Hungary Slovakia Romania Ukraine

Common Development of Volunteer Disaster Intervention Capability

PARTNERSHIP
WITHOUT BORDERS

CODE VDIC (HUSKROUA/1702/8.1/0035)

Output 1.2.
Summary Report on Situation Analysis

2020

EUROPEAN UNION

Introduction

The Summary Report on Situation Analysis contains two chapters; the first chapter "Situation analysis and experiences" contains data about the organizations involved in project, their structure in disaster response, specific responsibilities in disaster management/response, organization's operability area, equipment/assets used in disaster management/response, former activities concerning the area of disaster response and prevention, volunteer intervention experiences of the past years and their cooperation with other national and international organizations/institutions in the field of disaster response/management, as well.

The second chapter includes information regarding hazards, vulnerability, exposure and risk. The flood hazard and risk in the project implementation area were also analyzed in detail in chapter II, including hazard maps in GIS shapefile format.

A survey regarding the forest fires hazard - forest fires in Romania, Hungary, Slovakia and Ukraine - was done also in chapter II in order to assess the fire risk in the project implementation area.

Content

CHAPTER I. SITUATION ANALYSIS AND EXPERIENCES

1. Organisation

Zemplén Region Civil Protection and Disaster Management Association

Type: non-governmental organization

Location of headquarters: Hungary, 3980 Sátoraljaújhely, Kossuth Square 5.

Number of employees: 3

Number of volunteers: 35

Volunteer Firefighters Association Pálháza

Type: non-governmental organization

Location of headquarters: 3994 Pálháza, Malom köz 1.

Number of employees: 4

Number of volunteers: 40

***Municipality Kráľovský Chlmec*:**

Short general description: Kráľovský Chlmec until 1948 Kráľovský Chlumec, Hungarian: Királyhelmec) is a town in the Trebišov District in the Košice Region of south-eastern Slovakia. It has a population of around 8,000 inhabitants. Kráľovský Chlmec lies at an altitude of 130 metres (427 ft) above sea level and covers an area of 23.08 square kilometers (8.9 km2).[3] It is located in the southern part of the Eastern Slovak Lowland, only around 5 kilometers (3 mi) north of Hungarian and 12 kilometers (7 mi) west of Ukrainian border. The regional capital Košice is 90 kilometers (56 mi) away.

Type (local government,): LGO/municipality local government, town council,

Location of headquarters: Ul. L. Kossutha 99

Number of employees:

- Municipality employees - 93;
- Municipality companies' employees – 18; (constant);

Number of volunteers in TRC: About 8 people are available in case of disaster.

New units in other places are planned.

Town of SEINI

Type: governmental (local public administration authority/institution)

Location of headquarters: SEINI, P-ta Unirii, 16

Number of employees: 54

Number of volunteers: 20

Babeș-Bolyai Univeristy - Research Institute for Sustainability and Disaster Management based on High Performance Computing

Short general description: ISUMADECIP is a research community composed of teachers and researchers in a consortium containing 8 faculties within Babeș-Bolyai University of Cluj-Napoca (Faculty of Environmental Science and Engineering, Faculty of Mathematics and Computer Science, Faculty of Economics and Business Administration, Faculty of Political, Administrative and Communication Sciences, Faculty of Geography, Faculty of Chemistry and Chemical Engineering, Faculty of Physics, Faculty of Biology and Geology).

Type: governmental (University/education and research)

Location of headquarters: Cluj-Napoca, 30 Fântânele St.

Number of employees: 3 (with contract on indefinite duration)

Number of volunteers: -

Number of members in ISUMADECIP: 27

Transcarpathian Reformed Church:

Type (religious): NGO/ religious - non-profit organization - non-profit

Location of headquarters: UA 90202 Berehovo, Mukachiv'ska str. 83, Zakarpatska oblast'/
UA 90202 Beregszász, Munkácsi út 83, Kárpátalja

Number of employees:

- TRC employees – 56
- TRC diaconal department employees – 18 (constant)
- The Transcarpathian Reformed Church's charitable institutions (mission centers, churches, congregation houses, kindergartens, rehabilitation centers, etc.) have a total staff of nearly 1,000 persons. Those working in institutions work on a voluntary, partly paid basis.

Number of volunteers in TRC: About 1000 people are available in case of disaster.

- Disaster Management volunteers of TRC diaconal department–15
- Disaster Management volunteers in TRC mobilization approx.
  - ➢ Ung county: 45
  - ➢ Ugocha county: 70
  - ➢ Bereg county: 85

Support of the TRC we have two functioning firefighter brigades:

- ➢ Dercen settlement 30
- ➢ Mezővári settlement 20

New units in other places are planned.

2. The structure in disaster response

***Zemplén Region Civil Protection and Disaster Management Association*:**

The Zemplén Regional Disaster and Civil Protection Association is responsible for protecting human life and material assets with the voluntary participation of citizens living in its area of activity and of organizations with legal personality or another status that have joined the Association. It contributes to the preparation of the population for civil protection and disaster preparedness. The member of the association participates in case of a disaster in the rescue operation and protection against the harmful effect. The association supports the activities both district and local rescue teams in the event of an emergency.

Volunteer Firefighters Association Pálháza:

Flood protection, high-capacity pumping, natural disaster recovery and remediation works, fire prevention, flood and inland water protection.

***Municipality Kráľovský Chlmec*:**

Main emergency response activity of the Municipality Kráľovský Chlmec is the humanitarian assistant and social charity support of the disaster affected people. The Municipality participate in case of disaster in direct response with own units (firefighting and flood protection capacities high capacity pumping,).

***Town of SEINI*:**

Voluntary Service for Emergency Situations Seini.

Babeș-Bolyai Univeristy - Research Institute for Sustainability and Disaster Management based on High Performance Computing:

ISUMADECIP is a network-style research Institute within Babeș-Bolyai University, dealing with topics like causes of disasters, the effects generated by various disasters, appropriate management strategies, short-, medium- and long-term effects on the population, economy and environment and proposed management strategies for various types of disasters.

***Transcarpathian Reformed Church*:**

Main emergency response activity of the Transcarpathian Reformed Church is the humanitarian assistant and social charity support of the disaster affected people. The TRC participate in case of disaster in direct response with own units (firefighting and flood protection capacities high capacity pumping,). The diaconal department services are one-part logistic capacity for rescue power and other part important inhabitant protection capacity (warm food, charity service, evacuated persons support, sheltering and supply, spiritual care, counseling etc.).

3. Specific responsibilities in disaster management / response

Zemplén Region Civil Protection and Disaster Management Association:

The Alliance is a recognized partner in the national organization of disaster management. The association cooperates local and sub regional organisations of the Borsod-Abaúj-Zemplén County Directorate for Disaster Management.

The national civil protection authority is the National Directorate General for Disaster Management, supervised by the Ministry of Local Government. The Minister of Local Government is thus responsible for the overall disaster management and oversees the management of civil protection and the implementation of related tasks. The civil protection organisational structure is as follows:

- Ministry of Local Government;
- National Directorate General for Disaster Management (NDGDM);
- County Disaster Management Directorates (19);
- The civil protection structure is organised at three levels: national, regional (county) and local level (municipalities).

At national level, the Parliament establishes the principles of civil protection and the main directions and conditions of implementation. The government may order the parallel deployment of civil protection organs, provides the fiscal basis for its development, coordinates related activities to civil protection, such as education and technical upgrade, and decides on the total number of civil protection organisations and their total number of personnel.

At regional level, the chairperson of the county General Assembly organises the enforcement of civil protection tasks. This includes:

- deployment of civil protection organisations;
- organisation of cooperation of the administration, armed forces, the community organisations and civil protection organisations;
- preparation and implementation of alerts and public awareness measures;
- harmonization of local protection and the resettlement/reception of inhabitants and property;

- establishment of local civil protection organisations, based on civil protection duty obligation, and for managing the civil protection system and its proper operation.

At local level, the mayor manages, within his competence, the implementation of civil protection tasks. This includes responsibility for:

- requests to citizens to undertake civil protection duties and to receive training and exercises in the regional or settlement organisation;
- operation of equipment used for public alert;
- pursuance the first jurisdiction in civil protection related matters;
- drafting of civil protection plans;
- conservation and appropriate storage of equipment and devices taken over from central reserves;
- management of public awareness, individual and shelter protection, evacuation, rescue, reception and resettlement facilities;
- management of the protection of equipment, provides for the necessary means of public subsistence;
- deployment of civil protection organisations;
- organisation of the armed forces, law enforcement bodies and community organisations, cooperation with mayors of other settlements in implementing civil protection tasks.

The competent minister who is the primary responsible for the disaster occurred, establishes and operates protection working committee with a view to managing and eliminating the consequences of:

- floods and inland waters;
- extreme weather;
- environmental pollution: damage to surface and sub-surface waters and air;
- nuclear accidents;
- dangerous industrial plants;
- industrial disasters during the storage of hazardous materials in industrial factories and the transportation thereof;
- incidents reaching the level of emergency (industrial disaster) in the production of hydrocarbons;

- mass migration;
- human epidemics;
- emergency level heat waves;
- animal epidemics and food safety related incidents, to ensure food chain safety;
- air, road, rail, waterway accidents reaching the level of emergency and to providing transportation capacities in international disasters;
- malfunctioning or breakdown of governmental or public information systems
- damage to the water works' infrastructure.

Risk assessment

Emergency management planning for natural and man-made disasters analyses and interprets the risks. The planning allows for the appropriate assignment of personnel and resources. Resulting from the risk assessment procedure for a given settlement, each settlement is classified into disaster management departments. The mayor of the settlement, with the help of the local disaster management body, carries out the risk assessment by 30 September each year. In the identification of risks, all known effects are considered in the given area, considering local characteristics. After risk identification, the assessment should identify the consequences of certain threatening effects in the area of the settlement and the likelihood of occurrence, considering the combined effects of each hazard.

Risk management planning

NDGDM Defense Management Department within Civil Emergency Planning develops a professional framework for classifying settlements based on real risks into disaster management. It provides the professional support necessary to carry out risk identification and assessment through the regional bodies. It provides professional support for the preparation of emergency plans at all stages of planning to ensure adequate protection of settlements. The department monitors the preparation of municipal and territorial emergency plans and ensures the adequate level of protection specified in the legislation. Additionally, it prepares and keeps an up-to-date central emergency plan. The department collects and processes information on emergency management, compiles reports, prepares proposals for decision-making, and informs organizations involved in disaster management. It carries out preventive and civil protection tasks and lays down professional requirements for the implementation of civil protection tasks.

Volunteer Firefighters Association Pálháza:

The specific tasks related to disaster management are listed in the statute of the Association, which are the following:

a. Organizes and ensures fire prevention, firefighting, damage prevention and technical rescue tasks with its members;

b. Organizes and ensures the preventive fire protection and flood and inland water protection related tasks with its members;

c. Provides fire protection information to the population by making extensive use of local opportunities;

d. Ensures the qualification of its members to perform the tasks of the Association through professional educations, courses, trainings, firefighting exercises and competitions;

e. Ensures the periodic technical inspection and proper use of the fire protection equipment and motor vehicles provided;

f. Represents the interests of its members, promotes the enforcement and provision of the rights of volunteer firefighters established in the relevant legislation;

g. Participates in the maintenance of parks, environmental protection, protection against ragweed, protection of public order and safety, and urban development;

h. performing community tasks, informing, providing publicity, organizing events;

i. education, training, skills development, dissemination of knowledge;

j. preservation of cultural heritage;

k. historical monument preservation;

l. nature protection, animal protection;

m. tourism development;

n. child and youth protection, child and youth advocacy;

o. promoting social equality for disadvantaged groups;

p. improving the quality of life and health of the population;

q. support for talented young people in Pálháza;

r. rehabilitation employment;

s. training of disadvantaged groups in the labor market, promotion of their employment, including temporary employment and related services;

t. the Association publishes its most important data related to its activities and management on its website (www.palhazaote.hu);

u. taking a role at the district level, in the Zemplén Rescue Group established in the area of Sátoraljaújhely, and in the Pálháza Rescue Rescue Group;

v. cooperates closely with the Pálháza Civil Guard Association in the course of its activities;

w. Activities related to national and ethnic minorities in Hungary and to Hungarians living abroad;

x. Activities with disadvantaged people;

y. Performing tasks related to social inclusion;

z. Health preservation, disease prevention, curative and health rehabilitation activities;

aa. Social activities, family assistance, care of the elderly;

bb. Scientific activity, research;

cc. Flood and inland water protection services;

dd. Sport, other than sports activities on a fee or contract basis;

ee. Voluntary employment.

Municipality Kráľovský***Chlmec***:

Municipality Kráľovský Chlmec is a cooperated partner in the national organization of disaster management in Slovakia. The Ministry of Interior of the Slovak Republic cooperates with local and regional organisations. It is the main authority in the list of central government authorities for formation and provision of the national policy in the field of Civil Protection:

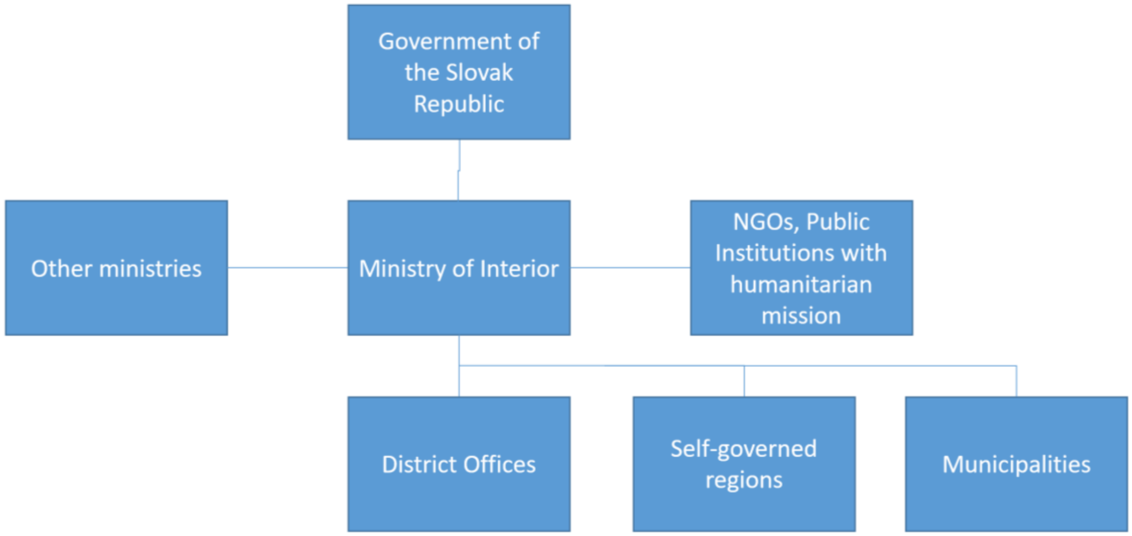

Figure I.1. *Diagram of Civil Protection control*

Crisis management system in the Slovak Republic is divided geographically, with each level of public administration playing its part in the system. The aim of civil protection is to protect lives, health, and property. The Ministry of Interior of the Slovak Republic cooperates with other state authorities, self-governing regions, municipalities, legal entities, individuals and with public-legal institutions with the humanitarian mission that in case of emergency are deployed in rescue operations. It also participates in rescue operations and evacuation in situations stipulated in the Act on Civil Protection.

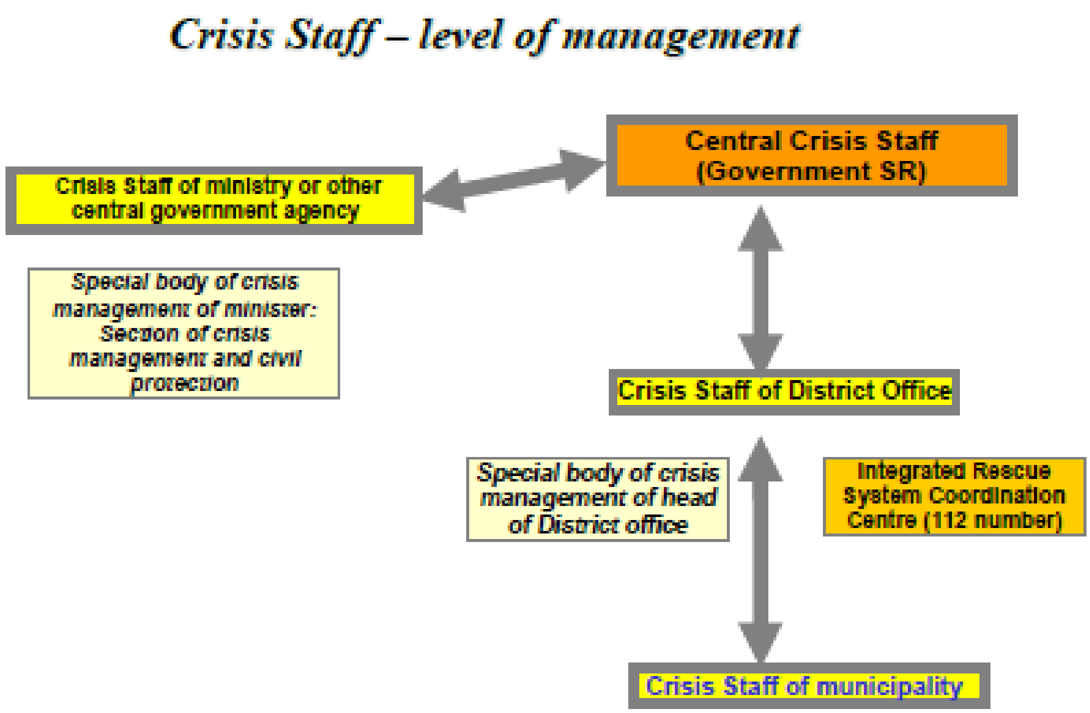

Figure I.2. *Diagram of Crisis Staff National System*

Regional departments of civil protection and crisis management (at the district offices) plan, manage, and provide the activities relative to the protection of civil population in the case of an emergency. The most important tasks of municipalities on their territory are the following: development of analysis of possible emergency events, preparing plans of protection of the population, organisation and control of civil protection training, oversee and control rescue operations on their territory, planning, controlling and implementation of the declaration of population evacuation.

PREVENTION:

Risk assessment

A comprehensive "Analysis of the territory of the Slovak Republic" in terms of possible emergencies is carried out regularly at national and regional level; however, currently it is absent at local level. Risks are identified with quantitative and qualitative factors, with additional use of historical data and models.

The Ministry of Interior of the Slovak Republic is the main authority for coordinating, evaluating and providing the final risk assessments on national level. On the regional level, district offices are the authorities responsible for gathering and evaluating the *regional data that are available to the public.*

Risk management planning

The Ministry of the Interior of the Slovak Republic manages and develops annual plans in the field of civil protection and determines the main aims and activities for the state administration authorities (district offices, ministries) and self-government authorities (municipalities – cities/towns, villages). This planning determines aims and is concurrent at the ministry level and at the state administration authorities.

The National Risk Management Strategy of the Slovak Republic describes the main risks and hazards. On identified threats, risk management plans are either prepared or controlled by the national authorities coordinated on governmental level. The most common types of crisis plans are as follows: preventive action plans; action plans for the crisis period and escalation, action plans for recovery measures and reconstruction.

Example of the most common plan is the “Flood plan”. This is a key document, which is prepared on local (municipal) level, that contains every specific data and information (maps, diagrams, capacities, key contacts, prevention and response) which is needed to handle the most common risk in Slovakia.

Risk communication and awareness raising

Communicating risks to the population is an established and on-going effort, with the Ministry of Interior of the Slovak Republic as a main authority. Communication to the public is carried out by communication departments specifically designated for this goal.

Raising awareness is a task carried out by multiple stakeholders coordinated by the Ministry of Interior of the Slovak Republic. Responsibilities are divided geographically (from local/regional to national level) and by target audience. Several examples of awareness raising activities include: educational activities in schools, competitions for children and young people, international 112 emergency number day, publications for general and/or expert public.

PREPAREDNESS:

Training and exercises

Key personnel who ensure fulfilling tasks of civil protection and crisis management are regularly trained and prepared accordingly to national plans and legislative. Several training facilities, under the Ministry of Interior, are used for specialised additional education in the field of civil protection, crisis management and prevention. National exercise programmes are included in the annual plans of action of Section of Crisis Management of the Ministry of the Interior; these include table-top, field and full-scale exercises throughout the year. These are jointly organised with other first responders (capacities in the Integrated Rescue System), to practice common procedures and methodologies used in emergency response and disaster recovery. Field exercises are conducted on various training facilities, with the cooperation of the Ministry of Defence.

Early warning systems

Early warning systems are a collaborative work of public authorities operating and maintaining national civil protection warning systems with private operators of important infrastructure, which are responsible for autonomous warning systems. The main warning method is sirens supplemented by spoken information and also broadcasting the alerts on radio and TV. A section of Crisis Management of the Ministry of Interior of the Slovak Republic, more specifically its coordination and response centre bear the responsibility of engaging the warning and providing the necessary information.

Scientific institutions and organisations provide the input data, which is needed for decision making. These are the Slovak Hydrometeorological Institute, the Public Health Office and the Nuclear Supervision Office. Organisations such as these are operating a nationwide network of sensors and monitoring equipment that feeds into the system and is used as a basis for early warning.

The most frequent (annual) use of early warning systems is during extreme weather events (thunderstorms, torrential rain) when the population is informed about the potential flooding risks or landslides, which are the most common threat at every level.

Emergency Response

Local authorities are primarily responsible for emergency response on emergencies in their territory.

The Mayor of the affected municipality is the head of rescue operations; the head of the district is responsible for response on district and regional level. Emergency response is carried out by first responders who are coordinated by the Integrated Rescue System, which is composed of the Fire and Rescue Service; the Emergency Medical Service; the Mountain Rescue Service; the Mine Rescue Service; the Control Chemical Laboratories, which are supported by local, corporate and volunteer fire fighting corps; the Armed Forces of the Slovak Republic, the Slovak Red Cross, and other civil protection units. Intervention from national level is provided whenever the emergency is a large-scale event (more than 2 counties are affected) or national capacities from state reserves need to be deployed to assist the rescue operations.

Cross-border, European and international cooperation

Cross-border cooperation is ensured by bilateral agreements that are either at the governmental level signed by heads of governments, or at the regional/local level signed by local authorities. Since the independence of the Slovak Republic, cross-border cooperation has been established with all neighbouring countries on all scopes (information exchange, assistance, prevention) and levels. International cooperation (the EU, UN, NATO, Central European Initiative, Visegrád Group) and intervention are governed by political agreements, which are carried out by the responsible national authorities: The Ministry of Foreign Affairs and the Ministry of Interior of the Slovak Republic.

***Town of SEINI*:**

Specific responsibilities in disaster management are: prevention and protection of the population and prompt intervention in case of disasters or other emergency situations, as well as providing assistance to specialized units in their interventions.

Babeș-Bolyai Univeristy – Research Institute for Sustainability and Disaster Management based on High Performance Computing:

The main scope of the activities of ISUMADECIP is to create the premises to ensure adequate prevention and response to disasters, in accordance with the specific national requirements, but also with the concepts promoted by the European Union and NATO.

Their research is focused on all the phases of disaster management, from prevention through preparedness, response and recovery. The work of their Natural and Technological disaster management laboratories is focused on the hazard and risk assessment of these events and the combination of natural and technological phenomena, called “Natech disasters”, by the development of studies for risk reduction, using safer available techniques; environmental consulting services; creating risk maps and safety reports, site reports, environmental documentation. Among the activities of the Disaster Management Technical Devices and Equipment Lab can be mentioned: the identification and testing the technical devices for disaster-response; methods of organization and coordination of the important points of response in the affected areas; methods of investigation of the areas affected by disasters using specific technical equipment; improving the standard operating procedures for multi-service response.

Their Risk Communication and Public Relations Lab conducts the following activities: investigation and application of efficient ways of risk communication through the mass-media; planning, organizing and conducting activities within the contact points offering information about the victims of the disasters.

Several research and infrastructure development projects were successfully implemented in the field of disaster management, such as RO-RISK - National Disaster Risk Assessment; MADECIP - Development of research infrastructure for disaster management based on high performance computing; DENATEH, - Mitigation of vulnerability and consequences of natural and technological disasters, in order to support local communities; etc.

Transcarpathian Reformed Church:

Transcarpathian Reformed Church is a cooperated partner in the national organization of disaster management. The TRC cooperates with local and regional organisations of the Ministry of Emergency Situations in Ukraine (MES), which is the main authority in the list of central government authorities for formation and provision of the national policy in the field of:

- civil protection;
- rescue activities;
- firefighting;
- governmental supervision of the technogenic and fire security;

- government supervision of the industrial security and mining;
- liquidation of the Chernobyl catastrophe effects;
- prevention of non-productive injuries; hydrometeorological activity.

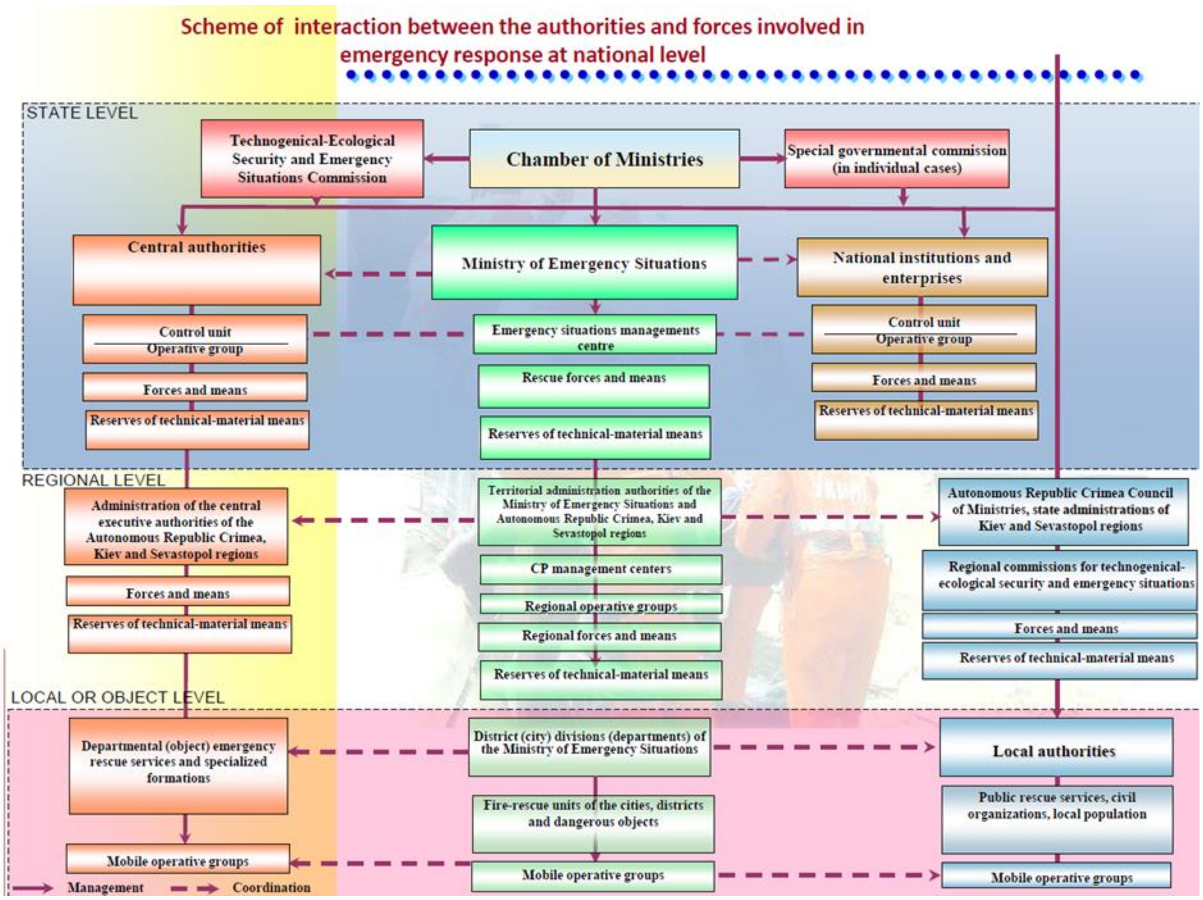

Figure I.3. *Structure of Ministry of Emergency Situations*

4. Organization's operability area

Zemplén Region Civil Protection and Disaster Management Association:

Country: Hungary

County / region: Field of operation of the Zemplén Region Civil Protection and Disaster Management Association covers the next three districts are administrative areas.

Territorial administrative units of **Sátoraljaújhely District** within Hungary and Borsod-Abaúj-Zemplén County.

Figure I.4. *The Sátoraljaújhely District*

Municipalities: Alsóberecki, Alsóregmec, Bózsva, Felsőberecki, Felsőregmec, Filkeháza, Füzér, Füzérkajata, Füzérkomlós, Füzérradvány, Hollóháza, Kishuta, Kovácsvágás, Mikóháza, Nagyhuta, Nyíri, Pálháza, Pusztafalu, Sátoraljaújhely, Vágáshuta, Vilyvitány.

