclusions from this work.

Appendix 'A' presents user guides through the web-based interfaces of the two flood portals.

2 BSC-OS Flood portals for citizens

This chapter will present the main objectives of the BSC-OS flood portals for citizens, together with the initial conceptual design for these applications. Some modifications to the case studies and consequently to the design and implementation of the applications, as compared to the original ideas presented in enviroGRIDS_D65 are also presented.

2.1 Main Objectives of the BSC-OS flood portals for citizens

The flood portals for citizens of the enviroGRIDS project have been developed with two main objectives in mind:

- Demonstration of the applicability of technological approaches researched and promoted within enviroGRIDS for developing applications that could support information dissemination and awareness raising among citizens and non-expert stakeholders in localized case studies characterized by some critical issues. In both case studies flooding has been addressed as a critical issue. The particular technologies that were tested are those of using web services for delivering geo-spatial and temporal data using standards promoted by the Open Geospatial Consortium (OGC). Knowledge generated in other work packages of enviroGRIDS (especially from WP2) related to technologies for developing Spatial Data Infrastructures (SDIs), was re-used and implemented for development of the flood portals. In this way the delivery of standardized web services (such as Web mapping Service – WMS, Web Feature Service – WFS for spatial data and WaterML 2.0 for water-related time series data), in combination with appropriate web-based user interfaces, could be demonstrated to be useful for applications targeting very diverse user groups, such as citizens and non-expert stakeholders, in addition to water professionals, environmental specialist and water authorities and decision makers.

- Evaluation and assessment of web-based applications intended for joint usage by water authorities and citizens and non-expert stakeholders aimed at improved water management, in this case dealing with flooding issues. This objective has been introduced in recognition of the added value of inclusive flood risk management approaches, in which water authorities and experts combine their knowledge and assessment about flood risks with knowledge available in the affected communities. This approach can lead to increased flood risk awareness, and consequently better preparedness in the communities, and in long term it can contribute to developing flood risk strategies based on shared interests and objectives among different stakeholders and the concerned citizens.

The first objective is primarily technological in nature and is attainable in an easier manner within the framework of one research project such as enviroGRIDS. The second objective touches upon the social arrangements in local environments exposed to flood risk and aims to influence existing practices of flood risk management by promoting more inclusive and participatory approach. As will be demonstrated later in this report, the developed flood portals are appreciated by the targeted stakeholders and citizens, but their usage in long term flood risk management would depend on adoption of this approach by the relevant authorities, which is a task that certainly goes beyond one research project.

It should also be noted that the whole process of developing the flood portals in partnership by the participating organizations (a mixture of water management authorities in Romania and research organizations) also contributes to the overall enviroGRIDS objective of capacity development within BSC, albeit in this case on local scales.

2.2 Conceptual design of the flood portals and its modifications

The conceptual design of the flood portal for citizens has already been introduced in enviroGRIDS_D65. These applications have been envisaged to be integral part of the BSC-OS portal. The overall portal architecture is quite complex as it integrates a number of different tools, but for the two flood portal applications addressed here a relevant subset of the BSC-OS tools and services, as already introduced in enviroGRIDS_D65, is presented in Figure 2.1.

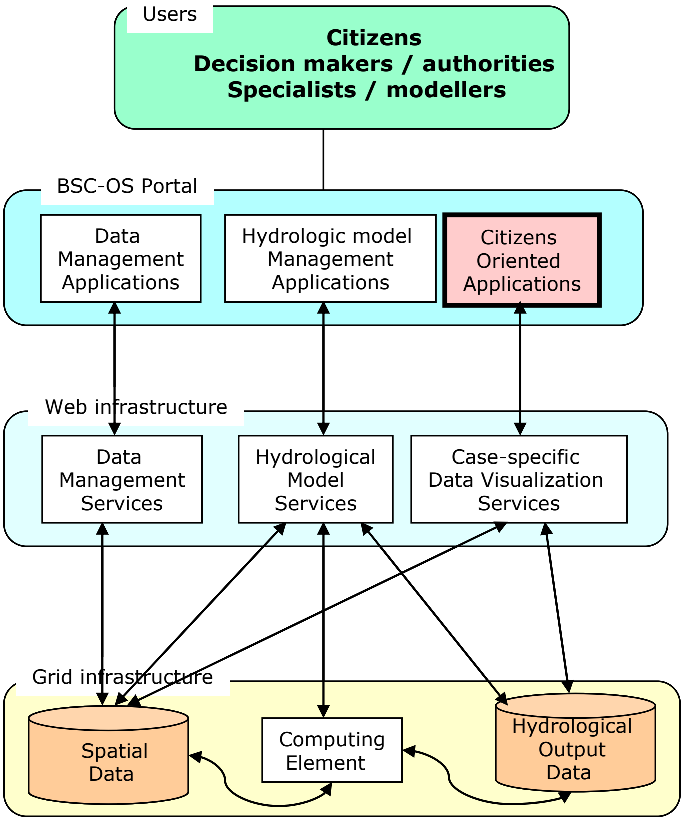


Figure 2.1. Subset of BSC-OS Portal tools and services relevant for the citizens-oriented demonstrator applications - flood portals *(adopted from enviroGRIDS_D65)*

During the course of development of the flood portal applications the design presented above was somewhat modified. The most important modification has been in the fact that the flood portals for citizens do not utilize any components in the Grid infrastructure, and both applications are only using the web infrastructure. The originally envisaged usage of the Grid infrastructure was related to the development of flood forecasting and warning application for the first flood portal of the Somes Mare catchment case study, in which the rainfall-runoff model (developed by the HEC-HMS modeling system) would be run on the Grid with different precipitation inputs (from gauged stations and from radar) in order to provide ensemble forecasts of discharge. This has not been realized because of two reasons: i) the developed model could not be brought to the required level of accuracy due to difficulties in proper capturing of the snow melt components, which seemed to be critical for high discharges during spring and ii) the raw radar data on precipitation could not be obtained as the operation of these data in the Somes Tisza directorate of Romanian waters is carried out by external commercial software related to the radar installations. It needs to be mentioned, however that there were successful tests of running the HEC-HMS model on the Grid infrastructure, but these were eventually not used in the final design of the flood portal for Somes Mare. The second flood portal application for the Danube River was not envisaged to use the Grid infrastructure.

On the other hand, some additional components that were not envisaged in the original conceptual design were introduced in the flood portal applications. These components are related to delivering time series data in the WaterML 2.0 format, which during the course of the enviroGRIDS project has been adopted by OGC as a standard for sharing water-related time series data via web services. This approach has been successfully tested with data from the Somes Mare case study and the flood portal has components for accessing time series data in Water ML 2.0 format for temperature, precipitation and discharge. These data are made available for all stations in the catchment for a period of one year (2007).

With these modifications we can present one updated general conceptual design of the flood portals for citizens as shown on Figure 2.2.

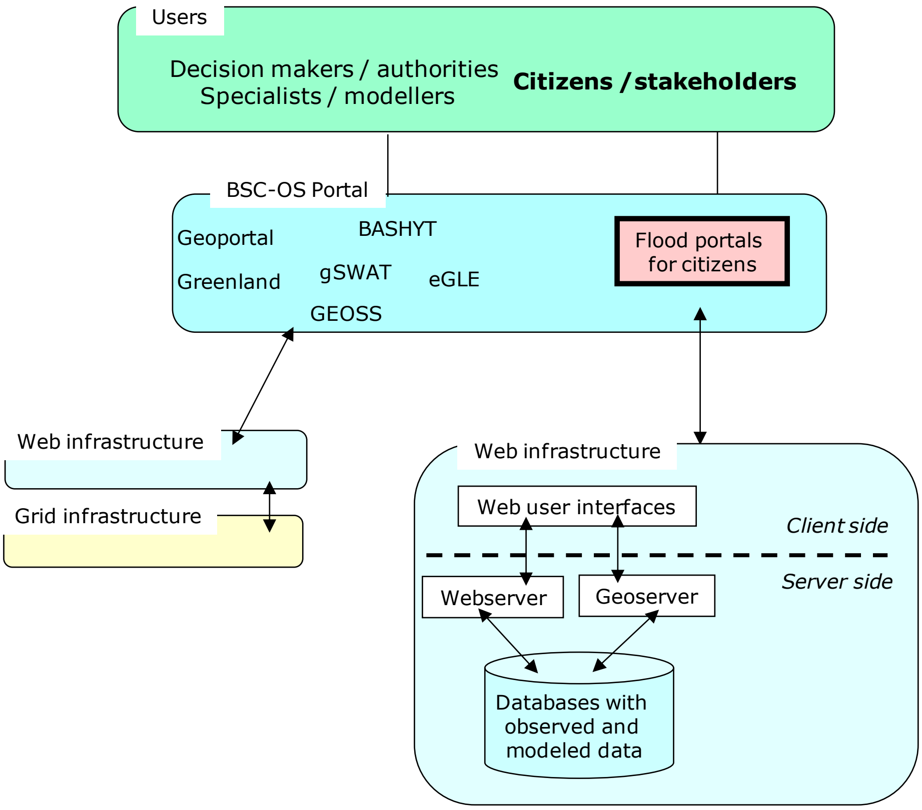


Figure 2.2. Updated generic conceptual design of the flood portals for citizens

As shown in Figure 2.2, while other BSC-OS tools utilize both the web and the Grid infrastructure the flood portals for citizens applications use only the web infrastructure with web-based user interfaces on the client side and three main components on the server side: a) Databases for observed and modeled data, b) Geoserver for serving standards-based geospatial and times series data and c) Web server. More details about the implemented design of the flood portals will be presented in Chapter 4 of this report.

3 Case study descriptions of the BSC-OS Flood Portals

This chapter provides descriptions of the two case studies that were used for developing the flood portals for citizens. The first case study is related to flooding problems in the mountainous Somes Mare catchment in north-western Romania. The second case study is related to flooding problems in a particular reach of the Danube River (between the towns of Braila and Isaccea), located in the downstream section of the river, just before the Danube Delta. For each case study a brief description of the flooding problems followed by available data and modeling approaches are presented.

3.1 Flood Portal Somes Mare

3.1.1 Flooding problems in Somes Mare catchment

The Somes basin is located in the north-western part of Romania (Figure 3.1). Two rivers, Somes Mare (Big Somes) and Somes Mic (Small Somes) from the upstream part of the catchment have a joint confluence in the town of Dej. The river Somes flows downstream of Dej till its confluence with river Tisza which is located in Hungary (Figure 3.2).

The total area of the Somes catchment is 15,015 km^2. Upstream of the city of Dej the catchment has an area of 8856 km^2. The focus of this case study will be Somes Mare, because of its larger potential for flooding. It has an area of 5078 km^2 with medium elevation of 678 mASL. The length of the main river - Somes Mare is 136 km. The whole catchment covers almost entirely the Bistrita – Nasaud administrative county and partially the Cluj County.

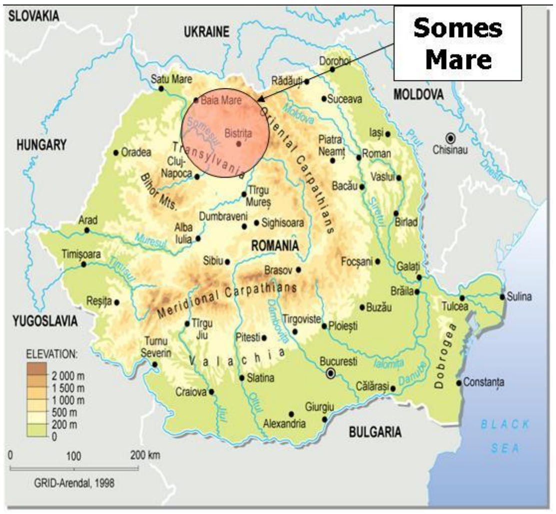


Figure 3.1. Location of the Somes Mare catchment

Figure 3.2. Catchments of the whole Somes River and of the Somes Mare River

Somes Mare (from its spring to the confluence with Somes Mic in Dej) lies in the contact area between the Eastern Carpathians with the Transylvania Depression. It is a varied and complex territory, being composed of mountains (36%) which open as an amphitheatre towards the Somes Mare Valley, ranging from 800 m to 2279 m in altitude and hills (64%) which belong to the Transylvanian Plateau, ranging between 400 m and 800 m in altitude.

The average annual discharge of Somes River in Dej, just after the confluence of Somes Mare and Somes Mic is 74.1 m^3/s. Of this discharge 64% is brought by Somes Mare and 36 % by Somes Mic. An analysis of the 100 years return period flood on Somes Mare (0.3 m3/s/km2) and Somes Mic (0.2 m3/s/km2) river upstream of their confluence, shows that the flood occurring on the Somes Mare river are much more important than the Somes Mic basin. In the past 35-40 years, the most important flood was the one of 1970, corresponding to the 100 years flood in Dej area. Flood peak of Somes Mare was about 2000 m^3/s, whereas on Somes Mic the peak was about 450 m^3/s.

The most devastating floods were the result of a combination of rainfall with snow melt. In the past 15 years, there is a tendency of having earlier floods (March-April instead of May-June) and more often winter floods (December to February). Also there are some areas with recurrent floods and more torrential aspect of the rainfall and drainage.

After the construction of Tarnita (1974) and Fantanele (1978) reservoirs in the Somes Mic upstream catchment no major floods have occurred on that river. Somes Mare, on the other hand, has almost no man-made reservoirs (except one small reservoir on the Bistrita tributary) and consequently has much higher flooding potential.

Lately, on Somes Mare River there are many occurrences of flash floods. The most devastating one was the one from 2009. This situation demonstrates the need for further studies in order to build and implement a better flood risk management strategy in the Somes Mare catchment.

3.1.2 Available data for the Somes Mare flood portal

All necessary data for developing the Somes Mare flood portal have been provided by Romanian Waters - Directorate of Somes-Tisza (DST). This is the main institution responsible for water and flood management in the area. Most of the available data have also been used for developing of the HEC-HMS rainfall-runoff model of the Somes Mare catchment

The available data are given in the list below:

- Geometry of the studied basin:
    1. DEM of the basin (30 x 30 m);
    2. Delineation of the sub-basins in Somes Mare;
- Hydrological and meteorological data
    1. Locations of meteorological and hydrological stations
    2. Discharge (daily data for the period 1999-2008)
    3. Precipitation (daily data for the period 2001 – 2008)
    4. Air temperature (daily data for the period 2006-2008)
- Flood extent maps along Somes Mare River
    1. Return period 1/20 years (1,421 m^3/s)
    2. Return period 1/100 years (2,043 m^3/s)

All above mentioned data have been used in the flood portal for Somes Mare. Most of the data have also been used for the development of the HEC-HMS model of the Somes Mare catchment as presented in the following section.

3.1.3 HEC-HMS model of the Somes Mare catchment

Within this study a hydrological rainfall-runoff model has been developed for the Somes Mare catchment. As mentioned in the previous chapter the original idea was to develop this model for forecasting purposes, but due to several difficulties the model has not been developed to that extent. Nevertheless the model results can also be combined with other available information which can be provided to the citizens on the portal in order to raise their awareness about potential flood risks in the area.

The tool chosen for the purposes of this case study is the Hydrological Modeling System (HEC-HMS modeling system), developed by the US Army Corps of Engineers. This is a freely available tool that can serve for various hydrological analyses including flood analyses.

HEC-HMS is a generic modeling system for simulating precipitation-runoff processes in dendritic catchments. The catchment under study is usually divided in a number of sub-catchments with spatially varying parameters and meteorological inputs. Runoff generation is computed for each sub-catchment and subsequently the generated runoff is routed downstream to the catchment outlet. Different methods for runoff generation are included (for event simulation or continuous simulation) as well as different routing methods. HEC-HMS comes with a fully developed user interface for setting-up the models and for post-processing the results. For spatial data analysis an associated tool named HEC-GeoHMS can be used, which is a Geographical Information System (GIS) tool that can easily integrated with HEC-HMS. For time series data the system uses the standard HEC-DSS (HEC – Data Storage System).

For the development of the HEC-HMS model of the Somes Mare catchment the catchment has been divided into sub-catchments, as presented in Figure 3.4. The same figure also presents the location of various meteorological and hydrological stations available in the catchment.

