

PRELIMINARY OF THE EUROZONE AND FOR THE BENEFIT OF STATE AND LOCAL ADMINISTRATION

I. INTRODUCTION

The inclusion of Bulgaria in the group of member states of the so-called Eurozone, in addition to the transition from the national currency - the Bulgarian lev - to the common European currency - the euro, also requires national governance in a much more direct connection with the common rules and regulations imposed by the European Commission and other European institutions.

In this regard, ASDE-ECOREGIONS begins publishing short materials related to the established operational capacity, in accordance with the introduced or upcoming mandatory European regulations, especially in the field of territorial planning, risk management, combating climate change, and the protection of natural and cultural-historical heritage.

In this short publication, we offer to the attention of the state and local administration, our comment and proposal, on the need for constant monitoring of flood risk along the main local river Rusenski Lom, as well as the identification of vulnerable areas, mainly for urbanized areas in the Municipality of Ruse in Bulgaria. The development is also in accordance with the requirements of European directives, decisions/regulations (in the sense of EU legal acts) and manuals/guidelines, which are used directly or indirectly in flood risk assessment and management and above all - Directive 2007/60/EC (Floods Directive) - "on the assessment and management of flood risks". It introduces the three steps - preliminary assessment, hazard/risk maps, flood risk management plans (FRMP) and 6-year cycles.

Other directives that almost always apply together with Directive 2007/60/EC:

- Directive 2000/60/EC (Water Framework Directive / WFD) – integrated river basin management; coordination with flood risk measures;
- Directive 2007/2/EC (INSPIRE) – important for spatial data (flood maps, layers, metadata, services) that countries share;
- Directive 2001/42/EC (SEA – Strategic Environmental Assessment) – impact assessment is often applied to plans/programs (including those related to water/floods);
- Directive 2011/92/EU (EIA) – for projects (dykes, river adjustments, reservoirs, and infrastructure) that affect flood risk.
- (Often relevant for measures/infrastructure and “green” solutions) Directive 92/43/EEC (Habitats) and Directive 2009/147/EC (Birds) – when flood protection measures affect protected areas/species (usually this is the standard “Natura package”);

There are other important European legal acts on civil protection and disaster risk management (in this case, related to floods), such as:

- Decision No. 1313/2013/EU (Union Civil Protection Mechanism / UCPM) – framework for prevention, preparedness, response, capacity exchange and coordination in disasters (including floods);
- working document (SWD) of the European Parliament and the European Commission, dated 29.09.2025, to a progress report on risk and resilience management in Europe (under the UCPM) – useful as "practical context" and expectations for member states;

Manuals/handbooks and methodologies (CIS/EC) for practical application are also useful, the most commonly used being:

- Floods Directive Reporting Guidance (version 08.03.2021) – technical guidance for reporting to the EC/WISE under the Floods Directive;
- Guidance for Reporting under the Floods Directive (2013, CIS) – an earlier (but still useful) structure for the types of reporting under Articles 3–7 (competent authorities, PFRA, maps, FRMP);
- "Flood Risk Management in the EU under the Floods Directive" (CIS technical document) – overview/lessons from the first cycles (useful for "good practices");
- The above-mentioned document – SWD (2019) (assessment of WFD/FD reports/plans, country profiles) – often contains specific remarks and recommendations on FRMPs, maps, climate assumptions and management;
- Current European overview - again SWD, but this time from 04.02.2025 (EU overview for the 2022–2027 RBMP/FRMP cycle) - current "European overview" of how the EC assesses the second FRMPs and maps.

From the perspective of local administration, the most frequently invoked and cited are Articles 4, 6, 7, 9 and 10 of Directive 2007/60/EC, in conjunction with Articles 3, 4, 11, 13 and 14 of Directive 2000/60/EC, supplemented by INSPIRE (Articles 4–6, 11) for maps and EIA/SEA for impact assessment.

Our operational capacity has been built on the basis of a number of projects under programmes such as the 7th Framework Programme, HORIZON 2020, INTERREG and ESA-PECS for Bulgaria – in this case, flood risk monitoring and the creation of rapid simulation models for vulnerable territories and infrastructure, mainly for urban development zones, implemented in the general development plans in each municipality. The next section of this publication provides a more detailed analysis of the most frequently used legal articles, as well as a sample template for preparing a report, limited to municipal administrations.

Monitoring of trends in the state of water bodies in the Municipality of Ruse is also proposed, from the perspective of the growing importance of water resources used by the municipal administration, industry and population.

II. STRATEGY

The main position of the expert team of ASDE-ECOREGIONS, when developing intelligent high-tech solutions, is that they should be maximally linked to real management practice, as well as to the operational capacity of the end user. On the other hand, we believe that there can be no sustainable and modern management of territory, resources, infrastructure and population without constant monitoring of mandatory priority indicators for the individual elements of territorial planning, such as the state of the natural environment, maintenance of environmentally friendly agriculture and, above all, sustainable management of the urban environment. For this type of monitoring to be meaningful, it must be linked to indicators that are monitored and respected by local authorities, which leads us to the so-called general development plans of municipalities (GDPs), mandatory for municipalities in accordance with the Territorial Planning Act (TPA).

As mentioned above, the European Union has adopted a number of legal documents related to flood risk prevention, which create a sufficiently good framework for monitoring, assessing and managing flood risk, preliminary modelling of possible vulnerable areas and damage to critical infrastructure, buildings and people's lives and health. An important condition, especially in the new climate change conditions, should be to extend risk assessment and modelling of vulnerability to areas that have traditionally not been within the scope of the accepted river systems and catchments. In recent years, the so-called "flash floods" and rainfall in areas where frequent rainfall has not been established have caused significant destruction, damage to infrastructure, and even human casualties. It is imperative to review the monitored territories, the definition of vulnerable territories and the system of regular monitoring.

In order to have a direct connection with the mechanisms of territorial planning and management, it is necessary to establish the direct impacts of potential flood risks on the so-called development/functional zones, defined by the mandatory general development plans (GDPs) for each municipality. For example, special attention should be paid to urban development zones, directly related to the health and life of people, as well as to the protection of the building stock and critical infrastructure. A mandatory condition for such monitoring is that it be carried out regularly and on the basis of objective data that combine remote and ground-based methods based on internationally accepted standards. In our opinion, this can be done on the basis of data received from satellite constellations for earth observation, which should be supplemented with data from the ground. In this case, the most suitable is the European COPERNICUS program, which provides free data from the satellite group - SENTINEL 1 and 2, which can be processed and extracted data in accordance with the global standards included in ISO 19144. In our case, with the help of external experts, an algorithm was set up, partially including artificial intelligence for structured processing of large data sets.