Table I.1. *Data about the Sátoraljaújhely District*

District seat	Sátoraljaújhely
Area	
• **Total**	321.38 km^2 (124.09 km2)
Area rank	13th in Borsod-Abaúj-Zemplén
Population (2011 census)	
• **Total**	23,058
• **Rank**	9th in Borsod-Abaúj-Zemplén
• **Density**	72/km^2 (190/km2)

Figure I.5. *Sárospatak District*

Table I.2. *Data about the Sárospatak District*

District seat	Sárospatak
Area	
• **Total**	477.67 km^2 (184.43 km2)
Area rank	5th in Borsod-Abaúj-Zemplén
Population (2011 census)	
• **Total**	24,946
• **Rank**	8th in Borsod-Abaúj-Zemplén
• **Density**	52/km^2 (130/km2)

Municipalities: Bodrogolaszi, Erdőhorváti, Györgytarló, Háromhuta, Hercegkút, Kenézlő, Komlóska, Makkoshotyka, Olaszliszka, Sárazsadány, Sárospatak, Tolcsva, Vajdácska, Vámosújfalu, Viss, Zalkod

Figure I.6. *Cigánd District*

Table I.3. *Data about the Cigánd District*

District seat	Cigánd
Area	
• **Total**	389.99 km^2 (150.58 km2)
Area rank	8th in Borsod-Abaúj-Zemplén
Population (2011 census)	
• **Total**	16,042
• **Rank**	14th in Borsod-Abaúj-Zemplén
• **Density**	41/km^2 (110/km2)

Municipalities: Bodroghalom, Cigánd, Dámóc, Karcsa, Karos, Ricse, Kisrozvágy, Lácacséke, Nagyrozvágy, Pácin, Révleányvár, Semjén, Tiszacsermely, Tiszakarád, Zemplénagárd

Volunteer Firefighters Association Pálháza

Country: Hungary

County / region: Borsod-Abaúj-Zemplén

Municipalities: Pálháza City Municipality

Figure I.7. *The Sátoraljaújhely District*

***Municipality Kráľovský Chlmec**:*

Country: Slovakia

Slovakia traces its roots to the 9th century state of Great Moravia. Subsequently, the Slovaks became part of the Hungarian Kingdom, where they remained for the next 1,000 years. After the formation of the dual Austro-Hungarian monarchy in 1867, backlash to language and education policies favoring the use of Hungarian (Magyarization) encouraged the strengthening of Slovak nationalism and a cultivation of cultural ties with the closely related Czechs, who fell administratively under the Austrian half of the empire. After the dissolution of the Austro-Hungarian Empire at the close of World War I, the Slovaks joined the Czechs to form Czechoslovakia. The new state was envisioned as a nation with Czech and Slovak branches. During the interwar period, Slovak nationalist leaders pushed for autonomy within Czechoslovakia, and in 1939 Slovakia became an independent state created by and allied with Nazi Germany. Following World War II, Czechoslovakia was reconstituted and came under communist rule within Soviet-dominated Eastern Europe.

In 1968, an invasion by Warsaw Pact troops ended the efforts of Czechoslovakia's leaders to liberalize communist rule and create "socialism with a human face," ushering in a period of repression known as "normalization." The peaceful "Velvet Revolution" swept the Communist Party from power at the end of 1989 and inaugurated a return to democratic rule and a market economy. On 1 January 1993, Czechoslovakia underwent a nonviolent "velvet divorce" into its two national components, Slovakia and the Czech Republic. Slovakia joined both NATO and the EU in the spring of 2004 and the euro zone on 1 January 2009.

Location

Slovakia lies between latitudes 47° and 50° N, and longitudes 16° and 23° E. The Slovak landscape is noted primarily for its mountainous nature, with the Carpathian Mountains extending across most of the northern half of the country. Among these mountain ranges are the high peaks of the Fatra-Tatra Area (including Tatra Mountains, Greater Fatra and Lesser Fatra), Slovak Ore Mountains, Slovak Central Mountains or Beskids. The largest lowland is the fertile Danubian Lowland in the southwest, followed by the Eastern Slovak Lowland in the southeast. Forests cover 41% of Slovak land surface.

County / region:Košice Region

The Košice Region (Slovak: Košickýkraj, pronounced [ˈkɔʃitskiː ˈkraj], Hungarian: Kassaikerület; Ukrainian: Кошицькийкрай) is one of the eight Slovak administrative regions. The region was first established in 1923 and its present borders were established in 1996. It consists of 11 districts (okresy) and 440 municipalities, 17 of which have a town status. About one third of the region's population lives in the agglomeration of Košice, which is its main economic and cultural center.

Figure I.8. *Map of Košice Region*

The Košice Region is situated in the South-eastern part of Slovakia. On the North it borders with the Prešov Region, on the West with the Banská Bystrica Region. The southern and eastern borders are made by the state boundaries of Hungary and Ukraine. The Košice Self-governing Region is the fourth largest region within Slovakia as for its area (6 754,5 km2) and the second by the density of the inhabitants. The City of Košice is the second largest and most significant city in Slovakia. Based on the official territorial-administrative division, the Košice Region consists of 11 districts /okres/ from which 4 districts make up the territory of the City of Košice (Gelnica, Košice I, Košice II, Košice III, Košice IV, Košice – okolie /Košice – Environs/, Michalovce, Rožňava, Sobrance, Spišská Nová Ves and Trebišov). In the territory of the region there are 440 municipalities from which 17 have the statute of cities The Košice Region consists of 11 districts. In Košice city itself there are four districts; seven districts are outside the city. There are 440 municipalities, of which 17 are towns.

The average population density in the region is 117.9 inhabitants per km2, which is very similar to the country's average (110 per km2). The largest towns are Košice, Michalovce, Spišská Nová Ves, Trebišov and Rožňava. According to the 2001 census, there were 766,012 inhabitants in the region, with a majority of Slovaks (81.8%), but there is a numerous Hungarian minority (11.2%) in the south, and there are minorities of Roma (3.9%) and Czechs (<1%).
Trebišov District (Slovak: okres Trebišov, Hungarian: Tőketerebesijárás) is a district in the Košice Region of eastern Slovakia.

Until 1918, the district was mostly part of the Hungarian county of Zemplén, apart from a small area in the south-east around Veľké Trakany which formed part of the county of Szabolcs. Okres Trebišov is an administrative unit of the Košice Region of Slovakia. It has an area of 1,074 km², a population of 103,779 (2001) and is based in Trebišov.

Town of SEINI:

Country: Romania

County / region: Maramureș

Municipalities: SEINI

Territorial administrative units: U.A.T. SEINI / Territorial administrative unit SEINI, which includes the town of Seini and two villages – Săbișa and Viile Apei.

Babeș-Bolyai Univeristy – Research Institute for Sustainability and Disaster Management based on High Performance Computing

Country: Romania

County / region: Cluj

Municipalities: their research activities are focused on the whole territory of Romania.

Transcarpathian Reformed Church:

Country: Ukraine

Ukraine is divided into several levels of territorial entities. On the first level there are 27 regions 24 oblasts, one autonomous republic, and two "cities with special status. Raions of Ukraine (Ukrainian: Райони України) are the second level of administrative division of Ukraine, below the oblast, and are the most common division of regions of Ukraine. Equivalent type of regional subdivision are also raions in city (Raions of cities in Ukraine), and cities of regional significance (City of regional significance (Ukraine). Raions are one of three types of administrative divisions of regions of Ukraine and second level in the administrative divisions of Ukraine. In 2019, the government proposed to carry out a reform of administrative divisions of Ukraine, which would reduce the number of raions is from 490 to 102.

County / region: Zakarpats’ka oblast’/

The Zakarpatska Oblast (Ukrainian: Закарпатська область, translit. Zakarpats’ka oblast’; see other languages) is an administrative oblast (province) located in southwestern Ukraine, coterminous with the historical region of Carpathian Ruthenia. Its administrative centre is the city of Uzhhorod. Other major cities within the oblast include Mukachevo, Khust, Berehove and Chop which is home to railroad transport infrastructure.

Zakarpatska Oblast was established on 22 January 1946, after the resignation of Czechoslovakia on the territory of Subcarpathian Ruthenia (Czech: Podkarpatská Rus), annexed forcibly by the Soviet Union and attached to the Ukrainian Soviet Socialist Republic, under a treaty between Czechoslovakia and the Soviet Union. Some scholars say that during the Ukrainian independence referendum held in 1991, Zakarpatska Oblast voters were given a separate option on whether or not they favoured autonomy for the region.

Situated in the Carpathian Mountains of western Ukraine, Zakarpattia Oblast is the only Ukrainian administrative division which borders upon four countries: Poland, Slovakia, Hungary and Romania. The Carpathian Mountains play a major part in the oblast's economy, making the region an important tourist and travel destination housing many ski and spa resorts.

With its almost 13,000 square kilometers (5,000 km2), the oblast is ranked 23rd by area and 15th by population as according to the 2001 Ukrainian Census, the population of Zakarpatska Oblast is 1,254,614. This total includes people of many different nationalities of which Hungarians, Romanians and Rusyns constitute significant minorities in some of the province's cities, while in others, they form the majority of the population (as in the case of Berehove).

Figure I.9. *The Zakarpatska Oblast region*

Table I.4. *Data about municipalities*

#	Name	Center	Year	Area (km²)	Population	Density
1	Berehove	Berehove		654	53,841	82
2	Velykyy Bereznyi	Velykyi Bereznyi		810	28,016	35
3	Vynohradiv	Vynohradiv		695	117,863	170
4	Volovets	Volovets		544	25,336	47
5	Irshava	Irshava		944	100,881	107
6	Mizhhirya	Mizhhirya		1,163	50,057	43
7	Mukacheve	Mukachevo		997	101,572	102

8	Perechyn	Perechyn		631	31,790	50
9	Rakhiv	Rakhiv		1,892	90,811	48
10	Svaliava	Svaliava		676	55,468	82
11	Tiachiv	Tiachiv		1,818	172,389	95
12	Uzhhorod	Uzhhorod		866	65,514	76
13	Khust	Khust		998	96,561	97

The activity area of Transcarpathian Reformed Church is next three counties:

- Ung;
- Ugocha;
- Bereg.

Municipalities:

Ung county (24): Bátfa, Botfalva, Csap, Csongor, Eszeny, Gálocs, Kisdobrony, Kisgejőc, Korláthelmec, Minaj, Nagydobrony, Nagygejőc, Palágykomoróc, Palló, Rát, Szalóka, Szürte, Tiszaágtelek, Tiszaásvány, Tiszasalom, Tiszaújfalu, Ungtarnóc, Ungvár, Szolyva.

Máramaros-Ugocsa county (30): Akli, Aklihegy, Aknaszlatina, Batár, Csepe, Fancsika, Feketeardó, Feketepatak, Fertősalmás, Forgolány, Gödényháza, Huszt, Királyháza, Mátyfalva, Nagypalád, Nagyszőlős, Nevetlenfalu, Péterfalva, Rahó, Salánk, Szőlősgyula, Tekeháza, Técső, Tiszabökény, Tiszakeresztúr, Tiszaújhely, Tiszaújlak, Tivadarfalva, Verbőc, Visk.

Bereg county (47): Asztély, Badaló, Bakos, Balazsér, Barkaszó, Bátyú, Bene, Beregardó, Beregdéda, Beregrákos, Beregsom, Beregszász, Beregújfalu, Bilke, Borzsova, Bótrágy, Búlcsú, Csetfalva, Csonkapapi, Dercen, Fornos, Gát, Gut, Halábor, Harangláb, Hetyen, Izsnyéte, Kajdanó, Kigyós, Kisbégány, Kispapi, Macsola, Makkosjánosi, Mezőgecse, Mezőkaszony, Mezővári, Munkács, Nagybakta, Nagybégány, Nagybereg, Nagymuzsaly, Rafajnaújfalu, Sárosoroszi, Szernye, Tiszacsoma, Zápszony, Újbátyú

Each of these settlements, villages and cities has a connection point (rescue, flood, continuous donation (clothing, food, etc.), fire), but especially flood-related emergency, rescue, etc. processes occurred most frequently in the following locations:

In Ung county (11): Bátfa, Csap, Eszeny, Kisdobrony, Kisgejőc, Nagygejőc, Szalóka, Tiszaásvány, Tiszasalom, Tiszaújfalu, Ungtarnóc.

In Máramaros-Ugocsa county (16): Akli, Batár, Csepe, Huszt, Királyháza, Nevetlenfalu, Péterfalva, Szőlősgyula, Tekeháza, Técső, Tiszabökény, Tiszakeresztúr, Tiszaújhely, Tiszaújlak, Tivadarfalva, Visk.

In Bereg county (20): Badaló, Barkaszó, Bátyú, Bene, Beregrákos, Beregsom, Borzsova, Bótrágy, Csetfalva, Csonkapapi, Halábor, Harangláb, Hetyen, Kispapi, Mezővári, Sárosoroszi, Szernye, Tiszacsoma, Zápszony, Újbátyú.

Territorial administrative units: They will be forming from 2020 according to Ukrainian law.

5. Equipment / assets used in disaster management / response

Zemplén Region Civil Protection and Disaster Management Association:

In case of disaster intervention, the ZRDMCPA consist and supported three civil protection district rescue and protection units. The necessary equipment is provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.).

Volunteer Firefighters Association Pálháza

The list of the intervention equipment is the following:

- 1 fire truck suitable for transporting people and equipment;
- 1 trailer;
- 2 power generators;
- petrol powered pumps;
- 1 diesel powered pump;
- 3 petrol chainsaws;
- 1 Plug Ladder;
- 8 petrol-powered mowers;
- 2 petrol-powered back sprayers;
- 1 High-performance light tower;

Municipality Kráľovský Chlmec:

The intervention capacity equipment of Municipality Kráľovský Chlmec is divided into three groups:

- The tools of their two operational municipality Civil Protection team (high-performance pumps, water guns, other auxiliary equipment);
- Flood Protection Kit Voluntary Flood Protection Units (Protective Suits, Hand Tools, Lighting Equipment, Sandbag);
- Logistic and supply equipment of municipality department services (transportation equipment, kitchen and food supply equipment, temporary accommodation camp equipment, tent camp laying capacity).

Town of SEINI:

The list of the intervention equipment is the following:

- fire engine (fire extinguishing vehicle),
- water pump,
- chainsaw,
- shovels.

Babeș-Bolyai Univeristy – Research Institute for Sustainability and Disaster Management based on High Performance Computing:

The list of the equipment and assets used in their activities is the following:

- IT and communication equipment:
    - Hardware: High Performance Computer, laptops, desktops, GIS server;
    - Software: modeling software for chemical hazardous releases (EFFECTS, ALOHA, MODFLOW), modeling software for floods (HEC-RAS, GIS based modeling), modeling software for atmospheric dispersion (AERMOD View);
    - Communication equipment: 2 Thuraya satellite phones and one satellite internet modem; 6 PMR portable radios;

- Intervention equipment for search and rescue: person detector under debris, gas leakage detectors, personal protection equipment (gas masks, autonomous respiratory system etc.), intervention terrain vehicle, low pressure inflatable tent, chemical decontamination tent, portable meteorological station.

Transcarpathian Reformed Church:

The intervention capacity equipment of Transcarpathian Reformed Church is divided into three groups:

- The tools of our two operational voluntary fire brigades (fire trucks, high-performance pumps, water guns, other auxiliary equipment);
- Flood Protection Kit Voluntary Flood Protection Units (Protective Suits, Hand Tools, Lighting Equipment, Sandbag);
- Logistic and supply equipment of diaconal department services (transportation equipment, kitchen and food supply equipment, temporary accommodation camp equipment, tent camp laying capacity).

6. Former activities concerning the area of disaster response and prevention

Zemplén Region Civil Protection and Disaster Management Association:

- Prevention and preparedness activities: The association organizes and participates in inhabitants training programs in the field of prevention. It has significant activities in the area of youth civil protection preparation (emergency education, competitions and campaigns).

Contributing to voluntary and compulsory civil protection local unit preparations in the last 5 years:

2014.05.07. - Tiszacsermely

2014.05.15. - Kishuta

2014.05.20. - Kenézlő

2014.05.23. - Alsóregmec, Mikóháza, Vilyvitány

2014.08.07. - Vajdácska

2015.05.13. - Füzér

2015.05.19. - Sátoraljaújhely

2015.10.13. - Felsőregmec

2016.03.10. - Kovácsvágás

2016.03.17. - Sátoraljaújhely

2016.03.24. - Sátoraljaújhely

2016.06.01. - Hollóháza

2016.06.08. - Pálháza

2016.10.12. - Sárospatak

2016.10.13. - Filkeháza, Füzérkajata

2017.03.29. - Sátoraljaújhely

2017.09.06. - Füzérradvány

2017.10.05. - Komlóska

2017.10.12. - Füzér

2018.03.07. - Bózsva

2018.05.30. - Füzérkomlós

2018.06.05. - Pusztafalu

2018.10.10. - Kovácsvágás

2019.05.23. - Felsőregmec

2019.05.29. - Alsóregmec

2019.06.05. - Alsóberecki

- *Risk analysis:* The association monitors the results of the annual risk assessment and integrates it into its activities. Occasionally, at the request of disaster management professionals, it participates in the risk assessment.
- *Response / intervention:* The Alliance, in case of disasters and emergencies after the alert, assists in setting up voluntary intervention organizations. During the response intervention, it is continually supplementing the rescue work with human resources and equipment. ZRDMCPA supports population protection (emergency communication, and evacuations organization)
- *Rescue:* The rescue operations can be carried out in Hungary, only certified disaster management units. The association supports volunteer capacities in local, three district and county rescue teams.

Alliance capacity is ready for intervention in the following areas: USAR urban search and rescue, flood protection and water rescue, forest, scrub, and building fires, S&R operations in wooded and swampy areas.

- *Sheltering:* The association is involved in the accommodation and care of the rescued and evacuated population. They help maintain war shelters and using of peace by organizing a responsible shelter guard network.
- *Training and education:* The association participates in the training of rescue and intervention organizations under the supervision of disaster management. Increases intervention capacity by organizing and performing exercises. Contribution to flooding protection exercises in the last five years:
  - 2018.03.23. - Baskó settlement;
  - 2018.10.18. - Erdőhorváti settlement.
- *Communication:* The association does not have its device of communication in the event the disaster management by providing EDR radio equipment. The Alliance supports the public awareness activities of disaster management in emergencies*;*
- *Surveillance:* They have not surveillance capacity.

Volunteer Firefighters Association Pálháza

- *Prevention and preparedness activities:* Participation in preparedness activities for national flood protection. Pumping exercises. With regard to fire prevention, maintenance works of gaseous inner areas, the employment and training of volunteers.
- *Training and education:* participation in small machine operator courses, participation in national flood protection preparations.

Municipality Kráľovský Chlmec:

- *Prevention and preparedness activities:* The municipality participates in inhabitants' training programs in the field of prevention. It has significant activities in the area of youth civil protection preparation in framework of Church youth and Pathfinder movement (emergency education, competitions and campaigns).

- *Risk analysis:* The municipality monitors the results of the annual risk assessment and integrates it into its activities. Occasionally, at the request of disaster management professionals, it participates in the risk assessment.
- *Response / intervention:* In case of disasters and emergencies after the alert, assist in setting up voluntary intervention organizations. During the response intervention, it is continually supplementing the rescue work with human resources and equipment. Supports supply activities of population protection (emergency communication, and evacuations organization)
- *Rescue:* Voluntary Municipality CO Team is ready for intervention in the following areas:
  - ✓ Forest, scrub, and building fires;
  - ✓ USAR urban search and rescue;
  - ✓ Flood protection and water rescue;
  - ✓ S&R operations in mountain and wooded swampy areas.
- *Sheltering:* The Municipality CO Team is involved in the accommodation and care of the rescued and evacuated population by logistic and supply capacity of social department services (housing search and insurance. nursing home. crisis center).
- *Training and education:* The Municipality CO Team participates in the training of rescue and intervention organizations under the supervision of disaster management.
- *Communication:* -.

Town of SEINI:

- *Prevention and preparedness activities:* prevention of the population and their warning through different means of communication (announcements in churches, leaflets and posters, posts on social networks, posts on the city website), cleaning of household chimneys;
- *Risk analysis:* floods, together with forest and vegetation fires represent the main disaster risks in their area;
- *Response / intervention:* in the event of disasters, the first intervention is realized by volunteer firefighters, assisted when needed by military firefighters of ISU Maramures, to which other volunteers for emergency situations from Seini are added in case of need.

- *Rescue:* The rescue of people and property is the main purpose of the primary disaster intervention.
- *Sheltering:* U.A.T. Seini provides people affected by disasters with a room having the capacity to shelter up to 100 people, as well as everything that is needed in terms of accommodation and food.
- *Training and education:* Periodically, activities are undertaken to train intervention personnel, volunteers and those actively involved in disaster mitigation.
- *Communication:* At the end of each intervention, an event report is prepared and presented in which the following aspects are detailed: the actions taken to eliminate the cause of the disaster, to rescue people and conserve property.

  In the UAT Seini area, semestrial actions are taking place in order to inform the population about the disasters caused by wildfires and by floods during periods of heavy rainfall. Also, every month, an alarm exercise is carried out, by means of the existent alarming system at the City Hall, which warns the population in case of disasters or emergency situations.
- *Surveillance:* Disaster surveillance and monitoring is important both in disaster prevention and in limiting their effects. Therefore, the courses of the valleys in Seini area are closely monitored and the volunteer firefighters intervene in those areas where risks are identified, either by decommissioning the valley or by repairing and consolidating the affected river banks.

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ISUMADECIP is a research Institute in the national education system, without direct disaster response activities.

Transcarpathian Reformed Church:

- *Prevention and preparedness activities:* The TRC participates in inhabitants training programs in the field of prevention. It has significant activities in the area of youth civil protection preparation in framework of Church youth and Pathfinder movement (emergency education, competitions, campaigns);

- *Risk analysis:* The TRC monitors the results of the annual risk assessment and integrates it into its activities. Occasionally, at the request of disaster management professionals, it participates in the risk assessment;
- *Response / intervention:* The two voluntary fire brigades of TRC is part of The State Emergency Service of Ukraine in Transcarpathian region. In case of disasters and emergencies after the alert, assist in setting up voluntary intervention organizations. During the response intervention, it is continually supplementing the rescue work with human resources and equipment. TRC supports supply activities of population protection (emergency communication, and evacuations organization);
- *Rescue:* Voluntary fire brigades of TRC is ready for intervention in the following areas:
  - ✓ Forest, scrub, and building fires;
  - ✓ USAR urban search and rescue;
  - ✓ Flood protection and water rescue;
  - ✓ S&R operations in mountain and wooded swampy areas.
- *Sheltering:* The TRC is involved in the accommodation and care of the rescued and evacuated population by logistic and supply capacity of diaconal department services (housing search and insurance. nursing home. crisis center).
- *Training and education:* The TRC participates in the training of rescue and intervention organizations under the supervision of disaster management;
- *Communication:* The TRC has no emergency communication device.

7. Volunteer intervention experiences of the past years

Zemplén Region Civil Protection and Disaster Management Association:

a. Disaster 1: (Flood protection on the river Danube)

- Type of disaster and year: periodic rives flood, 2013;
- Location: Nagymaros settlement, Pest County, this area endangered by the Danube;
- Short description of the disaster development: The area was flooded on June 2, 2013. The flood was at an all-time high of 751 cm, which was 37 cm above the previous highest level;

- Response activities taken by the organization: Following the alert, the team best suited to flood control was assembled. The number and technical equipment of the Bükk Rescue Team consisted of 70 persons according to the application and about 13 vehicles and other technical equipment. This team included a handheld unit, a reconnaissance and mobile information unit, a diver and a disability carrier and a logistics team. Kohánka István ret. Eng. cp. Colonel Commander of the Beech Rescue Team issued a command to leave after the blessing. After briefing the damage site, they rushed to the damage site to see where it was needed to perform their defense helicopter reconnaissance and reviewed the 2.5 km long embankments that protected the city. Sheeting defense, localization dam building, and canal closures took place;
- Equipment used by the organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / Local and to the area ordered rescue forces had cooperation, communicated through the disaster protection EDR network;
- Cross-border experiences: no;
- Lessons learned: After application, the rescue activity was revised based on the official disaster management report.

b. Disaster 2: (Flood protection on the river Hernád)

- Type of disaster and year: periodic river flood, 2014;
- Location: Borsod-Abaúj-Zemplén County, Miskolc district riverside;
- Short description of the disaster development: From May 15, 2014 to May 20, 2014, a flood wave hit the Hernád River;
- Response activities taken by the organization: Dam protection (construction of sand bag localization and emergency dike, slope stability berm, levee guard assistant service;
- Equipment's used by the organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);

- Cooperation with other organizations / institutions: Local and to the area ordered rescue forces had cooperation, communicated through the disaster protection EDR network;
- Cross-border experiences: no;
- Lessons learned: as general described procedure.

c. Disaster 3: (Flash flood protection on area of Kovácsvágás and Erdőhorváti settlements)

- Type of disaster and year: storm and flash flood, 2016;
- Location: Borsod-Abaúj-Zemplén County, Sátoraljaújhely district mountain area;
- Short description of the disaster development: On 10 February 2016, flash floods occurred in Kovácsvágás and Erdőhorváti as a result of sudden heavy rainfall;
- Response activities taken by the organization: construction sandbag localization dike, pumping and decontamination;
- Equipment used by your organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / institutions: Local and to the area ordered rescue forces had cooperation, communicated through the disaster protection EDR network;
- Cross-border experiences: no;
- Lessons learned: as general described procedure.

d. Disaster 4: (Flash flood protection on tributary area of settlement Sárazsadány)

- Type of disaster and year: storm and flash flood, 2015;
- Location: Borsod-Abaúj-Zemplén County, Sárospatak district hill area;
- Short description of the disaster development: On July 17, 2015 in Sárazsadány there was a sudden heavy rain and ice, which broke branches in several places;
- Response activities taken by the organization: construction of sandbag localization dike, pumping and decontamination, removal of fallen trees, temporary restoration of building damage;

- Equipment used by the organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / institutions: Local and to the area ordered rescue forces had cooperation, communicated through the disaster protection EDR network;
- Cross-border experiences: no;
- Lessons learned: as general described procedure.

e. Disaster 5: (Flash Flood protection on tributary area of the settlements of Kishuta and Nagyhuta)

- Type of disaster and year: storm and flash flood, 2015;
- Location: Borsod-Abaúj-Zemplén County, Sátoraljaújhely district mountain area;
- Short description of the disaster development: On May 25, 2015, a sudden heavy rainfall occurred in Kishuta and Nagyhuta settlements;
- Response activities taken by the organization: construction of sandbag localization dike, pumping and decontamination, removal of fallen trees, temporary, culverts cleaning;
- Equipment used by the organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / institutions: Local and to the area ordered rescue forces had cooperation, communicated through the disaster protection EDR network;
- Cross-border experiences: no;
- Lessons learned: as general described procedure.

f. Disaster 6: (Flash Flood protection on tributary area of the settlements of Nagyhuta, Nyíri and Füzérkomlós)

- Type of disaster and year: storm and flash flood, 2016;
- Location: Borsod-Abaúj-Zemplén County, Sátoraljaújhely district mountain area;

- Short description of the disaster development: Heavy rainfall caused a flash flood coming down from the surrounding hillsides to the settlements. The rain had damaged the pavement of several streets;
- Response activities taken by the organization: construction of sandbag localization dike, pumping and decontamination, removal of fallen trees, temporary. culverts and roads cleaning;
- Equipment used by the organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / institutions: Local and to the area ordered rescue forces had cooperation, communicated through the disaster protection EDR network;
- Cross-border experiences: no;
- Lessons learned: as general described procedure.

Volunteer Firefighters Association Pálháza:

a. Disaster 1: Chimney fires

- Type of disaster and year: Series of chimney fires, 2015;
- Location: Pálháza;
- Short description of the disaster development: This year we had to respond to several (constantly recurring) chimney fires;
- Response activities taken by your organization: in addition to securing the site, we prevented the spread of fire while the tar was burning;
- Equipment used by your organization during the event: fire truck, plug ladder, fire extinguisher;
- Cooperation with other organizations / institutions: Local firefighters, Volunteer Fire Brigade Hollóháza;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

b. Disaster 2: Stubble fires

- Type of disaster and year: Stubble fires, 2015;
- Location: Pálháza;
- Short description of the disaster development: To stop fire and prevent its spread as a result of stubble set on fire after the autumn harvest;
- Response activities taken by the organization: to prevent the spread of fire;
- Equipment used by the organization during the event: fire truck, motor mowers, motor sprayers, spark arresters, portable extinguishers, iron forks;
- Cooperation with other organizations / institutions: -;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

c. Disaster 3: Search for a missing person

- Type of disaster and year: Search for a missing person, 2015;
- Location: Kishuta – Kemencepatak;
- Short description of the disaster development: Participation in the search for a person who has been missing for several days;
- Response activities taken by the organization: Forest search, securing the location until the ambulance arrives;
- Equipment used by the organization during the event: fire truck, RDR radio.
- Cooperation with other organizations / institutions: Pálháza City Municipality, professional fire brigade, Civil Guard Association Pálháza, professional fire brigade.
- Cross-border experiences (if the case): -;
- Lessons learned: -.

d. Disaster 4: Rescue a person who has fallen into a well

- Type of disaster and year: Rescue of a person who has fallen into a well, 2016;
- Location: Füzérradvány;
- Short description of the disaster development: In Füzérradvány, a person fell into a well;

- Response activities taken by your organization: The person was rescued with the help of a cord;
- Equipment used by your organization during the event: cord, harness;
- Cooperation with other organizations / institutions: professional fire brigade;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

e. Disaster 5: Participation in restoration work due to pipe rupture

- Type of disaster and year: Participation in restoration work due to pipe rupture, 2016;
- Location: Pálháza;
- Short description of the disaster development: Based on a public announcement, they marched to the affected site, where a large amount of drinking water flowed due to a pipe rupture. They secured the site and participated in the restoration work;
- Response activities taken by the organization: they performed pumping on site and started excavating the damaged pipe section;
- Equipment used by the organization during the event: 2 pumps, 1 power generator;
- Cooperation with other organizations / institutions: Zempléni Vízmű Kft. Professional fire brigade;
- Cross-border experiences (if the case): -;
- Lessons learned: -

f. Disaster 6: Removing fallen trees on the roadway

- Type of disaster and year: Removal of fallen trees on the roadway, 2016;
- Location: Pálháza;
- Short description of the disaster development: Removal of trees that have fallen on the road due to extreme weather;
- Response activities taken by the organization: Cutting and then removing trees that have fallen on the road using petrol-powered chainsaws;
- Equipment used by the organization during the event: 3 chainsaws, trailer;

- Cooperation with other organizations / institutions: Pálháza City Municipality, Professional Fire Brigade;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

g. Disaster 7: Participate in the removal of a snow-covered roadblock

- Type of disaster and year: Participation in the removal of a snow-covered roadblock, 2016;
- Location: Pálháza;
- Short description of the disaster development: Participation in the release of a road section blocked due to extreme weather;
- Response activities taken by the organization: As a result of heavy snowfall, roadblocks have formed in several parts of the settlements of Hegyköz. We took part in the response activities;
- Equipment used by the organization during the event: Fire truck, trailer, rented snow dozer;
- Cooperation with other organizations / institutions: Pálháza City Municipality, Professional Fire Brigade;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

h. Disaster 8: Storm Damage Restoration Work

- Type of disaster and year: Participation in storm damage restoration works due to extreme weather, 2017;
- Location: Megyaszó;
- Short description of the disaster development: Due to the extreme weather, the roof structures of several residential properties in Megyaszó were severely damaged. They took part in the restoration works.