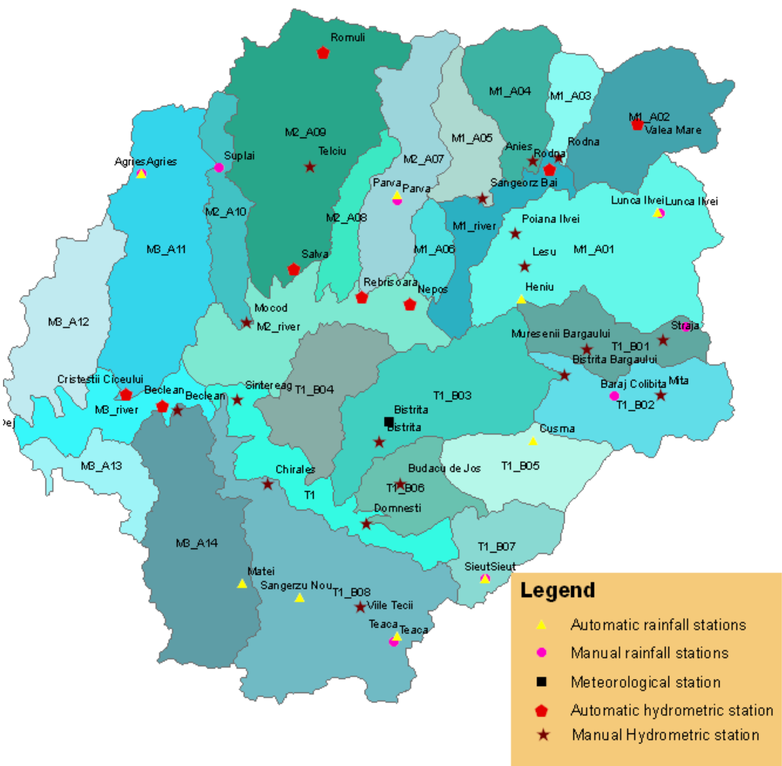


Figure 3.3. Sub-catchments for the Somes Mare catchment and locations of hydrological and meteorological stations

The actual set-up in HEC-HMS of this model is presented in Figure 3.4 below:

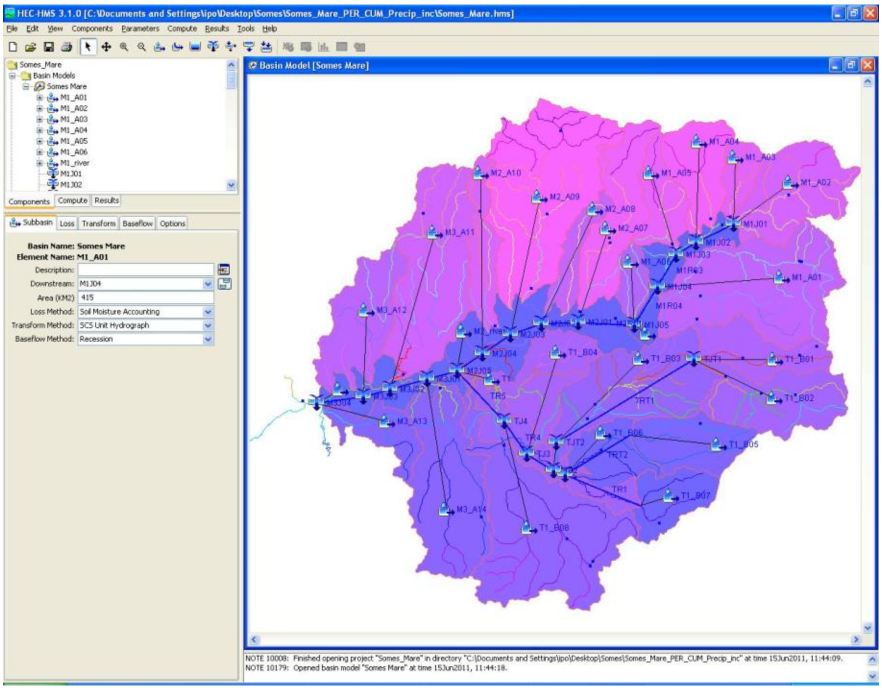


Figure 3.4. Somes Mare catchment model set-up in HEC-HMS modeling system

The HEC-HMS model has two main sub models – the basin model and the meteorological model. The basin model is composed of several key elements: sub basins, reaches and junctions. Sub basin elements are introduced to simulate the rainfall-runoff process within sub basins. These are connected to the river reaches, via junctions in such a way that the runoff produced within sub-basins is routed downstream via the river reaches. For the Somes Mare model the rainfall runoff process has been simulated with the Soil Moisture Accounting method available in HEC-HMS, which is suitable for continuous simulations. The SCS unit hydrograph method was used as transform method and lag routing for routing of the discharge along the river reaches. Evapotranspiration is accounted for by using calculated monthly potential evapotranspiration. All these methods contain critical parameters that need to be adjusted during calibration.

The meteorological model serves for specifying precipitation data (as main driver of the rainfall-runoff process), temperature data and the snowmelt model parameters. For the Somes Mare model the precipitation was supplied from gauges data, using gauge weights method for distributing the precipitation on sub basins. The recommended weights were provided by hydrologists from Romanian waters (DST). The radar measured precipitation, although originally intended, was not used, as explained in the previous section. Because snow melt is significant in the Somes Mare catchment the model also included the snow melt component by using the temperature index method of HEC-HMS. The mountains in the area are usually covered by snow in the period December-February, and depending on the temperature and elevation the snow melt component of the runoff can be very significant in subsequent spring months. These processes, in combination with spring rainfall events were most challenging to be captured in the developed HEC-HMS model.

Given the available temperature data for the period of 2006-2008 and the significance of the snowmelt component the model has been calibrated for the period 2006-2008. Although the general pattern of runoff has been captured, the accuracy of the simulated flood peaks is still not very satisfactory, as can be seen on the Figure 3.5 below. The model needs further refinement (and adjustment of its parameters –especially those related to snowmelt) if it is to be used in future for forecasting purposes.

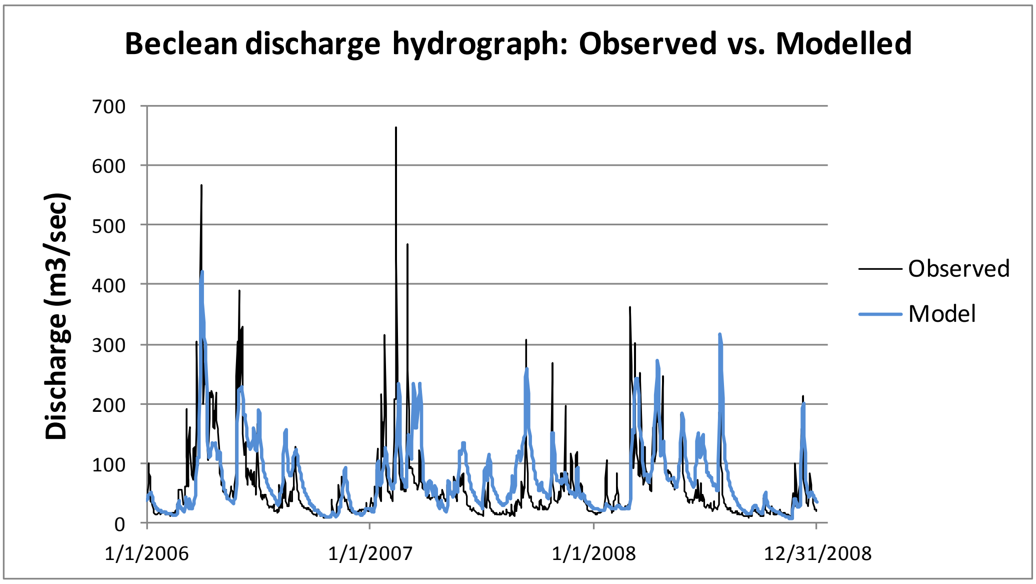


Figure 3.5. Simulated and observed hydrographs for Beclean station in the calibration period of 2006-2008

Even though the model results require further improvement it was decided to include them in the flood portal for citizens, as they may still provide useful information for both water professionals interested in this kind of modeling as well as for other citizens and stakeholders.

3.2 Flood Portal Danube of Braila – Isaccea section

3.2.1 Flooding problems in the Danube River - section Braila-Isaccea

Danube river basin covers about 10% of the European continent. The length of Danube is 2780 km with a catchment area of over 801,463 km2 and annual average flow of approximately 6500 m^3 /s (Figure 3.6).

Due to the geographical distribution and nature of the hydrological regime, the Danube is divided into three sections: the upper Danube (from its spring to Vienna), the middle Danube (from Vienna to Iron Gates) and the lower Danube (from Iron Gates to Black Sea). The lower Danube is characterized by a highly complex system, consisting of several sections, each one with its specific character.

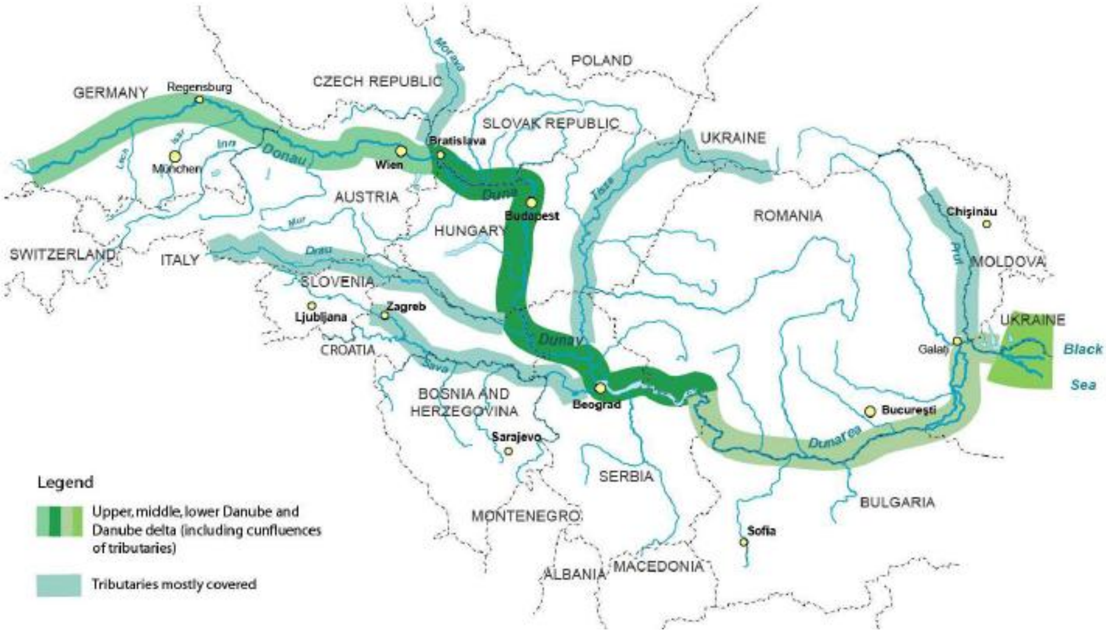


Figure 3.6. Danube river zones

The wetlands of the Lower Danube in particular have undergone various and complex changes in the period of 1950-1989, changes that have led to the disappearance of approx. 80% of semi-natural ecosystems, by turning them into man-controlled ecosystems, subsidized energy and materials for agricultural production, timber production and intensive fishing.

The main focus of the present case study is flood risk management in case on the lower Danube sector, between Braila and Isaccea. Initially the study was envisaged to analyze combined effects of flooding, sedimentation patterns and possible effects on the ecology in this area, but in consultation with partners from Romania waters (INHGA) it was decided to focus the study on flooding patterns only.

The studied area is close to Galati, and it is also know by its local name of the so called Cat's Bend (see Figure 3.7. The Danube Floodplain in the Cat's Bend area has insufficient capacity to reduce the peak flows, as observed during the summer of 2004 and 2005 and in the spring 2006, when a large part of the region was flooded and evacuation was necessary to be carried out. Flood mitigation measures, such as removing dams at certain points along the river, were performed and allowed the water to spread towards the floodplains. These kinds of measures often mean a fundamental change in the spatial and functional planning of the region, for example, the agricultural land in the areas surrounding the river is transformed into natural area. Traditional measures such as enhancing and strengthening the dykes are relatively expensive and offer limited opportunities of being effective.

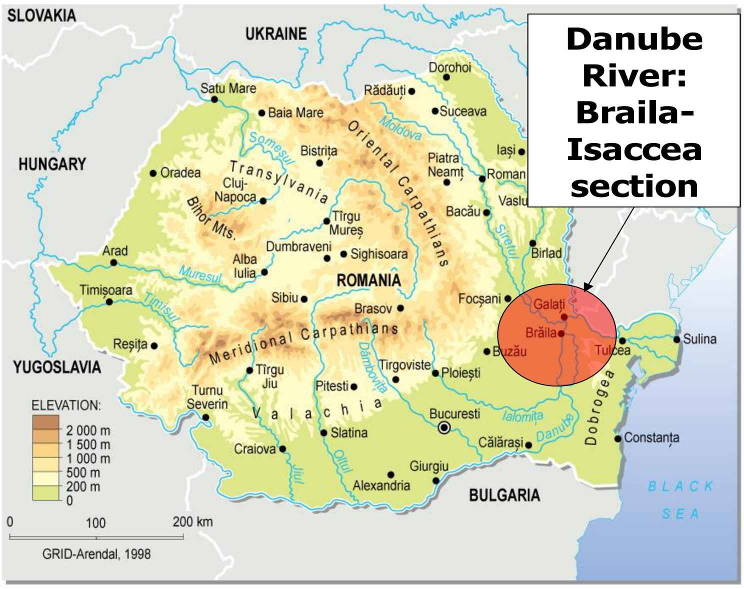


Figure 3.7. Location of the Braila-Isaccea section on the Danube River

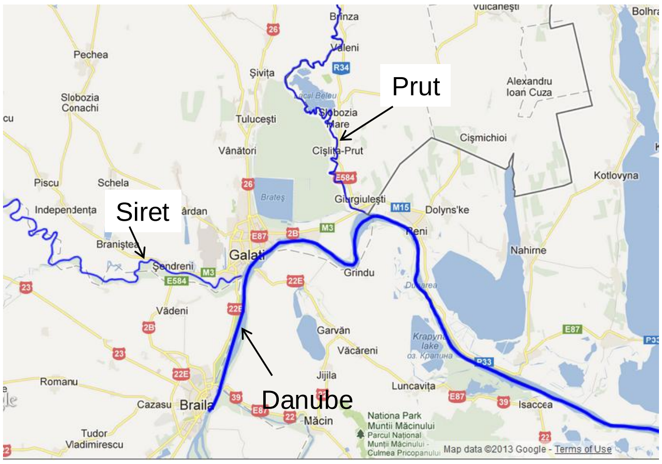


Figure 3.8. Cat's Bend area with locations of rivers Danube, Siret and Prut

During medium floods (1% probability of exceeding), the lower area of the Galati town is in danger to be flooded. The protection dykes are designed for a return period of 1 in 100 years, but due to the long duration of the floods which can exceed 100 days breaches in the dykes can develop through internal erosion mechanisms. The situation is worsened when floods occur simultaneously on Danube and two of its major tributaries: Siret and Prut River, which have confluence with the Danube in the close vicinity of Galati. Because Galati is located between two of Danube's main confluences, Siret in the upstream, and Prut in the downstream, special structures have been built to protect Galati against floods. The maximum discharges on Prut River are controlled by the Stanca-Costesti reservoir, and they will not exceed the value of 600-700 m3/s in the Oancea section. The maximum discharges on Siret River can reach 4000-4200 m3/s, in Lungoci section, 65 km upstream the confluence with the Danube. Figure 3.8 shows the Cat's Bend area with the location of the three rivers: Danube, Siret and Prut.

With this situation in mind the case study has been focused on analyzing flooding patterns in the Cat's Bend area due to simultaneous flood peaks coming from these three rivers. Scenarios of flooding with flood peaks coming on Danube; Danube and Prut (or Siret); and Danube, Prut and Siret together have been analyzed. For all these scenarios alternatives without and with rising of the protective dikes on the right hand side of the Danube River were also analyzed. This analysis has been carried out using the available data and the model described in the following sections.

3.2.2 Available data for the Danube flood portal

All data necessary for the Danube flood portal have been provided by National Institute for Hydrology and Water Management of Romania (INHGA). The list of data and their availability till now is given below:

- Geometry of the studied reach:
  1. cross-sections: 3 (at Braila, Grindu and Isaccea)
  2. DEM of the region – 90 x 90 m
  3. Roughness coefficient (different between river bed and flood plains)
- Hydraulic data
  1. Discharge hydrographs:
     - Danube – daily in the period 2000-2010 (at Braila and Grindu)
     - Siret – daily in the period May – July 2008
     - Prut – daily in the period May – July 2008
  2. Water levels at Isaccea – daily for the period 2000-2010
- Flood maps of the Cat's Bend area from previous project (Danube FloodRisk – EU project) for 1/1000 year return period.

Except for the discharge hydrographs of Prut and Siret all the above mentioned data have been deployed on the flood portal. The discharge hydrographs of these two rivers have been used together with the Danube data for developing the flood simulations with the SOBEK 1D-2D model described below.

3.2.3 SOBEK 1D-2D model of the Braila-Isaccea section of the Danube

The main aim of the SOBEK 1D-2D model is to simulate the flooding patterns with different flood peak scenarios (from Danube, Siret and Prut) and under different flood protection measures (without and with rising of the dikes). The model is also intended to serve as a future learning tool about the pressures, impacts and remediation strategies that can be implemented in the area, including the effects of possible interventions. The learning will be enabled by mashing the relevant modeling results with other data within a detailed map representation on the flood portal.

Calculation of floods is commonly carried out using computational models based on solutions of the full or approximate forms of the de Saint Venant equations for gradually varying flow in open channels. These types of models are one-dimensional (1D), but also two-dimensional (2D) can be constructed. Nowadays there is a gradual shift from the use of 1D to 2D models and even further to the use of integrated 1D/2D models.

