Flood risk management service in support of the implementation of the EU Flood Directive – First results for test sites in Romania and Bulgaria

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1 Introduction

Floods are considered worldwide as one of the major natural disasters. Changes occurred in climate patterns and land cover, altered river hydromorphology, loss of adjacent floodplains converted in dry land for agriculture or constructions, urbanization, etc. enhance their destructive potential.

In Europe, a rising number of flood disasters had been noticed in the last years and major flood events occur more frequently (Barredo, 2007). Also, the damages they produce have increased in the last few decades: 155 lives were lost and costs of over 35 billion euro were recorded between 2000 and 2005 (Barredo et al., 2007, quoted in Glaser et al., 2010).

As a consequence of the climatic changes, a major shift of the precipitation level occurred across Europe (IPCC, 2008), increasing up to 10-40 % in the Northern and Central part of Europe and decreasing by 20 % in South Europe; moreover, projections for the future, based on climate change models, indicate increasing frequency of extreme hydrological events, increasing the risk of river floods, flash floods, landslides, groundwater rise and storm drainage overflow (Kundzewicz et al., 2010).

In response to these alarm signals and projections, the European Union (EU) adopted recently the Flood Directive (2007/60/EC), according to which flood-protective measures should be coordinated at river basin scale, considering the solidarity principle (measures taken in one state must not increase the risk of flooding in neighbouring countries); each EU Member State shall prepare flood risk management plans, using the best available techniques and taking into consideration the area specificity. These plans should be based on flood hazard maps designed for three scenarios: low (extreme event), medium (≥ 100 years) and high probability, emphasizing the flood extent, water depths and flow velocity. The flood risk maps should emphasize the potential impact on inhabitants and economic and environmental damages in the affected area.

Within the framework of the European Commission's (EC) and European Space Agency's (ESA) joint initiative "Global Monitoring for Environment and Security" (GMES) several flood related geo-information services have been developed during the past few years. The project "Services and Applications For Emergency Response" (SAFER, www.emergencyresponse.eu) contributes to this initiative by providing rapid, reference and thematic mapping services relevant to an effective support for natural disaster management. In this contribution, the focus is put on thematic services addressing flood risk management and assets mapping.

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2 Materials and methods

The objective of the work performed by the authors within the SAFER project is to focus on the further development of a flood risk management service portfolio which is intended to provide up-to-date flood relevant products for test sites in Romania (Timis river catchment) and Bulgaria (Rousse and Sofia regions) and which can be transferred to other river catchment areas of different geography and topography. The products are derived from Earth Observation data, in-situ and ancillary data. The applied methodologies comprise hydrodynamic modelling, assets mapping (mapping of monetary values) and the application of damage functions. Altogether the portfolio comprises four products offering a solution for an integrated flood risk management approach: Past flood event maps, flood hazard maps, flood risk maps and the online information system www.floodserver.eu.

As there is a high demand for quantitative and qualitative risk maps in Romania and especially in Bulgaria – where no national flood maps are available (Moel et al., 2009) – we will focus here on the production of countrywide assets maps which can serve – in combination with the flood extent maps – as a basis for the generation of flood risk maps on a national level as well.

The workflow of the model applied here can be summarised as follows: In a first step to generate asset maps, socio-economic statistics that describe the valuables / assets are grouped to classes and assigned to one or more thematically fitting land use categories (e.g. household goods assets are assigned to urban areas). In a next step the assets maps serve as input data for the damage modelling. The rate of flood-related damage to a valuable class is determined by a number of factors, the most prominent ones being flooding depth and flow velocity. This hazard layer is calculated using a hydrodynamic 2D-modelling approach and the software FloodArea. The expected damage of each assets class can be shown as a function of each of these factors and reveals the damages in percent of the affected assets. The damage functions are applied separately to each class of assets. In a last step, the potential damages from each asset-class are summed up for each land use category resulting in a potential damage map (quantitative risk map) displaying values in € per m² or km². The work flow diagram for the damage assessment modelling is shown in Figure 1. For more details on the remainder of the flood risk management portfolio we refer to Holzhauer et al. (2009) and Mueller et al. (2009).

It is worth mentioning that the approach outlined here requires the making of several assumptions and neglects. Among them is for example the assumption that the assets value related to livestock splits evenly into two land use classes (here: pasture and rural built-up area). Among the neglects are the non-considerations of currency fluctuations or statements on the derived damage figures in relation to the respective national purchase powers. As to the accuracies and validations of the assets and damage assessment models and maps, there are still only few references and detailed enough on-site data available. Also, the indication of uncertainties in the final products is not yet implemented either but would definitely add further value to the maps. These facts in combination with the approach of assumptions and neglects sketched before demonstrate the need for more research and operational testing in this domain. Both will be subject during the remaining project run-time of SAFER until the end of 2011.