- Response activities taken by the organization: The tops of the damaged residential properties have been peeled and foiled;
- Equipment used by the organization during the event: Fire truck, trailer, 3 chainsaws, 1 power generator;
- Cooperation with other organizations / institutions: Professional fire brigade, voluntary rescue organizations;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

i. Disaster 9: Demolition of an accident-prone fence, new construction

- Type of disaster and year: Demolition of accident-prone wire fence, construction of a new one, 2017;
- Location: Pálháza;
- Short description of the disaster development: The technical condition of the wire mesh fence of the football field in Pálháza has deteriorated so much that it has become very dangerous. They dismantled the fence and participated in the construction of the new fence;
- Response activities taken by the organization: They dismantled the old, accident-prone fence and participated in the construction of the new fence;
- Equipment used by the organization during the event: Fire truck, trailer, 3 chainsaws, 1 power generator;
- Cooperation with other organizations / institutions: Local NGOs;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

j. Disaster 10: Cutting accident-prone trees

- Type of disaster and year: Cutting accident-prone trees, 2017;
- Location: Pálháza;

- Short description of the disaster development: A request was received from the Reformed Church to cut down of old accident-prone trees in the parish courtyard;
- Response activities taken by the organization: Trees were cut down, cut up and then transported.
- Equipment used by your organization during the event: Fire truck, trailer, 3 chainsaws;
- Cooperation with other organizations / institutions: Pálháza Reformed Church Community;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

k. Disaster 11: Storm Damage Restoration Work

- Type of disaster and year: Participation in storm damage restoration works due to extreme weather, 2017;
- Location: Sátoraljaújhely;
- Short description of the disaster development: Due to the extreme weather, the roof structures of several residential properties in Sátoraljaújhely were severely damaged. They took part in the restoration work;
- Response activities taken by the organization: The tops of the damaged residential properties have been peeled and foiled;
- Equipment used by the organization during the event: Fire truck, trailer, 3 chainsaws, 1 aggregator;
- Cooperation with other organizations / institutions: Professional fire brigade, voluntary rescue organizations;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

l. Disaster 12: Flood damage

- Type of disaster and year: Flood remediation works in Pálháza due to heavy rains, 2018;
- Location: Pálháza;

- Short description of the disaster development: As a result of the extreme weather, the water levels of the stream beds in the town of Pálháza have risen and ran out of their beds;
- Response activities taken by the organization: Packing sandbags, performing logistics tasks, pumping;
- Equipment used by the organization during the event: Fire truck, trailer, 3 chainsaws, 1 power generator, 3 pumps;
- Cooperation with other organizations / institutions: Professional fire brigade, voluntary rescue organizations;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

m. Disaster 13: Cutting accident-prone trees

- Type of disaster and year: accident-prone trees along the bike path and in the area of the Sports Ground, 2018;
- Location: Pálháza;
- Short description of the disaster development: Request from the local government to cut down accident-prone trees in the wooded areas along the cycle path and surrounding the sports field;
- Response activities taken by the organization: Accident-prone trees were cut down, cut up and then transported;
- Equipment used by the organization during the event: Fire truck, trailer, 3 chainsaws;
- Cooperation with other organizations / institutions: Pálháza City Self-Government;
- Cross-border experiences (if the case): -;
- Lessons learned: -.

Municipality Kráľovský Chlmec:

a. Disaster 1: Flood protection on the river Latorica

- Type of disaster and year: periodic rives flood, 2010;

- Location: Košice region, Trebišov district, settlements Boľ, Zatín and Svinice;
- Short description of the disaster development: from June 12, 2010 to June 28, 2010, a flood wave hit the Latorica River, which caused dam shift;
- Response activities taken by the organization: dam protection, construction of sand bag, localization and emergency dike, slope stability berm, levee guard assistant service;
- Equipment used by the organization during the event: the necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / institutions: local and to the area ordered rescue forces had cooperation;
- Cross-border experiences : no;
- Lessons learned: as general described procedure.

b. Disaster 2: Flash Flood protection in Kráľovský Chlmec

- Type of disaster and year: storm and flash flood in years 2010, 2012 and 2014;
- Location: Košice region, Trebišov district, settlement Kráľovský Chlmec;
- Short description of the disaster development: Heavy rainfall caused flash flood coming from the surrounding hillsides to the settlements.
- Response activities taken by the organization: construction of sandbag localization dike, pumping and decontamination, removal of fallen trees and roads cleaning;
- Equipment used by the organization during the event: The necessary equipment was provided by the disaster relief financial, technical service, which the association replenishes from its stock (personal protective clothing, hand tools, etc.);
- Cooperation with other organizations / institutions: Local and to the area ordered rescue forces had cooperation;
- Cross-border experiences: no;
- Lessons learned: as general described procedure.

Town of SEINI:

a. Disaster 1: floods on the valleys of Seini City

- Type of disaster and year: Floods on Boci stream – 2017,2019; on Seini Valley, 2018 and on Village Valley in Săbișa, 2019;
- Location: Seini, Săbișa;
- Short description of the disaster development: Flooding of several households and annexes, destruction of road sections in the village of Sabisa and town of Seini. The severity and size of the flood was evaluated upon arriving at its location;
- Response activities taken by the organization: evacuation of persons and goods in danger, decommissioning of footbridges and bridges in order to restore the course of the valley to the normal riverbed, cleaning the deposits resulting from the flood;
- Equipment used by the organization during the event: fire engine, bulldozer, dirty water pump, volunteer staff equipped with shovels and other necessary tools;
- Cooperation with other organizations / institutions: in the event of these disasters, SVSU Seini was supported by ISU MARAMURES, with pumps and specialized personnel, as well as by SGA MARAMURES, who sent machines to help in decommissioning the valleys;
- Cross-border experiences: -;
- Lessons learned: insufficient or inappropriate equipment. Better motor pumps, hoses, as well as a power generator would have ensured a faster and more efficient intervention of the volunteer firefighters.

b. Disaster 2: Vegetation fire in U.A.T. Seini

- Type of disaster and year: vegetation, forest and crop fire, 2018;
- Location: Viile Apei village;
- Short description of the disaster development: a surface covered in dry vegetation caught fire, and it extended to the nearby forest. In this case, an area of approximately 30 hectares of land with orchards, vines and forest were affected.
- Response activities taken by the organization: Limiting the extension of the fire and its prompt extinguishing. Delimitation of the fire area, using different methods;

- Equipment used by the organization during the event: fire engine, firefighters, volunteers and citizens from the area were equipped with shovels and other tools to extinguish and limit the fire;
- Cooperation with other organizations / institutions: ISU Maramures, who supported the local volunteer service with firefighting vehicles and qualified personnel;
- Cross-border experiences: -;
- Lessons learned: a more performing fire engine, as well as chainsaws in order to remove fallen trees, would have reduced considerably the duration of the intervention. The protective equipment of the volunteers is necessary both for their safety and comfort during their intervention.

c. Disaster 3: Household fires

- Household fires are quite common, especially during the cold period of the year, due to improperly cleaned chimneys or other improvisations that are made at the heating installations located in the households.

Babeș-Bolyai Univeristy – Research Institute for Sustainability and Disaster Management based on High Performance Computing:

Their team members have participated in several Civil Protection training courses and excercises organized within the European Union Civil Protection Mechanism. These exercises were organized in the topic of floods and forest fires, for the training of first responders and disaster management experts.

Transcarpathian Reformed Church:

a. Disaster 1: Flood protection on the river Tisa

- Type of disaster and year: periodic rivers flood, 1998;
- Location: Upper Tisa catchment area;

  Ung county settlements (11): Bátfa, Csap, Eszeny, Kisdobrony, Kisgejőc, Nagygejőc, Szalóka, Tiszaásvány, Tiszasalom, Tiszaújfalu, Ungtarnóc.

Máramaros-Ugocsa county settlements (16): Akli, Batár, Csepe, Huszt, Királyháza, Nevetlenfalu, Péterfalva, Szőlősgyula, Tekeháza, Técső, Tiszabökény, Tiszakeresztúr, Tiszaújhely, Tiszaújlak, Tivadarfalva, Visk.

Bereg county settlements (20): Badaló, Barkaszó, Bátyú, Bene, Beregrákos, Beregsom, Borzsova, Bótrágy, Csetfalva, Csonkapapi, Halábor, Harangláb, Hetyen, Kispapi, Mezővári, Sárosoroszi, Szernye, Tiszacsoma, Zápszony, Újbátyú.

- Short description of the disaster development:

  November 1998: The Upper Tisza Basin in Transcarpathia, Ukraine experienced catastrophic losses due to floods, landslides and mudflows with 17 victims claimed; successful emergency operation in Hungary against new peaks exceeding those on record by 20-93 cm;
- Response activities taken by the organization: Organizations across Transcarpathia and an overview of the limits have sensed the flood because of the extraordinary flood. Nearly 100 people took part in the protection of the dams. During the flood, thousands of people were provided with hot food. On top of that, they were supported with various aids, clothes, food for the injured people. The organization volunteers, volunteer fire brigades, church volunteers helped with sandbag piling, storage, placement, dam making, rescuing people, sheltering, securing, meals, providing clothing, and more;
- Equipment used by the organization during the event: From their own equipment, they were able to use most of the equipment of their volunteer fire brigade units, and of their volunteers provided by other organizations or our church volunteers (tractor, boat, truck, etc.);
- Cooperation with other organizations / institutions: During the event, they cooperated with denominations of the Hungarian Reformed Church and volunteers of other churches. We have been in constant consultation with state and municipal leaders;
- Cross-border experiences: A lot of help came from Hungary, financial and material assistance, and the involvement of experts in the protection;
- Lessons learned: After application, the rescue activity revised based on the official church records report.

b. Disaster 2. Flood 2001

- Short description of the disaster development: March 2001: extreme floods along the Upper Tisza, several dike breaches and 9 victims in Ukraine, in Hungary previous peaks were exceeded between Tiszabecs and Záhony in a magnitude of 1-56 cm; dike breach on the right bank of Tisza River near Tarpa, 26,000 ha flooded in Hungary and another 6,000 ha in Ukraine, 8 1/2 communities were flooded and evacuated, another 9 communities were successfully defended by confinement activities);
- Response activities taken by the organization: The organization volunteers, volunteer fire brigades, church volunteers helped with sandbag operation, storage, placement, isolation dam construction, rescuing people, sheltering, securing, meals, providing clothing, and more humanitarian assistance activities;
- Equipment used by the organization during the event: From their own equipment, they were able to use most of the equipment of their volunteer fire brigade units, and of their volunteers provided by other organizations or their church volunteers (tractor, boat, truck, etc.);
- Cooperation with other organizations / institutions: During the event, they cooperated with denominations of the Hungarian Reformed Church and volunteers of other churches. They have been in constant consultation with state and municipal leaders;
- Cross-border experiences (if the case): A lot of help came from Hungary, financial and material assistance, and the involvement of experts in the protection. Besides that, their two-firefighter brigade continuously throughout the year eliminates fires all across the Transcarpathian region. Their firefighters also helped during the floods in Hungary;
- Lessons learned: After application, the rescue activity revised based on the official church records report.

8. Cooperation with other national and international organizations / institutions in the field of disaster response / management

Zemplén Region Civil Protection and Disaster Management Association:

The association cooperates with other county civil protection associations in the system of the Hungarian Civil Protection Association. It is a member of the Hungarian national network of the DAREnet project: http://darenetproject.eu/hu/.

Volunteer Firefighters Association Pálháza:

The association cooperates with other volunteer civil protection associations from Hungary, such as:

- Hollóháza Voluntary Firefighter and Civil Protection Association
- Vágáshuta Volunteer Firefighters and Civil rotection Association
- Kovácsvágás Volunteer Firefighter and Civil rotection Association.

***Municipality Kráľ'ovskýChlmec*:**

- local authorities, local response agencies (coordination of emergency activities);
- Slovakian Government (professionals, equipment, financial assistance);

Town of Seini:

The organizations and the field of cooperation:

- County Inspectorate for Emergency Situations MARAMURES, in case of all types of disasters;
- Maramures Water Management Service (SGA Maramures) in case of floods.

Babeș-Bolyai Univeristy – Research Institute for Sustainability and Disaster Management based on High Performance Computing:

National collaboration:

- General Inspectorate for Emergency Situations;
- Ministry of Environment;

- National Environmental Protection Agency;

- National Environmental Guard;
- CN APELL-RO Foundation;
- Geography Institute of the Romanian Academy;
- EHC - Environmental and Health Center, Cluj-Napoca.

International collaborations:

- ECHO - European Commission's Humanitarian Aid and Civil Protection Department;
- DPPI - Disaster Preparedness and Prevention Initiative for South-Eastern Europe;
- IFRC - International Federation of Red Cross and Red Crescent;
- DiMTEC - Disaster Management Training and Education Center for Africa;
- NILU - Norwegian Institute for Air Research;
- NKE - National University of Public Service, Hungary;
- CK-TRIKOLOR - Technical Risk Identification, Hungary.

Transcarpathian Reformed Church:

The organizations and the field of cooperation:

- local governments, local response agencies (coordination of emergency activities);
- Hungarian Government (professionals, equipment, financial assistance);
- Dorcas Aid - Hungary Foundation (aids, tools);
- Hungarian Reformed Church Aid (aids, tools, clothing, food);
- Hungarian Charity Service of the Order of Malta (rescue equipment - boats, rubber clothes, etc.);
- Johannita Humanitarian Service (tools, clothing, logistics);
- Hungarian Interchurch Aid (clothing, food).

CHAPTER II. HAZARD AND RISK ANALYSIS

Disasters can cause a lot of damage, depending on their nature and characteristics, their magnitude, their impact speed and their origin. There are certain types of disasters, but each event is unique considering the vulnerability aspects of communities and their exposure to hazard.

One of the most important concerns of human society is to ensure the health, safety and security of life, belongings of society members, cultural, material and social values.

Unfortunately, disasters are familiar to all of us, floods, earthquakes, torrential rains, frost or heat, forest fires, as well as various man-made disasters have become quite common, as if entering everyday life.

In recent years, increasingly devastating disasters have affected the global population. One of the essential problems in the fight against destruction, regardless of their nature - natural or anthropic, is the ability of institutions and organizations to act in a unitary manner, in an integrated system, in such situations. This capacity is realized through an adequate and competent management, applied to the specifics of such situations.

In the field of risk and disaster emergencies, there have been several approaches to defining the management. A characteristic feature in defining management in the field of emergency situations is the fact that the terms risk, disaster, emergency or hazard are often used as having the same meaning but usually having a fairly comprehensive meaning for emergency situations.

UNISDR, (2009) “Disaster Risk Management: The systematic process of using administrative decisions, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disasters”. This term is considered to be an extension of the more general term "risk management" to highlight the specific issues of disaster risk. Disaster Risk Management aims to avoid, reduce or transfer the adverse effects of hazards through activities and specific measures to prevent, minimize and preparedness.

An integrated approach of disaster management includes: pre-disaster actions which are preparedness and prevention measures, actions during disasters materialized in intervention to limit the effects, helping those affected and post-disaster actions consisting in rehabilitation, reconstruction and economic recovery.

The most important steps of risk management are: hazard identification, the qualitative and quantitative analysis of risks, the cost-benefit analysis with change management and decision making. Hazard identification is usually the starting point for the risk assessment process. There are methodologies developed and adopted at European level, such as the Risk Assessment and Mapping Guidelines for Disaster Management of the European Commission (European Commission, 2010), or the national risk assessment methodologies used for the identification of most important hazards and risks in European Member States (IGSU, 2016; Katasztrófavédelem, 2014).

Disaster and emergency management issue has become one of the most current issues in the world in recent years.

1. Hazards

We all live with the hazards; there is no possibility of defining a "safe" area for individuals, society and environment. No matter where people are at home, at work, in the city, in the car, train or plane, at the top of the mountain or at the sea, they are exposed to a number of dangers and risks. In some areas, there are people who live with a relatively high level of risk to natural hazards, such as earthquakes and floods while in other places the major risk is represented by technological hazards.

Natural and anthropogenic hazards generate numerous losses of human life and property damage every year, which directly affect the economic and social development. Over time, the hazards changed their patterns, they expanded and became more frequent, becoming more and more difficult to predict. Under these conditions, efforts to prevent hazards and mitigate their impact on society need to become integral parts of sustainable development policies. This requires a good knowledge and understanding of them and the associated risks as well, which in close correlation with the degree of vulnerability can produce disasters with devastating effects on communities, environment and society in general.

1.1. The concept of hazard

There are many definitions for hazard. In “Multilingual Environmental Glossary” edited by Environmental Terminology and Discovery Service (ETDS) within European Environment Agency, hazard is defined as: “Threatening event or probability of occurrence of a potentially damaging phenomenon within a given time period and area” (EEA, 2000).

Mitchell and Cutter (1997) describe the hazard like: "Hazard is the broadest term and reflects a potential threat to humans as well as the impact of an event on society and the environment...hazards are... In part socially constructed by people's perceptions and their experiences. Moreover, people contribute to, exacerbate, and modify hazards. Thus, hazards can vary by culture, gender, race, socioeconomic status, and political structure as well”.

Another element can be observed in the hazard description - the society, through the connection that is made with the perceptions and experiences of the people, suggesting the idea that the hazards must be addressed in direct correlation with the people, with the society.

MacCollum (2006) describes the hazard like “A situation that poses a level of threat to life, health, property or environment”. He also considers that „Most hazards are dormant or potential, with only a theoretical risk of harm; however, once a hazard become “active”, it can create an emergency situation. A hazard does not exist when it happens. A hazardous situation that has come to pass is called an incident. Hazard and vulnerability interact together to create risk”.

There are a lot of definition regarding the term of “hazard” because there are numerous authors and numerous papers addressing this topic. Over time, there have been numerous concerns regarding the complex problem of the risks represented by these events and the definition and use of the most appropriate terms. In the specialized literature, different terms (extreme phenomena, dangerous phenomena, hazard, risk, calamity, disaster, catastrophe, cataclysm, etc.) are used to size and quantify the magnitude of particular natural or anthropogenic events and the property damage produced.

In these conditions, it was necessary the elaboration of norms in order to use a unitary terminology at international level for the research of such events.

An important contribution was done in 1992 by the UN and the IDNDR (International Decade for Natural Disaster Reduction) Secretariat, of a dictionary of terms, “Internationally agreed glossary of basic terms related to disaster management ”, regarding the main terms used in disaster studies. According to the definition from this dictionary, hazard is considered to be a "threatening event or probability of occurrence of a potentially destructive phenomenon in a particular region at a certain time" (UNDHA and IDDR, 1992).

In 2009 the term hazard , in “UNISDR terminology on disaster risk reduction”, is defined like „a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage” (UNISDR, 2009).

1.2. Hazard classification

We can say that it is generally accepted that hazard is a threat and not an event itself. Of course in any case, the hazard contains a certain degree of danger, involving, in most cases, extreme events.

It may also include latent conditions, which may represent future hazards and may have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological risks). Hazards can occur in the form of single events, combined or sequentially interposed into causes and effects.

Such extreme events have a random character. They can be large, unpredictable phenomena, often constituting true qualitative leaps, thresholds in the evolution of a system, which releases huge energies and determines disorders, imbalances on the normal evolutionary scale of society and environment.

Any hazard can be characterized by a certain geographical location, intensity or magnitude, frequency and probability of manifestation. It has a dynamic tendency (it is related to a particular magnitude and a specific return period), so it is quantified by the magnitude-frequency relationship, based on historical archives or probabilistic modelling.

There are numerous and different hazard classifications. These classifications differ and are specific to the respective fields and needs for which they were developed and in accordance with the purpose (geography, geology, environment, disaster management, etc.).

- **Classification based on origin**

- **Natural hazards** - natural processes or phenomena that have the potential to cause life loss, injury or damage to human health, destruction or deterioration of goods, livelihoods, infrastructure, utilities and services, deterioration of environmental factors or serious ecological imbalances producing such serious social and economic disturbances within communities.

  - ✓ **geological hazards** - geological processes or phenomena that include internal processes within the earth, such as earthquakes, volcanic activity and emissions, specific geophysical processes such as mass movements, landslides, surface collapses, and debris or mud runoff, Tsunami waves.

- ✓ **hydrometeorological hazards** - processes or phenomena of an atmospheric, hydrological or oceanographic nature, including tropical cyclones (also known as typhoons and hurricanes), storms, hail, tornadoes, mistletoe, massive snowfalls, avalanches, coastal storms, floods including flash floods. Each of the hydrometeorological hazards has their own natural characteristics that define them: the geographical area where they occur, the probable period of occurrence, the severity and associated risks. These characteristics allow the identification of each hazard, but many hazards included in this category are interdependent, which is in fact the basic reason for establishing this category. In most cases, a natural disaster or event involves multiple hazards. It is very likely that several hazards in this category will produce effects simultaneously; in this case it may be difficult to attribute damage to a single hazard.
- ✓ **climatic hazards** - processes or phenomena with a long period of installation and manifestation with global influences on the climate, which include, global warming, drought, heat waves and cold waves, changes of the El Nino current, increase of the greenhouse effect, thinning of the ozone layer, micro climatic changes.
- ✓ **biological hazards** - hazards that have organic origin, come from living organisms, are biological substances that pose a threat to the health of living organisms, first of all human beings but also animals. It can be included pathogenic microorganisms, toxins and bioactive substances, fungi, animals, insects, bacteria and viruses as well as biological vectors through which certain diseases that cause epidemics or epizootics are transmitted. This category may include medical waste or samples from a microorganism, virus or toxin (from a biological source) that may affect human health.
- ✓ **cosmic hazards (astrophysics)** - hazards that originate outside the Earth's atmosphere, such as cosmic radiation, comet collisions, black holes, UV radiation, geomagnetic storms, meteor falls, or various objects in the cosmos (satellites, spacecraft).
- ✓ **other natural hazards** - forest fires and vegetation fires.

- **Technological hazards** - which come from activities, processes, operations or technological or industrial conditions, including accidents, dangerous procedures, infrastructure failures, unintended malfunctions of technology, including human and system actions.

It can be said that these hazards occur as a result of human interaction with the environment: for example, the use of hazardous substances, industrial, nuclear, or transportation accidents, the failure of public utilities; failures in computer technology, release of hazardous materials and collapse of buildings, fires and spills of chemicals, industrial pollution, nuclear radiation, toxic waste, dam damage.

- ✓ **damage to hydrotechnical constructions** - collapses or malfunctions of dam structures, dams or other works that produce floods downstream;
- ✓ **nuclear accidents** - uncontrolled release of radioactive materials or radiation to nuclear power stations or other nuclear reaction facilities or during the transport of materials;
- ✓ **collapse of constructions, installations or industrial facilities**;
- ✓ **failure of public utilities** - vital and large public utilities: important radio networks; television, telephony, communications, electricity, gas, centralized thermal energy, water supply, sewage and sewage and stormwater treatment;
- ✓ **transport accidents** - land, air and sea transport, including subway, tunnels and cable transport;
- ✓ **mining accidents** - landslide heap, tailing dams failures, including lanslides caused by mining or other specific technological activities;
- ✓ **transportation and storage of hazardous products** - accidents during the transportation of hazardous materials including in pipeline systems;
- ✓ **industrial pollution** - environmental factors pollution with effects on human life and health, ecosystems destruction;
- ✓ **events with hazardous material** - uncontrolled release of hazardous materials from producing companies, handling or storing hazardous substances;
- ✓ **industrial accidents** - accidents, breakdowns of industrial facilities that can cause human life loss and material damage;

- ✓ **explosions and fires** - accidents at producing companies, handling or storing flammable and explosive substances;
- ✓ **mass fires** - large fires that can generate major negative consequences on the normal development of social-economic activities, as well as on the environment (excluding forest fires);
- ✓ **unexploded ammunition** - unexploded or inactivated ammunition left during military conflicts
- ✓ **historical contamination and toxic waste deposits** - events that lead to releases, discharges, dispersions, etc. of hazardous substances.
- ✓ **falling objects from the atmosphere or from the cosmos** - satellites, space crafts, ballistic missiles out of control

- ***Complex hazards*** -

- ✓ **terrorist attacks, armed conflicts** - these by their nature are very complex hazards, but at the same time are a trigger factor for other types of casualties;
- ✓ **technological hazards**, which can occur, directly as a result of the event effects belonging to natural hazards producing Natech disasters.
- ✓ **phenomena of soil erosion or desertification due to over** - exploitation or degradation of land and environment resources.

- **Classification based on manifestation area**

- **Punctual hazards** - presents potential danger on restricted areas, dispersed within a community;
- **Local hazards** - presents potential danger at the level of a territorial administrative unit (commune, city, municipality);
- **Zonal hazards** - presents potential danger in two or more localities within a county or at the level of the entire county;
- **Regional hazards** - presents potential danger on an area that comprises two or more counties;
- **Hazards with effects at national level** - presents potential danger on more than 30 % of counties, without exceeding the national territory

- **Cross-border hazards** - presents potential danger on areas that exceed the country limit, threatening also on the territory of the neighbouring states.

- **Classification based on magnitude or severity**

The hazard intensity or magnitude is given by the severity of the possible consequences in case of an impact. For the qualitative assessment of the hazards magnitude there can be used five levels:

1. *Minor hazards* - possible consequences:
    - Property damage: insignificant;
    - For persons: insignificant injuries;
    - Environment: minor adverse effects, which are for short-term and reversible;
    - Social: insignificant without cause for concern;
    - Infrastructure and services: there are no malfunctions.
2. *Significant hazards*- possible consequences:
    - Property damage: 10% affected properties;
    - For people: slight injuries, first aid is required;
    - Environment: minor, for short-term and reversible damages;
    - Social: slight decrease of life quality;
    - Infrastructure and services: affected for max. 24 hours.
3. *Severe hazards* - possible consequences:
    - Property damage: affected properties (>10% and <25%);
    - For people: injuries, medical treatment is required but do not lead to permanent disability;
    - Environment: damages, for medium-term, reversible;
    - Social: decreasing the quality of life, reduced production capacity;
    - Infrastructure and services: affected, some closed for more than a week.
4. *Critical hazards* - possible consequences:
    - Property damage: properties affected (> 25% and <50%);
    - For persons: serious injuries, possible medical treatment is needed, permanent disability;

- Environment: serious damage, affected ecosystems, reversible through long-term programs;
- Social: severely affecting the quality of life, interrupting the production activity;
- Infrastructure and services: severely affected, some closed at least two weeks.

5. *Catastrophic hazards* - possible consequences:
    - Property damage: affected properties (>50%);
    - For people: multiple deaths, serious injuries, possible medical treatment is needed, permanent disability;
    - Environment: destruction of ecosystems, irreversible damage;
    - Social: severely affecting the quality of life, interrupting the production activity;
    - Infrastructure and services: severely affected, some closed over 30 days.

- **Classification based on frequency**

Very low frequency hazards - events that occur frequently less than once per 1000 years (less than 0.1% per year)

Low-frequency hazards - events that occur from once in 100 years to once in 1000 years (0.1% to 1% per year)

Moderate frequency hazards - events that occur from once in 10 years to once in 100 years (1% to 10% per year)

High frequency hazards - (events that occur from once in 1 year to once in 10 years (10% to 100% per year)

Very high frequency hazards - (events that occur annually (100% per year)

- **Classification based on probability**
    - *Improbable* - it may occur in exceptional circumstances; IMPROBABLE
    - *Unlikely* - it can occur at some time - ISOLATED;
    - *Possible* - it may occur at some time - OCCASIONAL;
    - *Likely* - it can occur in many situations - PROBABLE;
    - *Almost certainly* - it occurs in most situations - FREQUENT;

1.3. Hazard identification and assessment

1.3.1. Hazards analysis

The hazard analysis aims to identify and assess the potential hazards in a specified area. For the risks analysis as part of disaster management, it is important and necessary to be taken into consideration, when assessing the hazards, the following characteristics: magnitude or severity, frequency, probability and manifestation area.

