Indicator: The extent to which the eligible area is covered by joint risk prevention systems

Danube is the most international river on Earth and the largest river of the European Union in terms of length, basin surface, water and sediment discharge (6470 mc/s and 1555 kg/s, respectively; McCarney-Castle, 2012). As it flows over 2870 km from the source in Germany to the delta at the Black Sea coast, Danube crosses 10 countries and collects its waters from 19 countries in a basin covering 817,000 km^2. The variation in stage is large (i.e., 10.5 m), placing the Danube immediately after the Mississippi river in this respect (Vidraşcu, 1921). After its emergence from the Iron Gates Dam, an extensive natural floodplain bordered the Danube along its lower course, studded with many lakes rich in fish and other wildlife.

Danube's floodplain varies in extent along it lower course. Immediately downstream of the Iron Gates Dam, which is the upper limit of Danube's lower course, the floodplain is narrow and occurs only sporadically. At Ostrovul Mare the floodplain starts to broaden preferentially on the left bank (Romania) with the width of the floodplain varying between ~200 m near Calafat and ~30 km in Balta Brăilei. On the right bank, in Bulgaria, the floodplain appears as a narrow fragmented strip that was largely embanked before World War II. In Romania, about 75% of Danube river length is embanked.

Flood hazard and risk

The frequency analysis of specific water levels highlights that in every month from March to May, the flood level this sector, was exceeded at least in 25% of the studied years (Fig. 2.13). In Romania, three alarm thresholds are used: warning, flood, and danger. The highest probability for the Danube water levels to exceed the flood level is typical of March (about 35%), it might happen also from December to February, but then this phenomenon is quite rare. Flooding frequency is low from August to November. However, in the latter period, low Danube levels are quite frequent, sometimes below the low-water line, then navigation conditions are quite poor, a situation occurring nearly every 3 years (31%, or 31 cases in 100 years). The latest documentary information on hazard and flood risk is the Danube Atlas. Hazard and Risk Maps, a result of the Danube FloodRisk – Stakeholders oriented flood risk assessment for the Danube floodplains project (http://www.danubefloodrisk.eu/) (Fig. 2.14). These maps have an important role

in informing the local communities along the Danube River on Flood Risk and Exposure (Danube Flood Risk Project. Summary Report, 2012).

The Atlas shows flood-prone areas with medium frequency (once every 100 years or 1%) and low frequencies (once every 1,000 years or 0.1%), and flood risk with a frequency of 1/1,000 years. The last scenario presents a disaster, hazard maps outlining 4 water-depth classes (over 4 m, 2–4 m, 0.5–2 m and less than 0.5 m), and risk maps highlight potential consequences as qualitative data in the range of low-to-high classes. Risk assessment targeted the main types of land use, namely industry, settlements, forest/agriculture, and others. For the first two types, three risk categories (low, medium, and high) are defined, and for the other two types only two risk categories (low and high) are indicated. In Romania, the development of hazard maps highlighting flood-prone areas by flood return periods of 30, 100 and 1,000 years, as well as water depth, resorted to the hydraulic model Sobek_Rural 1D2D (Constantinescu et al., 2012).

The BEAM (Basic European Assets Map) Methodology, used for vulnerability indices, is based on land-use data (CORINE Land Cover thematic layer), as well as on other geospatial data (NAVTEQ), EUROSTAT statistical data, and other national statistical data) (Manual of Harmonized Requirements, 2012). The maps of interest for the Calafat–Turnu Măgurele sector were scanned, georeferenced and vectorized. Based on water depth in the extreme scenario (1/1,000 years), three classes of hazard intensity were redefined as follows: 1 – low (0–2 m), 2 – medium (2–4 m), and 3 – high (> 4 m). The potential flood-prone area with this rare occurrence probability covers 999 km2 (99,914 ha) and is distributed throughout 28 administrative territorial units (NUTS5). Out of these, a total of 18 NUTS5 have potentially flood-prone areas larger than 25 km2, and 7 NUTS5 larger than 50 km2. Generally, most communes (NUTS5) are situated mainly in embanked areas (flood-prone lands), flooded once in 1,000 years (Cârna, Bistreţ, Gighera, Ianca, Rast, Turnu Măgurele and Desa)