In this case study the SOBEK modeling system has been used for setting-up the flooding model. SOBEK is a licensed product developed by Deltares, from Delft, The Netherlands. It is a software tool used for flow modeling in many areas such as irrigation systems, drainage systems, and natural streams. SOBEK 1D/2D couples one-dimensional (1D) hydraulic modeling of the river channel to a two-dimensional (2D) representation of the floodplains. The hydrodynamic 1D/2D simulation engine has an efficient numerical solution algorithm based upon the optimum combination of a minimum connection search direct solver and the conjugate gradient method. It also uses a selector for the time step, which limits the computational time whenever this is feasible.

The GUI of SOBEK allows the user to visualize input, reference data and simulation results as time series and animations of one- and two-dimensional data sets on the map and as time series.

The case study development has been carried out in stages as follows:

1. building and calibrating a one dimensional (1D) hydrodynamic model, which predicts discharges and water level on the studied reach;
2. building a coupled 1D-2D model that simulates flood inundation patterns in the studied area using only data for the Danube river
3. combining the flood simulations on the Danube (Scenario 1) with coincident peak arrival of Danube and Siret (Scenario 2); Danube and Prut (Scenario 3); and Danube, Prut and Siret together (Scenario 4)
4. simulation of the flooding patterns for all four scenarios above for the alternative when the dikes on the right hand side of the Danube in the studied area are raised (by 3 m).

A flood event that has occurred on Danube in the period 18 June 2010- 10 July 2010, and was estimated to correspond to about 1/100 years return period has been selected for the simulations. The measured flood hydrographs for Prut and Siret have been artificially shifted so that their peaks would coincide with the Danube flood peak. The three hydrographs used are presented in Figure 3.9. The upstream boundary condition just upstream of Braila is measured hydrograph, and the downstream boundary condition at Isaccea is rating curve. After calibrating the 1-D model (by adjusting the roughness coefficient in the river bed and flood plains) the above mentioned 1D-2D simulations have been carried out.

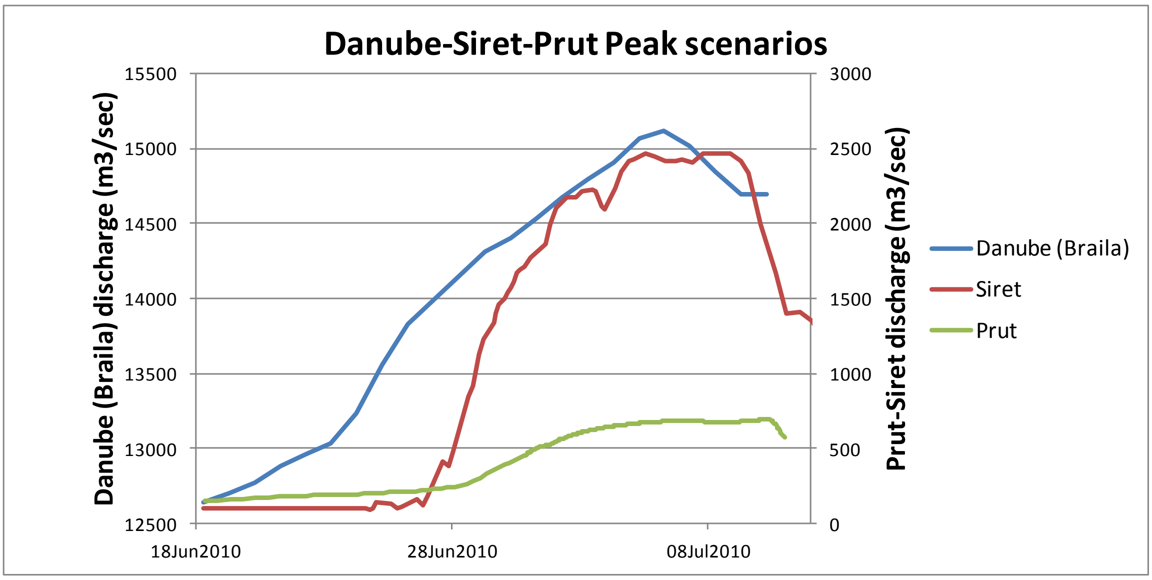


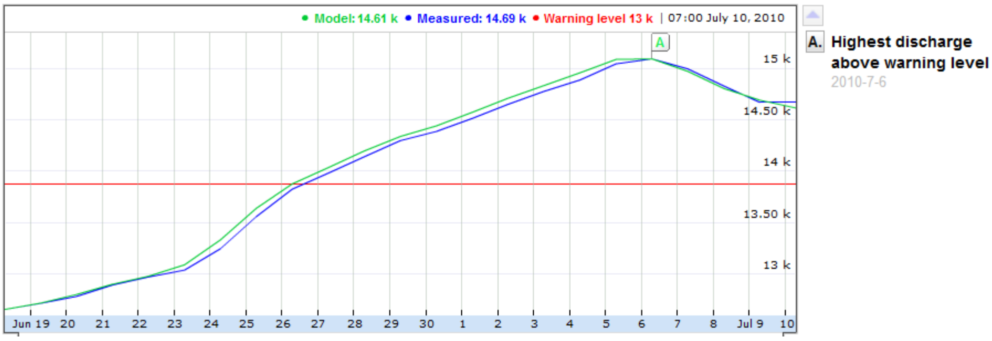
Figure 3.9. Hydrographs at Danube, Siret and Prut used for the simulations

All modeling tasks presented above have been carried out in an offline mode. For purposes of analyzing and evaluation of different results with the stakeholders and concerned citizens, the modeling results have been deployed on the flood portal via suitable user interfaces. Simulated hydrographs are made available at Braila, Grindu and Isaccea. Flood maps (showing flood extent and flood depth) are made available for the scenarios presented in the table below:

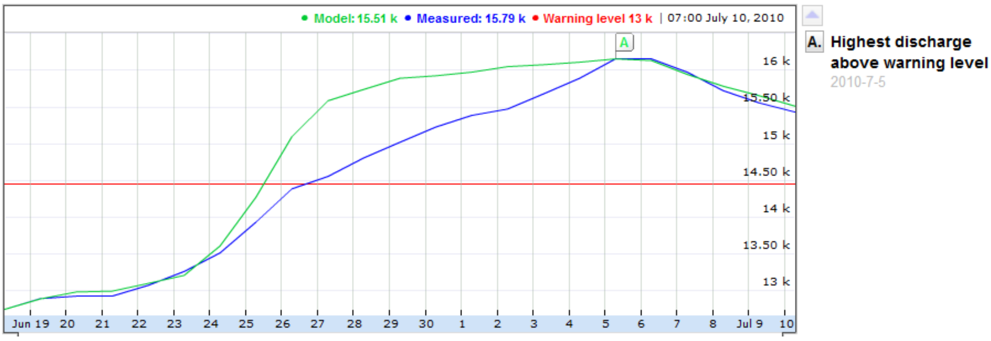
Scenarios:	Alternative A : without raised dikes	Alternative B: with raised dikes (by 3 m)
(1) Danube	1A	1B
(2) Danube and Siret	2A	2B
(3) Danube and Prut	3A	3B
(4) Danube Siret and Prut	4A	4B

All the above results have been made available on the flood portal for comparison. The simulated and observed discharges at the three stations are presented in Figure 3.10. Note that these results are taken from the actual flood portal where also a warning level has been indicated and the record with the highest discharge above that warning level. Also note that there is no measured discharge at Isaccea.

Braila: Measured vs Model Discharge



Grindu: Measured vs Model Discharge



Issacea: Measured vs Model Discharge

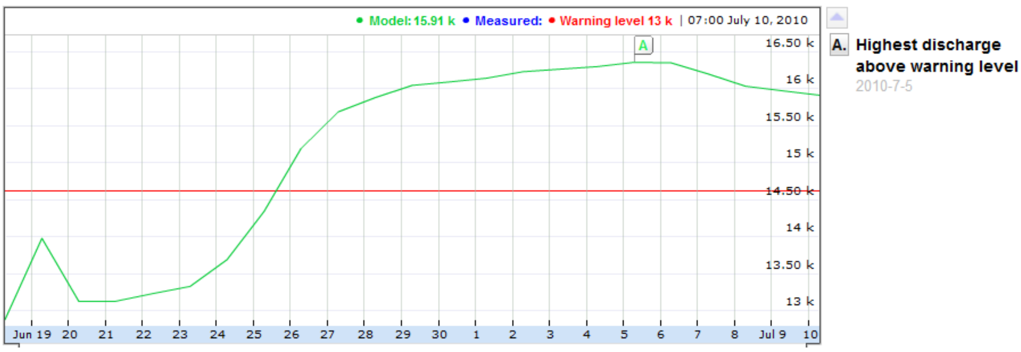


Figure 3.10. Simulated and measured hydrographs at the three stations along Danube (Braila, Grindu and Isaccea)

As an example result the flood maps for the composite scenarios 4A and 4B are presented in Figure 3.11.

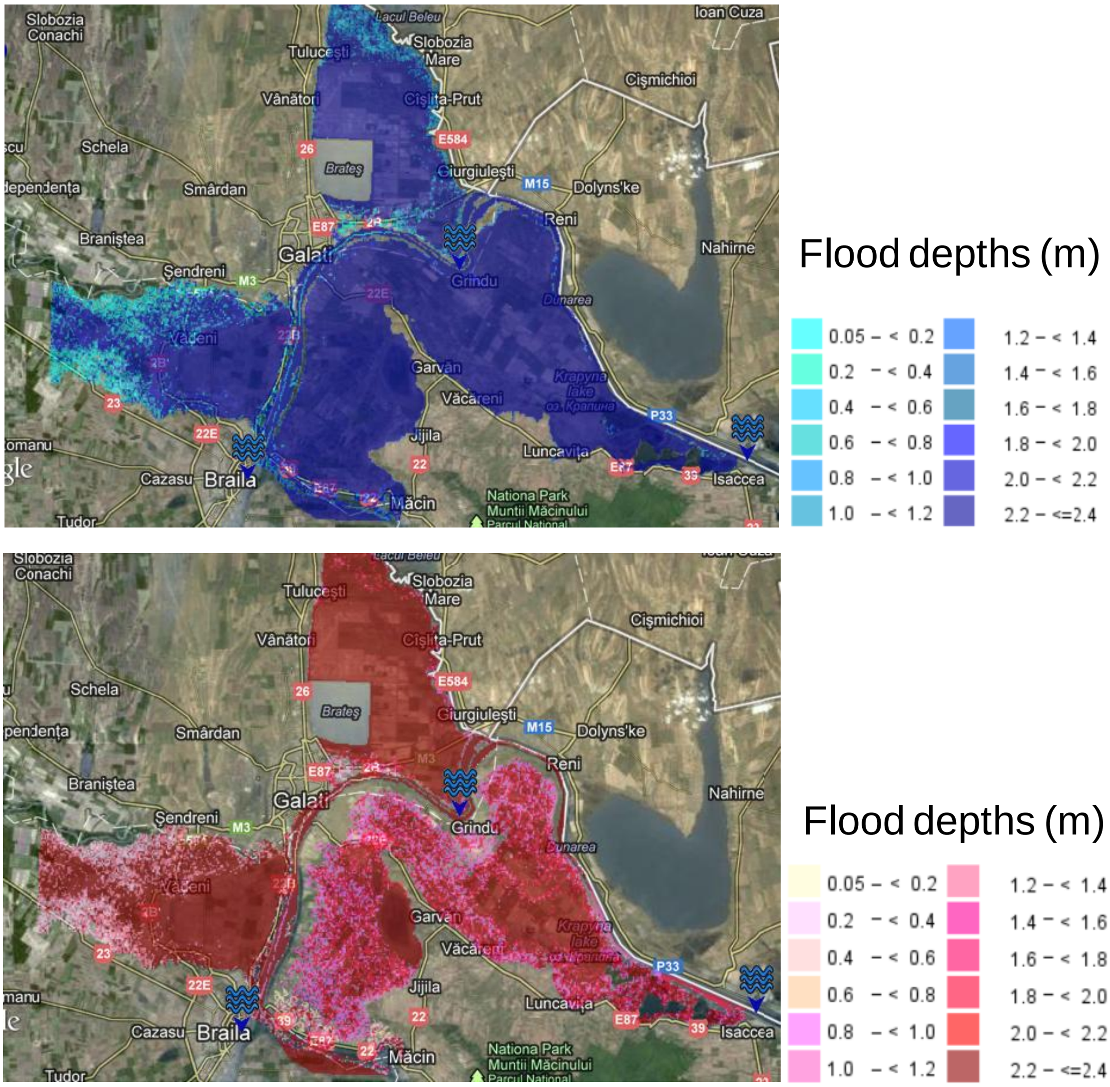


Figure 3.11. Flood maps for composite scenarios 4A (top) and 4B (bottom)

All other results are available on the flood portal.

4 Design and implementation of the flood portal applications

This chapter introduces the final design and implementation of the two citizens-oriented flood portal applications for the identified case studies. Although the applications are similar, because of the different types of floods, different models used and differences in types of data provided via the portals the two flood portals will be introduced separately. Initially, however, the general design of the front end of the flood portals will be presented. This is common for both portals and serves as a basis for designing the actual web-based user interfaces.

4.1 Flood Portals front end design

The flood portals have been designed with a number of sections which gradually guide the users from introductory pages containing information about the study area in question, sections about recognized flooding problems and existing flood management strategies, towards the sections where the actual flood portal data and modeling results are presented. Separate components are provided for collecting users' feedback on flood-related issues in the area and on the flood portal itself. The general structure of the front end of the portals is shown on Figure 4.1

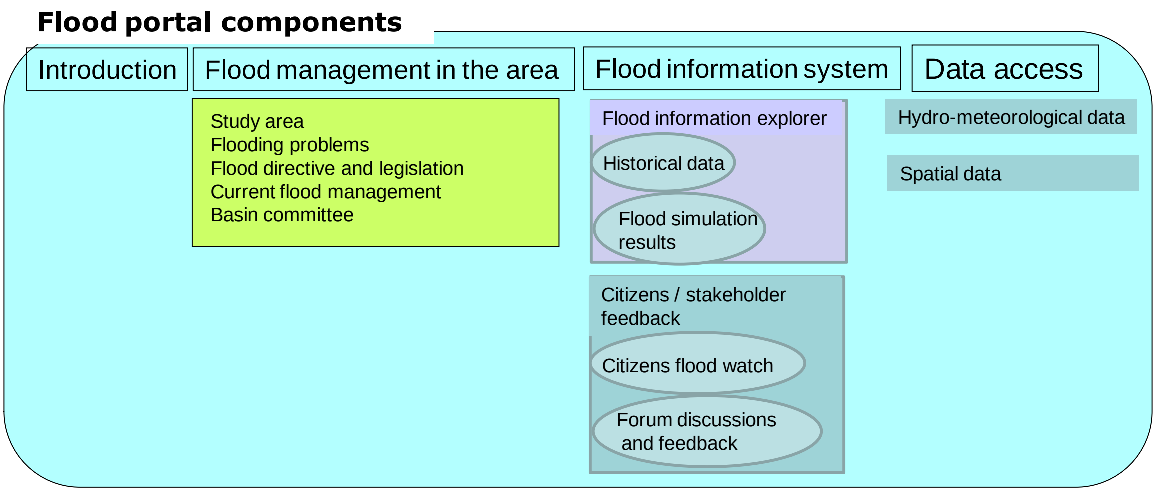


Figure 4.1. Components of the flood portals front end

Under the 'Introduction' section the users can familiarize themselves with the purpose of the flood portal, how and why it was developed. Information about the enviroGRIDS project is provided via appropriate links. Links are also provided for contacting the main platform developers.

The second section 'Flood information in the area' contains case-specific information, but structured in the same way for both platforms. The study area and the existing flood problems are briefly explained, followed by information on the EU Flood directive and existing flood risk management plans and strategies in the respective region. The last part of this section gives information about the so-called basin committees – the actual bodies that are already in place for exchanging information among different stakeholders. Through this section any user can get to know who are the main stakeholders involved in flood-related issues in the area.

The main section of the flood portals is entitled 'Flood information system'. This is the richest part of the portals in terms of available information. It consists of two main sections: The first one is named

'Flood explorer', which is further divided in two sub-sections named 'Historical floods' and 'Flood simulation results'. In the sub-section 'Historical floods' the users can access visual presentations (in maps and charts) of all available data for a particular case study. These data are presented with their necessary context for better understanding. The 'Flood simulation results' sub-section contains similar presentation of all available modeling results from the developed models (different for the two different case studies). The second main section is about 'Citizens / stakeholders feedback'. An important sub-section here is a map-based interface for potential users to provide own flood-related information (by sending messages or pictures of flooded areas). Additional components here are the discussion forum, and forms for the users to provide their feedback about the portal. It needs to be noted that for the Somes Mare portal, additional section has been provided for professional users with some explanations about the developed HEC-HMS model.

The last section of the portal is entitled 'Data access'. This may be of less interest to users such as citizens and non-expert stakeholders, but more for professional users. Through this section users can access the actual data (hydro-meteorological, time series and spatial data). This access is provided by using the OGC standards such as WMS, WFS and WaterML.