Directive 2007/60/EC – Floods Directive (the most frequently cited). Articles that are almost always cited:

- **Art. 3 – Designation of competent authorities and river basins** (cited under institutional framework, responsibilities, national authorities)
- **Art. 4 – Preliminary Flood Risk Assessment (PFRA)** (used for initial identification of areas at significant risk)

- **Art. 6 – Flood hazard and risk maps** (most often cited in GIS analyses, modelling, scenarios (Q10, Q100, Q1000))
- **Art. 7 – Flood Risk Management Plans (FRMP)** (key article for strategic and operational measures)
- **Art. 9 – Coordination with the Water Framework Directive (WFD)** (cited in integrated water management)
- **Art. 10 – Public information and participation** (important for public consultation and transparency)

Directive 2000/60/EC – Water Framework Directive (WFD). Most important articles:

- **Art. 3 – Definition of river basins and authorities**
- **Art. 4 – Environmental objectives** (often cited when reconciling flood protection measures with environmental requirements)
- **Art. 5 – Analysis of river basin characteristics, the impact of human activities on the environment and economic analysis of water use**
- **Art. 11 – Program of measures** (link between RBMP and FRMP)
- **Art. 13 – River basin management plans (RBMP)**
- **Art. 14 – Public participation**

Directive 2007/2/EC – INSPIRE. Most frequently cited articles:

- **Art. 4–6 – Creation and use of spatial data sets**
- **Art. 11 – Network services** (view, download services)
- **Art. 17 – Data access and sharing** (mainly used in flood maps, WMS/WFS services and GIS platforms)

Directive 2011/92/EU – EIA. Key articles:

- **Art. 2 – Obligation to assess projects likely to have significant effects**
- **Art. 4 – Screening** (assessment of whether an EIA is required)
- **Art. 5 – Content of the EIA report** (includes flood risk and climatic factors)
- **Annex I and II** – Infrastructure and hydro-technical projects

Directive 2001/42/EC – SEA. Most cited:

- **Art. 3 – When is SEA mandatory** (plans and programs)
- **Art. 5 – Environmental report**
- **Art. 6 – Consultations with the public and institutions**

Often applied to **FRMP, RBMP, regional and municipal plans**

Decision No 1313/2013/EU – Civil Protection Mechanism (UCPM). Most frequently used articles:

- **Art. 5 – Risk assessment at national level**
- **Art. 6 – Prevention and preparedness**

The latter articles are cited in **disaster risk management** strategies, early warning and coordination. Frequently cited "soft" acts that are not legally binding but are widely used (guidance, not directives):

- CIS Guidance on Flood Risk Management Plans
- Floods Directive Reporting Guidance (EC)
- EC Staff Working Documents (SWD) – assessments of national plans
- WISE Reporting Schemas

As an example, we present below a ready-made template / list for citing and structuring documents at the municipal level that can be used directly in:

- municipal flood risk management plan,
- municipal strategy/program,
- EIA/SEA,
- project proposal under programs or funds (POS, LIFE, Interreg, NLF).

The template is consistent with the most frequently required articles and with the practice of the Ministry of Environment and Water and the European Commission.

TEMPLATE

Legal and strategic framework for flood risk management (municipal level)

1. European legal framework

1.1 Directive 2007/60/EC on the assessment and management of flood risks

This document has been developed in accordance with the provisions of:

- **Art. 4** – preliminary assessment of flood risk, taking into account available data and identified areas with significant potential risk;
- **Art. 6** – use of flood hazard and risk maps for different probabilities of occurrence;
- **Art. 7** – measures set out in the current Flood Risk Management Plans (FRMPs) of the relevant river basin;
- **Art. 9** – coordination with the objectives and measures under the Water Framework Directive;
- **Art. 10** – ensuring public awareness and participation.

1.2 Directive 2000/60/EC – Water Framework Directive

The document complies with:

- **Art. 3** – river basin management and competent authorities;
- **Art. 4** – environmental objectives for surface and groundwater;
- **Art. 11** – program of measures;
- **Art. 13 and Art. 14** – River basin management plans and public participation.

2. Spatial data and mapping

Directive 2007/2/EC (INSPIRE)

The cartographic and analytical information has been prepared in accordance with:

- **Art. 4–6** – use of harmonised spatial data;
- **Art. 11** – network services for data access and visualization.

Official flood hazard and risk maps provided by the competent national authorities were used.

3. Impact assessment and planning

3.1 Directive 2001/42/EC – Strategic Environmental Assessment (SEA)

In developing this document, the requirements of:

- **Art. 3** – applicability of SEA to plans and programs;
- **Art. 5 and Art. 6** – preparation of an environmental report and consultations.

3.2 Directive 2011/92/EU – Environmental Impact Assessment (EIA)

When planning specific investment measures (dykes, river bed adjustments, infrastructure), the following apply:

- **Art. 2 and Art. 4** – obligation for EIA and assessment procedure;
- **Annex I and II** – hydro-technical and infrastructure projects.

4. Disaster Risk Management and Preparedness

Decision No 1313/2013/EU – Union Civil Protection Mechanism

The municipal measures are in line with:

- **Art. 5** – risk assessment;
- **Art. 6** – prevention and preparedness for disaster response, including floods.

5. National and regional coherence

This document complies with:

- the current **Flood Risk Management Plan** for the relevant river basin management area;
- River basin management plans;
- national legislation in the field of water, disasters and spatial planning.

III. FLOODING RISK ASSESSMENT IN THE RUSENSKI LOM RIVER BASIN, within the scope of the Municipality of Ruse - "City Laboratory" - Rusenski Lom

As mentioned above, the most important and frequently cited European acts and legal bases when it comes to **flood risk assessment and management** in municipal reports, plans, projects, EIAs, and strategies are presented in detail.

Within the framework of the European project NBSINFRA, under the HORIZON 2020 Program, ASDE-ECOREGIONS, together with the Municipality of Ruse and other partners, have identified the Rusenski Lom River region as a pilot region for the implementation of innovative applications for the prevention of the risk of natural and other disasters; so-called nature-based solutions (Nature-Based Solutions-NBS), such as green zones and restoration of riverbeds. In this case – prevention of flood risk and the condition of critical infrastructure. The package of applications includes both monitoring of vulnerable areas, based on integrated processing of satellite and ground data, simplified simulation models of probable floods and damage in vulnerable territories, and the introduction of a ground-based system of sensors monitoring the level of the river flow and the climate situation. Special simulation models have been developed, on the one hand, based on consultations with end users who want simplified solutions, and on the other hand, they are also related to important infrastructure initiatives that show potential flooding areas and serve as a basis for better planning, for example, including for the future highway, along international corridor 9 - Ruse-Byala-Veliko Tarnovo. In parallel with the monitoring systems, legal changes are also proposed, for example - measures to prohibit construction in riverbeds and limit construction in flood zones, requiring changes to the Water Act and the Spatial Planning Act.

III-A. ACWA ground sensor system - Fig.1. The ground sensor system - ACWA, is a development of the company Next Lab Ltd. The ACWA 3.0 system provides users with information about the current state of river levels (in real time), accumulated statistics and historical data on floods where the stations are installed. The result is presented through visualization of tables, graphic and geographic visualization on the screen, printing on paper and exporting data in Excel and CSV format. The system allows maintaining and providing specialized and public reports based on the collected, processed and verified information; maintaining reports on all changes in parameters with information about the operator, date and time of changes, receives data in real time, processes and archives them for providing information to all authorized users of the system, etc. At this stage, only a few sensors have been installed in the lower reaches of the Rusenski Lom River and after a one-year monitoring period, their effectiveness and the need to expand the monitored sections of the riverbed will be assessed. Regarding the system of ground sensors - ACWA, along the Rusenski Lom River, more information can be obtained on the website of the Ruse Municipality:

<https://obshtinaruse.bg/nbsinfra-citynature-based-solutions-integration-to-local-urban-infrastructure-protection-for-a-climate-resilient-society>

Network storage Asustor AS3302T, 2 bay NAS, Realtek RTD1296, Quad-Core, 1.4GHz, 2GB DDR4(not ex.), 2.5GbE x1, USB3.2 Gen1 x3, WOW (Wake on WAN), Ttoolless installation, with hot-swappable tray, hardware encryption, MyArchive, EZ connect, EZ Sync, WoL, Syst



Fig. 1. Ruse City Laboratory - Pilot Site B - Rusenski Lom – B1 - current status - Ruse Municipality is building a sensor system (green drop sign) for ACWA early warning of flood hazards, including 24/7 monitoring of on-site data. Image source, Map data ©2025 Google. See website: <https://ruse.acwa.app/mapWidget>

III-B. The ASDE-ECOREGIONS team is mainly engaged in preparing a package of simulation models along the Rusenski Lom river basin, as well as possible damages to critical infrastructure, urbanized, agricultural and natural territories. As mentioned above, the innovative applications were developed within the framework of the project **NBSINFRA– 101121210 “Nature-Based solutions (NBS) to safeguard critical urban infrastructure against both natural and human-induced hazards”,** under the European Program HORIZON 2020. The development was carried out with the kind assistance of the Municipality of Ruse – Directorate “Economy, Investments, International Cooperation and Projects”, local and external experts. The example presented below is related to the vulnerability assessment for the section of the Rusenski Lom river basin, which is limited within the Municipality of Ruse.