Instead, the built-up spaces, inside settlements, are generally situated at higher altitudes than the maximum flood-prone area defined by the 0.1% flow, respectively on the terraces. Only 36 localities, possible to be affected in varying degrees, have been identified. The total affected area inside settlements is of approximately 1,730 hectares (17.3 km2), in 5 of the 36 localities, the flood-prone area is less than 2 hectares. At the opposite, 23 settlements may be affected on over 10 ha and 14 on over 50 km2. The settlements more exposed to the flood hazard on areas of over 100 ha are: Desa, Rast, Cârna, Măceşu de Jos, Bechet, and Plosca. The settlements of Rast, Cârna, Măceşu de Jos and Plosca are at risk between 96% and 100% The total number of inhabitants of settlements potentially at risks from being flooded and distributied by 3 risk classes were determined in proportion to the area covered by water. **The proportion of affected inhabitants is lower than the affected area (19.5% versus 27.8%)**, which means that in the flood-prone areas of this sector there are, generally, localities with low population density. In terms of number of inhabitants, the most vulnerable settlements: Rast (3,951 inhabitants), Turnu Măgurele (3,623 inhabitants) and Desa (2,963 inhabitants) (Fig. 1). While the whole population of Rast is exposed, in Turnu Măgurele, only 10% are in this situations, that is, the inhabitants of the southern and far western part of this city. In the other 7 villages the population possibly affected by floods is extremely scarce, between 1,000 and 2,000 inhabitants.

Fig. 1 – Danube and its first order tributaries floodplains and possible flooding area (PFRA)

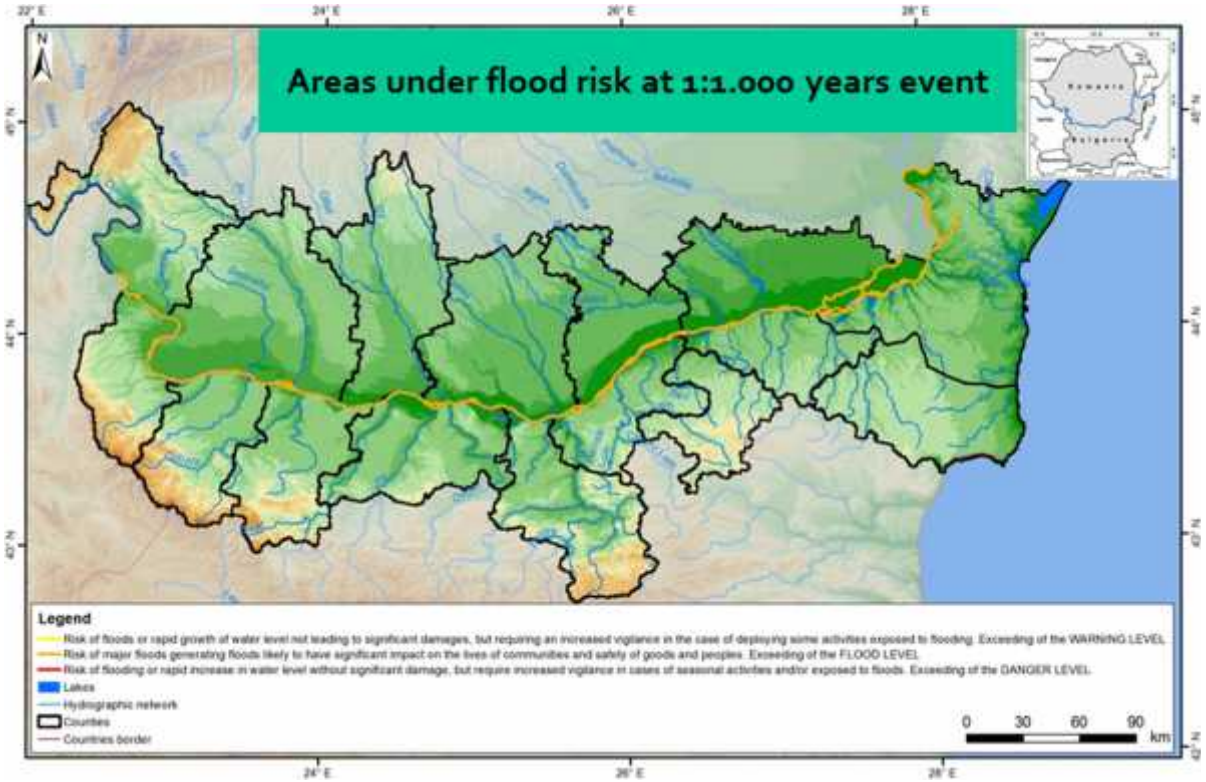


Fig. 2 – Danube floodplain and flood hazard of the eligible area for Danube WATER

From the whole area of administrative territorial units exposed to extreme flooding at a magnitude possibly recurring once in 1,000 years, almost half **(45%)** could be effectively covered with water in case of such events. However, the settlements are less exposed. Thus, only **20% of the inhabitants living in settlements affected** by such flooding are exposed. There is a high probability

that, from the 26,215 inhabitants likely to be affected, nearly 19,000 have households and land in class 1 (low intensity hazard), i.e. lands rarely flooded and low intensity of extreme hydrological phenomena.