With this generic structure of the front end the Somes Mare and Danube portals have been set-up. The actual design of the two portals with more detailed presentation of all back-end components is presented in the following sections.

4.2 Implemented design of the Somes Mare flood portal

The Somes Mare flood portal has been designed in such a way that all components of the front-end could efficiently communicate with server side applications that serve all the web content and the needed data and model results. The components, their communication and the tools and technologies used are presented in Figure 4.2.

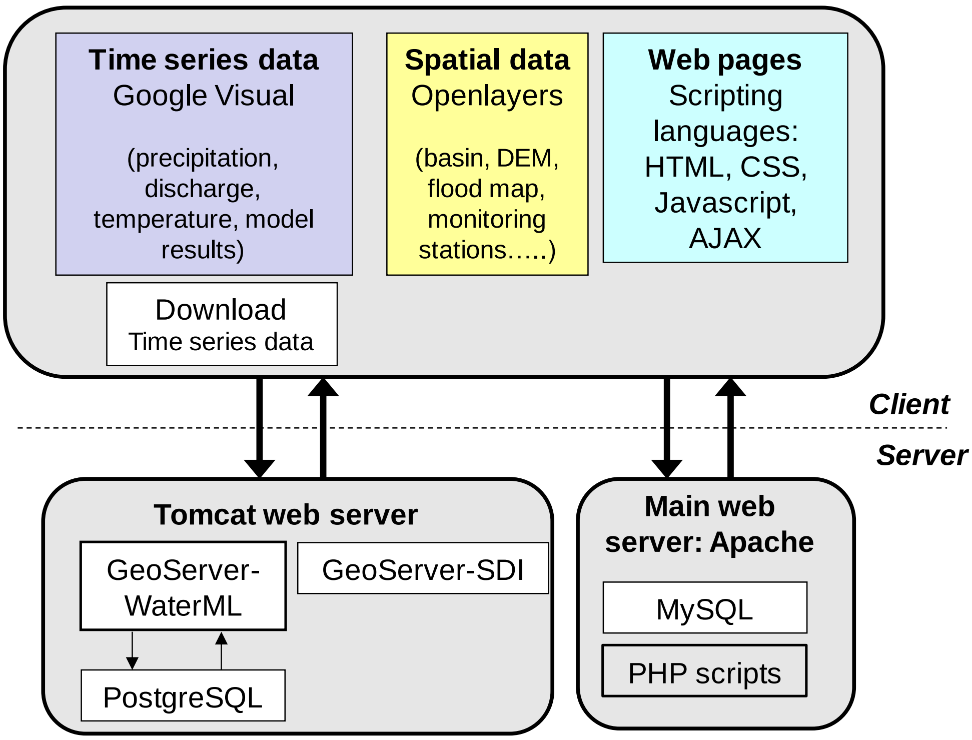


Figure 4.2. Somes Mare portal components, communication and used tools and technologies

As shown in the figure there are three types of components on the client side of the portal: Web pages, spatial data and time series data. These are combined (embedded within each other) on the portal as needed for creating the required interactive user interfaces. Each of the three components needs distinct support on the server side, provided by several components. The main web server (Apache) provides all the web pages with their basic interactive elements. This web server is extended with several PHP script for realizing various tasks on the server side, many of which are related to fetching required data from the implemented mySQL database.

For many pages (especially within the Flood Information System front end component) there is a need for embedding map interfaces, where spatial data need to be presented. In these applications the base maps are provided from Google servers, while all specific spatial data are provided by one instance of Geoserver application named 'Geoserver-SDI'. On the client side the spatial data are presented and manipulated using Openlayers (Javascript libraries for visualizing spatial data). For purposes of visualizing time series data map elements associated with such data are communicating with the mySQL database on the server side and the graphing component 'Google Visualize' is used for actual graph visualization.

The last and somewhat separate component on the client side is named 'Download time-series data'. This is implemented in the Data Access front end component for downloading or accessing time series data in WaterML 2.0 format. As mentioned earlier, this format has been adopted as OGC standard only recently and there are not many guidelines for its actual implementation. A team from the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia recently developed a framework and methods that implements the WaterML 2.0 schema using the Geoserver Web Feature Services (WFS). This framework and methods has been adapted here, but this required setting up a PostgreSQL database and a second instance of specially configured Geoserver ('Geoserver-WaterML' in Figure 4.2).

For clearer presentation of the interactions of these components Figure 4.3 shows typical embedding cases.

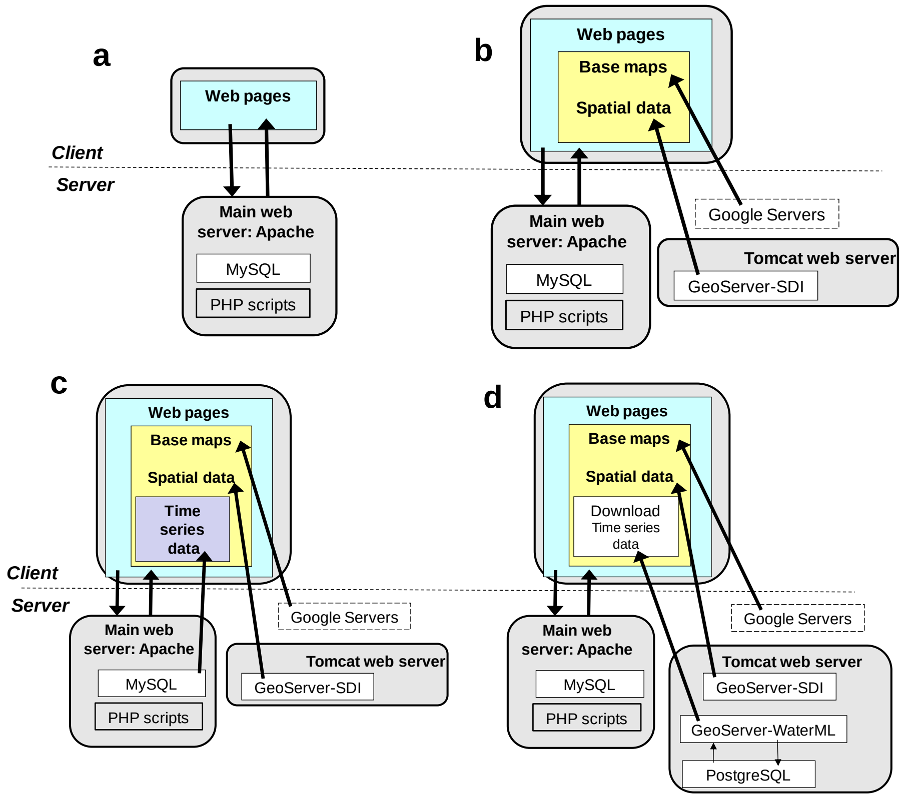


Figure 4.3. Embedding of components (Somes Mare): a) standard web pages; b) spatial data embedded in web pages; c)Time series data visualized from maps in web pages; d) Downloading time series data

As shown in Figure 4.3 the simplest communication is for case a), which shows how all web pages are provided in the portal. This communication takes place in all sections of the flood portal. Case b) shows how maps are embedded in web pages for accessing spatial data on top of base map layers, while case c) extends this with visualization of time series data from within such maps. Most of the pages in the 'Flood Information System' have these two types of communication. The last case (d), shows the communication in the 'Data access' section, when times series data need to be downloaded / accessed in WaterML 2.0 format. Note that both Geoserver instances are included in this case. Geoserver-SDI provides the spatial elements on a map so that the users can select those for which time series data should be downloaded, while Geoserver-WaterML delivers the actual data.

4.3 Implemented design of the Danube flood portal

The Danube portal has a similar implementation design to the Somes Mare portal. The only difference is that in this portal there is no implementation of the Geoserver-WaterML instance linked with the PostgreSQL database, because in this case the downloading / accessing of time series data in WaterML 2.0 has not been implemented. The implemented components and their communication are presented in Figure 4.4.

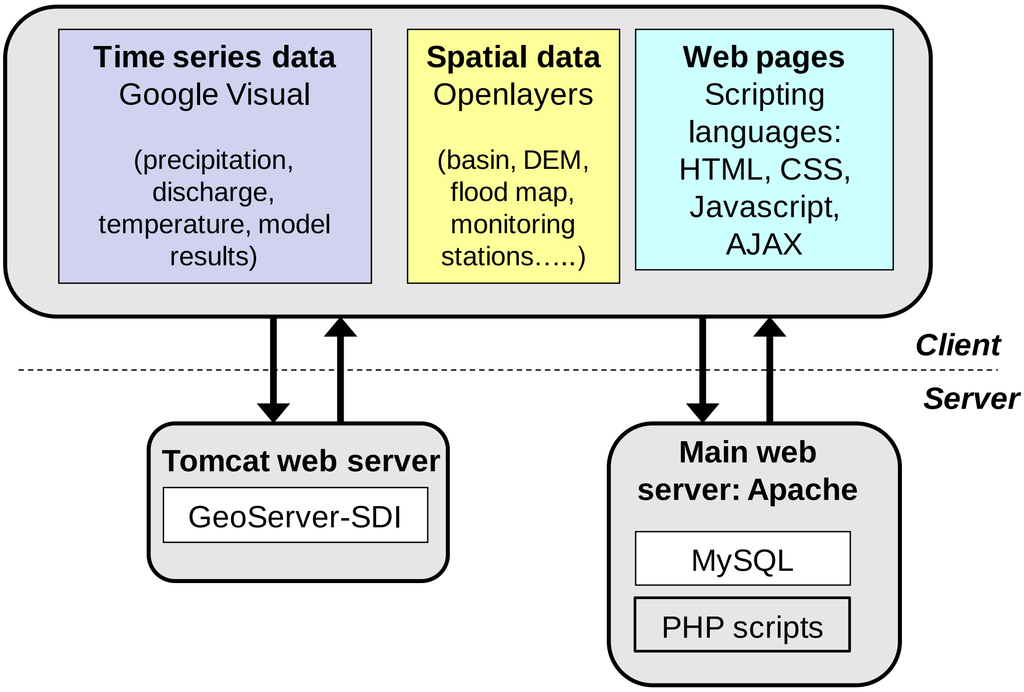


Figure 4.4. Danube portal components, communication and used tools and technologies

Accordingly, there are only three types of embedding of components in this case as demonstrated in Figure 4.5.

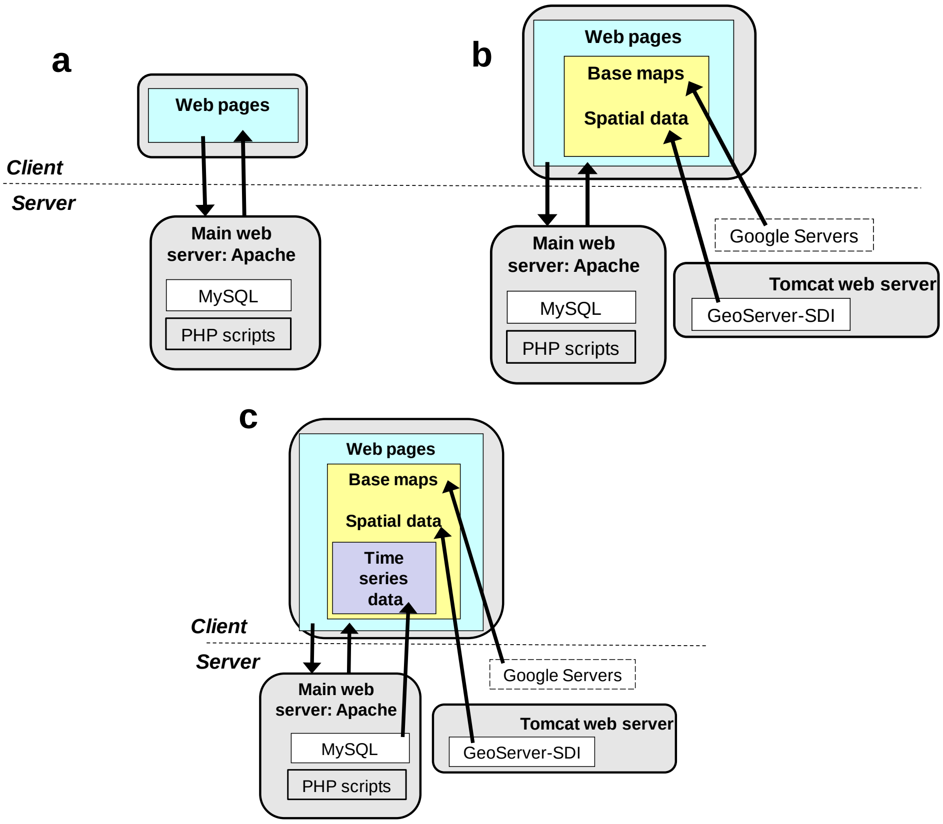


Figure 4.5. Embedding of components (Danube): a) standard web pages; b) spatial data embedded in web pages; c)Time series data visualized from maps in web pages

For the rest, the description of the components, their embedding and communication is same as for Somes Mare.

4.4 Linking of the flood portals to the BSC-OS portal

Like the other BSC-OS tools the two flood portals have been linked to the main portal via the main menu. A snapshot with the linked tools is provided in Figure 4.6.

Figure 4.6. Links to the flood portal applications from the main BSC-OS portal

For reasons of consistency the main menu of the BSC-OS portal with links to all available tools has also been included in the two flood portal applications, as demonstrated in Figure 4.7 on the example of the Somes Mare flood portal.

Figure 4.7. Links to the BSC-OS portal tools from the Somes Mare flood portal

5 Evaluation of the flood portal applications by stakeholders

5.1 Workshops and evaluation setup

Upon finalization of the two flood portals for Somes Mare and Danube the partners involved in their development organized two workshops with local stakeholders in Romania. The main purpose of the workshops was demonstration of the flood portals to these stakeholders and their evaluation of the portal as a whole and of its different components. The workshops were organized at the end of February 2013. Each workshop lasted approximately half a day. The workshop for the Somes Mare flood portal was organized in Cluj Napoca and the workshop for the Danube portal was organized in Tulcea.

Both workshops had a similar structure. Initially a broad introduction to the enviroGRIDS project as background information to the portal development was presented, followed by a detailed presentation and demonstration of all portal functionalities. After this phase the workshop participants were invited to test the flood portal functionalities using available computers connected to the Internet. Upon finalization of this hands-on testing the participants received evaluation forms with a set of evaluation questions that they were requested to answer.

Same evaluation questions were formulated for both case studies as follows:

(1) Is the structure of the flood portal clear and easy to follow?

(2) Is the information presented in the web platform sufficient to raise awareness about flooding?

(3) Please specify which type of information/application you find useful in the web platform?

(4) Is the historical discharge with warning level informative and useful to raise awareness about local flooding?

(5) Are the flood maps (model results) useful to raise awareness on the vulnerability of the areas if such flood scenarios happen?

(6) Are the feedback components (Citizens flood watch, forum, comments/suggestions) useful for citizen / stakeholder participation in flood risk management (FRM)?

(7) Would you recommend this flood portal to your colleagues, family and friends?

The workshop participants were asked to use a scale ranging between 1 and 5 for the first two questions (1 – lowest and 5 -highest score of evaluation). For the other questions scales with linguistic descriptions were used (e.g. for question 5: not useful at all; not useful; neutral; useful and very useful).

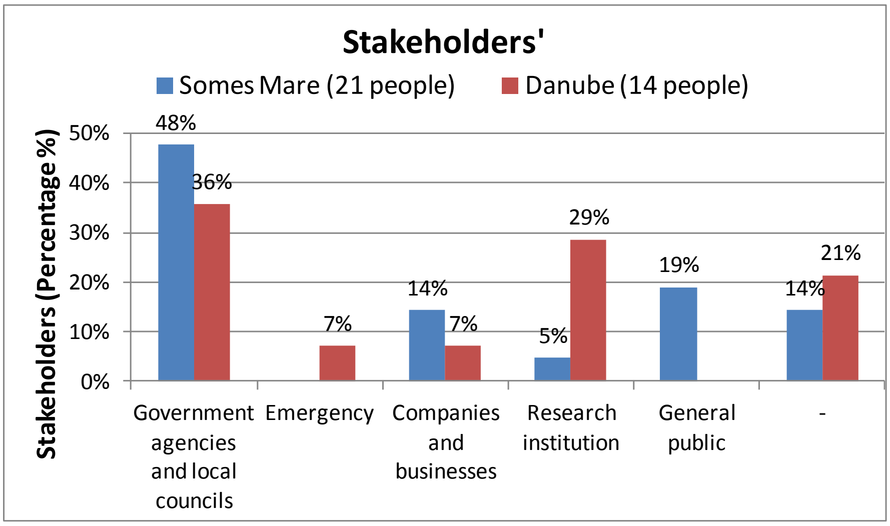
In addition to the evaluation questions the workshop participants were asked to provide information about the group of stakeholders to which they belong. Five stakeholder groups were used for clustering:

- Government agencies and local councils
- Emergency agencies
- Companies and businesses
- Research institution
- General public
- Other

For the Somes Mare workshop a total of 21 participants carried out the evaluation and for the Danube workshop a total of 14 participants.