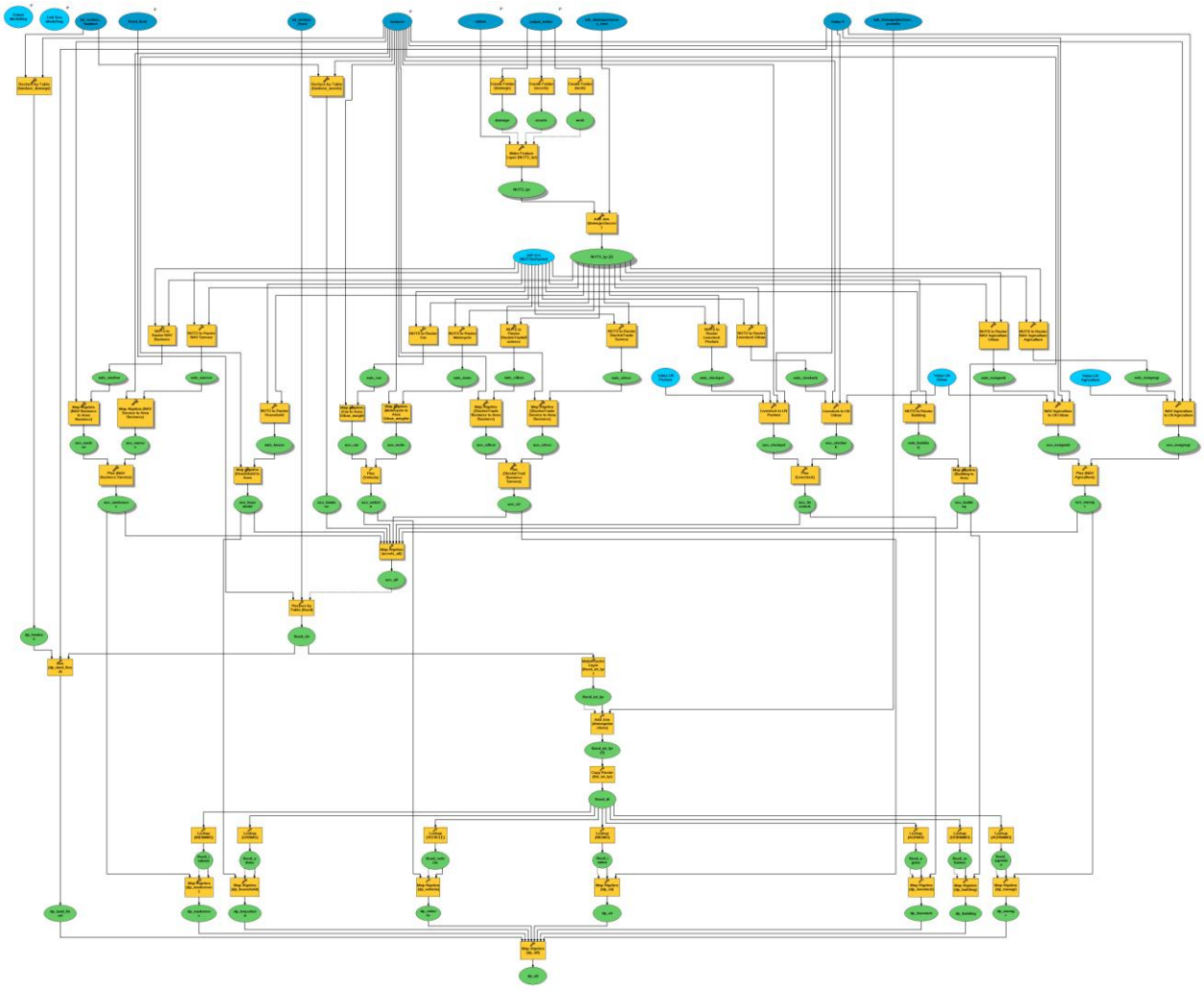

Figure 1. *Work flow diagram of the damage assessment model, implemented as ArcGIS model builder script. Land cover / use data and various (official) socio-economic statistical data in combination with flood inundation information serve as input data for the modelling procedure (Explanation: blue = input files and given constants; yellow = calculation processes; green = output files).*

3 Results and discussion

By providing past flood event maps, flood hazard / risk maps and a flood information system (see www.floodrisk.eu) the service portfolio contributes to the implementation of the EU Flood Directive (2007):

Article 4

2. (...) The assessment shall include at least the following:

*(b) a description of the **floods which have occurred in the past** and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity and for which the likelihood of similar future events is still relevant, including their flood extent and conveyance routes and an assessment of the adverse impacts they have entailed;*