In order to analyse the extent and frequency of natural disasters there are several options regarding the potential sources of information and the methodologies that can be used.

Information sources: data records, historical records, instrumental records, geological and geomorphological investigations, geotechnical investigations, modelling, expert experience.

Assessment methodologies

Various sources of information can be used in order to estimate the hazards. In certain situations, it may be possible to calculate the hazards and to express them quantitatively; in other cases, a qualitative estimation will be made. The quantitative estimation provides an objective, quantifiable measure of danger that can be compared and evaluated together with other similarly estimated hazards. In certain situations, if the analysis resources are limited, or if there is insufficient data, a qualitative estimation is made, based on analogy with similar areas, or by using the experts' expertise. Such initial, qualitative estimation can be reassessed and subsequently argued based on scientific calculations and evidence as they become available.

In the case of quantitative analysis, the frequency of natural disasters is expressed based on the number of events with a certain magnitude (severity), per unit of time (for example, the number of earthquakes of magnitude greater than 5.9 per 100 years). The inverse of the frequency is the period, the average interval between these events.

Technological hazard analysis involves the hazards identification in a site or facility and assessment of possible scenarios that may produce undesirable consequences. The hazard analysis stage is a very important part of the risk management process, because no action to avoid or to reduce the effects can be done unless the hazards are identified. Hazard analysis is based on a structured and systematic approach to identify the potential risks. There are a large number of techniques that can be used to perform this task, at various stages of the process life cycle. Hazards can be identified with specific methods from the design phase, or later in all stages of the facility, up to the operating phase. From disaster management intervention plans point of view, if such analyses were performed in the previous stages of the facilities, the obtained data will be used for risk analysis. If such analyses have not been performed, the hazards will be identified and analysed in the operating phase, so we are interested in ways of hazards analysis which are applicable in this phase.

The qualitative analysis has as main objective the establishment of the possible hazards list, it makes possible the events hierarchy in the order of the risk and presents the first step in the methodology for risk analysis.

The complexity of the phenomena involved in the natural and technological hazards development and the different impact on human activities require the mobilization of interdisciplinary studies.

2. Vulnerability

2.1. The concept of vulnerability

Vulnerability is a multidimensional concept and is defined in the literature in many ways. Although vulnerability is a simple intuitive notion, it is difficult to define and even more difficult to quantify and operationalize. Vulnerability as well as the notion of hazard, the vulnerability was defined by the different groups that use such notions, depending on the different needs that these groups have (academic field, disaster management companies, organizations dealing with climate change).

The term vulnerability in correlation with hazards and risks has been used since the 1970s from the field of social sciences.

In the opinion of R. Chambers (1989), referring to the vulnerability of communities and their livelihoods - the vulnerability is, in principle, the exposure "to contingencies and stress and also difficulty in coping with them". Thus, Chambers proposes two components for vulnerability, one internal and one external: the external component related to exposure to external shocks and stress, and the internal component, associated with the inability to cope without damaging losses (Chambers, 1989, cited by Villagran, 2006).

Correira considers the vulnerability as an expression of failure, emphasizing the primordiality of the damages suffered, in relation to the duration of the event, "Vulnerability expresses the severity of failurein terms of its consequences. The concern is not how long the failure lasts but how costly it is" (Correira et al., 1987, citat de Thywissen, 2006).

Pelling defines vulnerability „as exposure to risk and the inability to avoid or absorb potential harms". In his approach he defines three types of vulnerability, considering the physical vulnerability as belonging to the physical environment; social vulnerability attributed to social, economic and political people and systems; and human vulnerability as a combination of physical and social vulnerability (Pelling, 2004).

A number of international organizations have approached the concept of vulnerability, in accordance with their specific activities.

UNDRO, United Nations Disaster Relief Organization has defined the „Vulnerability is the degree of the loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss)" (UNDRO, 1991).

ISDR (International Strategy for Disaster Reduction) considers „vulnerability as characteristics determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (ISRD, 2004).

UNISDR in Terminology on Disaster Risk Reduction 2009 shows that vulnerability represents „the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (ISDR, 2009).

There are different aspects of vulnerability, resulting from different social, economic and environmental factors.

This may include the poor design and construction of buildings, inadequate protection of assets, the lack of public awareness and information, limited official recognition of risks and preparedness measure and disregard for adequate environmental management. Vulnerability varies significantly within a community and over time. This definition identifies vulnerability as a feature of the element of interest (community, system, or assets) that is independent of its exposure. However, in common usage the word is often used more broadly to include the exposure of the element.

The vulnerability is determined by multiple factors (economic, ecological, social and political), which interact in complex ways, and this complexity takes different forms in different locations. Therefore, vulnerability does not have a universally accepted definition and most scientists agree that it is essential for users to define vulnerability in their own context (Downing, Patwardhan, 2004).

Addressing the concept of vulnerability we must consider three periods of system evolution in correlation with the hazards; the period before the impact, the impact period and the period after the impact. These periods define three different components of the vulnerability, which together give the actual size of the system vulnerability.

The first component, specific to the period before the impact, is defined by the exposure to hazard and is characterized by the risk of occurrence of a dangerous event, the ability to anticipate the impact and the development of the ability to withstand the impact.

The second component specific to the impact period is the resistance as the ability to cope with the hazard impact to which they are exposed, to maintain the essential operating conditions of the system, the ability to deal with it, to absorb the impact and to maintain the system balance.

The third component considers the period after the disaster, called resilience, is characterized by the ability to recover the losses caused by the impact and restore the system balance.

The factors that determine the system characteristics can be:

- **Physical factors** that include the location and infrastructure characteristics and can be represented by factors such as the disposal in a dangerous area, the degree of isolation of an objective, the degree of buildings and infrastructure protection, the building materials and the techniques used to build the infrastructure, excessive urbanization, population density. This category also includes environmental factors that refer to the depletion and degradation of natural resources, the probability of pollution with toxic and dangerous substances, access to clean water, clean air and sanitation, inadequate waste management.
- **Social factors** refer to social problems, such as the lack of local institutions, the standard of living of individuals, the level of population health, the degree of preparedness of the population for emergencies, the existence of special groups of people at risk, the respect of human rights, social equality, traditional values and beliefs and the organization system.

Economic factors include low level of income, individual, local and national economic reserves, risky livelihoods, level of debt and access to loans, loans and insurance, local investments, diversity of the economy.

The analysis of the vulnerability models presents an unequal distribution of the specific risks for the different groups of people. The most vulnerable groups include the poor, indigenous populations, women and children, people with disabilities, the sick people.

The hazards characteristics refer to the harmful potential of dangerous phenomena or processes, substances, human activities or specific conditions, which can cause loss of life, injury or damage to human health, destruction or deterioration of goods, livelihoods, infrastructure, utilities and services, environmental damage or serious ecological imbalances, thus causing serious social and economic disturbances within the communities.

The vulnerability can also be perceived as the interface between exposing human well-being to the specific threats of different types of hazards and the ability of people and communities to cope with these threats.

Many natural phenomena represent threats, including extreme events, such as floods, drought, fires, storms, tsunami eruptions, landslides, volcanoes, earthquakes, insect swarms, etc.

Human activities have added to this list the technological threats from pollution, explosions, chemicals and radioactive contamination, other technological incidents, to complex situations such as terrorist attacks or armed conflicts.

The vulnerability concept is an important component of risk analysis which focuses primarily on natural hazards.

Vulnerability analysis is used by international organizations and research programs in the field of poverty reduction, sustainable development but also in the field of risk reduction and humanitarian aid. This activity contributes to the identification of vulnerable systems and the identification of causes as well.

These analyses are used to develop relevant recommendations for decision makers on how to reduce vulnerability and adapt to change. Regarding the vulnerability reduction Clark considers that is necessary to identify the seek points of intervention in the causal chain between a hazardous event and the human consequences (Clark et al., 1998).

Determining vulnerability means asking ourselves what would happen if a particular event creates an impact on a system exposed to risk (for example, a community).

The vulnerability evolves, is changing over time and differs in space, regarding this Rashed showed that "Vulnerability cannot be evaluated in absolute terms ...it should be evaluated with reference to specific spatial and temporal scales" (Rashed, Weeks, 2002).

In practice, a vulnerability analysis will often be limited to a certain scenario, and a certain extent of the event. This type of approach is appropriate for vulnerability assessment, but choosing the scenario for the event is difficult, sometimes subjective and is specific to each type of hazard.

There are many factors that influence vulnerability like physical, social, economic and environmental factors and many of them are not easy to quantify.

The vulnerability complexity is not only given by the multitude of factors, but also by the fact that it is specific to the location and because of this, the parameters change on a geographical scale. The parameters that determine the vulnerability are different at the household, community, and country level.

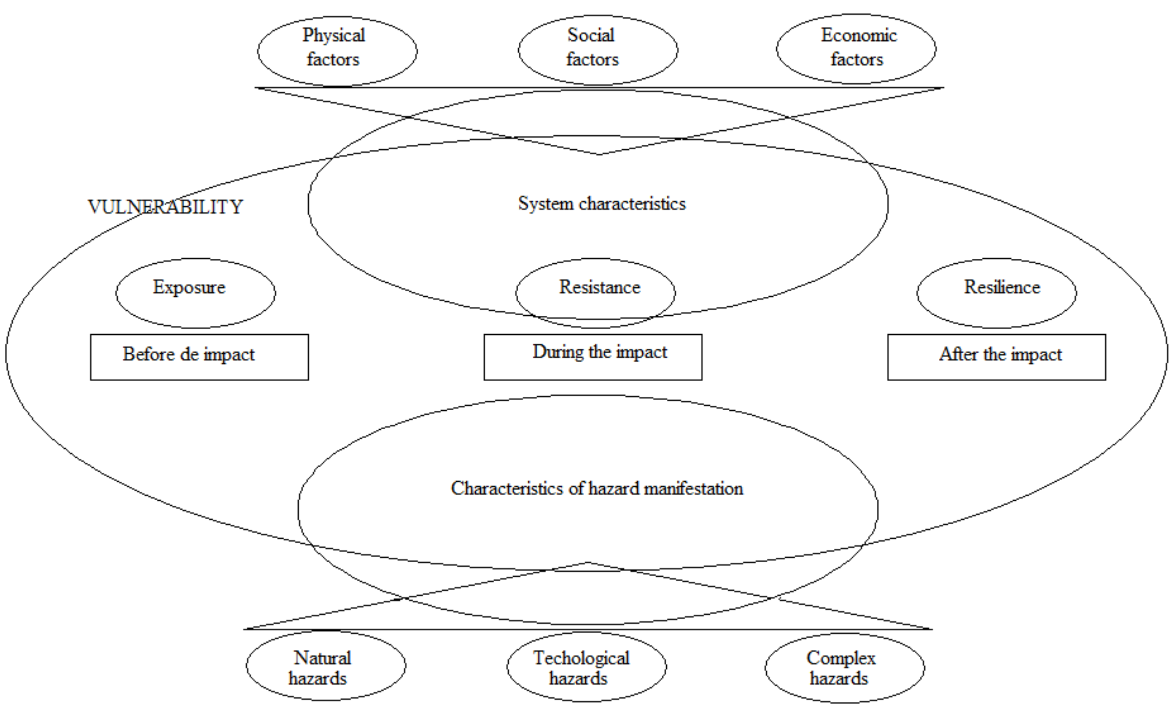

Figure II.1. *Factors which influence the vulnerability*

3. Exposure

3.1. The concept of exposure

Exposure is a component of disaster risk, together with vulnerability and hazard.

Similar to other concepts, "exposure" is the subject of numerous theoretical debates. Its definition varies according to the application field. In several scientific articles, exposure is considered a component of vulnerability, together with sensitivity and resilience. Exposure is considered to be the total value of elements at risk. It is expressed through the number of human lives and goods values which could be affected by hazards. Exposure is a function of the geographical location of the elements at risk. According to some experts, exposure represents the property of elements to be subject of hazard impact. This may be constant or variable in time. UNDP (2004) considers that exposure includes the entire population and the goods exposed to hazards. Sorocovschi, 2007 defines exposure as being the layout of goods with the aim of preserving them, and which may suffer damages produces by a natural hazard (Sorocovschi, 2007).

In recent years, several attempts have been initiated to define and establish exposure assessment methodologies. Particular attention was paid to the exposure and impact of chemical hazards on the population and the environment.

Regarding the environmental risks, exposure assessment is focused on characterizing the nature of the geophysical processes that present risks, including the magnitude, frequency, spatial dispersion, duration, onset velocity, time, and temporal spacing of physical conditions.

In order to analyse the exposure The United States Environmental Protection Agency uses initial tools for prioritization, the screening as well as higher-level tools. The initial tools include a database as a ranking source and use group scoring systems. Screening tools include chemical screening tools for exposure to environmental releases, screening tests, etc. Higher-level tools include geographical exposure modeling systems. However, these systems and tools are widely used to analyze exposure to chemicals or toxicants (EPA, 2011).

The exposure is expressed as a percentage, indicating how much of the analyzed elements are in the hazardous area. For the risk calculation, these percentages are expressed in values between 0.1 and 1.

While vulnerability determines the impact severity that a hazard may have on the risk elements, exposure is what gives the true value of the damage.

The exposure to hazard is relatively constant in an area, the vulnerability involves the reaction of the human society, the qualitative and quantitative level of its training and reaction to the danger, and the combination between those two, quantitatively defines the risk.

4. Risk

4.1. The concept of risk

The concept of risk is used in different fields with different meanings and in different contexts. The interpretation of this concept is related to the domain of use and responds to the specific requirements.

Many times the risk is considered to be the same as hazard or vulnerability. All these concepts refer to certain damages or expected damage.

The probability of occurrence must be taken into consideration, this being the characteristic of the risk, practically the risk is the probability that a certain hazard will occur.

While the vulnerability informs about the consequences of possible negative events, the risk also provides information regarding the probability of such events occurring.

There are many definitions for risk, depending on the field and context.

- "Risk can be defined as the likelihood, or more formally the probability, that a particular level of loss will be sustained by a given series of elements as a result of a given level of hazard. The elements at risk consists of populations, communities, the built environment, the natural environment, economic activities and services, which are under threat of disaster in a given area." (Alexander, 2000).
- "Risk is characterized by a known or unknown probability distribution of events. These events are themselves characterized by their magnitude (including size and spread), their frequency and duration, and their history" (Alwang et al., 2001). (In this definition risk and hazard are used as synonyms)

- "Risk: the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon, and consequently the product of specific risk and elements at risk.

[…]

The capacity of a system, community or society to resist or to change in order that it may obtain an acceptable level in functioning and structure. This is determined by the degree to which the social system is capable of organising itself, and the ability to increase its capacity for learning and adaptation, including the capacity to recover from a disaster."(Cardona et al., 2003).

- “Mathematical product between hazard and vulnerability expressing the connections between an event and its consequences” (Slaymaker,1999)

- " Risk’ is the probability of a loss, and this depends on three elements, hazard, vulnerability, and exposure. If any of these three elements in risk increases or decreases, then the risk increases or decreases respectively."(Crichton, 1999).

The diversity of approaches in defining the risk lies in the perspective of the type of analysis that are considered.

Risk can be expressed mathematically, as the product of hazard (H), elements exposed to risk (E) and vulnerability (V):

$$\mathbf{R = (H * V) * E}$$

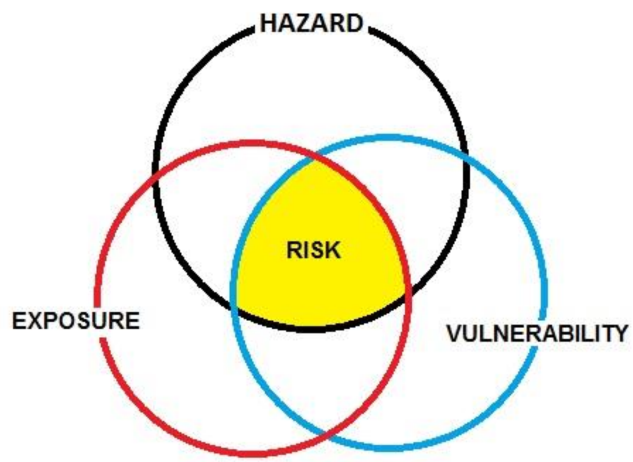

Figure II.2. *Risk based on hazard, exposure and vulnerability*

Therefore, the risk exists depending on the size hazard (natural or anthropic hazards), the elements exposed to the risk (population, goods, infrastructure, economic activities, etc.) and their vulnerability (the extent to which the evolution of a system can be negatively influenced by the impact of a hazard).

4.2. Risk assessment

Since the beginning of his existence, the man has been under permanent threat of natural hazards.

As the human society develops, new threats have emerged, the anthropic ones, created by the humans through industrial development or through destructive and invasive actions on environmental factors.

The need for identification new natural resources, as well as the need for expending the living space, causes human communities to be exposes at risk, even if these risks cannot be controlled and their effects cannot be fully identified.

These hazards can occur with exceptional forces. They can cause damage to ecosystems and human communities. Usually, only when people's lives or the integrity of property can be affected, we are concerned with conducting risk assessments.

The French geomorphologist J. Tricart, in an article on natural and technological hazards and risks, distinguishes between the terms hazard and risk (Tricart, 1992).

Hazard becomes a risk only when it threatens a human being or object. When this risk was realized and managed to cause significant damage, it could be a catastrophe.

Risk analysis is a very complex and difficult activity considering the multitude of risk elements, parameters and variables that must be taken into account.

So the risk could be appreciated between certain limits, but its manifestation is accidental, respectively, it is not known when, where, and under what form the "anticipated" event will appear (Ianoş, 1994).

Natural hazards analysis methodology

In this study, due to the hazards particularities, the floods are analysed at the level of hydrographic basin of Tisza river and the fires are analysed at the county level and in more detail for the areas included in the project.

Own territorial risk analysis

Country reports, country hazard and risk maps are also used to identify all possible natural and man-made hazards in the project area. A multi-hazard and multi-risk analysis is conducted for each country’s project area.

Unfortunately there is no unitary methodological approach addressing the Areas with Significant Potentially Flood Risk (APSFR) mapping between the countries concerned. This issue makes difficult to unitary approach this concept.

GIS - Database and processing

Data types and sources

To analyze the flood and forest fire hazard we created a general GIS database for the area of the project. During this process we identified several data sources at European level and several other national data sources.

Methodology

The main steps in order to build the database are:

a. Identify all possible data sources

b. Process the primary data in order to obtain derivate results

c. Process the data in order to determine the hazard and risk areas

d. Create dedicated maps

The process was not a seamless one, several problems being identified during the database buildup.

The first and major one was the lack of data for Ukraine. The other partner countries being part of the EU there was data available in direct usable form (vector and raster data). As for Ukraine the data accessibility is scarcer and thus, we encountered problems matching the data from the EU countries with data from Ukraine.

At first, we collected data from ICPDR (International Commission for the Protection of Danube River), considering the entire Tisa river basin. Other data sources included the European Environmental Agency and Copernicus project database.

Rivers and river catchments were obtained from European catchments and Rivers network system (ECRINS), a spatial database developed by JRC, Corine land Cover, WFD reporting elements and other sources. Catchments are drained by 1,348,163 river segments, sorted as “main drains” and secondary drains. Each segment is populated with distance to the sea, to ease further processing.

Country borders were downloaded from Natural Earth database. This is a public domain map dataset available at 1:10m, 1:50m, and 1:110 million scales. Featuring tightly integrated vector and raster data, with Natural Earth you can make a variety of visually pleasing, well-crafted maps with cartography or GIS software

County borders were obtained from the Eurostat/GISCO database with the exception of Ukraine. Within Eurostat, GISCO is responsible for meeting the European Commission's geographical information needs at 3 levels: the European Union, its member countries, and its regions.

Regional borders for the Zakarpattia Oblast were obtained from the regional authorities website.

Local area units (LAU) data for ROU, HU and SK was obtained from Eurostat. Population data was downloaded and related to the unique identifiers from the LAU database. For Ukraine this type o data was more difficult to obtain.

The LAU borders were downloaded then population data was compiled from different governmental websites. At first the Ukrainian data was obtained as polylines, so it needed processing to be converted into polygons.

For the EU countries we used a Digital Surface Model (DEM) obtained from Copernicus database. EU-DEM is a digital surface model of EEA member and cooperating countries representing the first surface as illuminated by the sensors. It is a hybrid product based on SRTM and ASTER GDEM data fused by a weighted averaging approach. It was downloaded from the EEA website. The spatial resolution for this dataset is 25 meters.

As this model was not available for Ukraine we obtained equivalent data from the Natural Earth database.

Considering the different sources of data, it was mandatory to process the raw data. This includes projecting the data, converting between formats and several other geoprocessing tools.

For the EU spatial data is usually available using the Lambert Azimuthal Equal Area projection (EPSG:3035). The raw data for Ukraine is WGS84 (EPSG:4326). In order to avoid data issues, the Ukrainian dataset was projected into EPSG:3035 which’s scope is to represent a single CRS for all Europe. It is used for statistical mapping at all scales and other purposes where true area representation is required.

Land use data was obtained from CORINE Land Cover (CLC) inventory. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. The time series are complemented by change layers, which highlight changes in land cover with an MMU of 5 ha. Different MMUs mean that the change layer has higher resolution than the status layer. Due to differences in MMUs the difference between two status layers will not equal to the corresponding CLC-Changes layer. If you are interested in CLC-Changes between two neighbor surveys always use the CLC-Change layer.

As CLC data is not available for Ukraine, land use data was obtained by compiling different sources, including OpenStreetMap data and satellite images. The raw data was checked and further vectorizing was used when needed.

Table II.1. *Database structure*

No.	Data	Type	Availability	Usage
1	River network	Vector/ line(geodatabase)	ROU, HU, SK, UKR	Flood hazard
2	Catchment data	Vector/polygon (geodatabase)	ROU, HU, SK, UKR	Flood hazard
3	Country border	Vector/polygon	ROU, HU, SK, UKR	Map development
4	County border	Vector/polygon	ROU, HU, SK	Map development, Forest fire
5	Region border	Vector/polygon	UKR	Map development, Forest fire
6	Cities and population data	Vector/point	ROU, HU, SK, UKR	Map development/ General maps
7	Local area units and population data	Vector/polygon	ROU, HU, SK	Flood hazard/Forest fire
8	Local area units	Vector/polyline	UKR	Flood hazard/Forest fire
9	Digital elevation model	Raster	ROU, HU, SK	Flood hazard/Forest fire
10	Digital elevation model	Raster	UKR	Flood hazard/Forest fire
11	Land use data (CLC)	Raster/Vector	ROU, HU, SK	Forest fire
12	Land use data	Vector	UKR	Forest fire
13	Potential flood prone areas	Raster	ROU, HU, SK	Flood hazard
14	Flood prone areas	Raster	UKR	Flood hazard

Considering the different partners we needed to take into consideration also data at the county level, so we investigated several national data sources, including population and other statistics.

Hazard maps and analysis

Because of the different nature of the flood and forest fire hazards, they were treated separately. Flood hazard is always determined considering the catchment of a river, not the administrative boundaries so in this respect the target river basins needed to be identified. On the other side, forest fire can be analyzed based on administrative boundaries, so in this case we were able to use data available at county level.

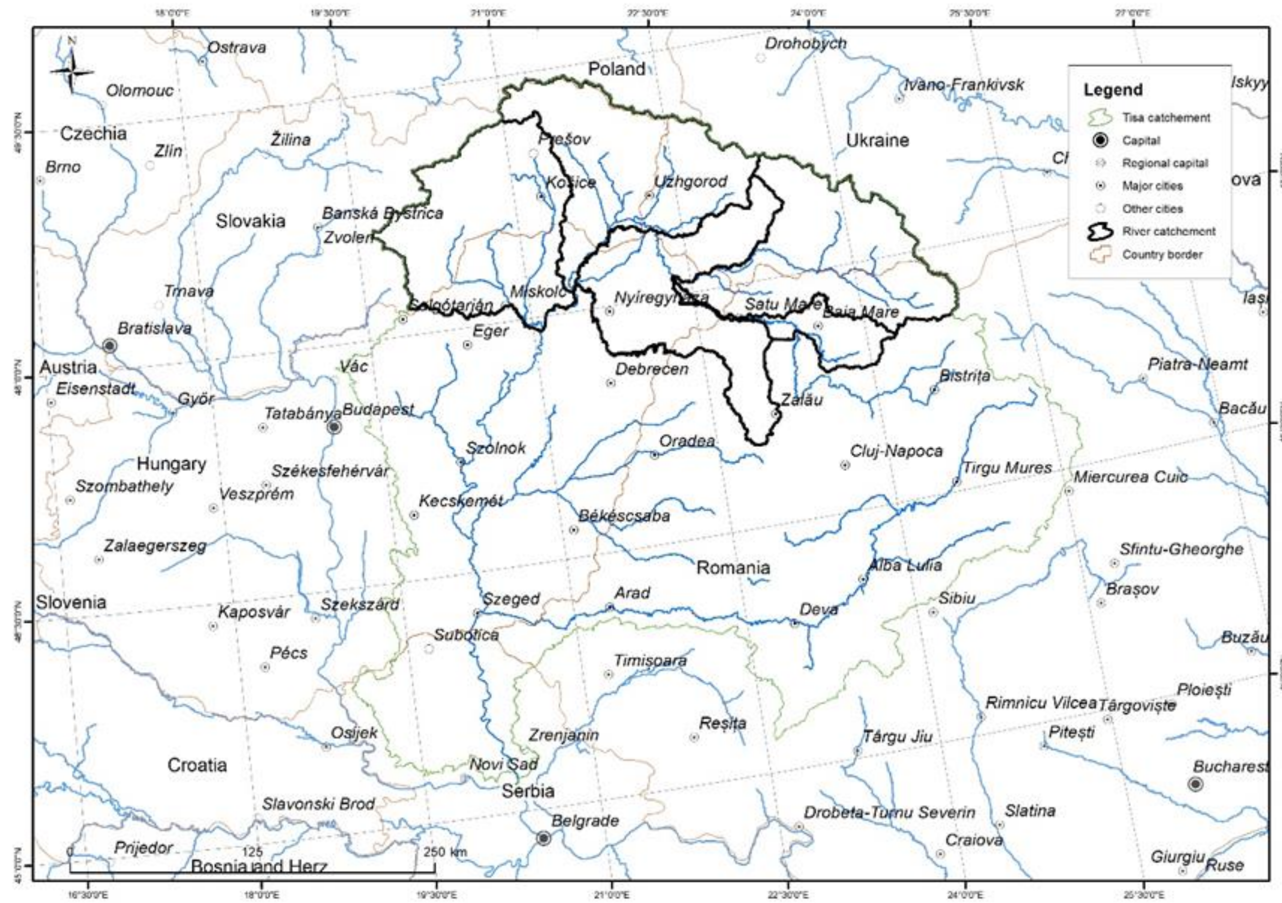

Figure II.3. *River catchments analyzed for flood hazard*

FLOOD HAZARD AND RISK ANALYSIS

Introduction

Floods are hydrological phenomena graphical represented in the form of a hydrograph. In a typical pattern, a hydrograph shows a rapid increase in river discharge/levels up to a peak discharge, followed by a decrease, which is generally less steep than the rise slope. Flood events are triggered and/or exacerbated by intense long-lasting heavy rainfall, rapid snowmelt, and failure of a dam or embankment system, earthquakes, landslides, ice jams, high tides, storm surges and by human activities, including the operation of flood control systems (Šlezingr, 2009).

Beside the floods are natural phenomena, they can turn into a natural hazard triggering disasters with widespread damage and causalities. Although individual earthquakes and hurricanes are the hazards that usually produce the greatest losses per event (Munich Re, 2007), floods and storms occur with such a temporal and spatial frequency throughout the world that, in total, they are the disasters responsible of the major economic and human losses (Arghius et al., 2011).

Flooding accounts for some 40% of all loss-related natural catastrophes since 1980, with losses worldwide totaling more than US$1tn (US$ 1.092tn, 1980-2019) (https://www.munichre.com/en/risks/natural-disasters-losses-are-trending-upwards/floods-and-flash-floods-underestimated-natural-hazards.html). In Romania only, such phenomena have caused 208 causalities and have generated direct tangible damages of approximately 4.215 billion US $ between 2000-2009. The most dramatic situation was in the year 2005, when 76 persons have died and the damages have totaled 2.05 billion US $ (*Arghiuş, 2011*). Consequently, there is a great public interest in this issue.

Large flood disasters could happen where rivers have been cut off from their natural floodplains or are confined to man-made channels where houses and industrial sites have been constructed in areas that are naturally prone to flooding (Bakoni, 2010). On the other hand, large disasters could accompany the flash-floods events.

According with the projected increase in floods frequency and intensity, as well as in growth of assets and goods values in conjunction with ongoing urbanization process, the potential flood losses are expected to increase in the future.

In order to perform this study a comprehensive literature survey was performed, searching through most relevant available documentations:

- Flood Risk Management Plans (FRMPs) in the River Basin Districts covered by Project;
- Documentations/reports regarding Flood Risk Management Plan in the Tisza River Basin. The most relevant and up-to-date studies could be found in Jointisza Project and ICPDR Reports;
- Other relevant (papers, books, conference papers etc.).