In the course of the work, it was established that due to the influence of climate change, in parallel with the assessment of the risk of floods, it is necessary to carry out regular monitoring of trends in the state of water bodies, such as lakes, dams, reservoirs, etc. in order to carry out proactive work on providing drinking and other water for the needs of citizens, industry, agriculture, tourism. More information on this issue is given in Fig. 11

EXAMPLE - FLOODING VULNERABILITY ASSESSMENT MAP - RUSENSKI LOM RIVER FOR URBANIZED AREAS IN RUSE MUNICIPALITY

(developed within the framework of the NBSINFRAS project under the European HORIZON 2020 Program)

As a basis for developing the relevant applications, the AURE-ECOREGIONS team takes into account the adopted General Development Plan of the Municipality of Ruse, as the main legal document for territorial management. For risk prevention applications, the so-called development/functional zones are used.

Preliminary information from the General Development Plan of Ruse Municipality: The main types of functional (or development) zones in the General Development Plan (GDP or Master Plan) of Ruse Municipality are 8. They are:

- o **Residential areas** - with subcategories:
 - Rl — low-rise development; Rm — mid-rise building; Rh — high-rise building; Rc — complex development - [Ruse Municipality](#)
- o **Production areas — with subtypes:**
 - Mostly a production area (Pm); Pure production area (Pp)
- o **Mixed multifunctional areas** - with subtypes: Mmf, Mmf 1, Mmf 2
- o **Public service areas** — e.g. "Ps" and "C" (mixed central zone)
- o **Recreational areas** — e.g. villa areas Rv, holiday, resort areas, etc. (recreation / rest areas)
- o **Sports and attractions areas** — sports areas, coastal areas, attractions, etc. (Sa)
- o **Green systems / landscaping** — greening areas, areas for cemetery parks and green areas, green systems (G,T)
- o **Nature conservation areas and protected areas** — areas covering protected areas, natural areas, areas with ecological/protection regime, etc. (N)

Note: MUNICIPALITY OF RUSE - total area 570,624 km2; according to the website of the Municipality of Ruse - <https://obshtinaruse.bg/obsht-gradoustroystven-plan>

Other functional (or development) zones have been introduced separately, but they refer to non-urbanized territories, such as - "Agricultural" and "Forest territories (AT, FT), or territories with special purposes - "Special regime zones" (SZ) or "Transport and engineering infrastructure zones" (T, I).

Flood vulnerability monitoring is mainly focused on the Rusenski Lom River and the urbanized areas of the Ruse Municipality, because other types of territories - natural environment and agricultural areas - require other monitoring methods. In addition, urban development zones are of fundamental importance for protecting the quality of habitation, the necessary standard of infrastructure, the health status of citizens, as well as providing a basic factor for risk prevention.

Within the framework of the NBSINFRA project, an analysis of the vulnerable areas along the Rusenski Lom River was carried out, within that part of the catchment area that is covered by the borders of the Ruse Municipality. Of course, in order to obtain objective and useful results, it is necessary to examine the entire river system of the Rusenski Lom River – Fig. 1-1, by preparing flood models for other vulnerable areas. This has been done and two information arrays can be used – one is a package of simplified simulation models on the Bulgarian Spatial Data Infrastructure page, presented in Fig. 1-2:

https://bsdi.asde-bg.org/floods.php?vodosbori=rusenski_lom; the second is on the Danube Basin Directorate website, Fig. 2. - <https://www.bd-dunav.bg/>

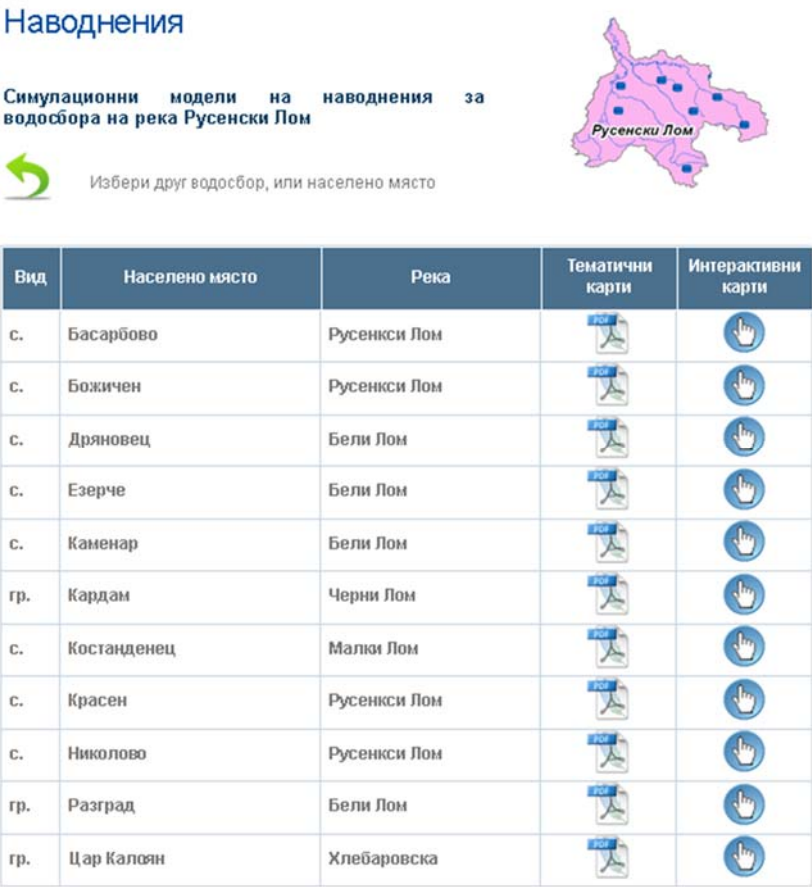


Fig.1-1 Watershed (river system) of the Rusenski Lom River and a package of simulation models – Fig. 1-2, of floods in selected vulnerable areas, according to the Internet portal – Bulgarian Spatial Data Infrastructure - https://bsdi.asde-bq.org/floods.php?vodosbori=rusenski_lom