5.2 Evaluation results

The first set of result obtained is related to the structure of the participants with respect to the identified stakeholder groups. Figure 5.1 shows the clustering in terms of number of responses and in percentages.



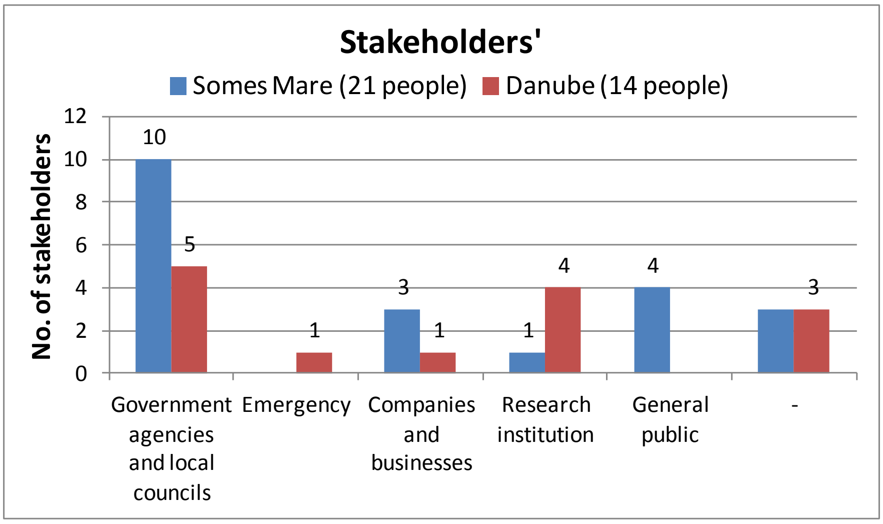


Figure 5.1. Summary of clustering of participating stakeholders (percentages and numbers)

Although most of the participants belonged to the government agencies and local councils, there was also some spreading to other stakeholder groups.

The second set of results which summarizes the responses of the participants to the evaluation questions is presented in Figure 5.2.

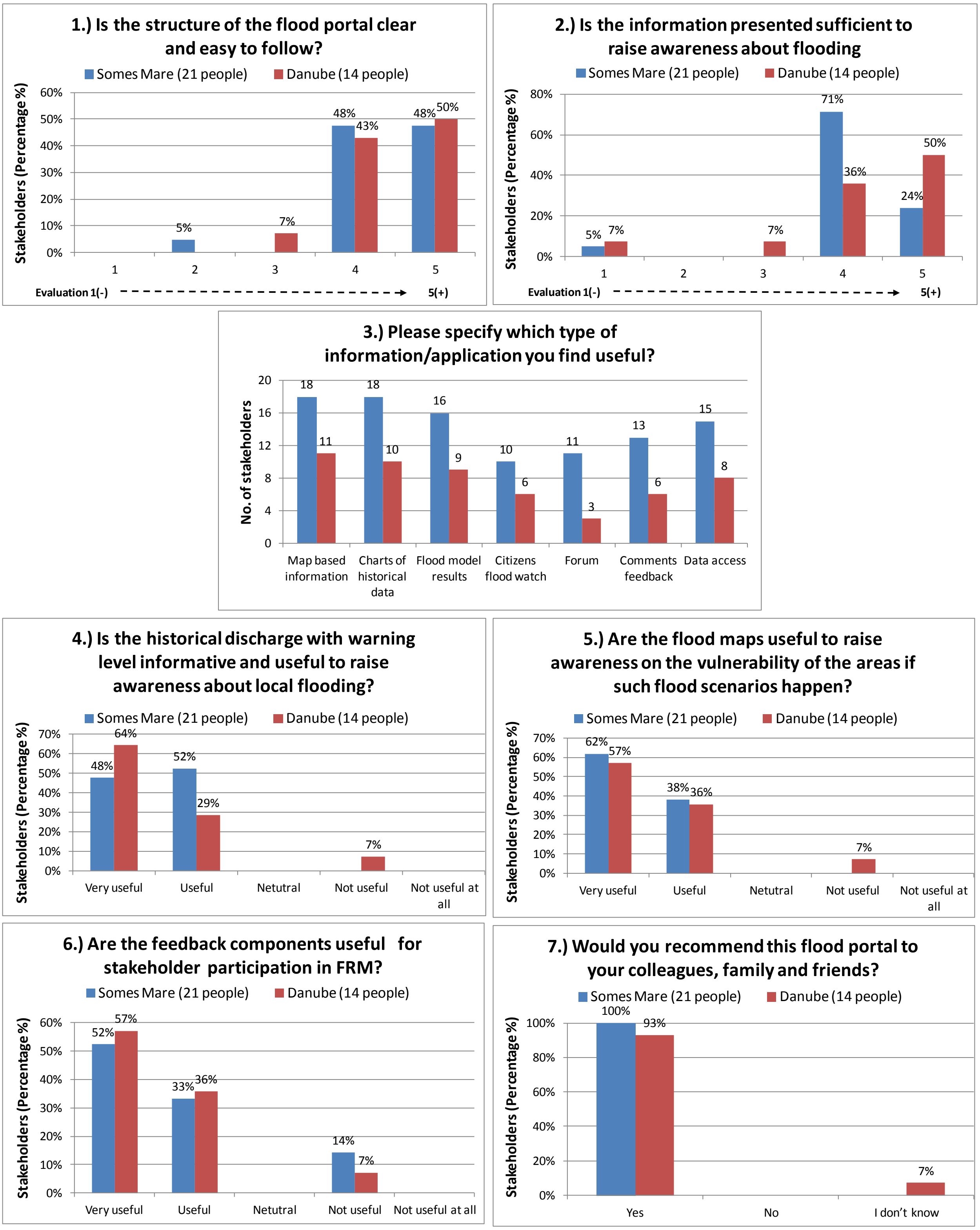


Figure 5.2. Results of the flood portals evaluation by the stakeholders

In addition to the evaluation done by answering questions, all stakeholders were invited to provide comments / suggestions about the portals. A summary of such comments and suggestions (merged from both workshops is provided as follows:

Stakeholders' comments and suggestions:

- It is recommended to add examples on how to use the system by specific users, such as mayors, city hall employees, environmental agencies;
- It is recommended to add the portal to different sites not just to enviroGRIDS site. Examples of sites where it can be linked is: city hall website, local newspaper, local weather site;
- We are looking forward to have the same portal for other catchments in the area;
- We are looking forward to have the same portal for the entire Somes basin;
- We would like the portal to be extended to other basins as well;
- This example should be extended to other branches of the Danube, in particular to Branch Maciu, where there were many dike breaches in the past. These kinds of phenomena triggered a lot of social problems. A second wish is to look at floods with smaller return periods as well, such as floods with return periods 1 in 20 years and 1 in 5 years.
- Is it possible that the ones who developed such a platform are implementing a programme which can verify the validity of the feedback given by the citizens and the frequency with which these data is provided to the platform?
- No comments are needed, the platform is very clear and useful;
- Congratulations for such a project;
- Very much appreciated project.

As can be seen from the evaluation results and from the provided comments both portals were appreciated by the attending stakeholders. Most comments are about extending similar work to other basins and areas in Romania where similar flooding problems exist. The requests for additional information will be taken by the responsible authorities of Romanian waters.

6 Conclusions

This report presented the outcomes of the implementation of two web-based applications for citizens and non-expert stakeholders developed within WP6 of enviroGRIDS project. Both platforms have been developed for case studies in Romania where flooding has been identified as a critical issue (Somes Mare and Danube: Braila-Isaccea section). Consequently both applications have been introduced in this report as 'Flood portal for citizens'. In relation to the objectives that have been set out for developing of the flood portals the following can be concluded:

- The development and implementation of the platforms has successfully demonstrated that latest web services technologies based on adopted standards for deploying and sharing spatial and time series data (WMS, WFS, WaterML 2.0), combined with browser-based suitable user interfaces can be used for developing water-related applications for diverse groups of users, including citizens and non-expert stakeholders. These technologies are entering a more mature stage, with tools and methods increasingly becoming available for easy and efficient deployment of required data in such applications.

- From the demonstration and evaluation of the flood portal to the broad groups of diverse stakeholders it can be concluded that these applications are highly appreciated. The need for sharing of flood-related knowledge has been recognized by both authorities and broader stakeholder groups, and the developed applications seem to point the way forward in achieving this. The workshops with the stakeholders have demonstrated that these user groups expressed wishes for extensions of the demonstrator applications (flood portals) with additional information and development of similar applications for other basins or study areas.

In general it can be concluded that while the flood portals have been successful demonstrator applications, there is clearly a need for continuing further research and development of such applications that can lead to their broader adoption in the flood management practice.

7 Appendix A

This appendix presents the user guide through the interfaces developed for the two flood portals. The presentation will follow the order of the portal front end sections introduced in Figure 4.1 (Section 4.1).

7.1 User Guide Somes Mare Flood portal

Introduction

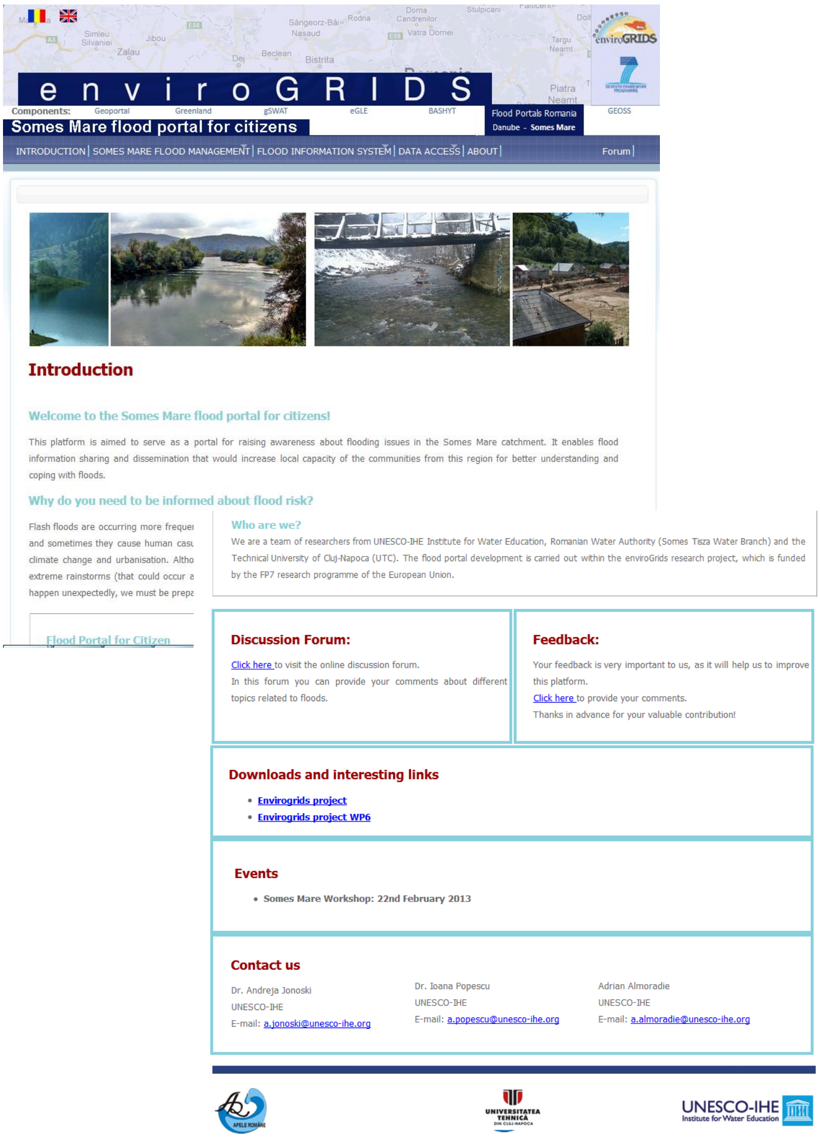


Figure A.1. Introduction section – Somes Mare

As shown in Figure A.1, the Introduction section gives introductory information about the portal, with links to discussion forum, feedback forms, web site of the enviroGRIDS project and contact information.

Somes Mare Flood Management

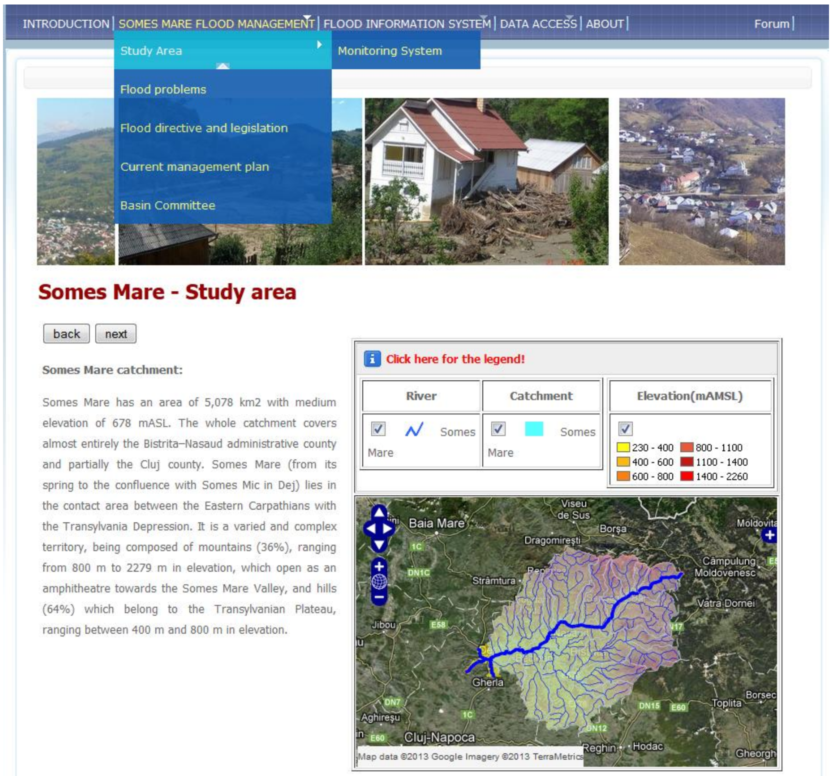


Figure A.2. Somes Mare Flood Management – Study Area

This section contains several sub sections. Figure A.2 shows the interface with information on the study area. Some basic spatial data about the catchment is presented together with textual information organized in few pages (browsed by the 'back' and 'next' buttons). As part of the study area the monitoring system is also presented with locations of all monitoring stations (Figure A.3).

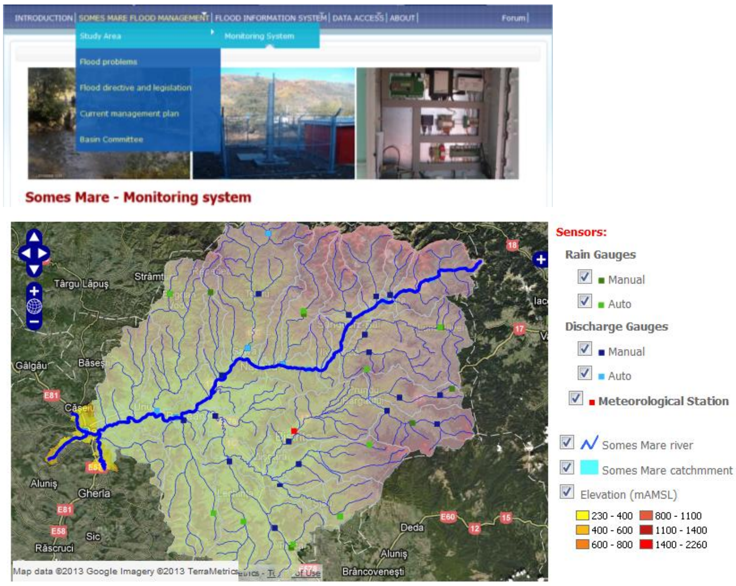


Figure A.3. Somes Mare Flood Management – Study Area – Monitoring system

The other sub-sections under 'Somes Mare Flood Management' ('Flood Problems', 'Flood Directive and Legislation', 'Current Management Plan' and 'Basin Committee') contain textual information combined with images and downloadable documentation. They are available on the portal and they will not be presented here.

Flood Information System

As mentioned earlier this is the richest section of the portal in terms of provided information. It is divided in two parts aimed for citizens and professionals. The main interface of the 'Citizens' Flood Information System for accessing its subsections is shown in Figure A.4 below.