In some situations, the information was refined in order to adjust them at the context of the study area. Also, we use relevant and/or up-to-date data where we found errors and outdate information.

1. Study area - general description

The Tisza River is the longest tributary to the Danube River, and flows through five countries. It drains 157,186 km² and its basin is the largest sub-basin of the Danube Basin.

It is home to over 12.5 million people from Ukraine, Romania, the Slovakia, Hungary and Serbia. The states in the Tisza Basin agreed on a close transboundary co-operation, aiming to achieve integrated management of the Tisza River Basin (ICPDR, 2010, Jointisza Project Report, 2018).

The study area, in this Project covers six counties from Romania (Satu-Mare and Maramureș), Hungary (Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg), Ukraine (Zakarpattia) and Slovakia (Košice). Unfortunately the countries area doesn't perfectly overlap the study Tisza basin. So, based on above remarks, the study area of the Tisza basin, in this Project (49,441 km²) is extended at the junction of the Slovak (15,849 km²), Hungarian (10,803 km²), Romanian (9,742 km²) and Ukrainian (13,047 km²) borders, upstream the confluence with Sajó tributary (including Sajó basin) (Figure II.4). The reason lies in the integrated approach of the rivers which usually is carried out at the level of river basins.

More precisely the main sub basins covered by this area are the following:

- Ukraine – all the Tisza basin in this country (Zakarpattia county/oblast). Here, it is a unique case when administrative and hydrographical borders match, which creates favorable conditions for flood risk management (ICPDR, 2009);

- Slovakia – Slaná, Bodva, Rimava, Hornád and Bodrog basins;

- Romania – Vișeu, Iza, Tur, Crasna and Someș basin (cathcment from the border with Hungary and confluence with Lăpuș river, including Lăpuș basin)

- Hungary: Felső-Tisza, Szamos-Kraszna, Bodrogköz, Tokaj-hegyalja and Sajó basin.

The main tributaries by average annual discharge and basin areas are Someș/Szamos (15,857 km², Q=135.7 m³/s), Bodrog (12,337 km², Q=119.6 m³/s), Sajó/Slaná (12,990 km², Q=62.2 m³/s) and Hornád/Hernád (5,447 km², Q=31.9 m³/s). The most important tributaries of the Tisza River with catchment areas over 1,000 km² in the study area is provided in Table II.2.

Table II.2. *Main tributaries of the Tisza River with basins over 1,000 km²*
(Jointisza Project Report, 2018)

Country	River
Ukraine	Bodrog, Latorica, Uzh, Tur, Borzhava, Rika, Teresva
Romania	Vișeu, Iza, Tur, Someș, Lăpuș, Crasna
Slovakia	Bodrog, Uh, Laborec, Latorica, Topla, Ondava, Hornád, Torysa, Rimava, Slaná, Bodva
Hungary	Túr, Szamos, Kraszna, Hernád, Sajó, Bódva

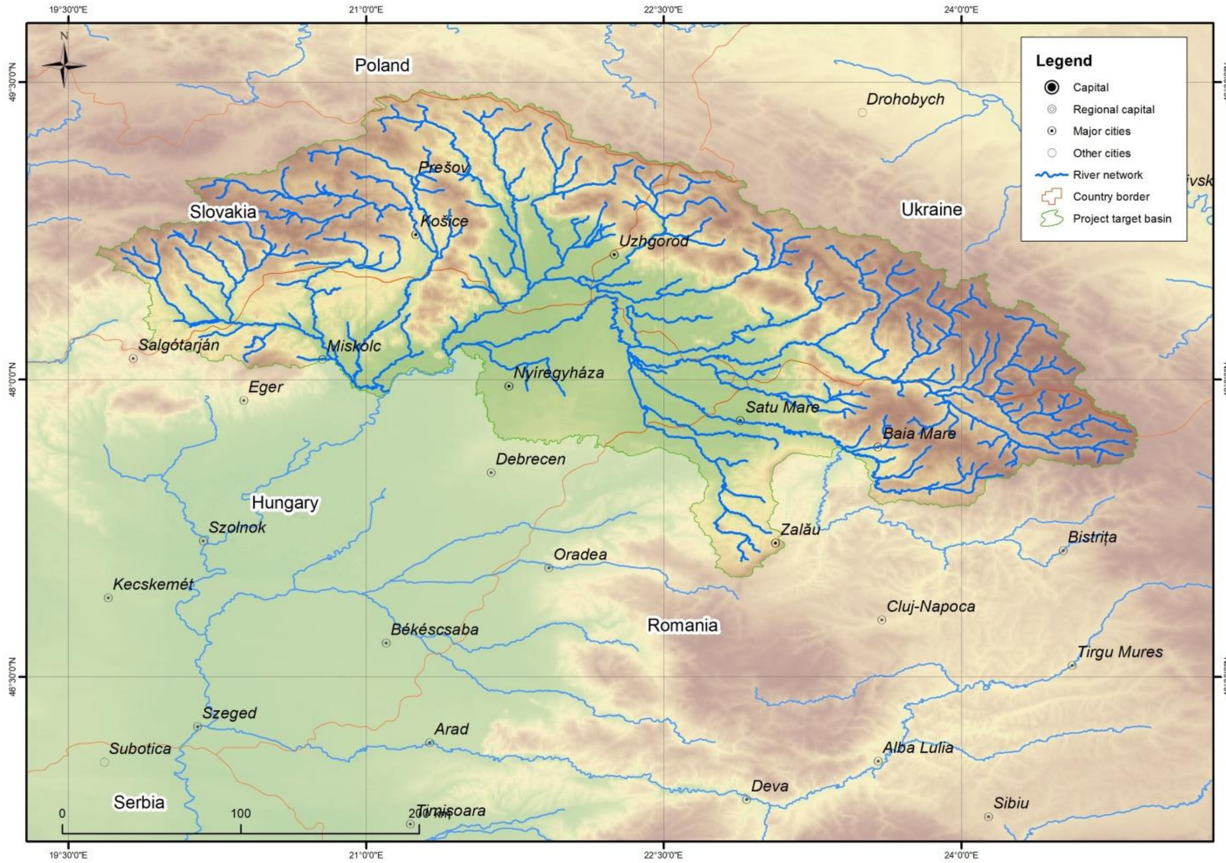

Figure II.4. *Tisza river basin in the study region*

Tisza basin in the study area overlaps two orographic units, which are the Carpathians and Pannonian Basin. The morphological type of the relief is predominantly plane in the southern part of the area, becoming steeper and steeper in the Carpathians. These units covers a large variety of rocks (igneous, sedimentary and metamorphic rocks), which is reflected in the high drainage density in the upper sub-basins and a large varieties of land forms. The climate is moderate continental temperate, showing a strong influence of the westerlies. In case of precipitations that are the main factor involved in triggering floods, the highest annual amounts are characteristic for the north-east area (mainly in mountainous area of the Romania and Ukraine), where rainfall totals about 1,000-1,400 mm. The Ruska Mokra is considered as a peculiar "humidity pole" in the Tiachivskyi rayon, Ukraine; average annual amount of precipitations per year is 2,499 mm (Jointisza, Country report for Ukraine, 2019).

The precipitation amount decreases steeply to the south-west, where annual mean values are below than 600 mm. The mean annual temperature range between 0°C in the high mountain to 9-10°C in case of lowland areas. The largest part of the Carpathians is covered by forests (mainly beech and coniferous species), while the arable lands are widespread in the Pannonian Basin. In the whole Tisza River Basin, the average afforestation coefficient is 26 %, the forest being concentrated in the northern and eastern part of the basin in the mountain area (37.4 % in the study area).

2. Floods in the Tisza River Basin

On the surface of the Tisza River Basin, floods were recorded in all seasons and can be showery, snowy and snow-flurry by origin, but the most significant are formed in the winter, spring and summer season, the phenomenon being influenced by the moisture intake brought by the air masses. In the mountain area with high drainage density, relatively small basins with steep slopes, thin soils and rocks with low permeability are mainly rapid onset and flash-floods and last from 1-20 days. These conditions are particularly characteristic to Ukraine, Romania and Slovakia. Large floods on the Tisza in Hungary, in contrast, can last for as long as 100 days or more (the 1970 flood lasted for 180 days) (Arghiuș, 2010, Jointisza Project Report, 2018). This is due to the very flat characteristic of the river in this region and multi-peak waves which may catch up on the Middle Tisza causing long flood situations. Also characteristic in area between the Upper and Middle Tisza region is that the Tisza floods often coincide with floods on the tributaries, which is especially dangerous in the case of the Someş/Szamos, Crasna/Kraszna and Bodrog rivers (Bakoni, 2010). Snowmelt flooding without rainfall rarely occurs in the Tisza Basin and floods resulting from this account for no more than 10-12% of the total amount. The rise in temperature in late winter and early spring is almost always accompanied by some rain, so large slow-onset flood are more frequently in this period. The warm period from May to October accounts for nearly 65% of total floods, and the cold period from November to April accounts for only 35%. However maximum discharges and the flood volumes in the cold period generally exceed those observed in warm period (Bakoni, 2010).

In the Tisza basin, during the last decades, high intensity floods have occurred, resulting in loss of human lives and significant material damages. An analysis report that provides an overview on historical floods events from 1879 to 2006 has indicated 24 extreme flood events with serious damage in the Tisza River Basin during this period. Over 28 months between November 1998 and March 2001, 4 extreme floods travelled down the Tisza River. The extreme Tisza flood in April 2006 was preceded by several floods in February and March generated by melting snow and precipitation (ICPDR, 2010). This flood event created an unexpected situation when the flood discharge of the Tisza River was not particularly high but the simultaneous large flood of the Danube River backed up the Tisza creating critical situation along the Lower (Hungarian and Serbian) Tisza (ICPDR, 2009). In May 1970, important floods have occurred on the main rivers in Romania. The maximum peak discharge at this event was recorded at the Satu-Mare gauging station on the Someș River (3,342 m^3/s) (Table II.3). In Ukraine, the flood in March 2001 was one of the most catastrophic for the last 200 years in Zakarpattya Oblast (Jointisza_Project Report, 2018).

Table II.3. *Average and maximum discharges for the main tributaries in Romania*

River	**Basin area (km^2)**	**Average discharge (m^3/s)**	**Q1%**	**Historical peak discharge in the river basin (m^3/s)**
Viseu	1,581	34.6	1,155	1,330 (2008)
Iza	1,293	16.9	775	606 (1970)
Tur	1,008	10.9	-	519 (1970)
Somes	15,740	126	3,190	3,342 (1970)
Lăpuș	1,820	18.7	940	780 (1970)
Crasna	1,931	5.7	595/495	204 (2000)

3. Flood protection systems and the status of flood protection structures

More and more frequently, specialists in the field claim that the flood management through flood control works is an obsolete practice. Among the frequently arguments are the high costs and environmental balance disorder.

On the other hand it is doubtless that in some places and specific context, some structural measures are absolutely needed in order to mitigate the flood damages, but these ‚hard' measures need to be supported by non-structural measures, also known as "soft measures'', that are more efficient in some context and more friendly with environment, (Arghiuș, 2009).

Nowadays, the sustainable forest management plays an important role in the Tisza river basin. Cooperation with relevant organizations such as UNEP-Carpathian Convention is a good potential for further investigating in this issue. Also space for rivers should be the overarching strategy for sustainable flood protection measures within the Tisza Basin, but it is clear that in some cases, structural solutions like dyke and bank reinforcements are needed to protect urban settlements. Identifying measures that have benefits for both flood protection and nature protection (win-win measures) are part of such 'space for the river' strategies (ICPDR, 2010).

In the Tisza Valley, organized, systematic flood protection works started in the mid-19th century. In upstream countries, where reliable rating curves are available, the "Q1%" is used for the design of the flood control works. On the flat region of the Tisza the rating curves are not single-valued, hence the discharge statistics are not reliable, so the water level statistics are used to provide the "H1%" design level. This leads to a different 5 degree of protection at border sections, but in the frame of the existing bilateral agreements, this problem could be relaxed during negotiations (Bakoni, 2010).

Regarding structural measures the levees and reservoirs are the most important flood control works involved in flood risk management.

In **Ukraine**, nine water reservoirs with a total capacity for flood attenuation of 40.553 million m^3 are multi-purpose. Three of them belonging to the drainage system of Chornyi Mochar are intended for accumulation large flood volumes (9.09 million m^3). Anyway, the largest water reservoir in this area is the Tereble-Ritska (24 million m^3 for flood attenuation). The total length of the dikes in the Ukrainian part of the Tisza River Basin is 770.1 km (Jointisza, Country Report for Ukraine, 2019).

In **Romania** the largest reservoir for flood attenuation in the study area is Vârșolț - Crasna river (23.318 million m^3 for flood attenuation) followed by Călinești Oaș - Tur river (18.413 million m^3 for flood attenuation). There are also 30 permanent reservoirs with a total attenuation flood capacity of 4.2634 million m^3.

Other 8 non-permanent reservoirs located in Satu Mare County are designed for flood attenuation with a total capacity of 4.263 million m³. Two large polders are located in the Crasna river basin (Moftin and Supur) with a total attenuation flood volume of 11.566 million m. The total length of the levees in the study area is 387.369 km (Tabel 4) (Flood Risk Management Plan – Someș-Tisa basin).

Table II.4. *The length of embankments in the Romanian study area (PMRI)*

River	Length of the levees (km)
Tizsa	4.9
Vișeu	12.13
Iza	15.675
Tur	77.12
Someș	87.248
Lăpuș	17.69
Crasna	172.606

In **Slovakia** the sum of the reservoir volumes for flood attenuation is 98.21 million m³. The largest reservoir is Zemplínska Šírava with total capacity for flood attenuation of 65 million m³ (the larges reservoir for flood control in the study area). Also Slovakia included 6 polders with a total volume of 53.4 million m³. The largest polder - Beša (53 million m³) is located in the southern part of the basin. The total length of the dikes in the Slovak part of the Tisza River Basin is 748.32 km. (Jointisza, Country Report for Slovakia, 2017, Jointisza Project Report, 2018).

In **Hungary** the terrain topography encourages especially the construction of levees and polders for flood control. More than 1,500 km of dikes are extending along the rivers in the study area (Table II.5). There are also 2 polders designed to flood attenuation (Szamos-Kraszna közi and Cigándi), but no permanent reservoir (Bakoni, 2010, Jointisza Project Report, 2018).

Table II.5. *The main flood control works (levees and reservoirs) in the in the Hungarian study area* (Bakoni, 2010, Jointisza Project Report, 2018)

Country/River	Length of the dike (km)	Reservoir total volume (10^6 m³)
Hungary		
Tisza	1,064.1	94 (1 polder)
Tur	75.7	-
Szamos	93	126 (1 polder)
Kraszna	62.3	-
Bodrog	57.9	-
Hernad	62.0	-
Sajo (incl.Takta)	119.6	-

4. Assessment of flood hazard and risk

Flood Directive 2007/60/EC require to all Member States of the European Union to carry out activities in flood risk management, which will permanent reviewed and if necessary updated. Based on Flood Directive recommendation, all EU member states had approached flood risk management in a three steps:

- Preliminary Flood Risk Assessment by 2011;

- Flood Hazard and Flood Risk Mapping by 2013;

- Flood Risk Management Plans by 2015.

Since Ukraine is a non-EU country, this is at the stage of legal approximation to the EU Flood Risk Directive (according to EU-Ukraine Association Agreement), whereas implementation (preparation of flood risk and flood hazard maps and development of the Flood Risk Management Plan) is planned for later that in EU countries. Yet, there is no data, regarding flood hazard and risk map for this country. The schedule of the implementation of the EU Flood Risk Directive, stated in the EU-Ukraine Association agreement, is as follows:

- adoption of national legislation and designation of competent authorities (Nov 2016) - in progress;

- the law “On Amendments to Some Legal Acts of Ukraine regarding the introduction of integrated approaches in water resources management following the river basin principle” № 3603 was adopted in autumn 2016 and came in force from 2017. The document gives legal definitions to the number of terms used in Flood Risk Directive (2007/60/EC), namely “flood risk management plan”.

- undertaking preliminary risk assessment (Nov 2018) – in progress Order "On Approving the Methodology of the Preliminary Flood Risk Assessment" is being drafted;

- preparation of flood risk and flood hazard maps (Nov 2020) – in progress Order “On Approving the Methodology of the Flood Risk and Flood Hazard Maps Development” is being drafted;

- establishment of flood risk management plans (Nov 2022) – in progress Resolution of Cabinet of Ministers “On Approving the Procedure for the Development of Flood Risk Management Plans” is being drafted (Jointisza Project Report, 2018).

Prior to this, the project „Identification of zones of possible inundation at rivers of Zakarpattya Oblast", was implemented by „Ukrwodproject" in 2009 in frame of implementation of state programme of integrated flood protection in Tisza basin. The project has identified maximum calculated water levels and possible inundation zones in times of floods with 1%, 5% and 10% annual probability of exceedance in conditions of future infrastructure projects (Jointisza, Country Report for Ukraine, 2019).

The main organizations at national level responsible for the management of flood risk, for each countries concerned in this study are the following:

- **Romania**: National Administration "Romanian Waters" which belongs to Ministry of Water and Forest (Somes-Tisa Water Basinal Administration in the study area); Ministry of Internal Affairs through General Inspectorate for Emergency Situations with subsidiary local and County Committees;

- **Hungary**: The General Directorate of Water Management (OVF), National Technical Committee (OMIT) under the direction and supervision of the Minister of Interior (Nyíregyháza and Miskolk Regional Water Directorate in the study area);

- **Slovakia:** Slovak Water Management Enterprise (Branch of an enterprise Kosice in the study area);

- **Ukraine:** State Agency of Water Resources of Ukraine (SAWRU) and State Service of Emergency Situations (SSES) which belongs to Ministry of Ecology and Natural Resources and Ministry of Internal Affairs (Zakarpattya Oblast in the study area) (Jointisza, 2018).

4.1. Flood Hazard

Flood hazard maps and flood risk maps are usually used as a tool for integrated flood risk management and spatial planning aimed to reducing adverse consequences of floods and for guidance of activities in floodplain areas (Jointisza, Country Report for Slovakia, 2017).

Regarding the flood hazard and risk assessment, in the first stage, the member states have carried out a preliminary assessment of the flood risk in order to identify the locations where **potential significant flood risk** exists or might be considered likely to occur, mainly based on previous historical flood event data (e.g. magnitude of floods, causalities, damages).

Unfortunately there is no unitary methodological approach addressing the Areas with Significant Potentially Flood Risk (APSFR) mapping between the countries concerned. This issue makes difficult to unitary approach this concept at the Tisza basin level. For example, in some countries like Romania and Hungary mapping of these areas has been drawn as areas (polygons) and/or lines along the main rivers, while in others (e.g. Slovakia) through hot-spots, more specifically points that shows the municipalities with significant historical floods.

The areas with significant potentially flood risk related to the study area in Romania is showed in the Table II.6.

Table II.6. *Areas with Significant Potentially Flood Risk (APSFR) in the study area from Romania (Flood Risk Management Plan – Someș-Tisa basin)*

River basin	Length along the rivers, including tributaries (km)
Tizsa	49.6
Vișeu	103.1
Iza	85.2
Tur	152.5
Someș	~100
Lăpuș	143
Crasna	213
Other basins	18.6

Flood hazard maps

The flood maps are based on the catchment and river data. First water catchments that needed to be analyzed were identified. From Romania we included the Somes, Tur and Crasna rivers, from Ukraine the Tisza river with its tributaries, from Slovakia the Torysa, Ondava and Slana. In Hungary all the above-mentioned rivers flow into Tisza.

The only arbitrary limit was chosen in Romania, where including the entire Somes catchment would have been unfeasible because of its size. As a result the analysis is done including the Somes catchment after the confluence with Lapus (included).

The potential flood prone area extent delineates the area that is flooded and takes into consideration the the probability of flooding assuming that flooding is unrestricted. The potential flood prone area is comprised of the river channel and floodplain. This does not consider the flood protection works.

Considering also those, the floodplain is split into an active floodplain where flooding still occurs, and former floodplain where flooding limited due to flood protection. This latter category could be flooded again if a flood exceeds the capacity of flood protection, or if the works are damaged or removed.

Based on this methodology the raster and vector layers were processed resulting flood hazard maps at different time scales.

The data was processed individually for each country. Again a special analysis involved the Tisa basin in Ukraine where flood hazard analysis and data was not available as ready as within the EU.

To develop the flood maps for Ukraine we used several sources, bot vector and raster. Some areas were identified based on georeferenced maps and for others we used the DEM and flood data.

The resulting maps were integrated obtaining a flood hazard map for the entire project catchment.

Flood hazard maps were performed for the geographic areas, in which the preliminary flood risk assessment has identified the existence of a potential significant flood risk and areas where probable occurrence of significant flood risk can be assumed (Jointisza, 2018).

The method used for accomplish of hazard maps at the Tisza river basin is based on complex studies and usually contains two components:

- **topographic and geodetic studies;**
- **hydrological and hydraulic studies.**

The annual exceeding probability along with the main parameters of the flood hazard (water depth, water velocity) was included in the flood hazard maps (Jointisza, 2018).

Since the annual exceedance probability scenarios for hazard maps aren’t common between UE countries and Ukraine have no available hazard maps yet, we used the European Environment Agency (EEA) database (https://www.eea.europa.eu/data-and-maps/data/eea-potential-flood-prone-area-extent) in order to harmonize the data and solve the gaps for Ukraine.

In EEA database the hazard map covers a lot of scenarios, but similar with every EU countries done based on Flood Directive 2007/60/EC requirements we used only 3 scenarios, as following:

- **low probability scenario** (Q0.2%- floods that can occur, on average, once every 500 years) (Q1 % is missing in this database);
- **medium probability scenario** (Q1% - floods that can occur, on average, once every 100 years);
- **high probability scenario** (range between Q10%).

For **Ukraine** the hazard maps for the above mentioned 3 scenarios are reported in the below figures (source: EEA).

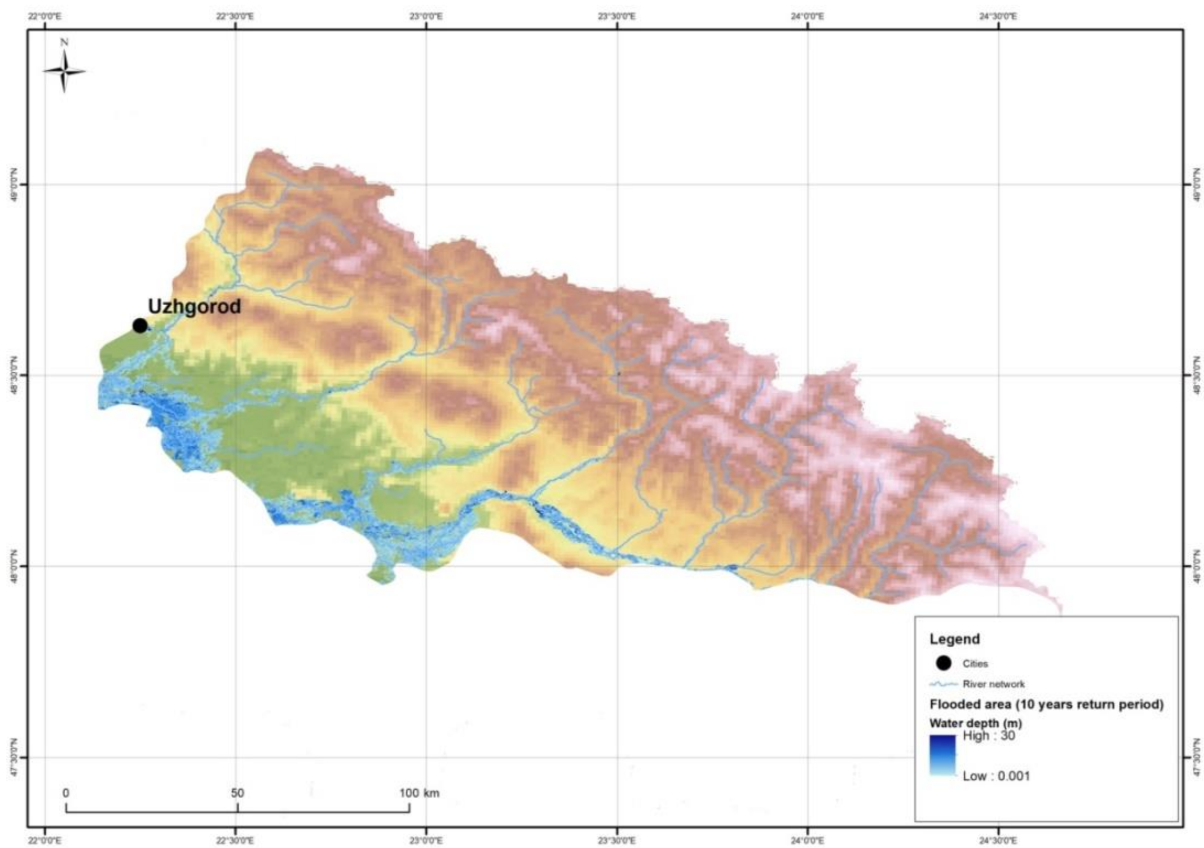

Figure II.5. *Flood hazard in study area of the Tisza River Basin, Ukraine* (Q10% scenario)

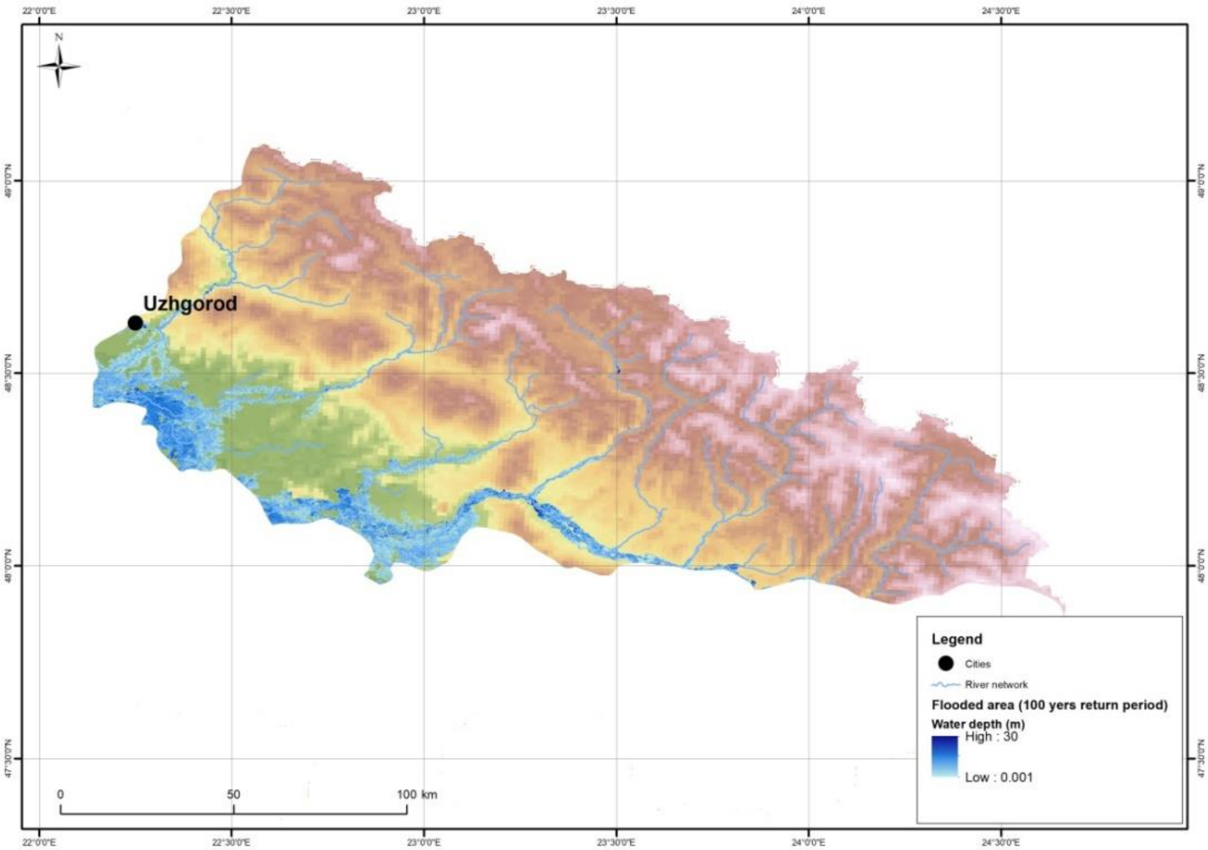

Figure II.6. *Flood hazard in study area of the Tisza River Basin, Ukraine* (Q1% scenario)

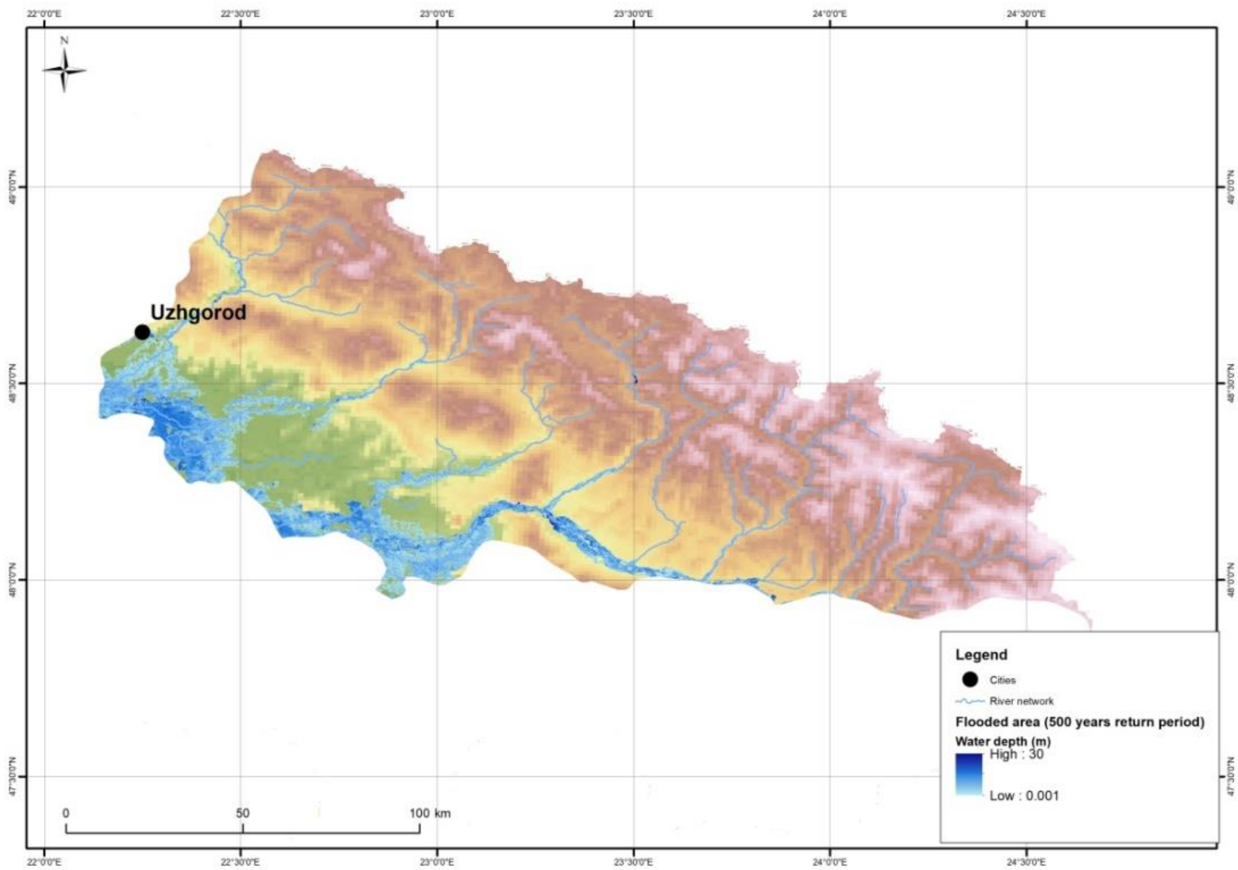

Figure II.7. *Flood hazard in study area of the Tisza River Basin, Ukraine* (Q0.2% scenario)

In **Romania**, most of flood hazard maps (Figure II.9 - II.11) reported to EC were elaborated through the national project "Plan for Protection, Prevention and Mitigation of the floods effects in the river basin" as a result of hydrological and hydraulic studies. For the rest of the areas simplified methods (based on fuzzy systems modeling – GrassGis and approximate modeling with HEC-RAS) were developed (Jointisza Project Report, 2018). The below flood hazards maps show the maximum extension of inundation in case of three scenarios (Q0.2%, Q 1% and Q10%) (source: EEA).