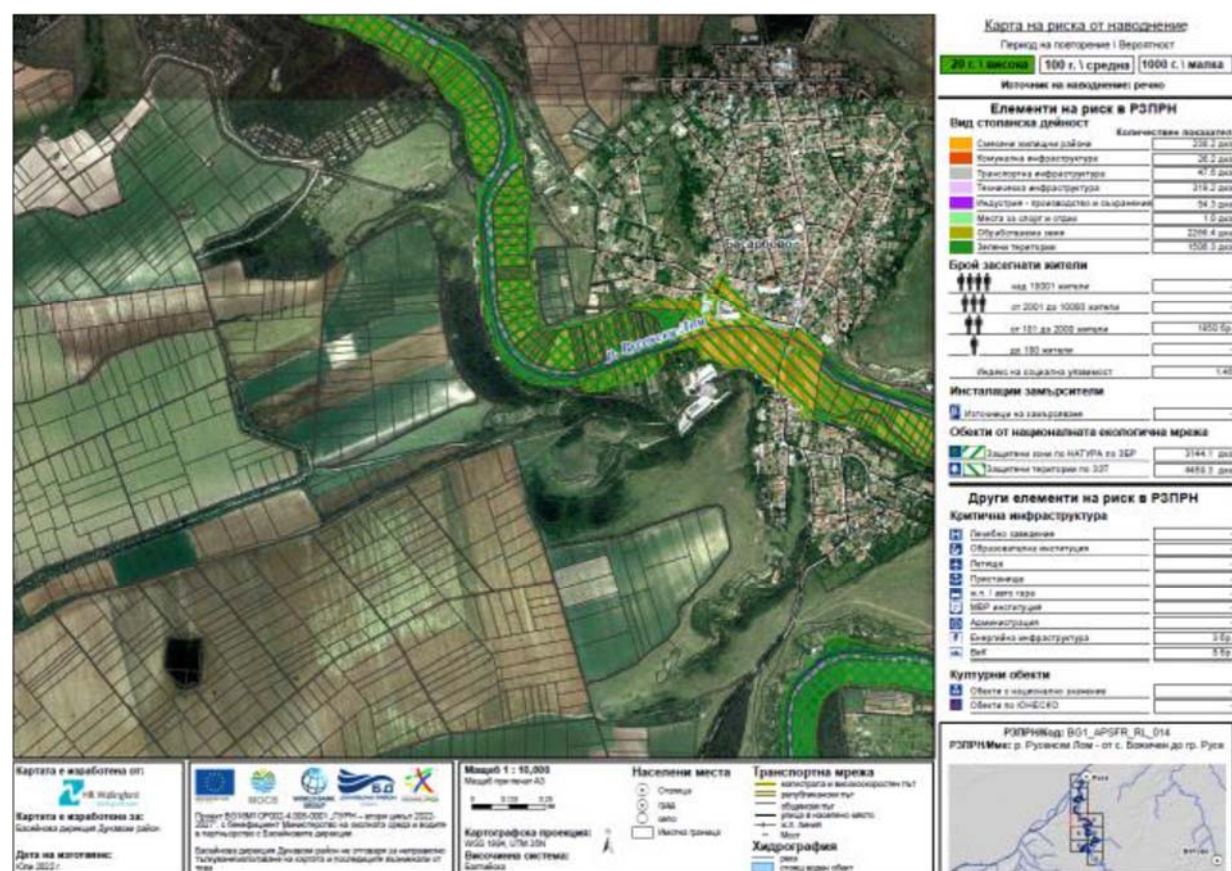




Fig. 4. Map of vulnerable territories and main elements of critical infrastructure for the city of Ruse and an imposed flood model with a periodicity of 1000 years, according to data from the National Institute of Hydrology and Hydrology

Fig. 5, 6 and 7 present thematic maps of potentially flood-affected territories and critical infrastructure, including the coastal zone of the Danube River. We note the need for joint discussion with municipal specialists of the presented information, with the aim of preventive measures.

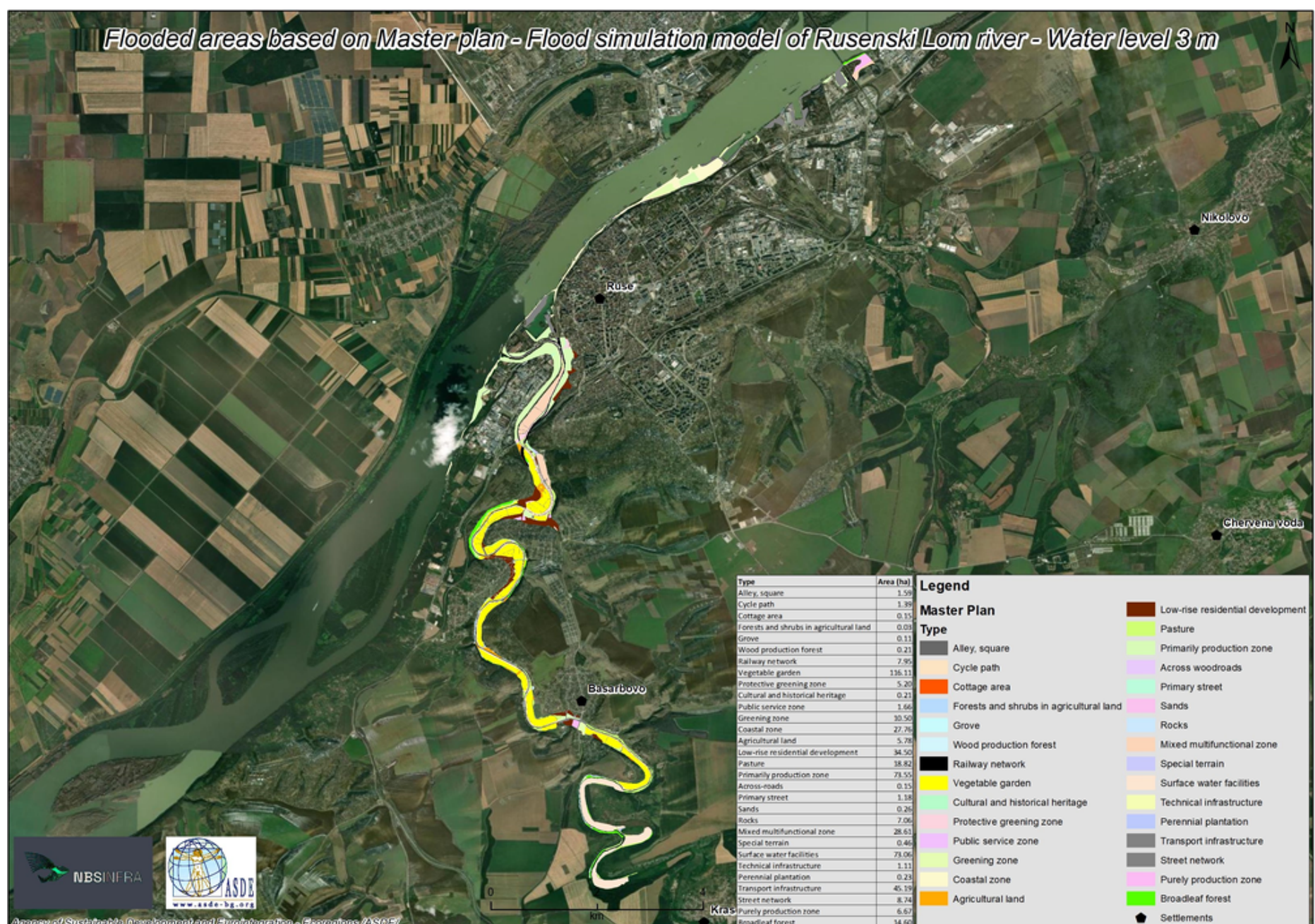


Fig.5. Potentially flooded areas in the event of a flood of 3m water column along the thalweg of the Rusenski Lom River. A table with potentially vulnerable areas is also included. The simulation model is within the boundaries of the Ruse Municipality. Additionally, the Bulgarian bank of the Danube River is included. Underlying image, Map data ©2025 Google.