*(c) a description of the **significant floods which have occurred in the past**, where significant adverse consequences of similar future events might be envisaged;*

Article 6

*1. Member States shall, at the level of the river basin district, or unit of management referred to in Article 3(2)(b), prepare **flood hazard maps and flood risk maps**, at the most appropriate scale for the areas identified under Article 5(1).*

Article 10

*1. In accordance with applicable Community legislation, Member States **shall make available to the public** the preliminary flood risk assessment, the flood hazard maps, the flood risk maps and the flood risk management plans.*

The substantial benefit of this service portfolio results from the combination of Earth observation data with regional/local data and enhanced modelling techniques. The former enables a European-wide harmonised and cross-border approach, the latter contributes to the provision of custom-tailored solutions considering also e.g., specific geographical/hydrological circumstances of the river basin.

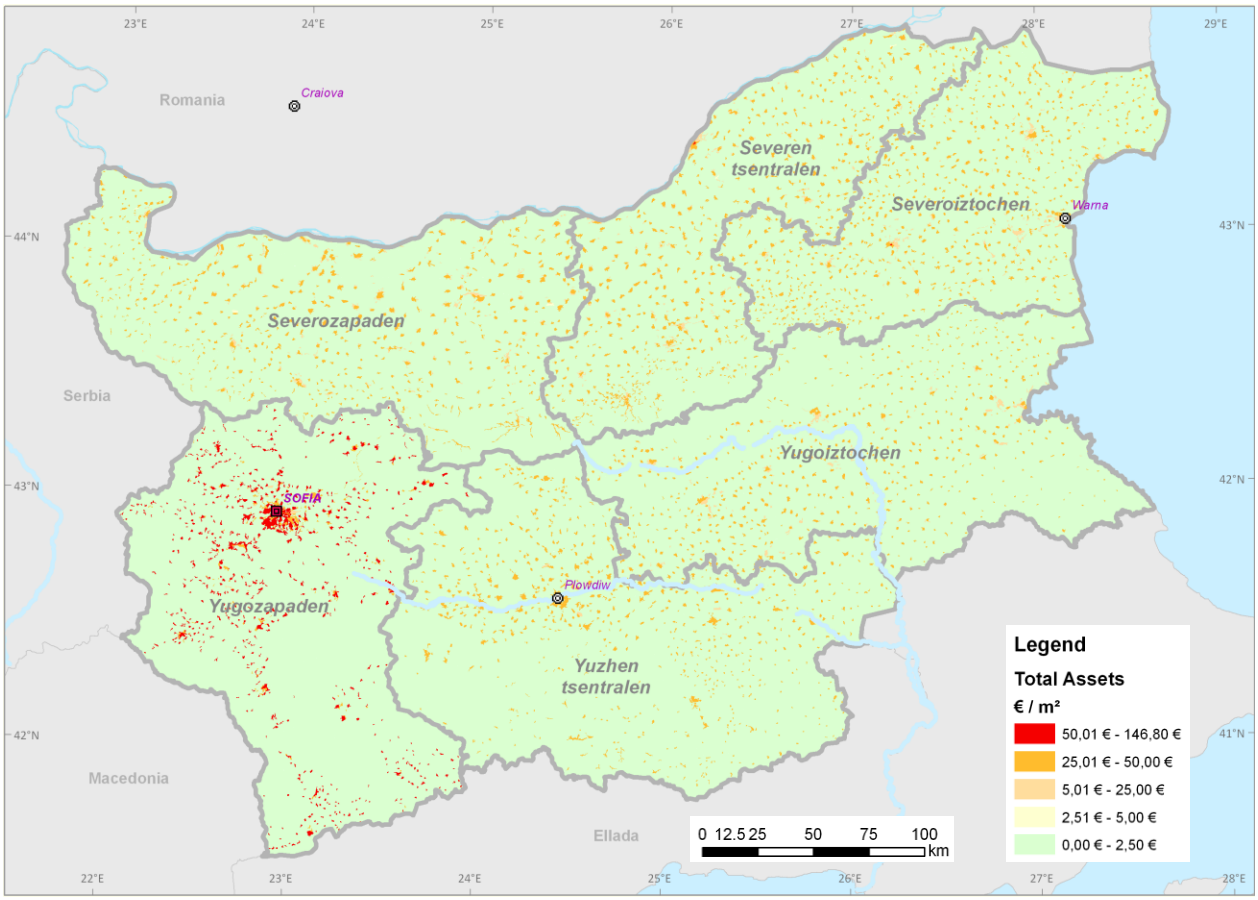

Figure 2. *Basic European Assets Map (BEAM) for Bulgaria.*

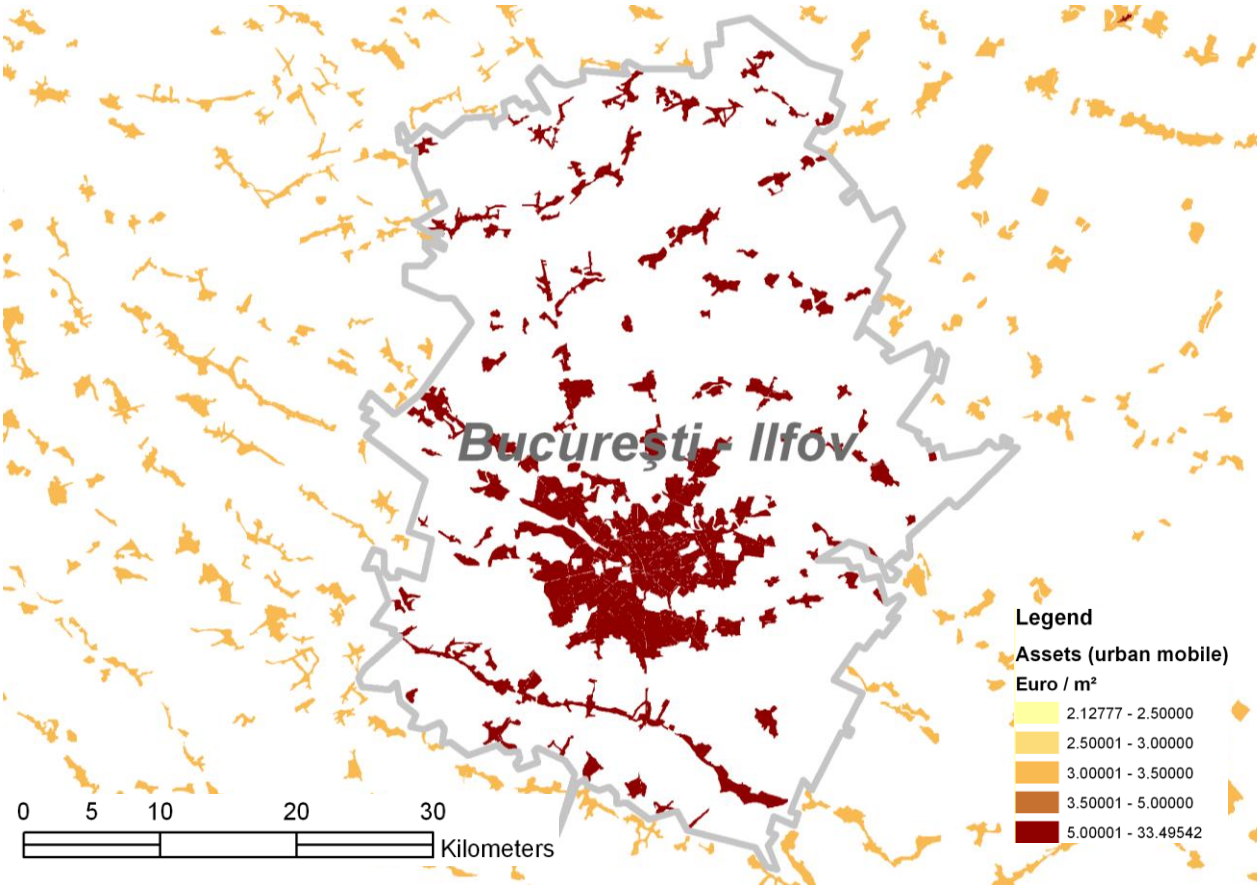

Figure 3. *Basic European Assets Map (BEAM) for Romania: Map section Bucharest region – displaying the assets class "household".*

Main results of the first project year (2009) are the data collection, preparation and production of the Basic European Assets Map (BEAM) for the complete territories of Romania and Bulgaria. Figure 2 shows the BEAM product for Bulgaria, figure 3 gives a detail from Romania (Bucharest). This is also an example for a single class representation (here: household goods). The bottom line of the methodology developed here is that BEAM can relatively easy be transferred to other European countries. The data sets used here as inputs are European-wide available land cover data sets and socio-economical statistics obtained from the European Commissions statistics database.

4 Outlook

Within the project's run-time the further development of BEAM to a sort of European core service is currently ongoing - including the production for additional selected countries in Europe. Furthermore, the diversification of the service portfolio will be advanced, i.e. generating assets map products of higher level of details for regions (but less transferable, in terms of GMES so called downstream services). The same applies to the service portfolio for the flood products, i.e. following a double tracked approach - comprising both core and downstream products as elements of an integrated solution for an effective flood risk management. From this it follows that the service presented here offers a suited portfolio to contribute to the implementation of the EU Flood directive and is thus of special relevance to the persons responsible – in order to take the right actions in policy, water management and civil protection.

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