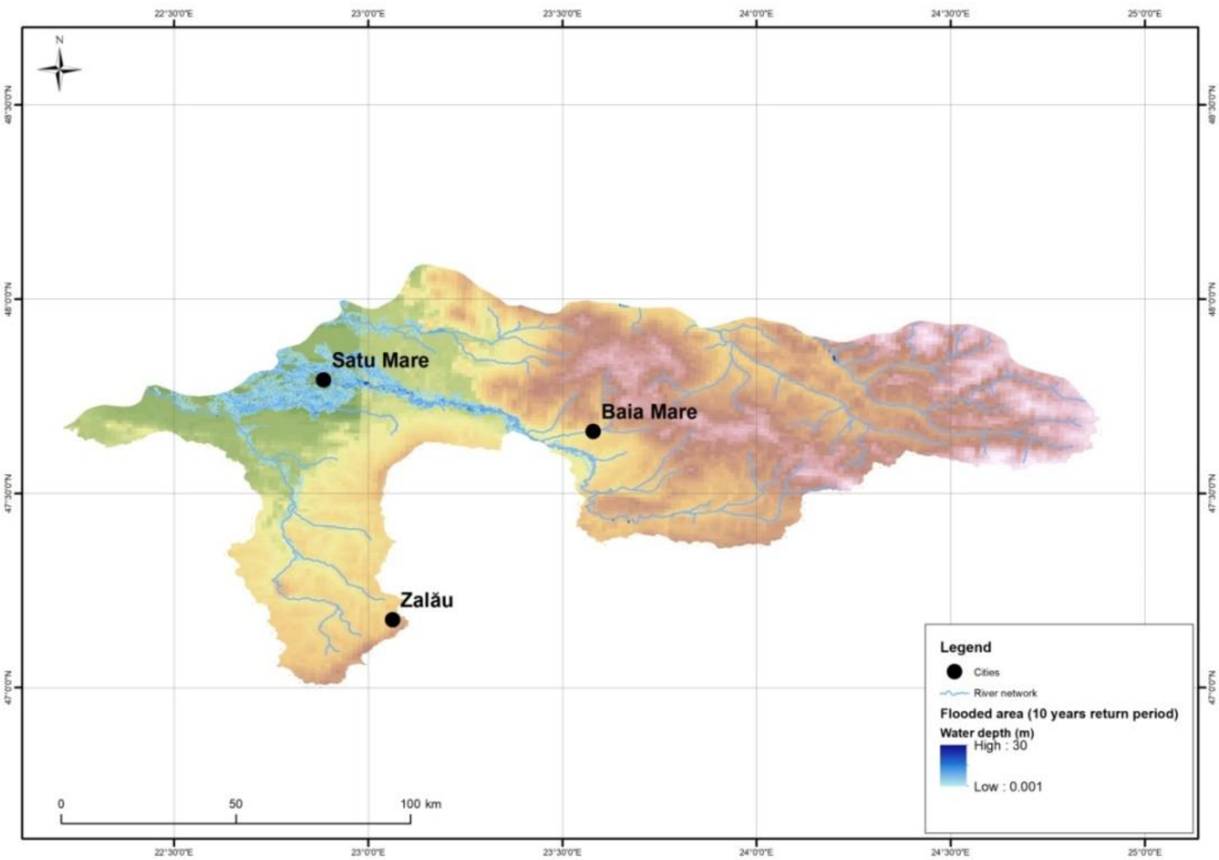

Figure II.8. *Flood hazard in study area of the Tisza River Basin, Romania* (Q10% scenario)

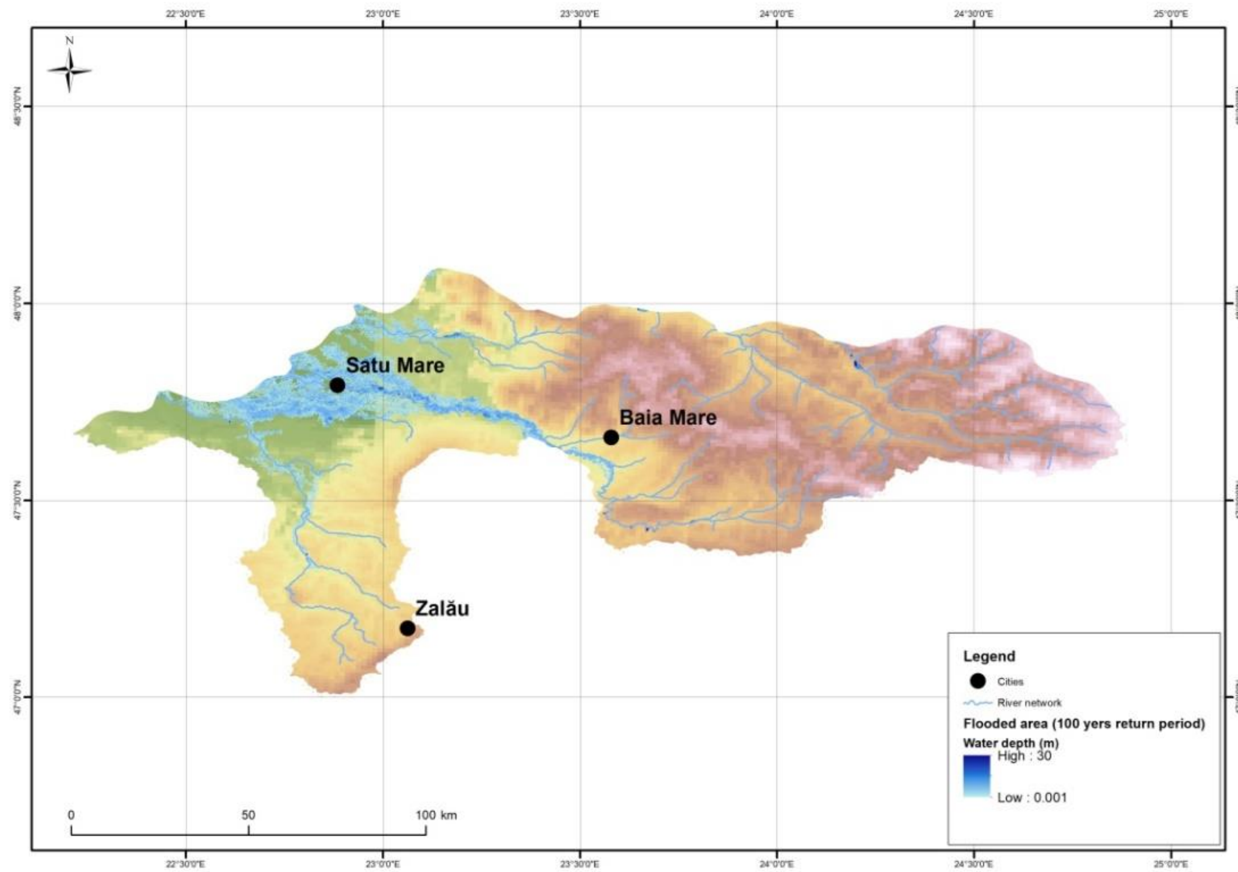

Figure II.9. *Flood hazard in study area of the Tisza River Basin, Romania* (Q1% scenario)

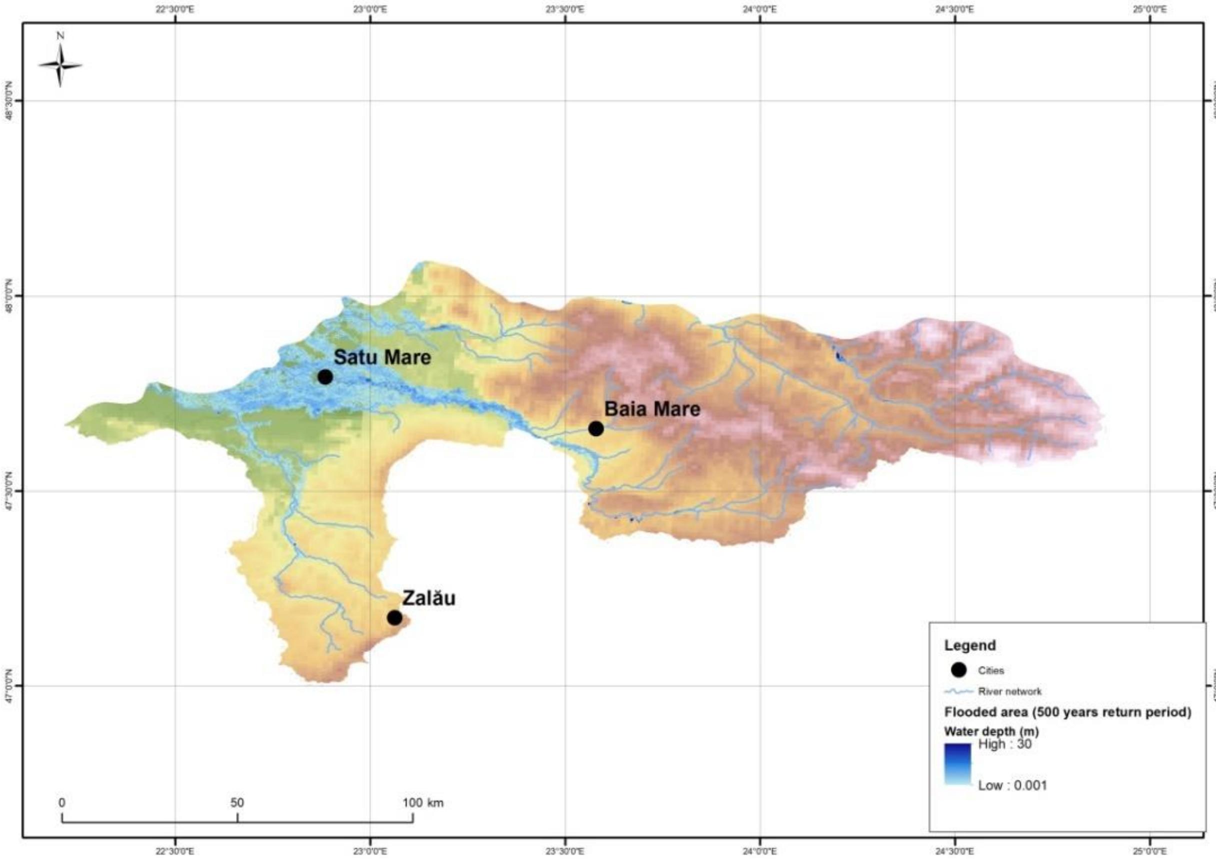

Figure II.10. *Flood hazard in study area of the Tisza River Basin, Romania (Q0.2% scenario)*

In **Slovakia**, flood hazard maps (Figure II.7), resulted after mathematical hydrodynamic modeling of steady and unsteady flow, were elaborated for the geographic areas in which the preliminary flood risk assessment identified the existence of a potential significant flood risk and for areas where probable occurrence of significant flood risk can be assumed (Jointisza, Country Report for Slovakia, 2017) (Figure II.11 - II.13) (source: EEA).

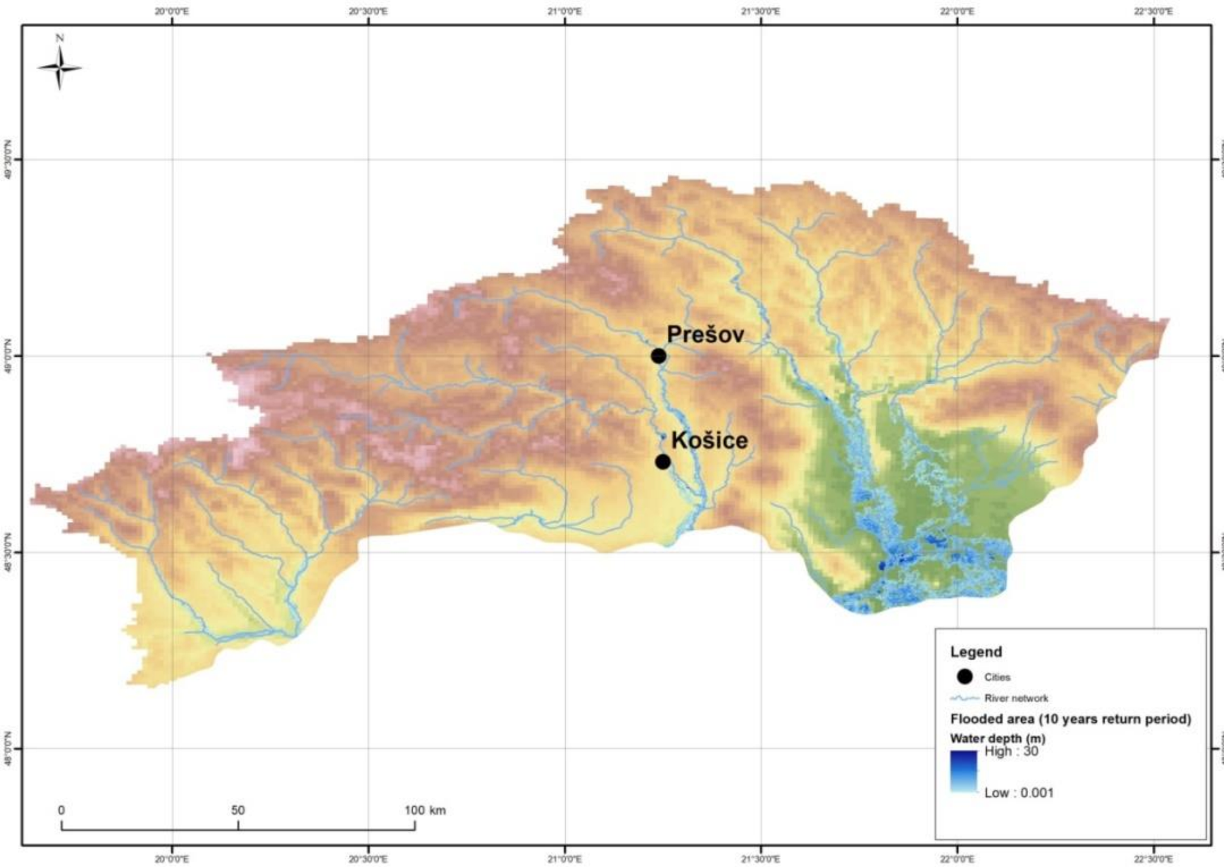

Figure II.11. *Flood hazard in study area of the Tisza River Basin, Slovakia* (Q10% scenario)

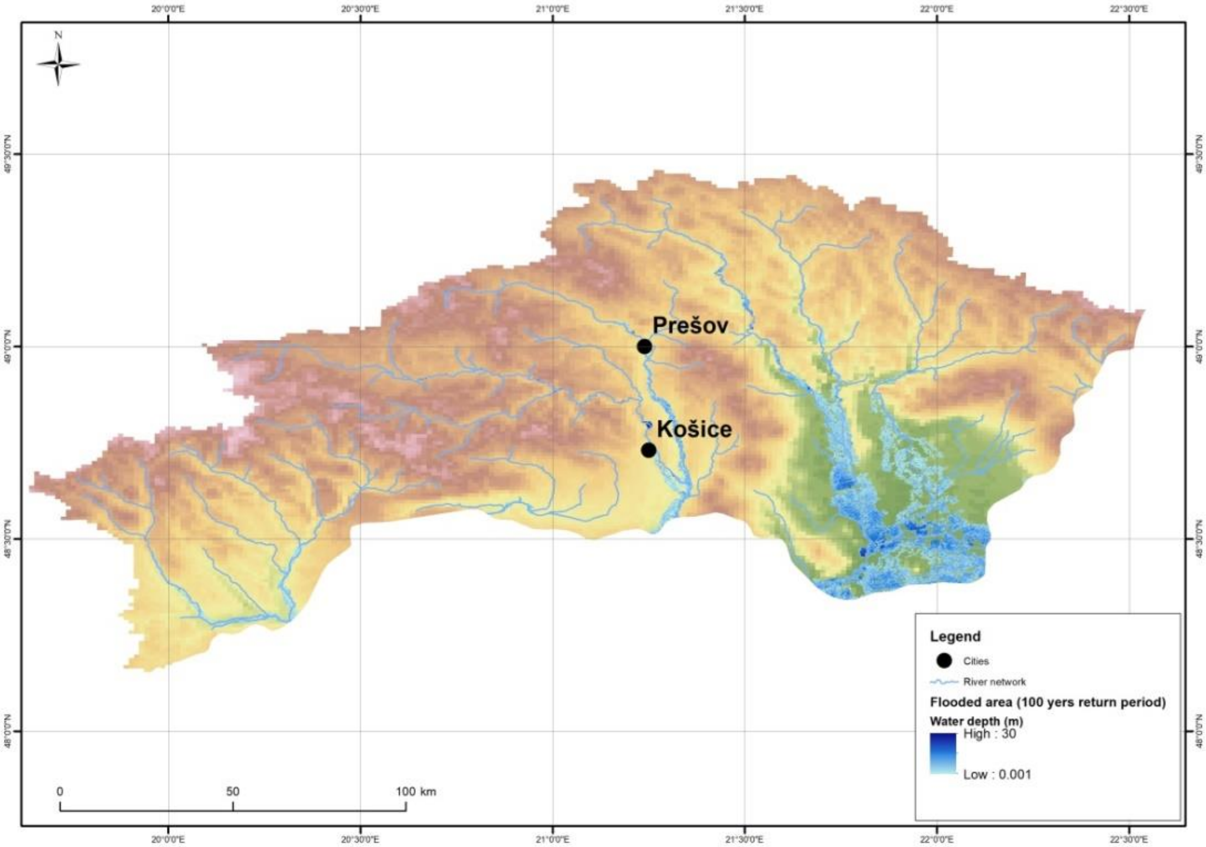

Figure II.12. *Flood hazard in study area of the Tisza River Basin, Slovakia* (Q1% scenario)

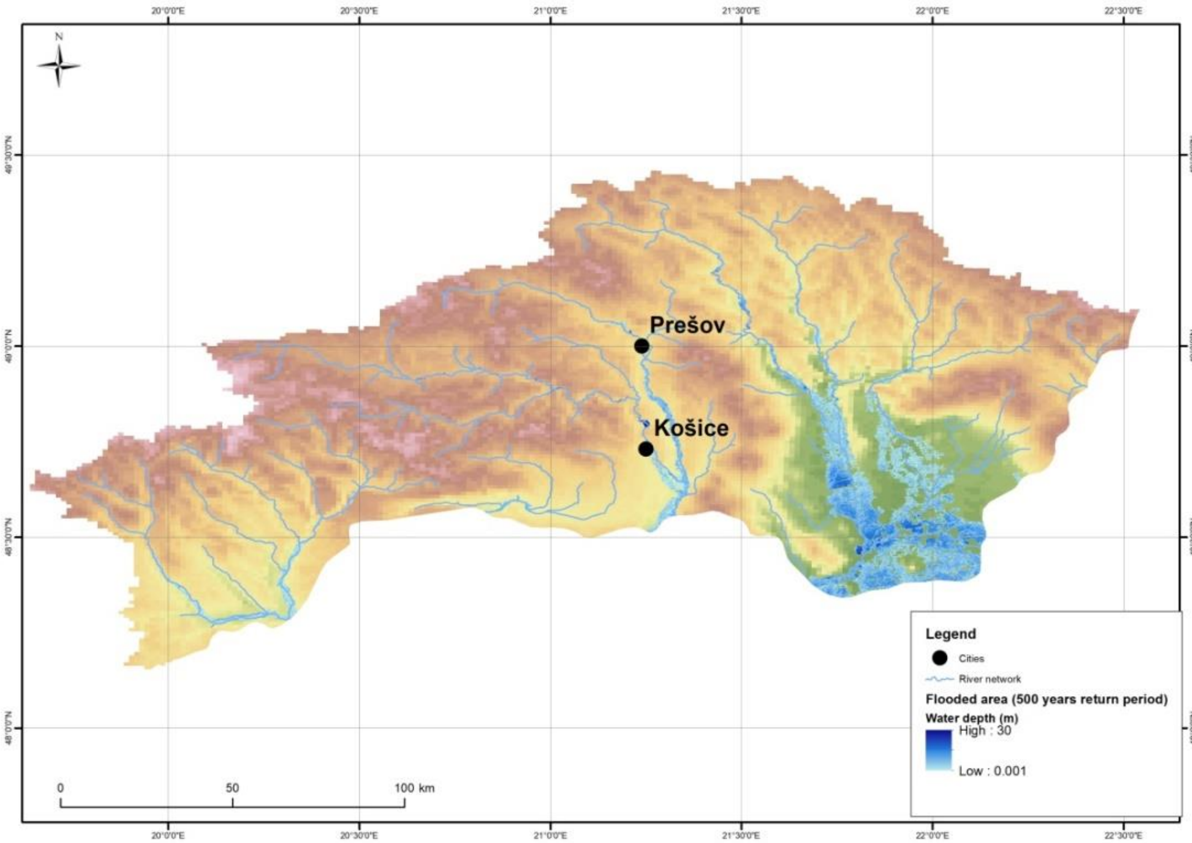

Figure II.13. *Flood hazard in study area of the Tisza River Basin, Slovakia* (Q0.2% scenario)

In **Hungary**, flood hazard maps (Figure II.15 - II.17) were prepared for floodplains which are protected by dykes and also for unprotected floodplains. During the flood mapping process there were prepared terrain models and 2D hydrodynamic models for 120 floodplains. In Hungary, for the total of 745 flood protection dyke breaking points in eight designed areas (three designed areas are located in Tisza River Basin) 1367 scenarios were calculated. During the 2D hydraulic modeling process the Mike 21 FM HD model was used for 50 m x 50 m square grid. The result of the 2D hydraulic modeling consisted in the inundation maps. MIKE 21 FM models were used for modeling the unprotected floodplains (Jointisza, Country Report for Hungary, 2017). The below flood hazards maps show the maximum water depths in these areas in case of Q0.2%, Q1% and Q10% (source: EEA).