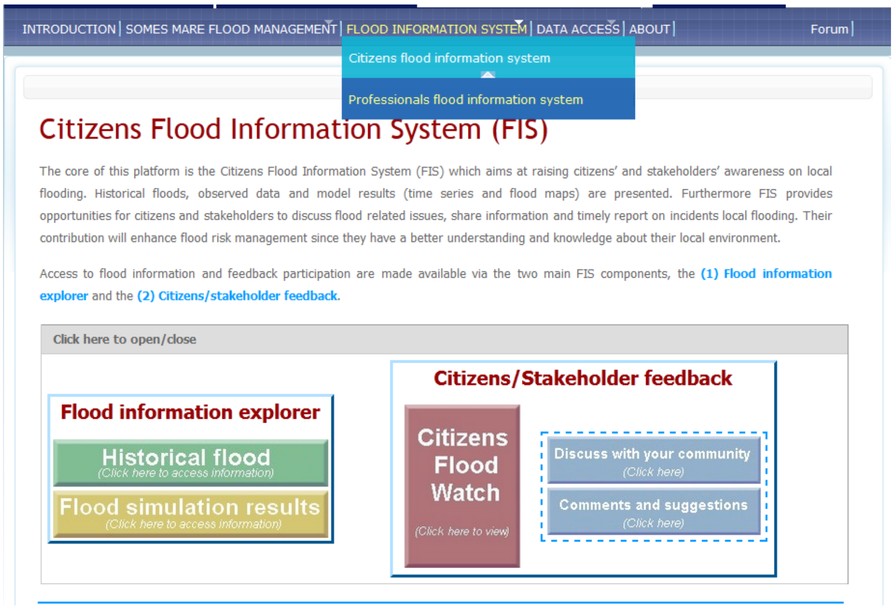


Figure A.4. Somes Mare – Citizens' Flood Information System interface

Under the 'Flood Information Explorer' the interface for viewing historical data is accessed as shown in Figure A.5.

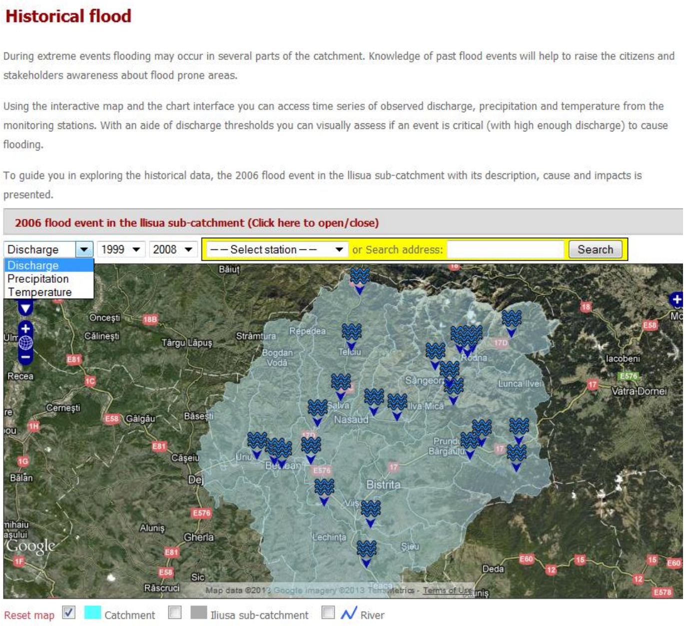


Figure A.5. Somes Mare – 'Historical flood' main interface

Stations for historical data on discharge, precipitation and temperature are shown on the map interface (with different types of markers for different data types). For viewing graphs with time series of historical data the user may select station from the map, from a drop-down list or find a station closest to a certain address. Once the type of data and station is selected the visualization is as shown in Figure A.6.

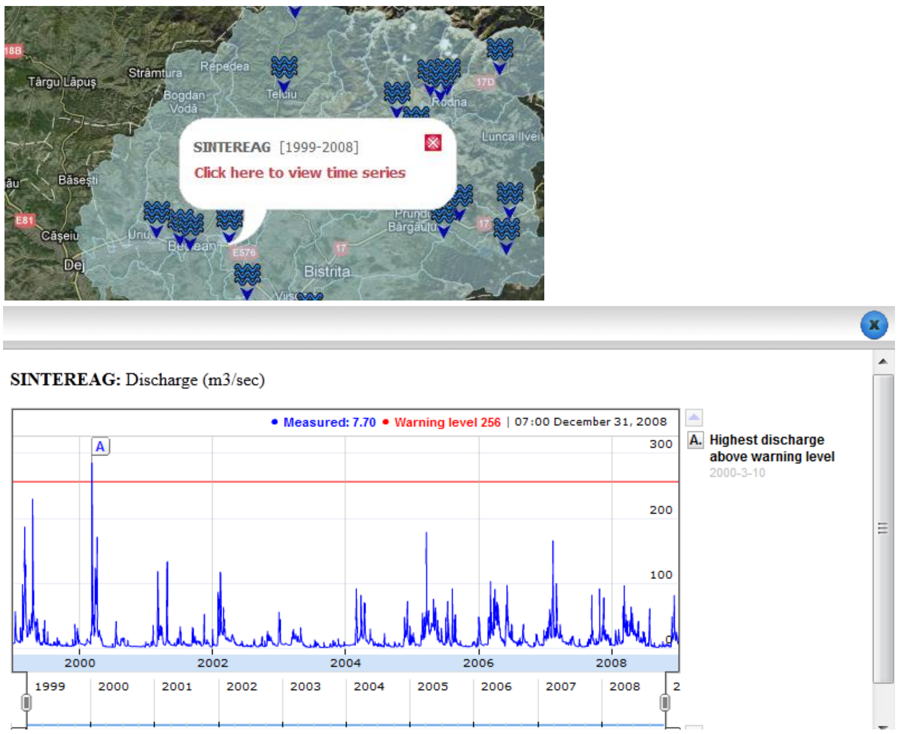


Figure A.6. Somes Mare – Visualization of time series graphs of historical data

Under 'Flood Simulation Results' similar interface is provided, but now the observed discharges can be compared with those simulated by the HEC-HMS model, as shown in Figure A.7.

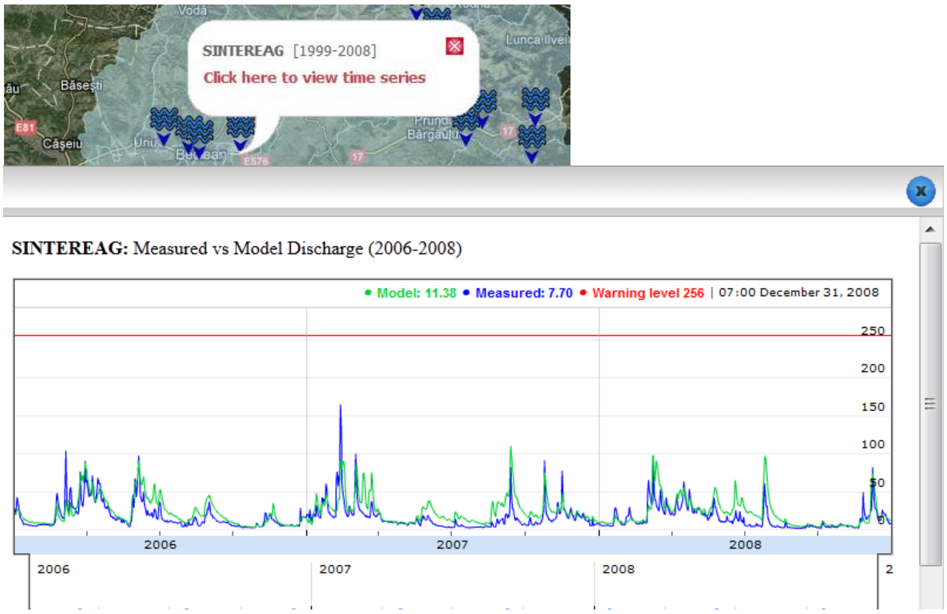


Figure A.7. Somes Mare – Visualization of time series of measured and modeled data

The main interface in this section also allows for showing flood extent maps for return periods of 1/20 and 1/100 years. Figure A.8 shows the flood extent map for 1/100 years return period.

Figure A.8. Somes Mare – Flood extent map – 1/100 year return period

Under the 'Citizens / Stakeholders feedback' sub section the most interactive component is 'Citizens' flood watch'. As shown in Figure A.9 below, by using this component users can provide location-based information (feedback) on any flood-related issue occurring within the catchment. By using the input forms on the right a user provides identification data (name, e-mail address, etc) and supplies the textual information that he or she needs to communicate. A supporting image can be uploaded by browsing through the file system. When ready, the user zooms in the map interface to the desired location and clicks to provide the information. A marker is placed on the map – visible for all other users. The provide information is accessible by clicking on a marker (without the personal data – for retaining anonymity).

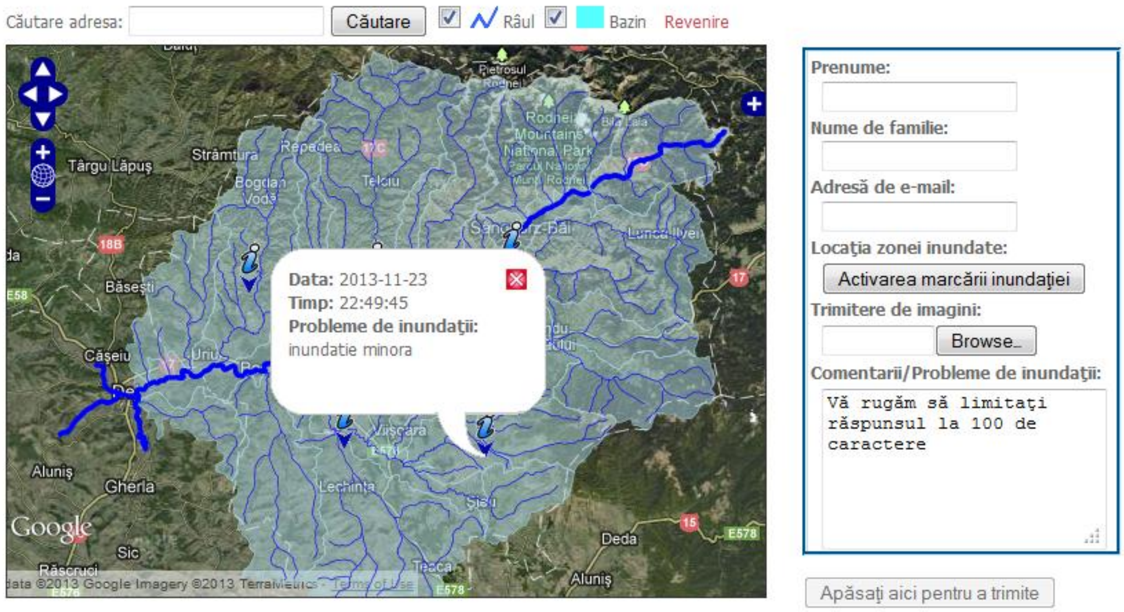


Figure A.9.Somes Mare – Citizens' flood watch (Romanian version of the portal)

This component can be particularly useful when we consider the widespread availability of smart phones that are connected to the Internet. These devices may enable users to directly provide flood-related information (text and images) from their actual location and this information will be available via the Citizens flood watch interface.

The components of discussion forum and feedback forms are standard in many web sites and will not be presented in this user guide.

The Somes Mare flood portal has an additional component under the 'Flood Information System', namely the 'Professionals Flood Information System', which provides more specialized information about the developed HEC-HMS model of the Somes Mare catchment. In additional to their spatial data, the supporting user interface in this section also contains the elements of the developed model, as shown on Figure A.10.

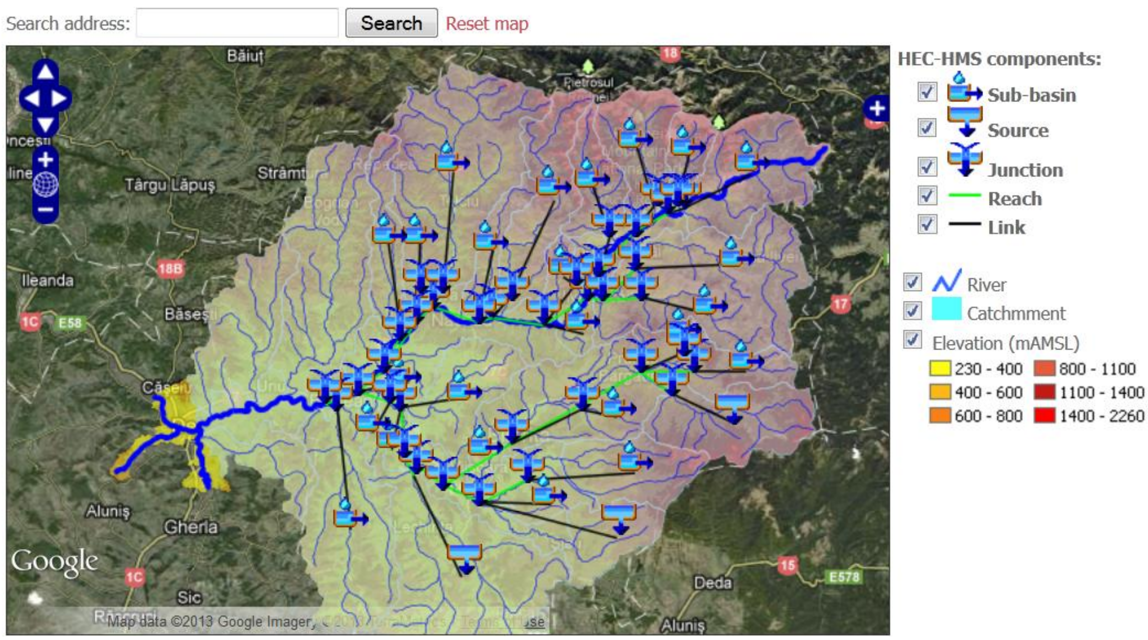


Figure A.10. Somes Mare – Interface for exploring the developed HEC-HMS model.

The last component of the Somes Mare flood portal is 'Data Access'. It is divided in two sub sections: 'Hydro-meteorological data' and 'Spatial data'. The 'Hydro-meteorological data sub section contains the interface for accessing and downloading time series data of precipitation, discharge and temperature for the year 2007 in WaterML 2.0 format (as agreed with DST – Romanian waters). The initial interface for realizing this task is again map based, with display of available stations for the three types of data (again types of markers on the map changes as the user switches from precipitation to discharge or temperature data). Similarly to the 'Flood Information explorer' (Figure A.5) the stations can be selected by clicking on a station marker on the map, by using a drop-down list, or by searching for a station nearest to a given address. . Once the station and type of data has been selected, the user is asked to confirm the selection and the data item is placed in a list displayed to the right of the map. The example presented in Figure A.11 below shows a case when 3 data items have already been selected (two discharge and one temperature data item), whereas the user is about to select a fourth data item (precipitation).

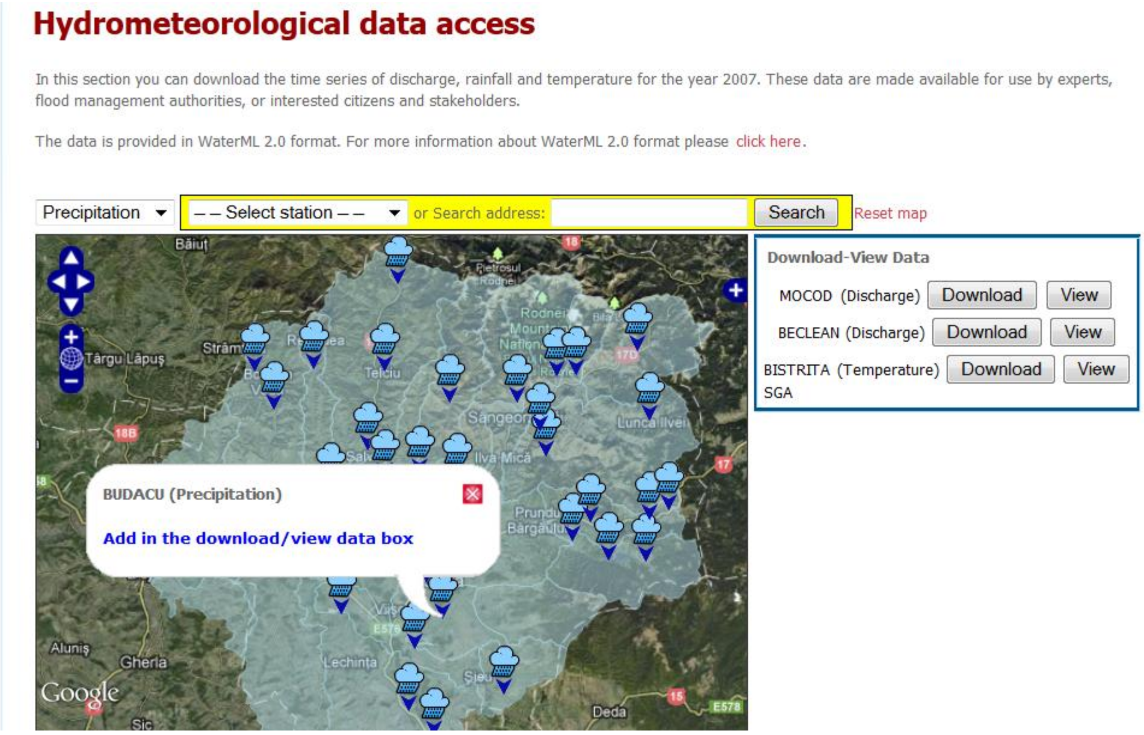


Figure A.11. Somes Mare – Interface for accessing times series data in WaterML 2.0 format