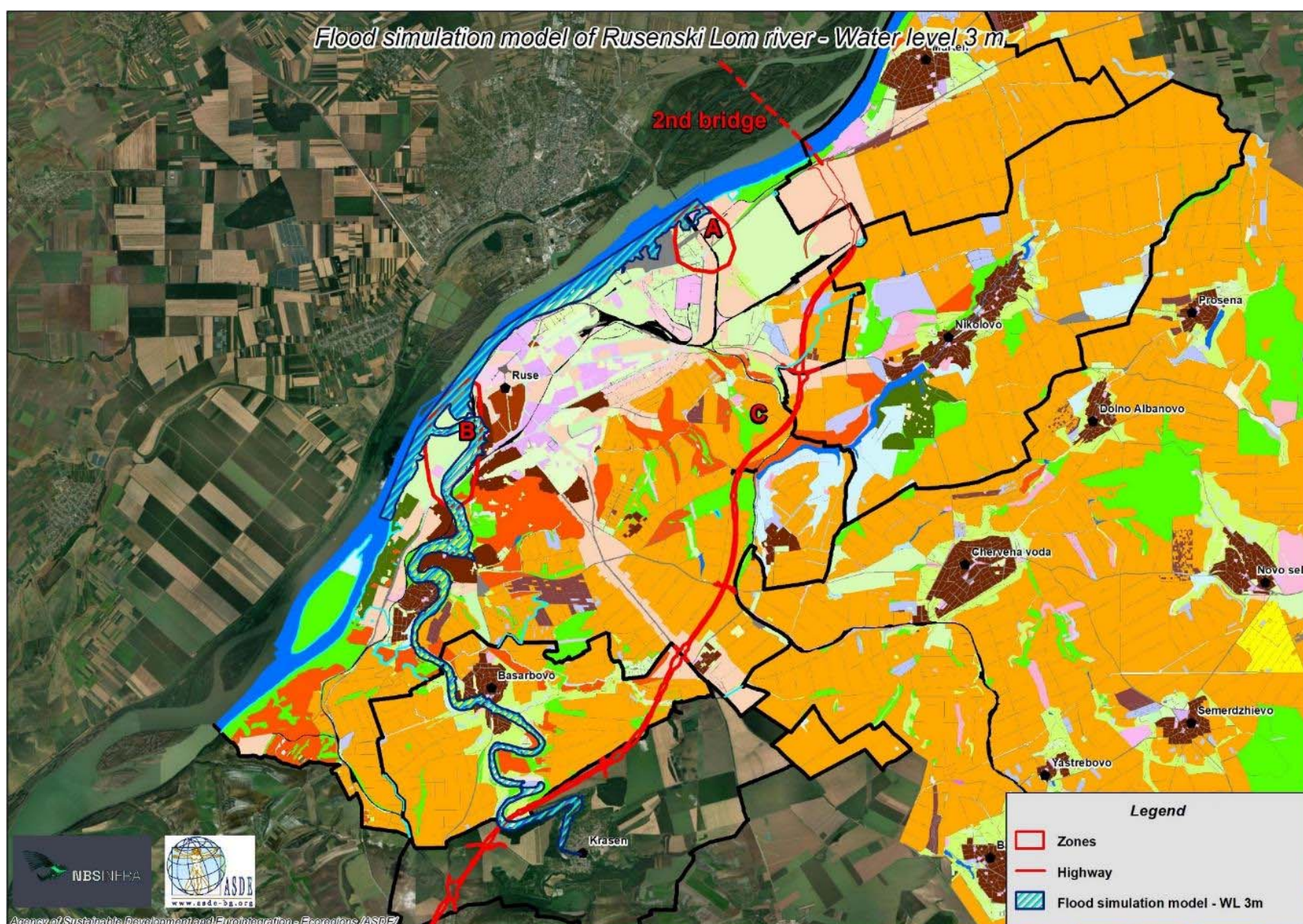


Fig.6. Thematic map of floodplains along the Rusenski Lom River, plotted on a base plan of the territory of the Municipality of Ruse. Base image, Map data ©2025 Google.

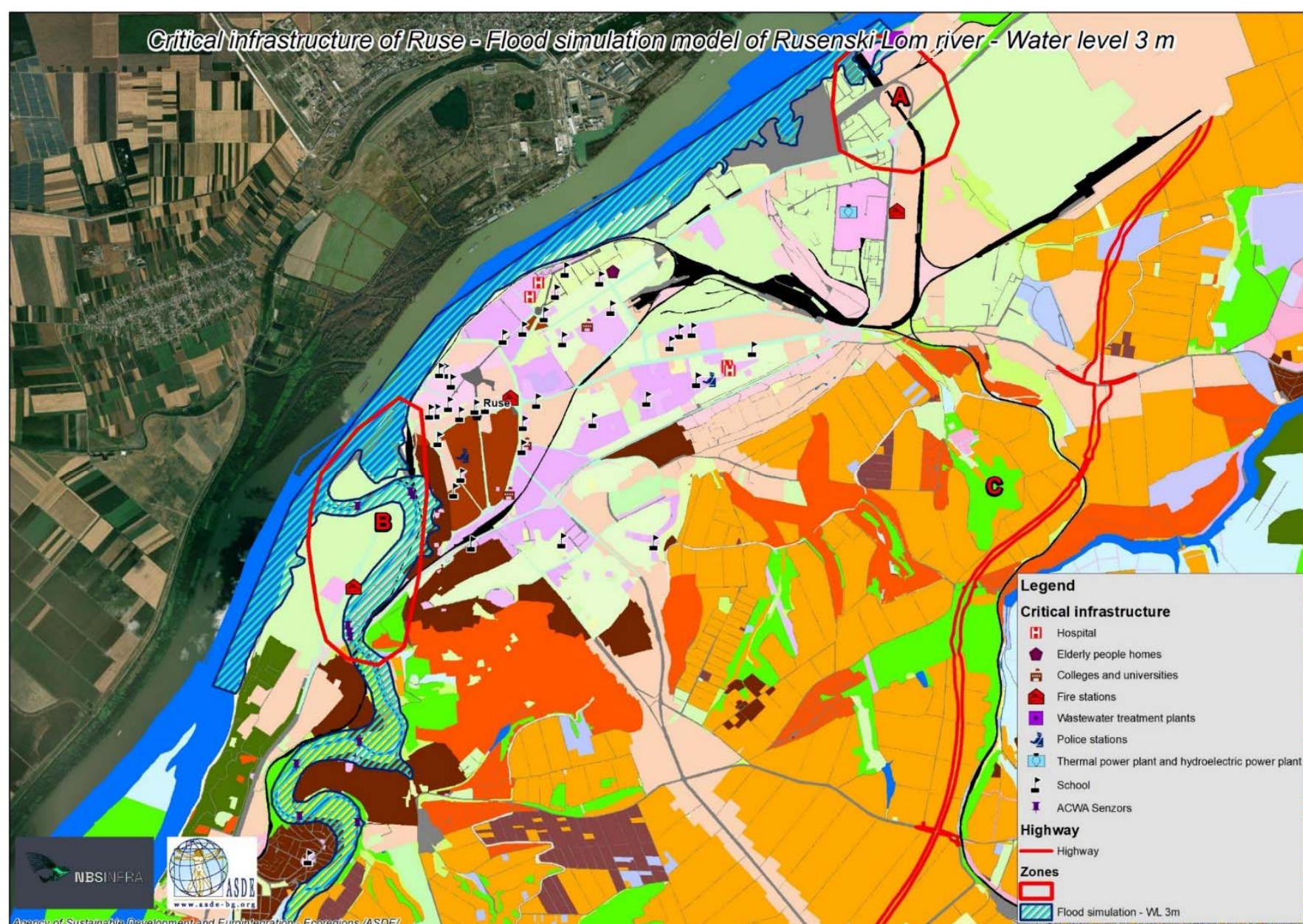


Fig.7. Thematic map of potentially affected critical infrastructure in the lower reaches of the Rusenski Lom River, with an expected flood of 3m column along the river's thalweg. The simulation model is plotted on a base plan and critical infrastructure of the Municipality of Ruse. Underlying image, Map data ©2025 Google.