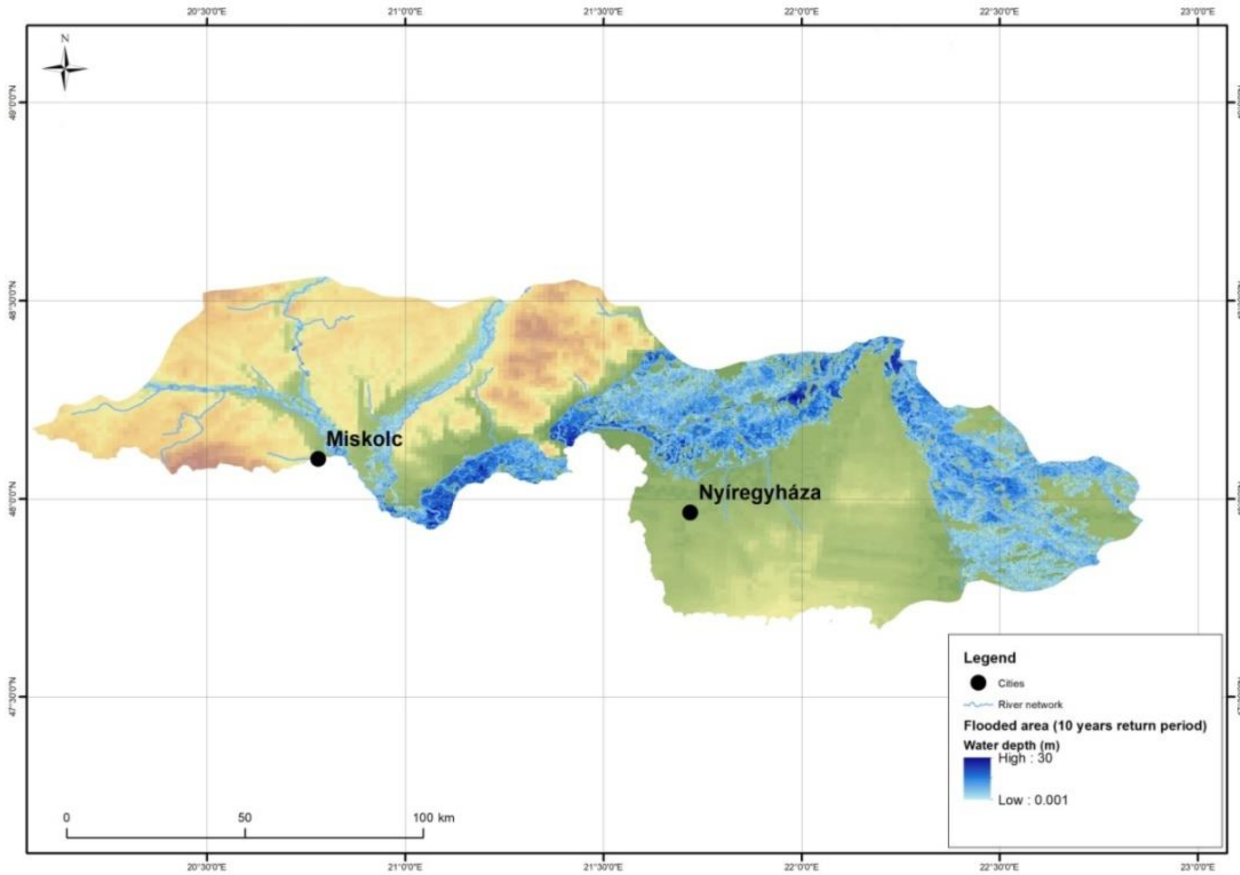

Figure II.14. *Flood hazard in study area of the Tisza River Basin, Hungary* (Q10% scenario)

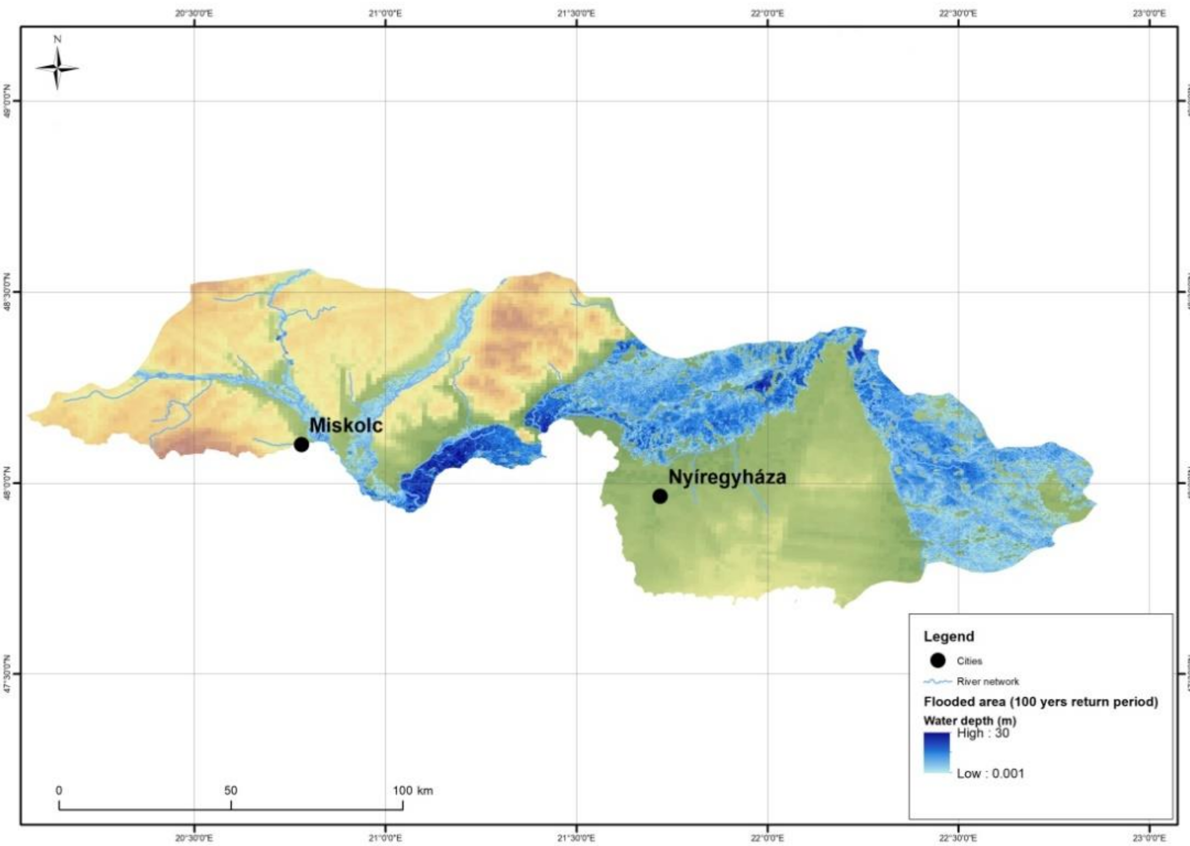

Figure II.15. *Flood hazard in study area of the Tisza River Basin, Hungary* (Q1% scenario)

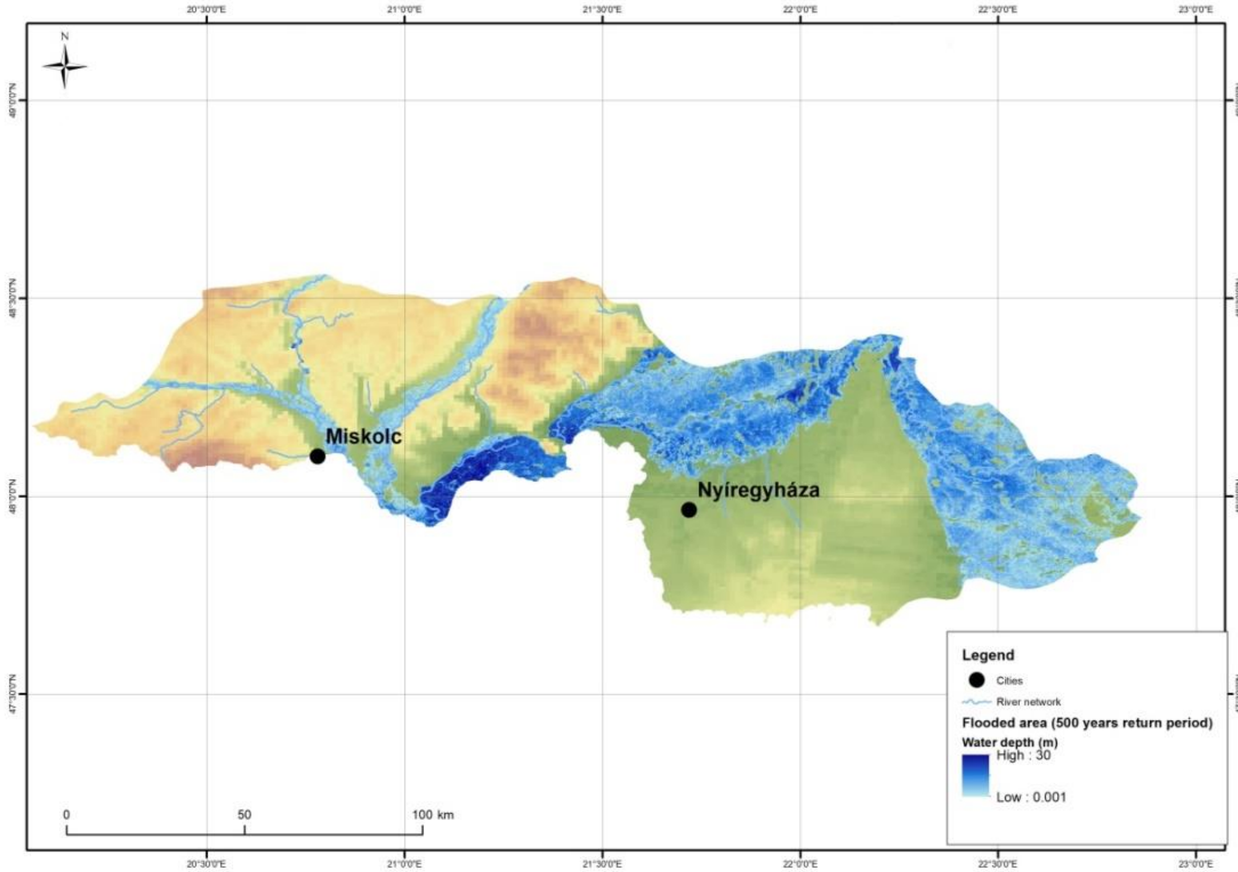

Figure II.16. *Flood hazard in study area of the Tisza River Basin, Hungary* (Q0.2% scenario)

Analyzing level of exposure to floods in the study region the highest values are specific to the flats areas overlapping the plains. Hungary prove to be the most exposed country (about 2.5 million people and one-third of the arable lands, 18 000 km²) (ICPDR, 2009, Jointisza, 2018).

5. Flood risk maps and potential adverse consequences

Flood risk means the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event 2007/60/EC (Zeleňáková, 2011).

Flood risk maps contain data of potential negative consequences of floods, in areas which are displayed on flood hazard maps. Estimated number of potential affected inhabitants and other economic and cultural activities in flood potential endangered areas are highlighted (Jointisza, 2018). In line with the provisions of the Floods Directive 2007/60/EC, 4 types of potential adverse consequences were determined: social, economic, environmental and cultural heritage.

Yet, there is no data, regarding flood risk map for **Ukraine.**

In **Romania** qualitative flood risk maps have been developed based on a risk matrix, considering three classes of flood risk (high, medium and low risk) (Figure II.17). This involved, first of all, identifying risk receptors, and then assessing the vulnerability of the elements exposed to flood hazard, taking into account the potential damage of water depth.

For the Romanian part of Tisa River basin, 392,787 possible affected inhabitants, approximately 514 km of railway and 1,405 km of roads, 29 SPA areas, 49 SCI areas, 70 protected for the abstraction of water intended for human consumption, 17 IED installations, 228 churches, 9 museums and 3 cultural monuments have resulted from flood risk analysis (Jointisza, Country Report for Romania, 2017).

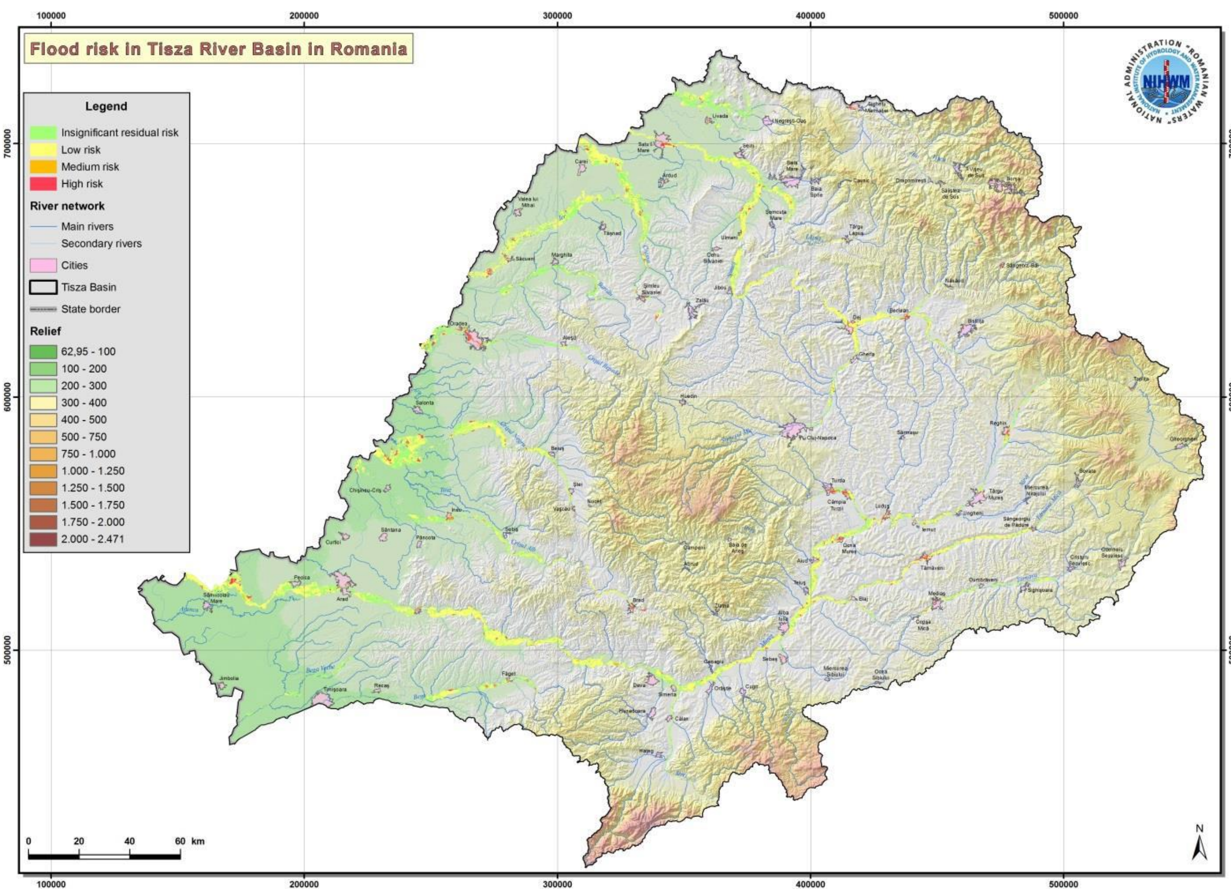

Figure II.17. *Flood risk map in study area of the Tisza River Basin in Romania*

In **Slovakia**, risk indicators that describe the principal potential adverse consequences (economic, social, environment, cultural heritage) were identified for each area with potential significant flood risk. The indicators were coded taking into account the nature of damage. With regard to economic consequences, the risk assessment took into consideration the flood effects on properties (including homes), to uses of the land, to agricultural activity, forestry, mineral extraction and fishing, to manufacturing, construction, retail, services, other sources of employment etc. Environmental consequences refer to pollution sources (IPPC and Seveso installations point or diffuse sources). Adverse consequences for cultural heritage included the elements of cultural heritage and the ones of cultural assets (archaeological sites/monuments, architectural sites, museums, spiritual sites and buildings). The description of statistical risk indicators was performing only in qualitative form, missing the quantification data (number, length, financial etc.) (Jointisza, Country Report for Slovakia, 2017) (Figure II.18).

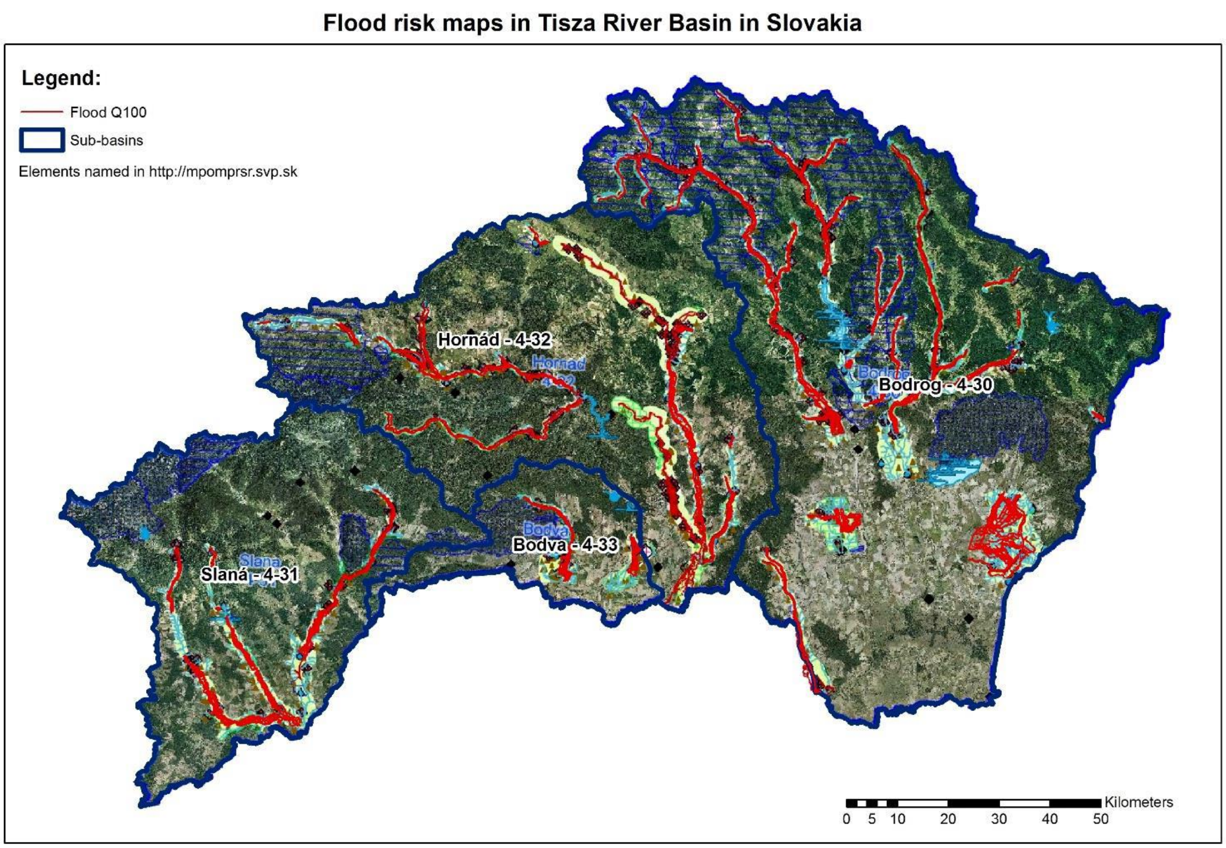

Figure II.18. *Flood risk map in Tisza River Basin in Slovakia*

In **Hungary**, the flood risk maps are produced in 50 m x 50 m square grid. The total amount of financial damages is estimated of about 136,343 million HUF/year in entire Tisza River Basin. The human life risk values were determined as a function of flooding probability, density and load class. Regarding the cultural heritage, about 8,288 ha which contain elements of cultural patrimony may be affected. Regarding the ecological impacts of flood, 30 plains may be affected with a total area of ecological damages of about 1,0435 ha (Jointisza, Country Report for Hungary, 2017) (Figure II.19).

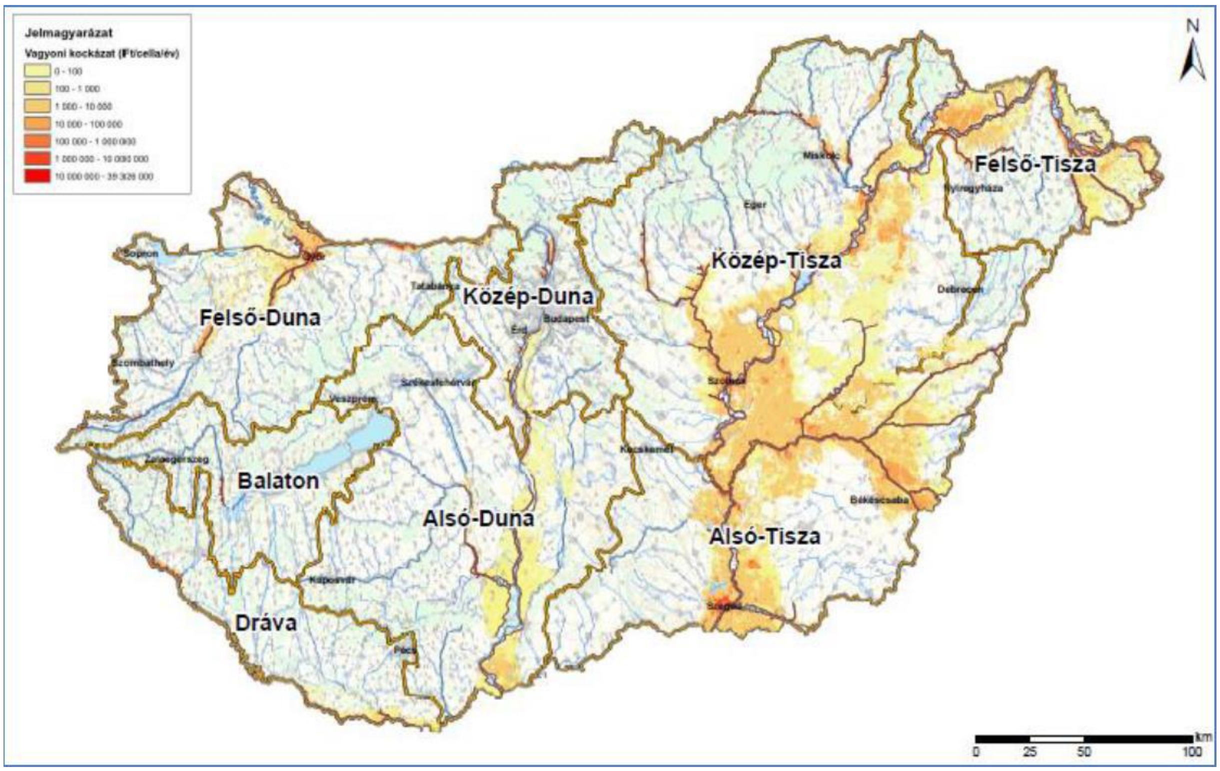

Figure II.19. *Flood risk map in Tisza River Basin in Hungary*

In the next steps of the Project, flood risk maps will be accomplished and customized to the study area in order to highlight the significant flood risk areas in the study region in terms of hot-spots of potential losses**.**

Conclusions

The study area, in this Project is extended at the junction of the Slovak, Hungarian, Romanian and Ukrainian borders, in the Tisza basin, upstream the confluence with Sajó tributary (including Sajó basin). The main tributaries by average annual discharge are Someș/Szamos, Bodrog, Sajó/ Slaná and Hornád/Hernád. The study area overlaps two orographic units (Carpathians and Pannonian Basin), expressing evident disparities of geographical conditions between these areas. On the Tisza River Basin, floods could be recorded in all seasons, but the most significant are formed in the winter, spring and summer season.

In the mountain area are mainly rapid onset and flash-floods, while in the flat areas (mainly in Hungary) slow onset floods affecting large territories are prevalent. The main flood protection works in the study area are dykes (3,340 km in length) and reservoirs (185 million m^3 for flood attenuation).

Based on Flood Directive 2007/60/EC all EU countries have carried out specific activities in flood risk management, including the development of flood hazard and flood risk maps. Since Ukraine is a non-EU country, this is at the stage of legal approximation to the EU Flood Risk Directive, whereas implementation is planned for later those in EU countries. Considering the availability of common data at source of data (source: EEA), the hazard map have been designed for Q0.2%, Q1% Q10% floods scenarios in this Project. Analyzing level of exposure to floods in the study region the highest values are specific to the flats areas overlapping the plains. Hungary prove to be the most exposed country (about 2.5 million people and one-third of the arable lands, 18 000 km^2). Flood risk maps contain data of potential negative consequences of floods, in areas which are displayed on flood hazard maps. Estimated number of potential affected inhabitants and other economic and cultural activities in flood potential endangered areas are highlighted. In the next steps of the Project, flood risk maps will be accomplished and customized to the study area in order to highlight the significant flood risk areas in the study region in terms of hot-spots of potential losses.

FOREST FIRES HAZARD

The forests are the lungs of the planet and with their various ecosystems they are playing an important role also from the social, cultural, economic and environmental point of view, with multiple benefits for the humanity.

Existing forests in the EU-28 and other forested land cover approximately 180 million hectares, 42.4% of the total European area and around 5% of all existing forests worldwide[1]

[1] Eurostat, Statistics on agriculture, forestry and fisheries, 2013 edition

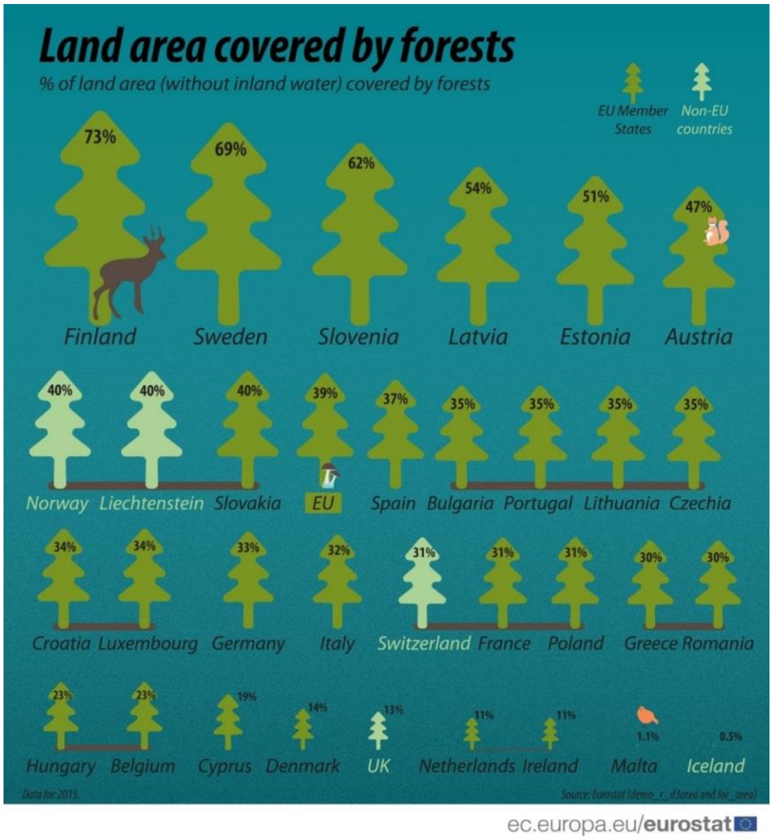

Figure II.20. *Infograph: Land area covered by forests*
(% of land area (without inland water) covered by forests)
Source: Eurostat (demo_r_d3area) and (for_area)

Forest fires have multiplied in the last few decades. The reasons can be found in climate extremities, less precipitation, the increase of mean annual temperature and a series of winters without snowfall.

Due to the warming, the dangerous period of wildfires have extended, which may issue in the increase of such fires, especially if the socio-economic circumstances remain the same

The effects of the Forest fires are easy to identify, they can have social, economic, cultural and environmental impacts, starting with the initial period and continuing with short, medium and even long term impact in accordance with the magnitude and severity of the fire.
Forest fires can be catastrophic for the ecosystems and biodiversity in the affected area, the trees, animals, plants, birds, bugs can be in danger or even worse.

The huge forest fires can have effects on population health, the air is contaminated with smoke which can have influences also on the balance of greenhouse gases and in a worst case scenario it can end with life losses.

Any way the quality of the life can be seriously affected due to the physical damages on the properties, resources, cultural and natural heritage with influences on economic and social infrastructures and activities.

Introduction

Forest fire is a major natural disaster, mainly caused by human careless, but fortunately it is one of the most easily preventable natural disasters (JRC Scientific and Technical Report, 2008).

The main natural risk factors for forest fires are represented by the forest vegetation (arboretum), the climatic factors, the relief, the soil and the hydrographic network, as reported in various areas, from the forests in the Mediterranean area in central Europe (Burlui, 2018).

Forest fires are most often spontaneous phenomena, their triggering and evolution depends on a number of favorable factors, such as the state and nature of the combustible material (the proportion of the living vegetation and the dead plant material, the composition, the structure and the density of the forest, etc.) or the orographic and weather conditions, as well as the causal factors (natural and anthropic), and finally, the prevention and extinction measures taken (Barbu, 2018).

The forest fires have a negative effect even after the event, such as soil erosion, debris flow and flooding.

In order to assess a hazard like wildfire it is very important to follow the steps: 1. to identify local wildfire threats and also to assess the risks to communities; 2. to train the community; 3. to help the land managers and planners in making suitable decisions about land management and development in fire-prone; 4. to help local fire protection districts in pre-attack planning (UNISDR, 2017).

1. Forest fires in Europe

Since 2000 European Forest Fire Information System (EFFIS) supports fire management and offers data and information in order to support forest fire prevention, preparedness and firefighting activities as well, covering the full cycle of forest fire management (JRC Scientific and Technical Reports – Forest Fires in Europe 2010;). EFFIS included 40 countries: Albania, Algeria, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Former Yugoslavian Republic of Macedonia, Germany, Greece, Hungary, Ireland, Italy, Kosovo, Latvia, Lebanon, Lithuania, Montenegro, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey and the United Kingdom.

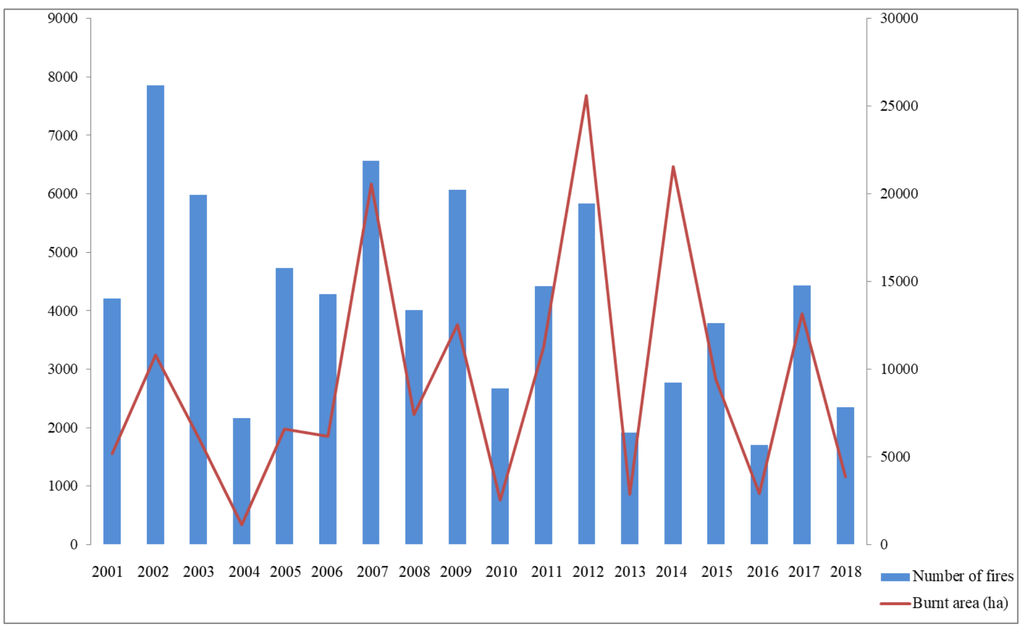

Figure II.21. *Number of fires and burnt area between 2001 - 2018 in Romania, Hungary, Ukraine and Slovakia (project area)*

(Source: https://gwis.jrc.ec.europa.eu/static/gwis.statistics.portal/countries-estimates/EU/SK)

It can be observed in the Figure II.21 the problem of forest fires in Europe is an old and persistent problem. It has to be mention that the data regarding burnt area from Hungary in 2001 is not available.

In some years the number of forest fires and burnt area has decreased but it has always been a problem that humanity has had to face with.

The number of forest fires and burnt area decreased significantly in 2018 compared with 2017 but according to Commission Annual Report on Forest Fires more countries than ever were hit by forest fires in 2018. The wildfires destroyed almost 178000 ha of forests and land in the EU.

During these years (2001-2018) Ukraine has the highest number of fires (2902 fires – the average), followed by Hungary (740), Slovakia (307 fires) and Romania (250 fires). (European Commission Annual Report on Forest Fires in Europe, the Middle East and North Africa – 2018, 2019).