In terms of risk, which combines the intensity of the phenomenon and the value of goods exposed to floods, no class 3 areas (high risk) have been identified in this sector. As shown above, the settlements are located generally at high enough altitude against flood-water levels. The value of socio-economic units is not so high as that in developed urban areas along the Danube. However, it should be noted that, in elaborating the Atlas, only exposure indices (value of goods) were taken into consideration, and not vulnerability, which should observe the level of development and education of the communities correlated with their ability to cope with such events and subsequently recover.

Further proposal for the green corridor in the high risk flooding areas is shown in figure 3.

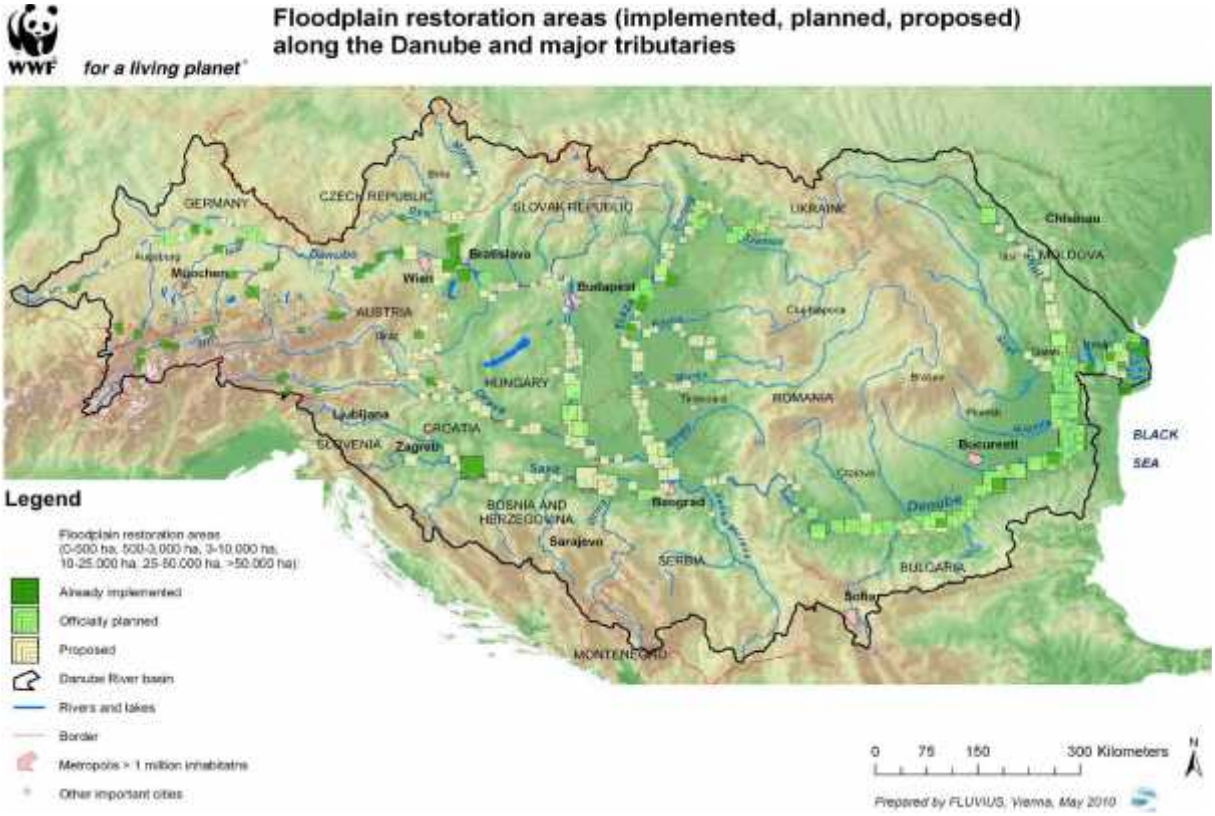


Fig. 3 Green corridor along the Danube floodplain

Protecting localities, Danube WATER grant was used for equipment acquisition for flood protection, as machines and inflatable dykes, pumps, preparing intervention.

Diminishing flood risk by an integration of flood risk management and water management, scenarios were defined – see the following pictures.