IV. GIS ANALYSIS

The GIS analyses include an algorithm using partial artificial intelligence and based on data from the COPERNICUS Programme (EGMS) and local data. Data from the European Ground Motion Service, as part of the Copernicus Land Monitoring Service of the European Environment Agency, were used. The limited resources of the NBSINFRA project do not allow for a more detailed study of the state of the development zones under the Ruse Municipality Master Plan, but the AUREIEKOREGIONS team, with the assistance

of external experts, conducted additional studies for some areas in the urbanized part of the city of Ruse, where there are worrying trends for potential vulnerability to flooding.

It is necessary to hold a discussion with specialists and representatives of various structures in the field of urban construction, infrastructure, civil and fire protection, in order to assess what preventive measures are necessary, to establish more regular monitoring and in what form.

Important preliminary note: The maps and data presented are an intermediate stage of development and should not be considered as a final product. In addition to completing the analysis of the satellite data, coordination with on-site data should be carried out, as well as discussions with experts from the capital administration in order to identify possible errors or possible other interpretations, as well as possible explanations for the changes that have occurred and trends noted.

V. INPUT DATA FROM THE SENTINEL SATELLITE CONSTELLATION PROVIDED UNDER THE EC'S COPERNICUS PROGRAMME

The current maps are the result of implementing the mechanism of regular monitoring of changes - CbM (Change by Monitoring), in accordance with the best European and global practice. Data from the SENTINEL satellite constellation, under the European COPERNICUS Program, were used. The analysis is combined - human expert analysis, with the application of artificial intelligence algorithms. Data from the radar and optical sensors of SENTINEL-2 satellites and products from the Copernicus Land Monitoring Service of the European Environment Agency for the period 2017-2023 were analyzed, including with regard to the state of water bodies in the Municipality of Ruse (with data from the Global Surface Water Explorer). The results show relatively good maintenance of the riverbank of the Rusenski Lom River and the coastal zone of the city of Ruse along the Danube River, including the construction of reinforcing concrete walls and platforms along the coastal promenade; vulnerabilities are mainly noted along riverbank dikes - after walking on site, rare areas of partial seepage should be noted. It is necessary to note that the banks of the urbanized territories of the Municipality of Ruse in the lower reaches of the Rusenski Lom River are well maintained, including a cleaned riverbed.

As a result of the ongoing climate change, permanent trends towards a decrease in water quantities should be noted along the Rusenski Lom River. Such an example of a detailed analysis of the dynamics of water in a certain section of the Rusenski Lom River for a certain period - 1984-2021 is presented in Fig. 8. The right image shows the loss of water quantities for the period 1984 - 2021. The section includes an area that is described as the "Sandzhaka" eco-park, but in crisis situations it can also be a group of retention volumes.

The extent of surface waters, as established by the time series of the product "CLC+Backbone" of the Copernicus Land Area Monitoring Service - Fig. 9. The analysis of the data from satellite images shows a decrease in the total area of water bodies (standing and floating) in the municipality of Ruse by 9 ha (for the period 2018-2023).

This is one of the main indices of sustainability, primarily for the protection of critical infrastructure, constructed buildings and facilities. Of course, it is also necessary to maintain the so-called "retention volumes", which can absorb suddenly invading water masses. In this regard, we have made an assessment of two possible volumes for accumulating additional water quantities during heavy rainfall - 394'326 m³ and 687'748 m³, presented in Fig. 10. Of course, the values are approximate, and on the other hand, it is important to keep these territories clean from unregulated landfills, siltation, as well as to provide sluices for the inflow and outflow of water quantities. For compliance with the adopted legal forms of management, the analyses were made on the basis of the adopted development/functional zones under the General Development Plan of the Municipality of Ruse.

The development is related to applied projects of AURE-ECOREGIONS, implemented under the PECS Program of the European Space Agency, as well as under the European Program HORIZON 2020 - "HARMONIA". Partners in these developments are specialists from the Municipality of Ruse.



Excerpt from the GDP of Ruse Municipality - part of the Rusenski Lom River

Loss of water quantities for the period 1984-2021

Fig.8. Example of a detailed analysis of water dynamics in a certain section of the Rusenski Lom River, for a certain period – 1984-2021. The right image shows the loss of water quantities, for the period 1984 – 2021. The section includes the so-called "Sandzhaka" eco-park or retention volumes. Underlying image, Map data ©2025 Google.

The data used can be extracted from the database - Global Surface Water Explorer <https://global-surface-water.appspot.com>



Fig.9. Surface water extent as determined from the time series of the CLCplus Backbone product as part of the Copernicus Land Monitoring Service, <https://land.copernicus.eu/en/products/clc-backbone>. The analysis of data from satellite images shows a decrease in the total area of water bodies (standing and floating) in the municipality of Ruse by 9 ha (for the period 2018-2023. Underlying image, Map data ©2025 Google.

Possibility for analysis of the capacity of the drainage fields along the Rusenski Lom River