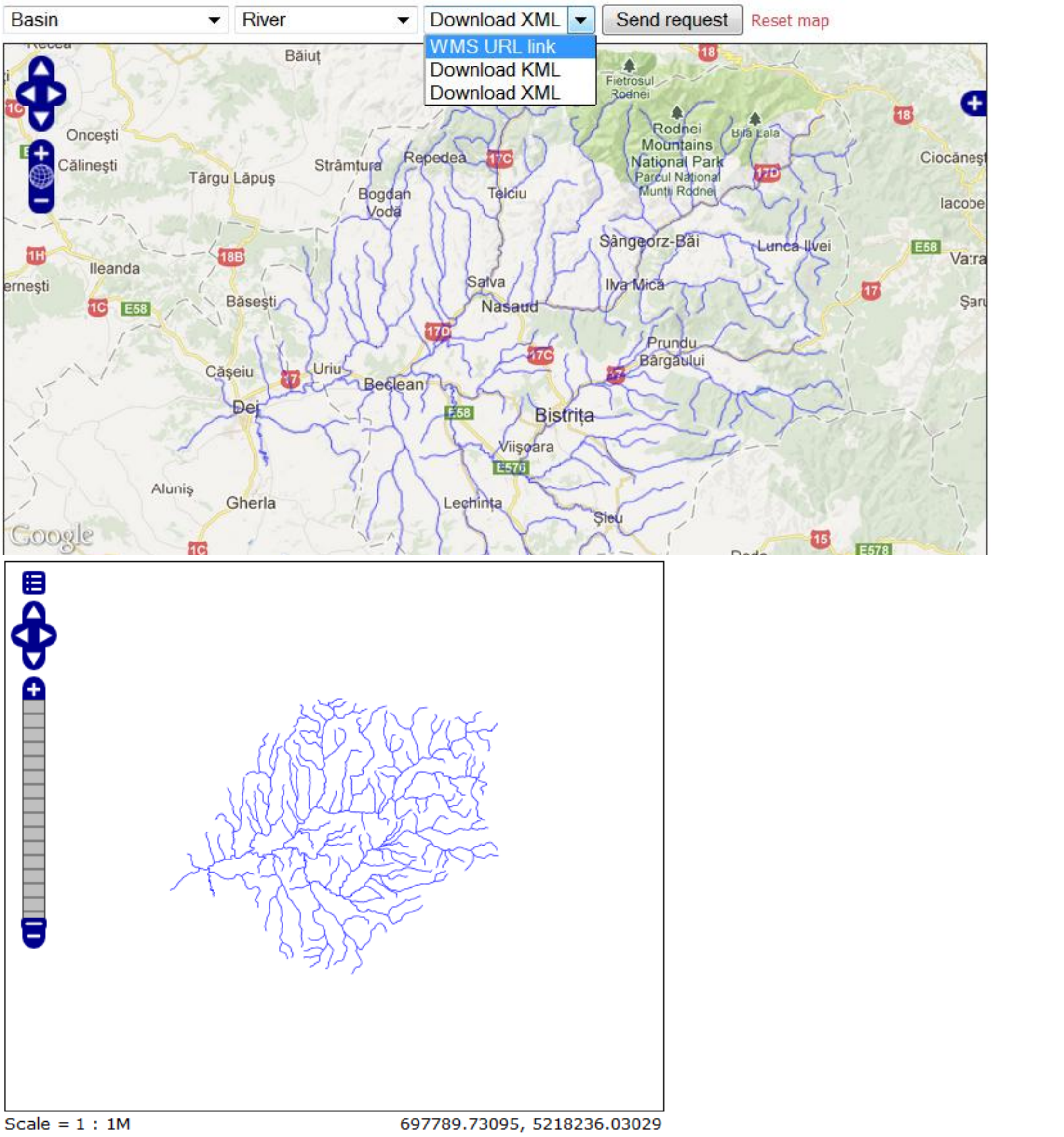
From the created list the user can then either download the data (as Type-of-data_station-name.xml – e.g. the second item from the list in Figure A.11 would be Discharge_BECLEAN.xml), or the same data can be directly viewed in the browser window in the WaterML 2.0 (xml) format, as shown in Figure A.12 below.


```
2007-11-09T07:00:00 2007-11-10T07:00:00 2007-11-11T07:00:00 2007-11-12T07:00:00 2007-11-13T07:00:00 2007-11-14T07:00:00 2007-11-15T07:00:00 2007-11-16T07:00:00
2007-11-17T07:00:00 2007-11-18T07:00:00 2007-11-19T07:00:00 2007-11-20T07:00:00 2007-11-21T07:00:00 2007-11-22T07:00:00 2007-11-23T07:00:00 2007-11-24T07:00:00
2007-11-25T07:00:00 2007-11-26T07:00:00 2007-11-27T07:00:00 2007-11-28T07:00:00 2007-11-29T07:00:00 2007-11-30T07:00:00 2007-12-01T07:00:00 2007-12-02T07:00:00
2007-12-03T07:00:00 2007-12-04T07:00:00 2007-12-05T07:00:00 2007-12-06T07:00:00 2007-12-07T07:00:00 2007-12-08T07:00:00 2007-12-09T07:00:00 2007-12-10T07:00:00
2007-12-11T07:00:00 2007-12-12T07:00:00 2007-12-13T07:00:00 2007-12-14T07:00:00 2007-12-15T07:00:00 2007-12-16T07:00:00 2007-12-17T07:00:00 2007-12-18T07:00:00
2007-12-19T07:00:00 2007-12-20T07:00:00 2007-12-21T07:00:00 2007-12-22T07:00:00 2007-12-23T07:00:00 2007-12-24T07:00:00 2007-12-25T07:00:00 2007-12-26T07:00:00
2007-12-27T07:00:00 2007-12-28T07:00:00 2007-12-29T07:00:00 2007-12-30T07:00:00 2007-12-31T07:00:00
</wml2dr:timePositionList>
</wml2dr:TimePositionList>
</gml:domainSet>
- <gml:rangeSet>
- <gml:QuantityList uom="http://vocabs.auscope.org/classifier/bom/sbasin/0.1/uom/cum/sec">
23.1 40.6 41.0 33.5 32.8 28.2 25.2 48.4 60.4 58.2 50.2 87.5 126.0 72.1 57.8 51.7 43.3 36.0 194.0 217.0 112.0 169.0 125.0 179.0 316.0 194.0 112.0 79.8 67.2 60.7 52.1 50.0 51.6 44.1 41.9
44.9 37.5 39.9 63.0 143.0 208.0 208.0 663.0 462.0 261.0 204.0 143.0 108.0 81.9 70.6 64.0 55.4 55.6 91.9 74.2 62.8 55.2 52.8 52.1 54.0 285.0 469.0 262.0 187.0 127.0 92.6 93.1 91.6 92.1
90.2 84.1 78.1 71.0 67.0 67.6 66.6 60.9 57.5 56.9 67.6 121.0 121.0 113.0 82.7 69.3 65.4 58.7 54.9 57.6 58.2 58.7 56.0 51.3 46.7 43.0 44.0 46.7 41.8 39.7 39.6 41.2 42.3 42.3 46.9 47.2 45.4
42.2 40.6 47.2 44.3 42.2 43.2 38.4 37.5 37.6 45.2 46.5 47.9 53.1 54.9 47.2 41.6 37.8 36.8 37.4 42.8 53.0 64.0 66.0 61.2 55.0 52.4 48.6 46.5 44.5 44.2 55.9 77.7 69.5 55.6 45.4 39.5 36.6 46.3
65.4 83.4 74.8 65.3 60.5 66.0 63.9 79.2 84.4 65.5 52.1 49.2 52.7 35.5 35.5 31.1 27.8 27.7 27.9 27.4 23.4 23.1 21.9 20.7 24.5 22.3 21.5 20.4 18.8 17.5 17.4 16.7 15.3 15.1 15.7 15.4 15.0 14.6
13.7 12.8 12.7 43.0 65.1 52.7 35.1 28.1 26.4 30.9 73.7 64.3 39.7 33.0 27.5 24.0 22.0 20.8 19.5 17.2 16.3 15.6 15.5 15.0 15.6 14.8 13.9 13.3 13.0 14.4 16.5 14.8 13.7 13.5 15.0 19.1 16.6 13.7
14.7 14.4 15.0 21.4 19.5 17.9 17.8 15.9 12.9 12.0 12.9 30.9 21.4 15.8 14.0 12.6 12.7 27.0 36.0 20.9 23.7 38.1 39.1 32.2 31.4 30.4 26.9 25.8 70.5 59.6 41.4 42.6 60.6 58.9 204.0 308.0 128.0
66.6 66.6 53.6 41.4 43.6 45.6 39.5 36.4 33.3 31.5 26.8 26.1 25.3 25.3 28.3 28.1 24.4 22.8 22.0 21.6 21.6 36.6 37.7 30.4 26.6 24.1 23.1 22.4 26.5 27.2 24.1 21.6 22.0 21.6 22.7 27.4 27.4 29.7
34.4 86.6 268.0 114.0 67.9 49.6 41.5 37.7 35.0 36.7 35.9 32.5 34.1 51.8 44.2 39.8 43.7 46.3 83.4 84.3 61.3 53.0 54.7 66.2 197.0 106.0 75.2 83.5 78.7 63.8 47.8 50.6 58.2 70.5 116.0 102.0
71.4 58.4 50.2 48.2 42.8 44.7 115.0 120.0 77.6 63.7 59.0 48.8 44.2 48.0 66.9 62.4 51.7 44.2 40.6 37.6 33.4 32.5 32.5 28.0 23.5 21.9 20.6 19.5 19.5 19.5 18.7 18.7 18.7 18.7
</gml:QuantityList>
</gml:rangeSet>
- <gmlcov:rangeType xlink:href="http://www.opengis.net/def/nil/OGC/0/unknown">
- <swe:DataRecord id="dr.sbasin.hydrometeo.27.observation.2">
- <swe:field name="observed_value">
- <swe:Quantity definition="http://vocabs.auscope.org/classifier/bom/slake/0.1/observedproperty/Dischargecum/sec">
<swe:uom code="cum/sec"/>
</swe:Quantity>
</swe:field>
```


Figure A.12. Somes Mare – Viewing time series data in WaterML 2.0 format

The figure shows part of the file where Data / Time stamps are followed by corresponding values (of discharge in this example).

The section Data Access also contains sub-section for accessing available spatial data using WMS URL link that opens the data in a separate window, in KML format or the XML file itself (just like the time series data). The interface followed by resulting view of the river network when the WMS URL link is used is shown in Figure A.13.



FID	LENGTH	RIU_BAZINE	BAZIN	OR1	OR2	OR3	OR4	OR5	OR6	COD	DENUMIRE	CONFLUENTA
river_WGS1984_Project.26	15269.547	2457	II	1	25	1				II_1.25.1...	APATIUL (BOZIES)	Valea Morii (Jimbor)

Figure A.13. Somes Mare – Viewing spatial data using WMS URL link

7.2 User Guide Danube Flood portal

The Danube Flood Portal has a similar interface to the Somes Mare portal. The 'Introduction' section is basically the same, and the 'Study area' under the 'Braila-Isaccea Flood Management' is similarly presented as shown in Figure A.14.

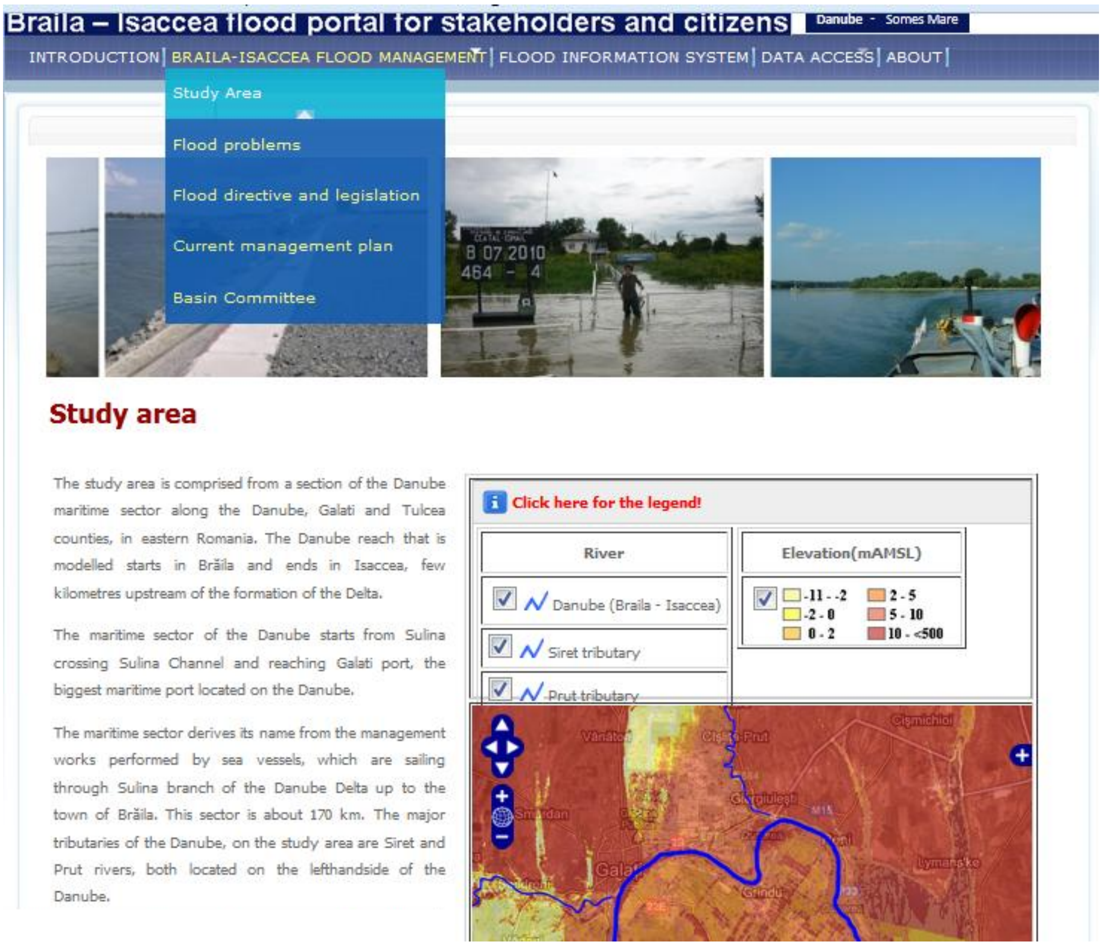


Figure A.14. Danube: Braila-Isaccea Flood Management – Study Area

The remaining sub-sections under 'Braila-Isaccea Flood Management' ('Flood Problems', 'Flood Directive and Legislation', 'Current Management Plan' and 'Basin Committee') again contain only textual information combined with images and downloadable documentation. They are available on the portal and they will not be presented here.

The 'Flood Information System' section has an interface to its subcomponents as shown on Figure A.15.

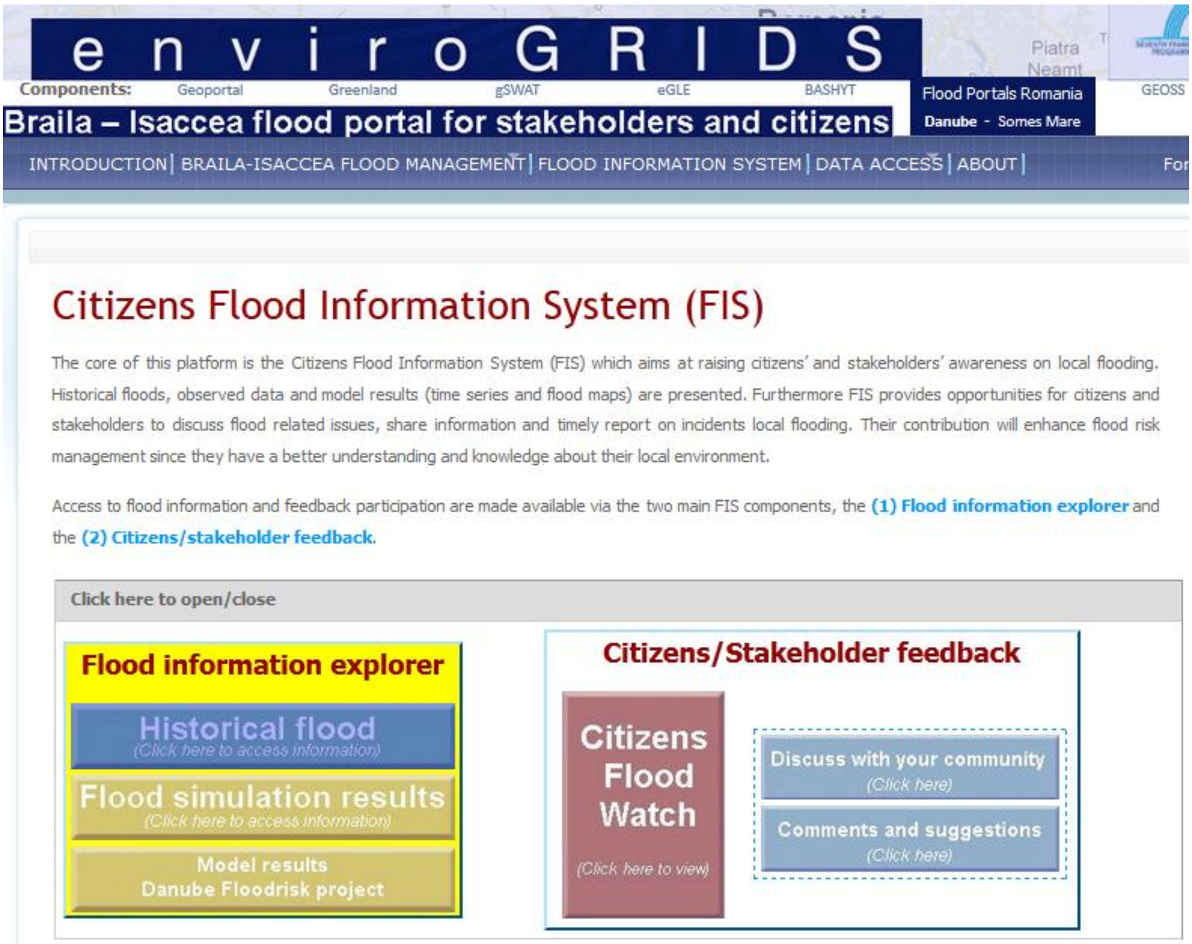


Figure A.15. Danube – Citizens' Flood Information System interface

Because the components under 'Citizens / Stakeholder feedback' are same as in the Somes Mare portal they will not be presented here.