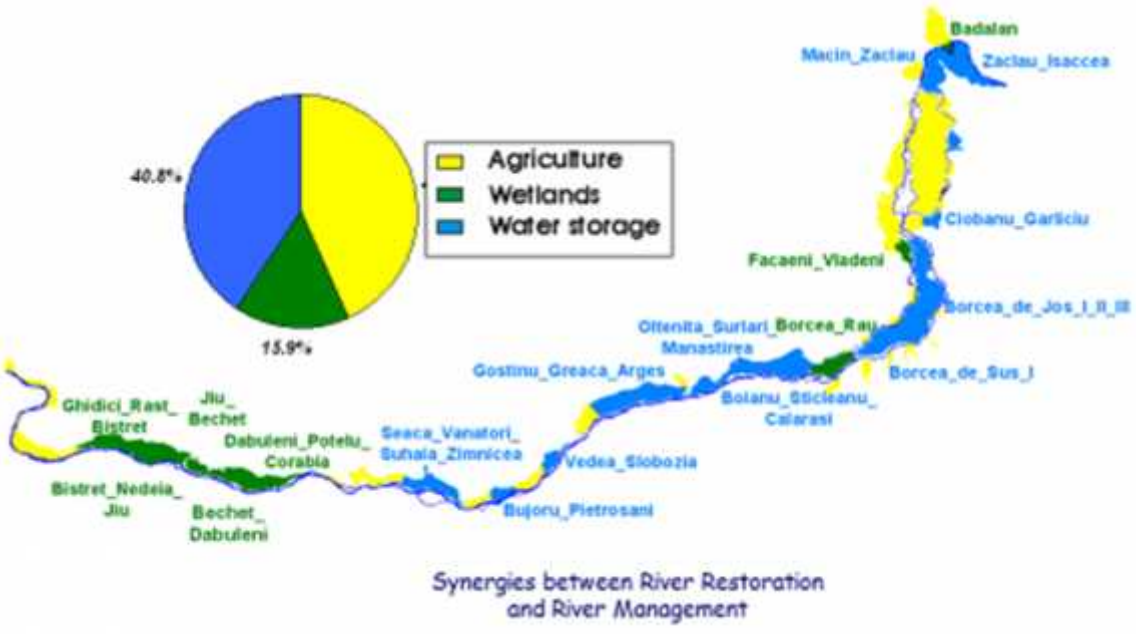
Scenarios for lateral conectivity

I. A number of 8 polders reverted to wetlands (15%)

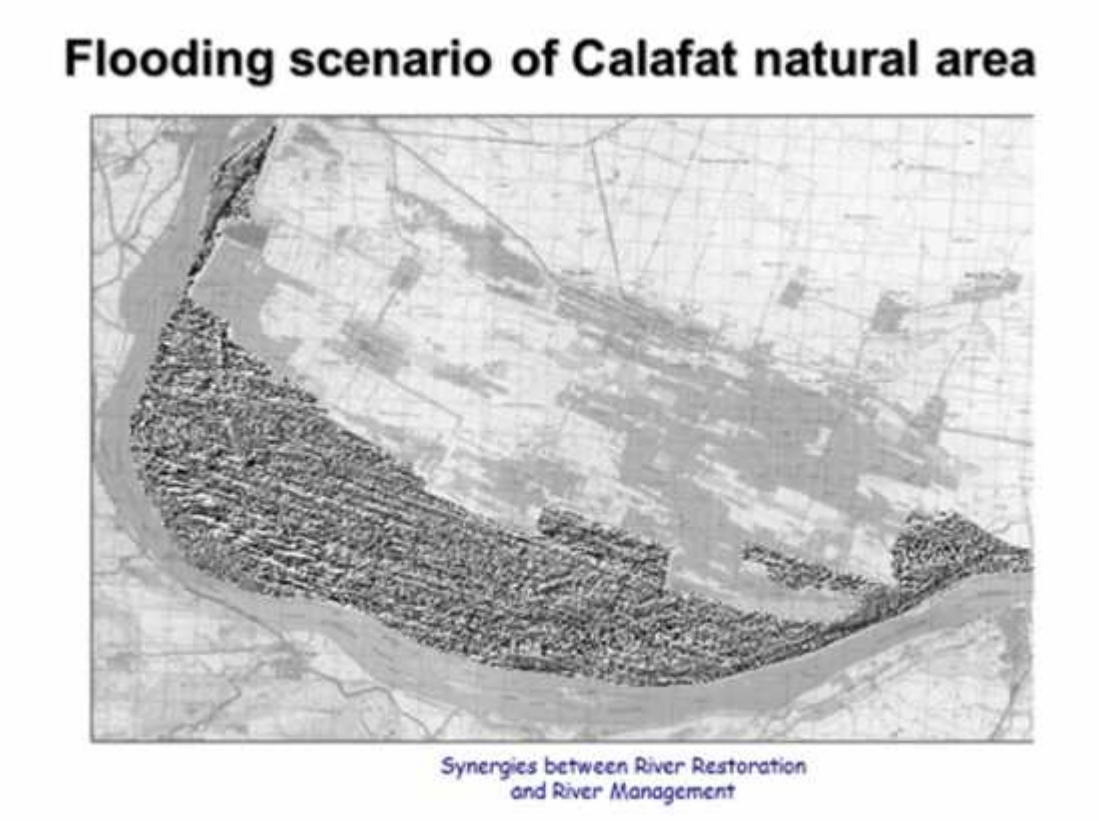
II. 8 polders reverted to wetlands and additional 12 polders used for temporary water storage at high flood events (40,8%)-(mixed use)