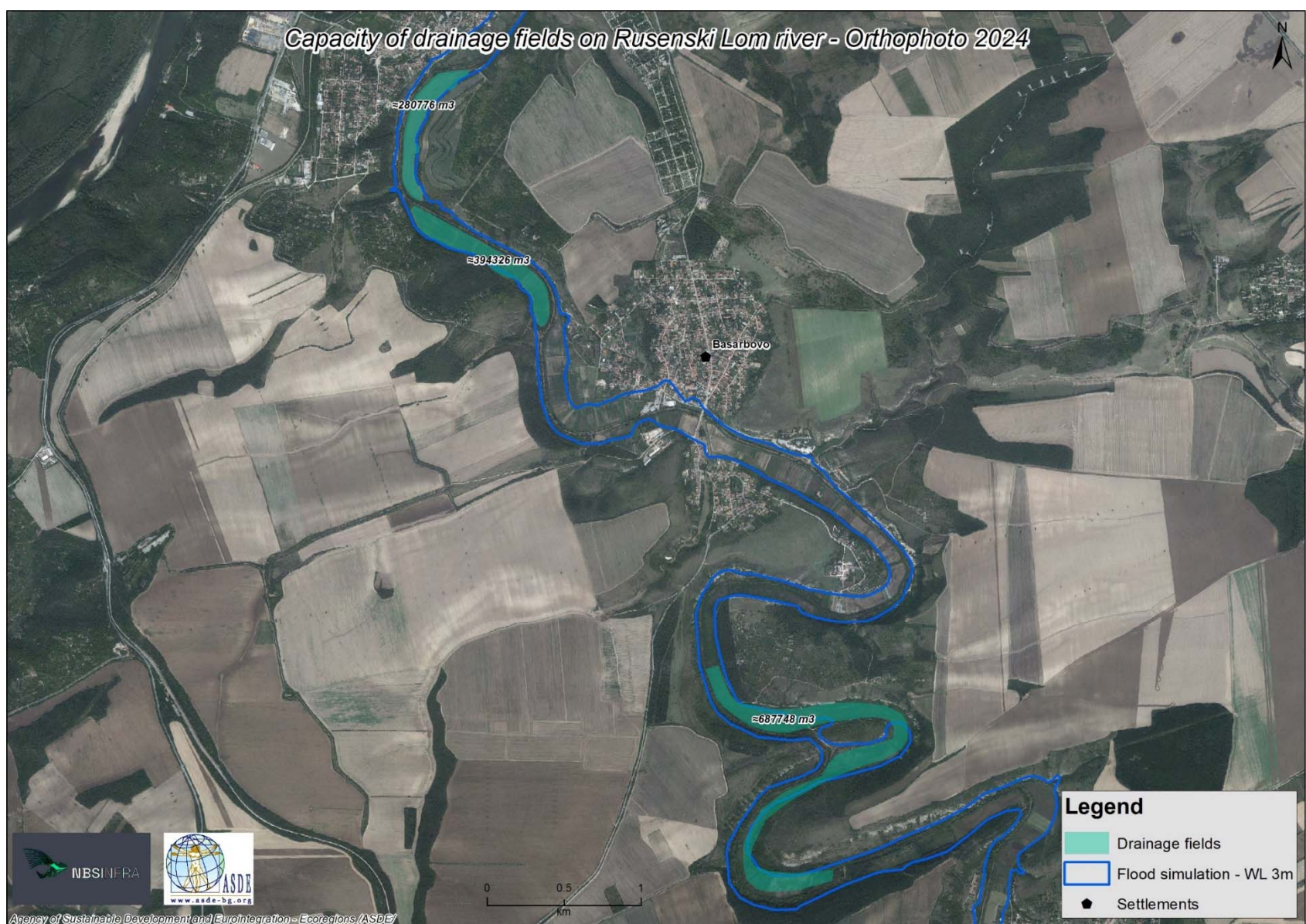


Fig. 10. Estimation of retention volumes along the Rusenski Lom River. Base image, Map data ©2025 Google.

Fig. 10 presents an example of an assessment of the retention (retaining additional water quantities) volumes in a part of the Rusenski Lom riverbed - near the village of Basarbovo. An assessment has been made of two possible volumes for accumulating additional water quantities during heavy rainfall – 394'326 m³ and 687'748 m³. Of course, the values are approximate.

The flood simulation model corresponds to a water column of 3 m along the riverbed.

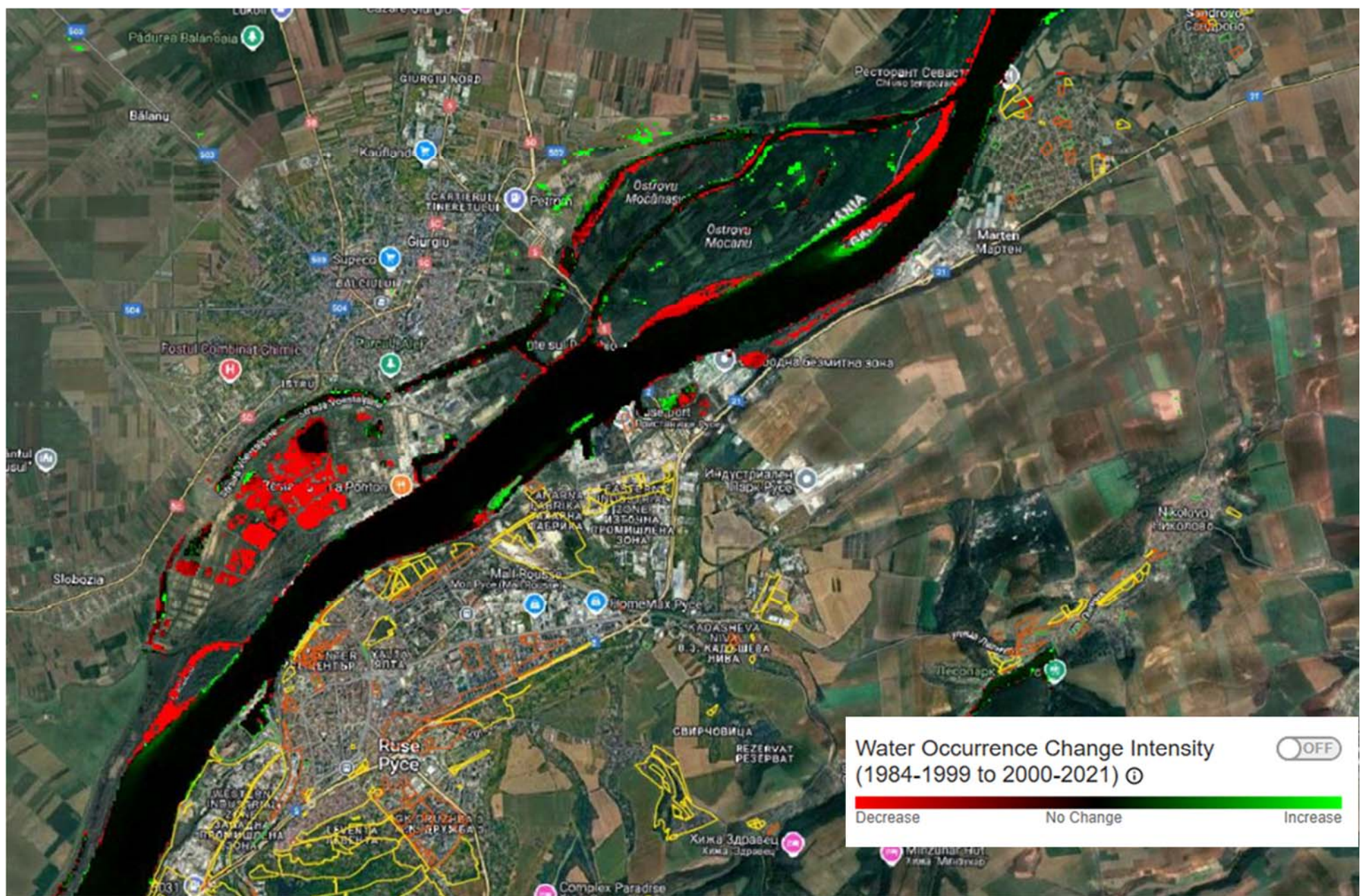


Fig.11. Monitoring of water surface dynamics for the Municipality of Ruse for the period 2000-2021. Source: <https://global-surface-ter.appspot.com>. Underlying image, Map data ©2025 Google.

VI. INPUT DATA FROM SITE AND ADOPTED ALGORITHMS

The main source of information on the type of development/functional zones is the Territorial Planning Act (TPA), REGULATION 7 on rules and regulations for the development of individual types of territories and development zones, and the general development plan (GDP) of the respective municipality. The ASDE-ECOREGIONS team has worked on the trends in flooding for urbanized development zones, using data from the published GDPs presented on the website of the Municipality of Ruse:

<https://obshtinaruse.bg/obsht-ustroystven-plan-na-gr-ruse-2020>

Unfortunately, we did not find information on the number, individual and total area of the relevant development zones, according to the table of development regimes and the rules and norms of the individual types of territories (under REGULATION 7 of 22.12.2003). This makes it difficult to make a comparison with the areas, according to the relevant data from the SENTINEL satellite constellation and products from the Copernicus Territory Monitoring Services. For the needs of the analysis related to the Municipality of Ruse, an algorithm was prepared, combining the expert work of the expert with the help of artificial intelligence. The number of development zones and their individual and total area were derived through this algorithm. In our opinion, the data needs to be checked and agreed upon by the experts from the Municipality of Ruse, in order to ensure relevance and reliability. This is also necessary due to the operational work of the planning mechanisms of the Ruse Municipality, responsible for territorial development, planning and building permits, where relevant updates and changes are made, as long as they are subject to the law and the adopted rules and regulations.

VII. INCLUSION OF THE POTENTIAL OF ARTIFICIAL INTELLIGENCE IN THE DEVELOPMENT OF DATA ANALYSIS ALGORITHMS

In its developments, ASDE uses methods for the standardization of in situ data, according to the principles of the ISO 19178 standard. This is crucial for increasing the effectiveness of AI-based land monitoring systems that use remote sensing (RS) data. By providing a consistent framework for data collection, integration and interpretation, ASDE solutions aim to facilitate reliable correlation between in situ measurements and remote sensing data. This synergy enables more accurate environmental assessments, improved land use planning and timely detection of changes in urban areas and in contact areas with other land uses. This ultimately leads to better and more informed decisions in the field of sustainability and resource management. Through data standardization, ASDE contributes to the fact that different data sources can be seamlessly integrated, maximizing the potential of AI technologies in the monitoring and analysis of land dynamics.