Under 'Flood Information Explorer' the first component is 'Historical flood', from which historical discharges along the studied reach of the Danube river can be accessed, as shown in Figure A.16.

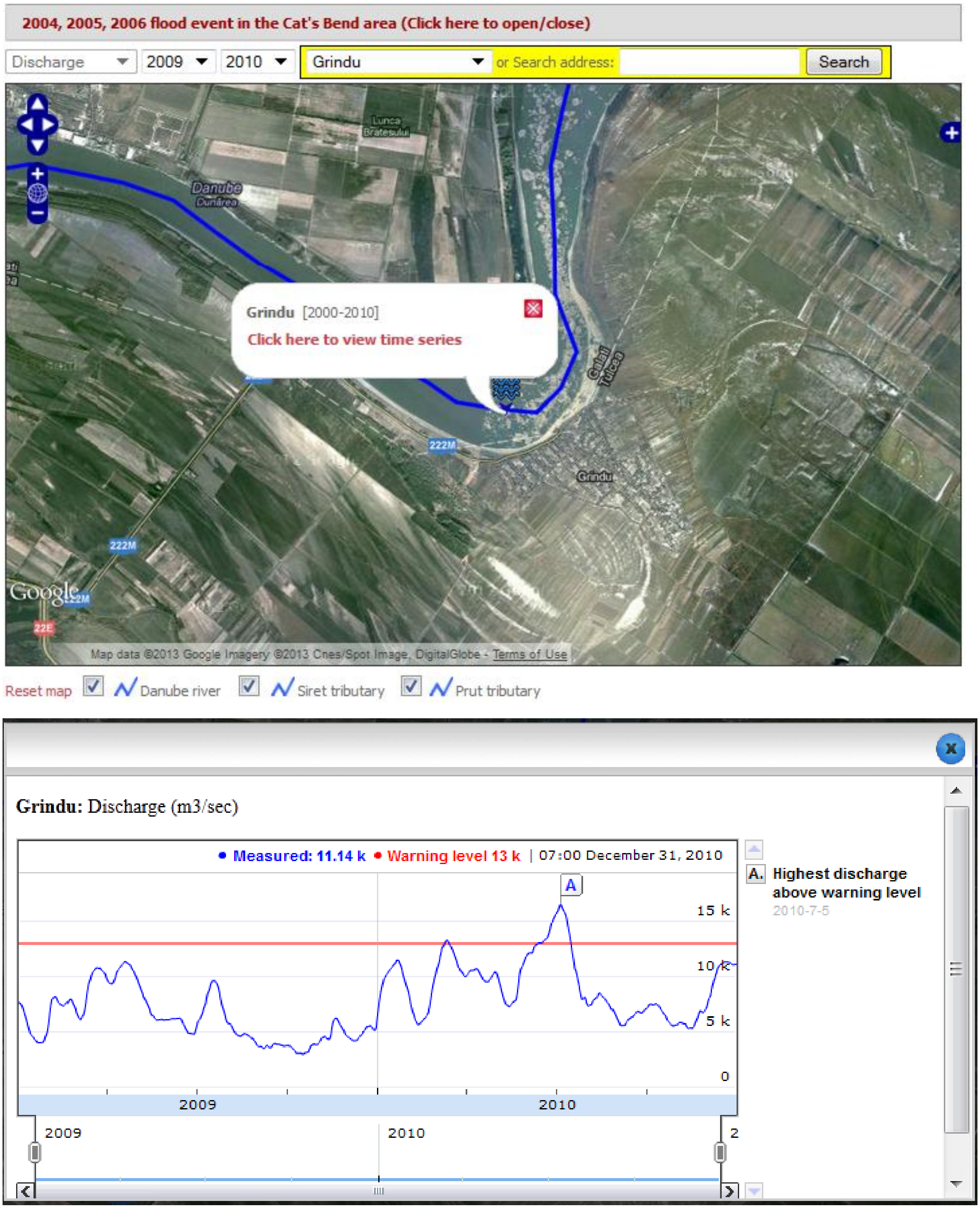


Figure A.16. Danube – Visualization of time series graphs of historical discharge data

The most interesting and interactive Information of the ‘Flood Information Explorer’ is presented in the ‘Flood simulation results’ sub section. Here the users can compare the flood maps (extent and flood depth) for the eight composite scenarios modeled by the SOBEK 1D-2D model. The map interface allows for overlaying two different flood maps (in different colors) for such a comparison. The scenarios are selected from the matrix interface placed above the map, as shown in Figure A.17.

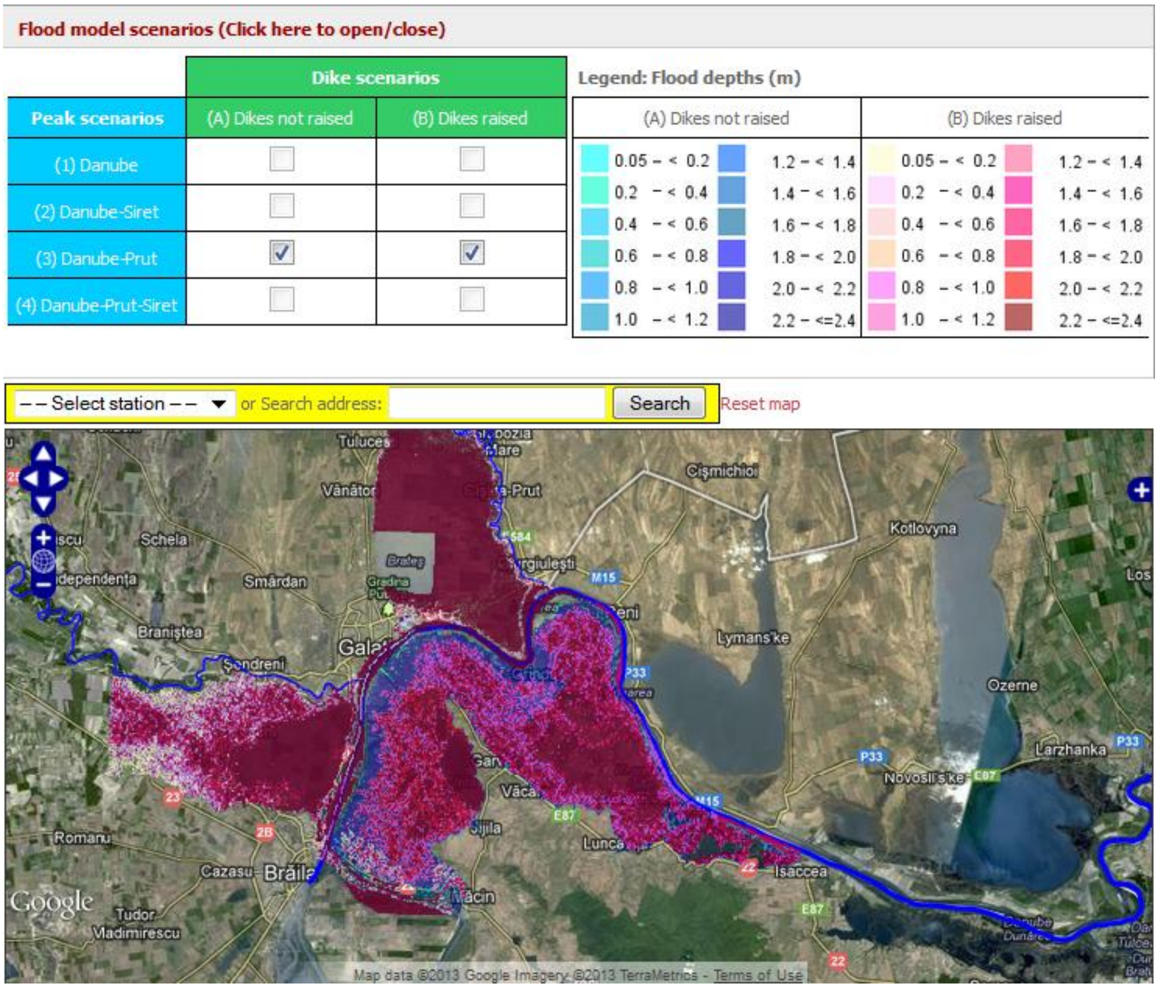


Figure A.17. Danube – Visual comparison of the flood maps for composite scenarios modeled by the SOBEK 1D-2D model.

For further comparisons the interface also has a link to the food hazard and flood risk maps of the same area obtained from an earlier research project - Danube FloodRisk (EU project) generated for 1/1000 year return period. The Danube discharges for this return period are estimated to be around 20% higher compared to the 1/100 year return period (about 18,500 m^3/s, compared to 15,500 m^3/s). Nevertheless, as shown in Figure A.18, the flooding pattern obtained is very similar, with the difference of higher flood depths for the 1/1000 return period.

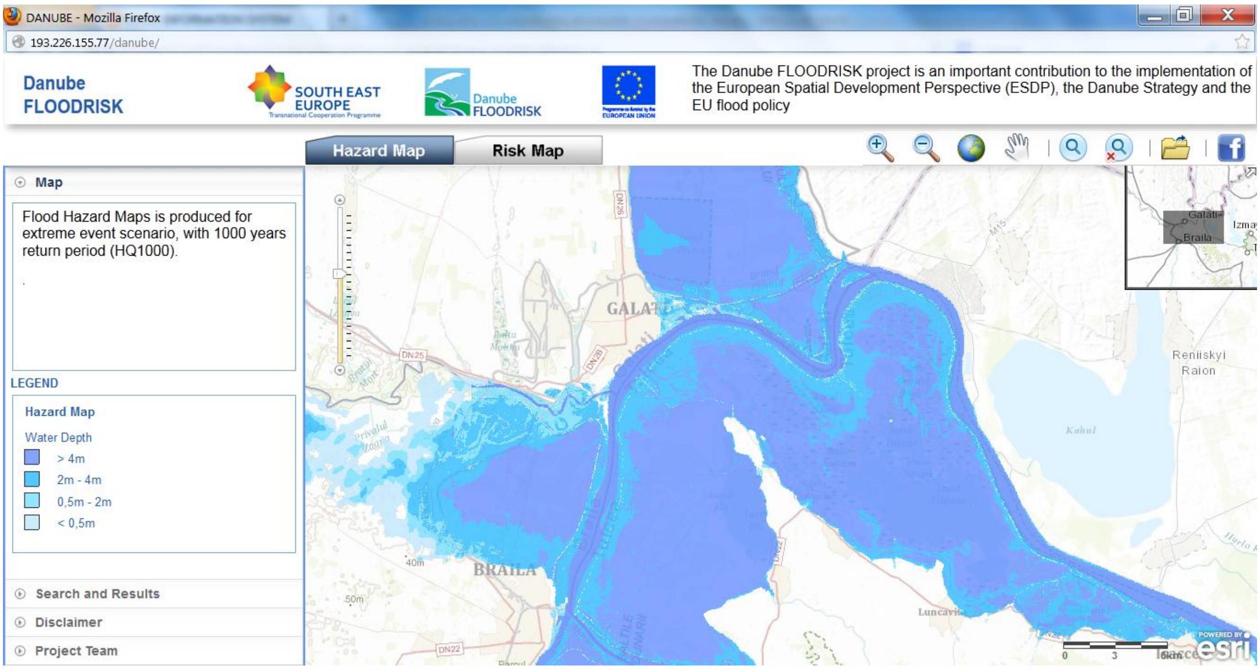


Figure A.18. Danube – Flood maps for 1/1000 return period obtained from the Danube FloodRisk research project

The last section in the Danube portal is again the ‘Data Access’. For the ‘Hydro-meteorological data’ subsection the available discharge data are made available via downloadable Excel files. The sub section for spatial data is similar to the Somes Mare portal. In addition to other spatial data, the generated flood maps from the SOBEK 1D-2D model are also made available in the three formats (WMS URL link, KML or downloadable XML). The selection and display of one such map via the WMS URL link is presented in Figure A.19.

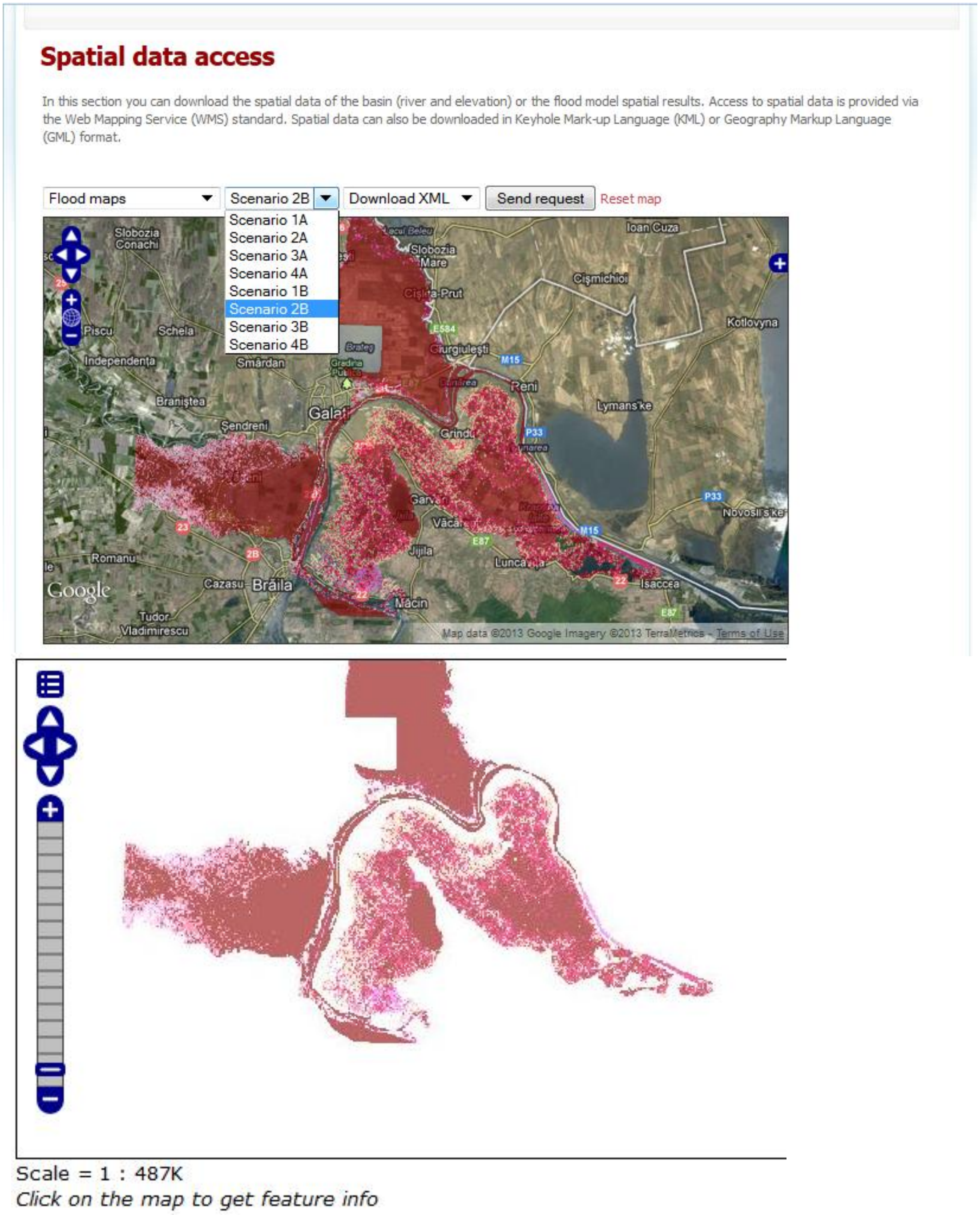


Figure A.19. Danube – Viewing spatial data (flood maps) using WMS URL link