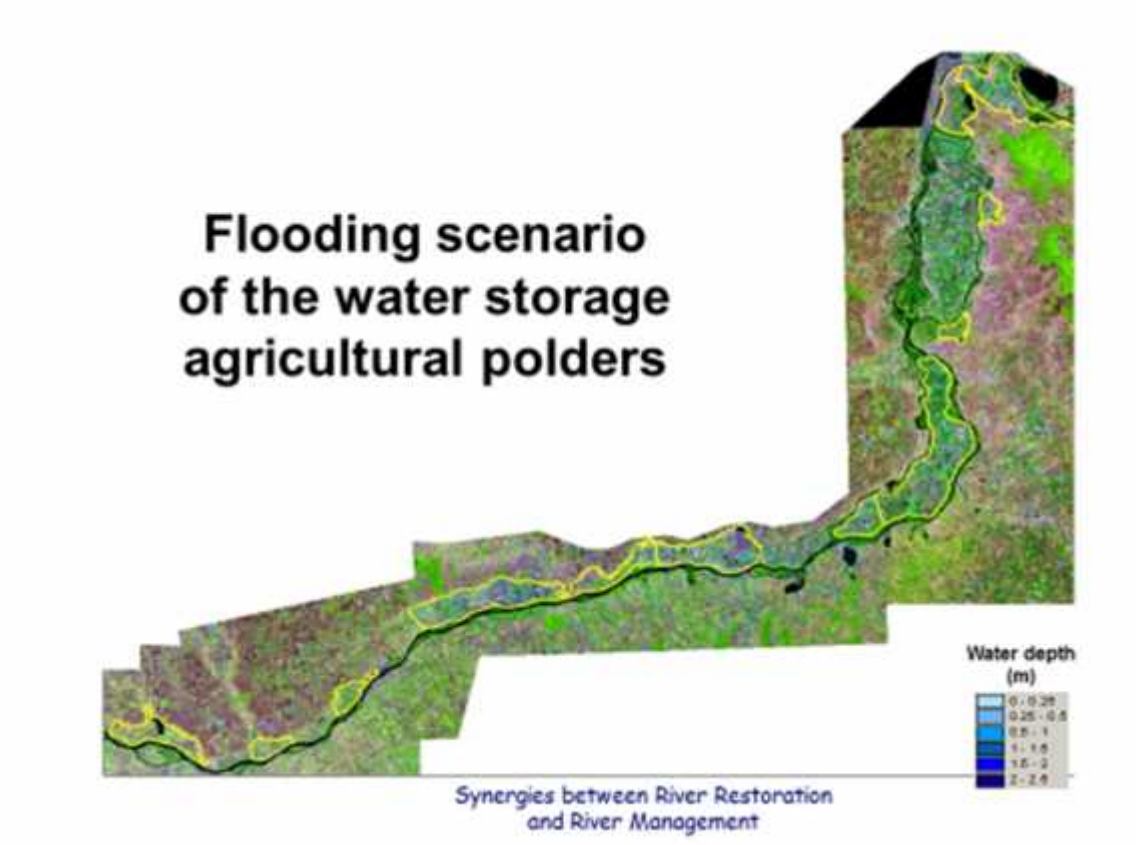
III. All polders reverted to permanent wetlands (100%)

Mixed use option



Synergies between River Restoration and River Management





Pictures 1-4 are scenarios studied in Activity 10

Findings and recommendations address to improve studies for flood risk management – see Report of Activity 10.