VIII. CONCLUSIONS

Some of the **basic principles for territorial development**, enshrined in the General Development Plan of the Municipality of Ruse (GDP-Ruse), as well as general principles of spatial planning that the plan follows, are:

- **Sustainable and integrated development** - The plan is a strategic document that sets the guidelines for the social, economic and spatial development of the municipality, in order to ensure balanced growth, sustainability and high quality of the environment and living standards;
- **Clear territorial definition and zoning according to purpose** - The territory is divided into zonal categories - residential, mixed, industrial, public service areas, green systems, etc. This allows for a clear definition of the functions and regulations of each zone;
- **Compliance with legislation and regulations** - The Ruse Master Plan is implemented in accordance with national laws (e.g. the Territorial Planning Act), as well as with additional rules/norms for spatial planning, which specify permissible parameters of development, purpose, protection, etc.;
- **Protection and integration of the natural environment and green systems** - The plan provides for zones for green systems, recreation and nature conservation areas, as well as regulations aimed at preserving natural, ecological and landscape qualities;
- **Flexibility and opportunities for gradual regulation and development** - The Master Plan sets strategic guidelines, but the implementation of development measures is carried out through Detailed Development Plans (DDP), which allows for phased and tailored development;
- **Preservation and integration of historical and cultural heritage** - Planning provides for special regimes for territories with cultural and historical value, in order to protect them during new development and construction
- **Publicity, transparency and an orderly administrative process** - Through zoning, regulations and development rules, predictability and transparency are guaranteed in investments, regulation, privatization and control over the territory.

In this regard, as well as a result of the analyses of trends in potential flood risk, the following conclusions can be drawn:

- **The flood risk monitoring application for urban areas promotes urban resilience and risk prevention through integrated decision support systems (DSS) and advanced modeling tools;**
- **The results are objective as independent satellite segment data are used, combined with local environmental data and local geospatial data to monitor trends in urban green spaces and monitor compliance with local regulations;**
- **Most functional areas have maintained their resilience;**
- **However, parts of important urban planning zones may fall into flood-prone areas, especially in certain parts of the wider city center of Ruse;**
- **Monitoring of trends in surface water status is needed;**
- **Further review by local experts and general discussion is needed as some of the observed trends could be due to: unpublished zoning changes, updates to parcel plans and noise in the processing of satellite data.**

IX. NATIONAL MANDATORY REGULATORY REQUIREMENTS

As stated in Article 2 of the Territorial Planning Act (TPA), it "regulates public relations related to territorial development, investment design and construction in the Republic of Bulgaria, and determines the restrictions on ownership for development purposes" -

<https://www.mrrb.bg/bg/zakon-za-ustrojstvo-na-teritoriyata-84665/>. In turn, each municipality is obliged to develop, approve and comply with the so-called General Development Plan (TDP) / Master Plan, which should be the basis for municipal development for a long period of time - an average of 15-20 years. Of course, during this period, necessary changes may occur in the indicators and content of certain territories and development zones, but this should be done in accordance with the relevant legal order. Therefore, it is necessary to regularly monitor compliance with the municipal development plan, as well as the relevant indicators for sustainability of each of the development/functional zones.

These indicators are determined by both the TPA and the accompanying Regulation 7 on rules and regulations for the development of individual types of territories and development zones. - <https://www.mrrb.bg/static/media/ups/articles/attachments/>

The proposed innovative application for simplified simulation models of floods in vulnerable areas along the Rusenski Lom River, especially for urbanized functional/development zones, is a necessary tool for national and local administration, in order to ensure objective control and preventive measures on changes and trends in preventing the risk of vulnerability and destruction of critical infrastructure, buildings and facilities and protecting human health and life. In addition, anticipatory measures for vulnerable territories reduce financial, resource damage and human casualties.

In the municipal ordinance that determines the indicators of development zones, we propose to include indicators for flood vulnerability, but other important indicators can also be included, for example - percentage of built-up area, percentage of sealed area, etc.

LEGAL BASIS—DEVELOPMENTAL ZONES, according to REGULATION 7 of December 22, 2003 on rules and regulations for the development of individual types of territories and development zones. The indicators in the corresponding table from the Ruse Municipality's Master Plan are presented at the following internet address:

<https://obshtinaruse.bg/obsht-ustroystven-plan-na-gr-ruse-2020>

POSSIBLE DISCUSSION ON FORECASTS AND OFFERS FOR REGULAR MONITORING AND SUPPORT BY ASDE-ECOREGIONS:

1. Following the market behavior of users of a particular product, they would probably be most interested in getting a product at extremely low shipping prices and, if possible, without subsequent data maintenance fees. We are ready to have a free trial period. It is possible to discuss a high one-time license price with a longer validity period, for example 3 or 5 years with free maintenance. More subscription options should be provided, similar to mobile operators. Higher interest can only be caused by a proven and obvious superiority of the platform over the competitors.
2. Of interest would be the option for self-maintenance and updating of the data and the possibility of integration, transfer (migration) or at least one-way data exchange with an existing GIS, if this is considered possible. The interest of the municipalities is related to the provision of a free version for at least one year, possible reduction/optimization of the costs of mandatory insurance for non-threatened sites (those outside the risk zones), with possibilities for relevant amendments to the applicable laws and regulations.
3. This application supports REGULATION (EU) 2024/1991 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 June 2024 on nature restoration.
4. Other innovative applications are also under development, such as the implementation of “municipal risk prevention vouchers” (subject of another study).

X. EUROPEAN REGULATION

European regulations and directives are listed in item I. The main issue is the lack of a relevant regulation for monitoring the territory, including control over risk prevention and shifting the burden not to financing restoration works after the respective disaster, but to preventive measures that increase the resilience of society, the economy, infrastructure, and the natural environment.

EU Cohesion Policy and the European Structural and Investment Funds (ESIF) promote integrated, sustainable urban development through strategic planning, such as Urban Development Plans (UDPs) or Green Space Plans (GSPs). For Bulgaria, these correspond to the General Development Plans (GDPs). Key frameworks include:

- **Regulation (EU) 2021/1060** - sets out general provisions for the ESIF for the period 2021-2027 and includes requirements for integrated territorial development, which may include the Urban Development Plans.
- **Objective 5.1 of the Cohesion Policy** - promotes the integrated and sustainable social, economic and environmental development of urban areas, which may include strategic planning requirements, such as the Urban Development Plan.
- **European Urban Initiative (EUI)** – supports innovation and sustainable urban development by encouraging local authorities to develop integrated strategies that may include UDP.

Although no EU directive obliges the SDP to finance, strategic planning is strongly emphasized. In Bulgaria, the National Spatial Planning Act (NSPA) requires municipalities to adopt a UDP as part of the national legal framework. Each plan and its implementation need regular monitoring of the implementation and compliance with basic and accepted parameters for sustainable development and risk prevention.

It is logical that this monitoring is carried out by a relevant independent team of specialists based on objective data from European sources, such as the COPERNICUS Program and accepted standards, such as ISO 19144.

We are ready to share our experience and knowledge, which have been improved in continuous contact with European structures that provide independent, evidence-based knowledge and science, supporting EU policies for a positive impact on society.

ASDE-ECOREGIONS TEAM AND PARTNERS / 1998-2025