In Europe during the past decades. More than 50,000 forest fires larger than one hectares erupt each year in the most affected countries, with an annual average of 500,000 hectares of burnt forests in the European Union. In the EU, large fires (≥50 hectares) account for 75% of the total burnt area, representing 2.6% of the total number of fires. Man-induced forest fires represent about 95% of the overall number (*Assessment of Forest Fire Risks and Innovative Strategies for Fire Prevention*, 4–6 May 2010 Rhodes, Greece, WORKSHOP REPORT)

2. Assessment of forest fires hazard in the study area

The study area is largely framed by the forest steppe area and the deciduous forest floor, which are much less prone to fires compared to coniferous forests. The coniferous forests have a greater extension especially in the upper mountain basin of the Tisza, related to the Carpathian Mountains from Maramures (Romania) and Transcarpathia (Ukraine). However, in the regions with high expansion of the coniferous forests, the precipitations are more significant, and the temperatures have low values and, consequently, droughts are very rare events.

In Europe, fires are more frequent in areas with a Mediterranean climate, where temperatures are higher, droughts are frequent, and vegetation abounds in coniferous forests and other woody plants prone to self-ignition.

These data are strengthened by results obtained within the project ENSEMBLES, indicating the study area (excepted Ukraine - no data) one of the lowest annual values of the Seasonal Severity Assessment index (SSR) of forest fires in Europe (values predominantly between 0-2 units out of a maximum of 15 units). Even if in the region there is a tendency to increase the annual danger of forest fires (1.5 - ≥2.0%/year) and these are statistically significant, they have low values in absolute terms (https://www.eea.europa.eu).

Forest fire hazard maps

As opposed to flood, for the forest fire maps we used the administrative borders, in order to define the target area. Data availability allowed this type of delineation because population and land use data is usually available al LAU level.

The target areas includes: Borsod-Abaúj-Zemplén and Szabolcs-Szatmár-Bereg counties in Hungary; Košický County from Slovakia; Zakarpattia region from Ukraine; Satu-Mare and Maramures counties from Romania.

The forest fire hazard was assessed by using population and land use data, especially forest types of data. Also, we checked other sources in order to evaluate the historical forest fire record and frequency.

Firstly, population data al LAU level was collected. This data set is based on GIS data (LAU borders) and population tabular data obtained from Eurostat and national authorities. The LAU borders were checked for consistency and EU data was integrated with data for Ukraine. The layers were included into a geodatabase and the topology was checked and corrected in order to avoid topological error such as slivers or overlaps. The main problems encountered were related to different scales used to develop LAU borders for Ukraine and other countries and different coordinate systems.

After this stage an accurate dataset comprising the LAU polygons for the project area was developed.

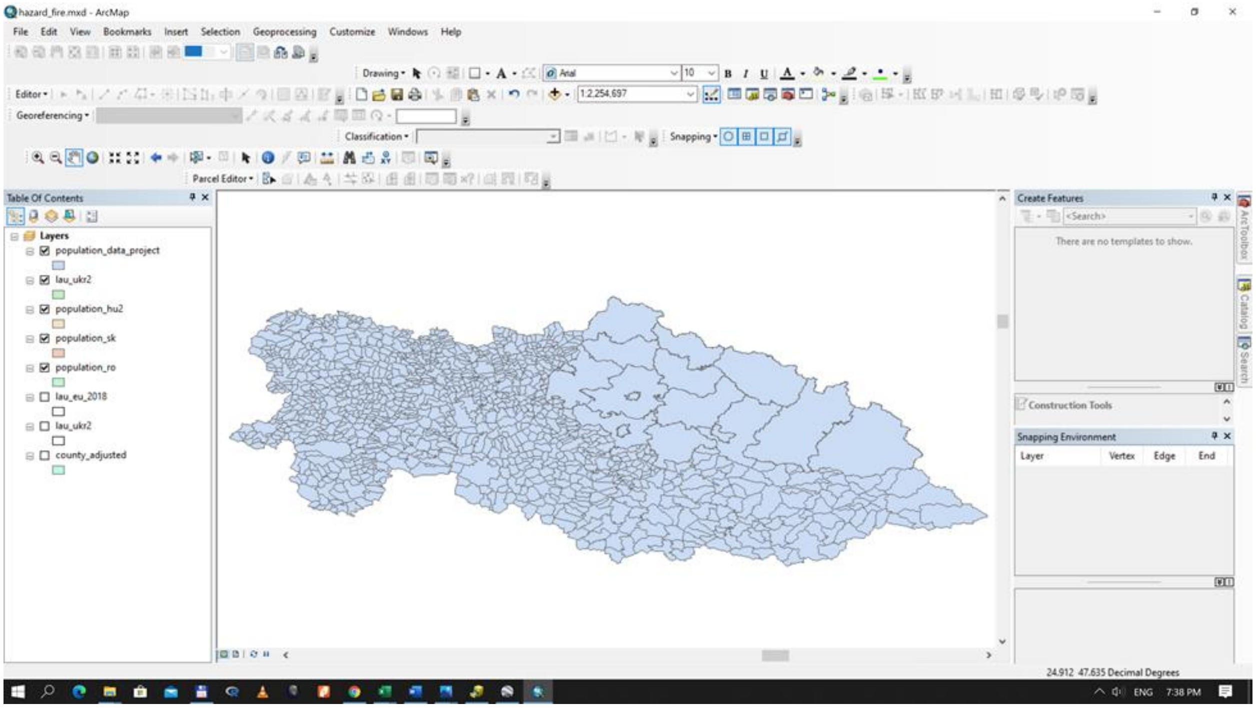

Figure II.22. *LAU's in the project area*

There is a visible disparity between Ukraine and the other countries, but this is because Ukraine has a different administrative system as compared to the NUTS regulated at EU level.

Al, the LAU's included in the dataset were unique identified either by a national code or name.

Population data was obtained in tabular format (Excel) from Eurostat. This data was compared to national sources and integrated in relate tables within the GIS environment.

Because of different reporting mechanisms between EU countries, the country codes for Hungary were different. We extracted the codes from the EU database and replaced them with country codes from Hungary. The validity of the dataset was checked by comparing names and data locations.

Table II.7. *Sample population database (tabular format)*

OBJECTID	LAU_CODE	NAME	POP_1961_01_01	POP_1971_01_01	POP_1981_01_01	POP_1991_01_01	POP_2001_01_01	POP_2011_01_01
764	28610	CIUHOI	3,863.77	3,570.35	3,116.42	2,480.12	2,317.30	2,210.79
1648	15448	CICANESTI	1,931.12	2,237.92	2,462.10	2,481.81	2,297.71	2,133.54
2179	99922	TUTORA	3,170.59	2,801.55	2,442.39	2,119.92	2,119.10	2,052.00
3137	135681	TATARU	2,399.97	2,023.14	1,746.82	1,553.56	1,303.84	1,065.38
2599	50987	OCNA DE FIER	2,104.85	1,647.35	1,313.24	1,069.08	818.49	740.52

After the population data for Hungary, Slovakia and Romania was compiled, we integrated the data for Ukraine. The administrative LAU's for Ukraine were a little bit difficult to integrate because data is divided by LAU's but also based on municipalities that have a special administrative status.

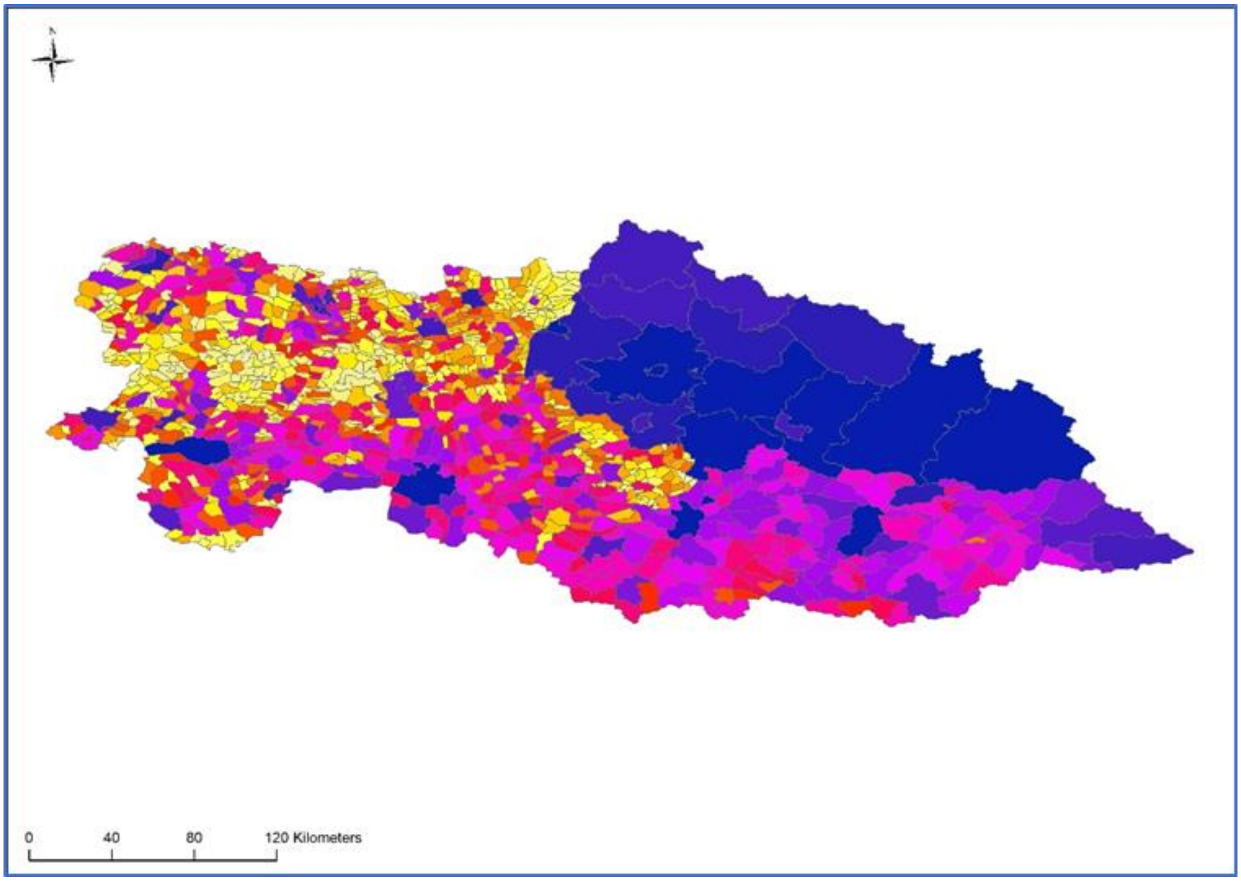

Figure II.23. *Population data for each LAU*

The second step in the analysis consisted in the development a forest type database. To do this data from CLC and satellite images were used.

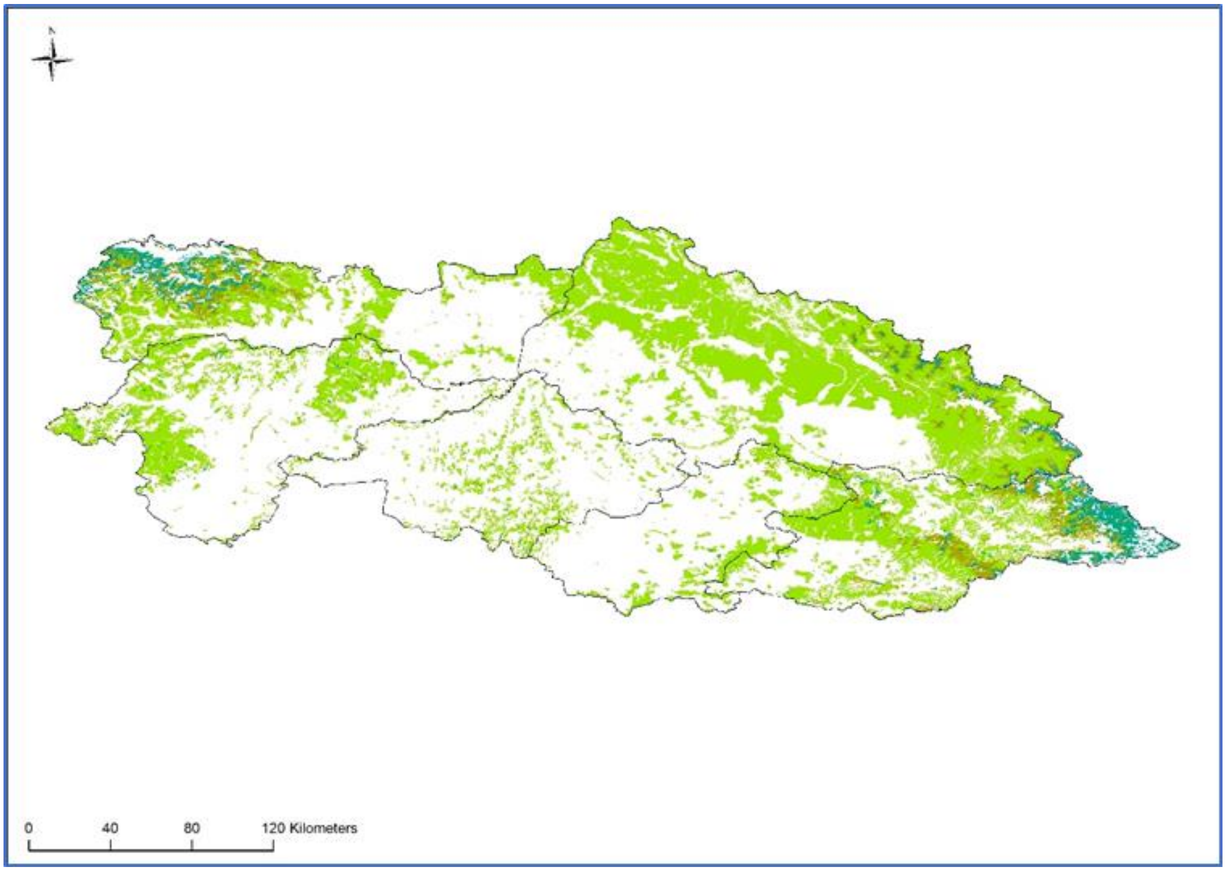

Figure II.24. *Forest cover for the protected area*

These two datatypes were processed to calculate the population density and forest types of database. The forest types are: Broad leaved forest, mixed forest, and coniferous forests.

Forest types were graded according to the forest fire hazard class. The same grading system was used to classify the population density data.

We used the following formula in order to integrate population and fire hazard:

(FC+PC)/2=FH where FC-Forest class; PC=population class; FH=fire hazard.

The resulting data was further processed, and the fire hazard map was obtained.

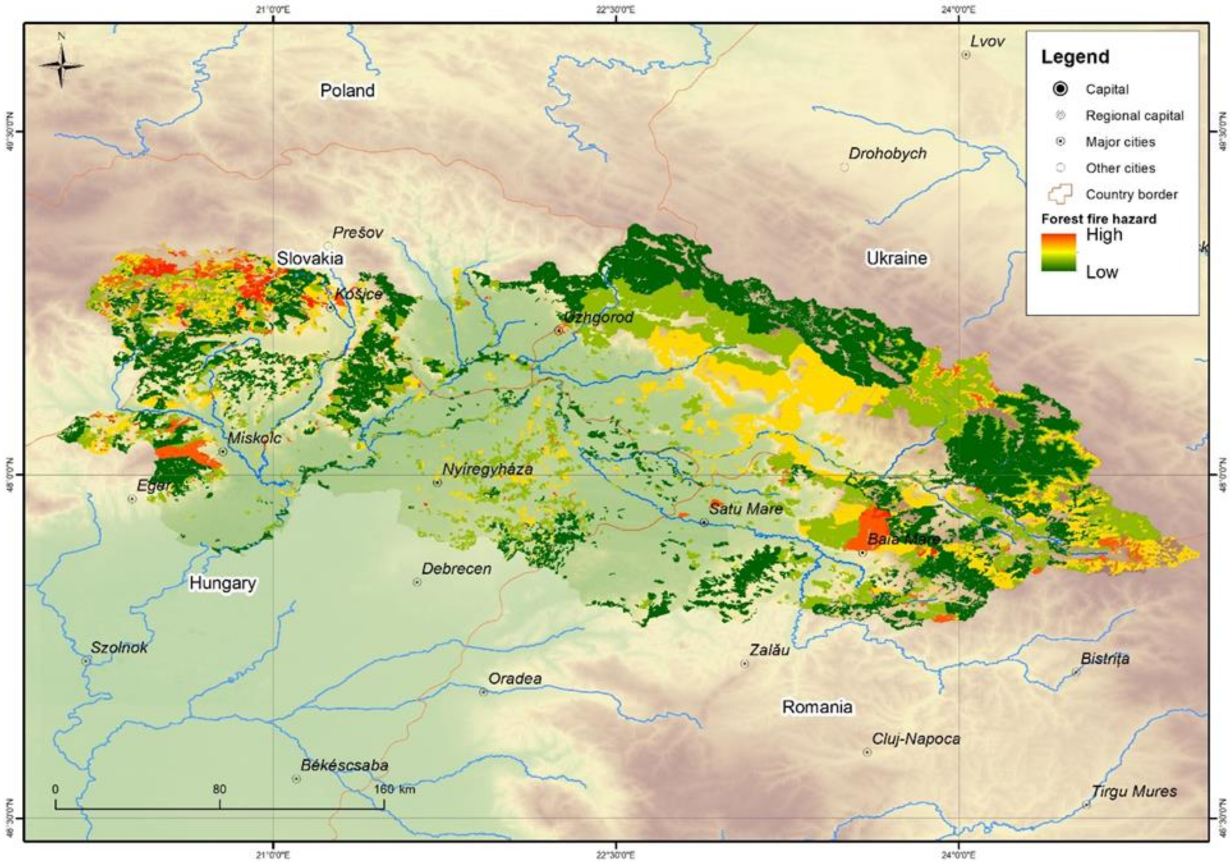

Figure II.25. *Fire hazard*

The main advantages for this analysis are that, being based on relatively available data it can be easy replicated and updated. On the other hand several difficulties arise because data for Ukraine is not as readily available as for the other project countries.

There are different coordinate systems used and data need to be processed, projected and topological errors need to be checked and corrected.

We consider that the database developed for this analysis is reliable and can be further used for different analysis in order to strengthen the relationship between the partner countries.

Forest fires in Romania

Romania is situated in the southeastern part of Central Europe having a total area of 238.397 km². The neighbours of Romania are: Bulgaria - south, Serbia - southwest, Hungary - northwestern, Ukraine – northeast, Republic of Moldova - east and Black Sea - southeast.

The territory of Romania is characterized by a high variability of the climatic conditions, which have led over time to the appearance of extremely dry or extremely rainy periods (Barbu, 2018).

In Romania the forests are mostly located in the mountain area (59% of the entire forest area - about 4.1 million hectares), after it comes the hilly area (35% - about 2.4 million hectares), follow by the plane region (6% of the entire forest area - 0.4 million hectares) (Mallinis et al, 2018).

Unfortunately, about 350 ha are lost annually in Romania as a result of fires, the damages being even greater if we consider the consequences that they have on short term (altering the landscape, the disappearance of the fauna or flora, sometimes belonging to the rare species) or on long term (the reconstruction of the biotope) (IGSU).

Regarding the statistical data of National Institute for Research and Development in Forestry “Marin Drăcea” Bucharest, in the period 1968-2003 (33 years) in Romania there have been 3,453 forest fires, an average of 105 fires / year (Burlui, 2018).

The issue of forest fires in the territory of Romania was also performed by Lorent et al, 2018. Regarding the study a total number 9974 forest fires were reported in Romania, from 1956 to 2015, resulting an average of 166 fires per year, with a total affected area of 50,538 ha (on average 880 ha per year and 5.1 ha per fire).

Regarding the recent years, in 2018 in Romanian there were 158 forest vegetation fires which affected 1341.25 ha of which:

- 156 fires occurred in the national forest - 1336.25 ha;
- 2 fires occurred in forest vegetation - outside the forest - 5 ha.

Economic losses registered in 2018, as a consequence of these fires, were estimated at 30000 EURO, produced by burning a number of 48000 seedlings of plantations and natural regenerations and an amount of 470 mc wood materials.

So in 2018 the most important forest fires were: 2 forest fires in the spring - 1 of 56 ha extinguished after 11 days and another one of 4 ha extinguished after 18 days; 2 forest fires in the autumn - 1 of 264 ha and another one of 84.9 ha, the both were extinguished after 4-5 days (JRC Technical Report – Forest Fires in Europe, Middle East and North Africa 2018).

In 2017, a total number of 447 forest vegetation fires were recorded in Romania, affecting a total area of 2459.3 ha, of which:

- 442 fires occurred in the national forest - 2446 ha;
- 5 fires occurred on forest vegetation, outside the forest - 13.3 ha.

As a result of these fires (from 2017) economic losses were estimated at around 1300000 EURO, produced by burning a number of 207 thousand seedling plants and an amount of 267 mc wood materials (Raport privind starea pădurilor României în anul 2017)

As can be seen in Figure II.26 and Figure II.27 in 2017, there was an alarming increase in the number of forest fires and burnt area compared to 2016, the maximum being registered in 2012. It is obvious that the main cause of forest fires is the fire propagation from the agricultural lands bordering the forests.

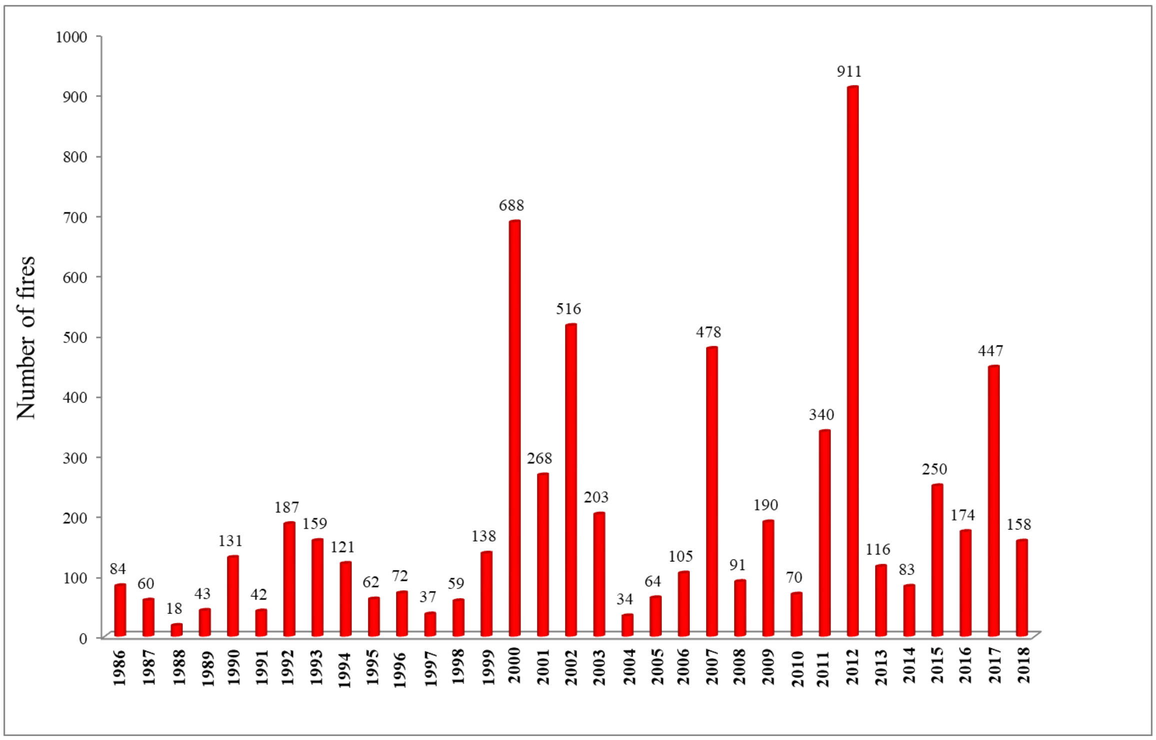

Figure II.26. *Number of fires in Romania between years 1986 – 2018* (Raport privind starea pădurilor României în anul 2017; JRC Techincal Report – Forest Fires in Europe, Midlle East and North Africa 2018)

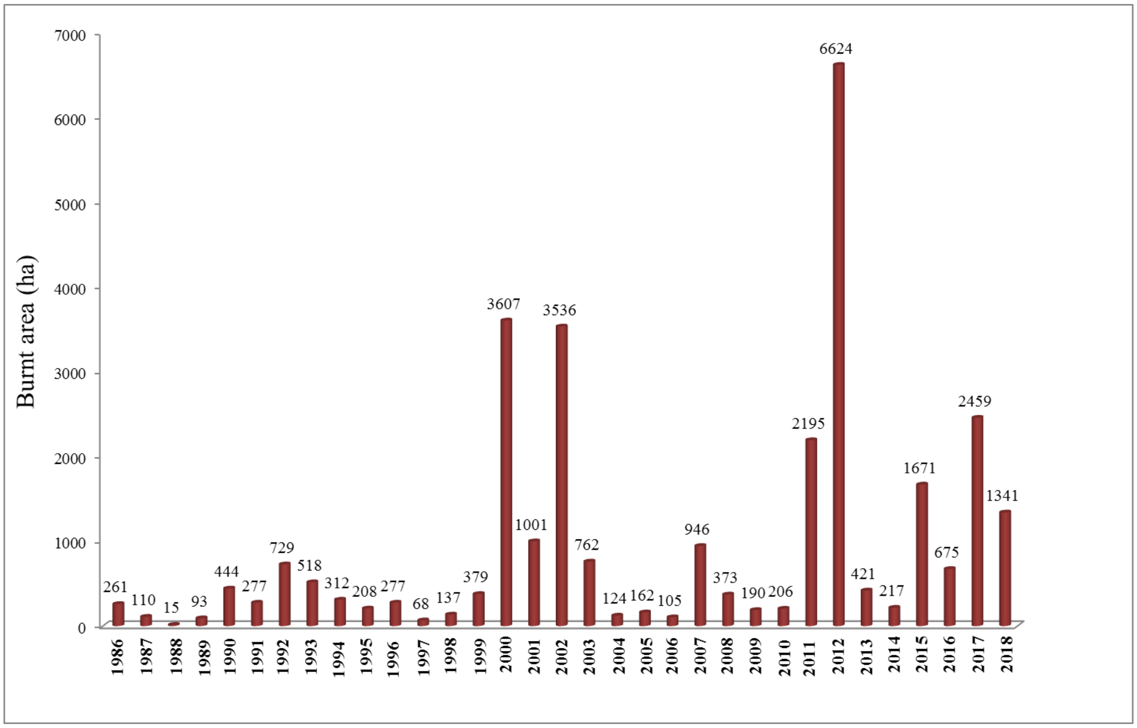

Figure II.27. *Burnt area in Romania between years 1986 – 2018* (Raport privind starea pădurilor României în anul 2017; JRC Techincal Report – Forest Fires in Europe, Middle East and North Africa 2018)

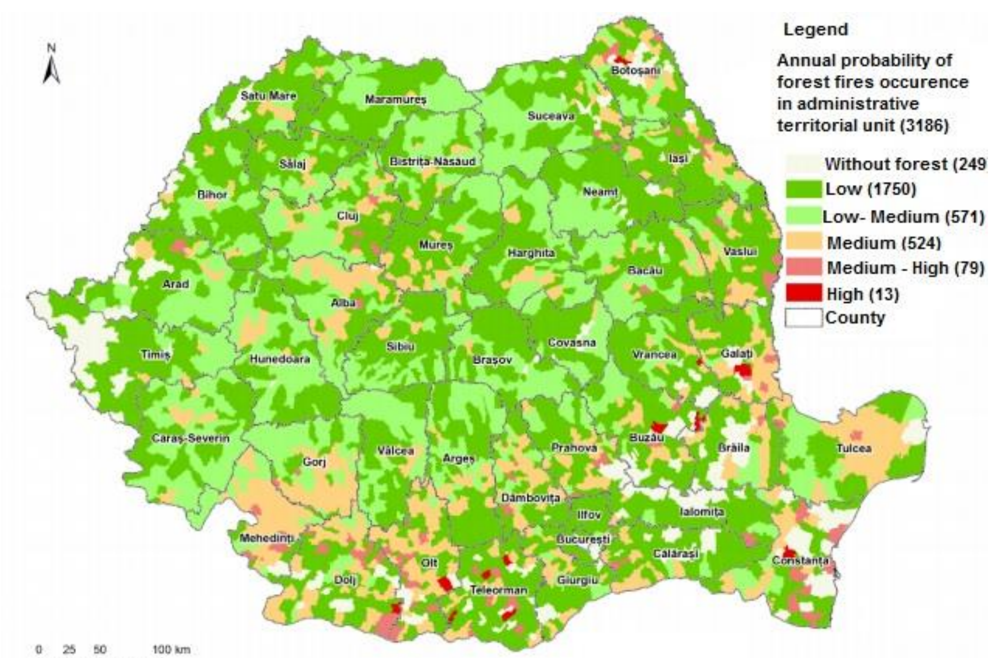

Figure II.28. *Annual probability of forest fires occurrence in administrative territorial unit* (after Lorent, et al, 2018)

Regarding RO-RISK Project (National Disaster Risk Assessment), for the study area in Romania - Maramures and Satu Mare counties – the probability of forest fire is low.

Maramures County occupies fourth place regarding forest area. The areas which are vulnerable to forest fires are those ones which bordering urban and rural areas.

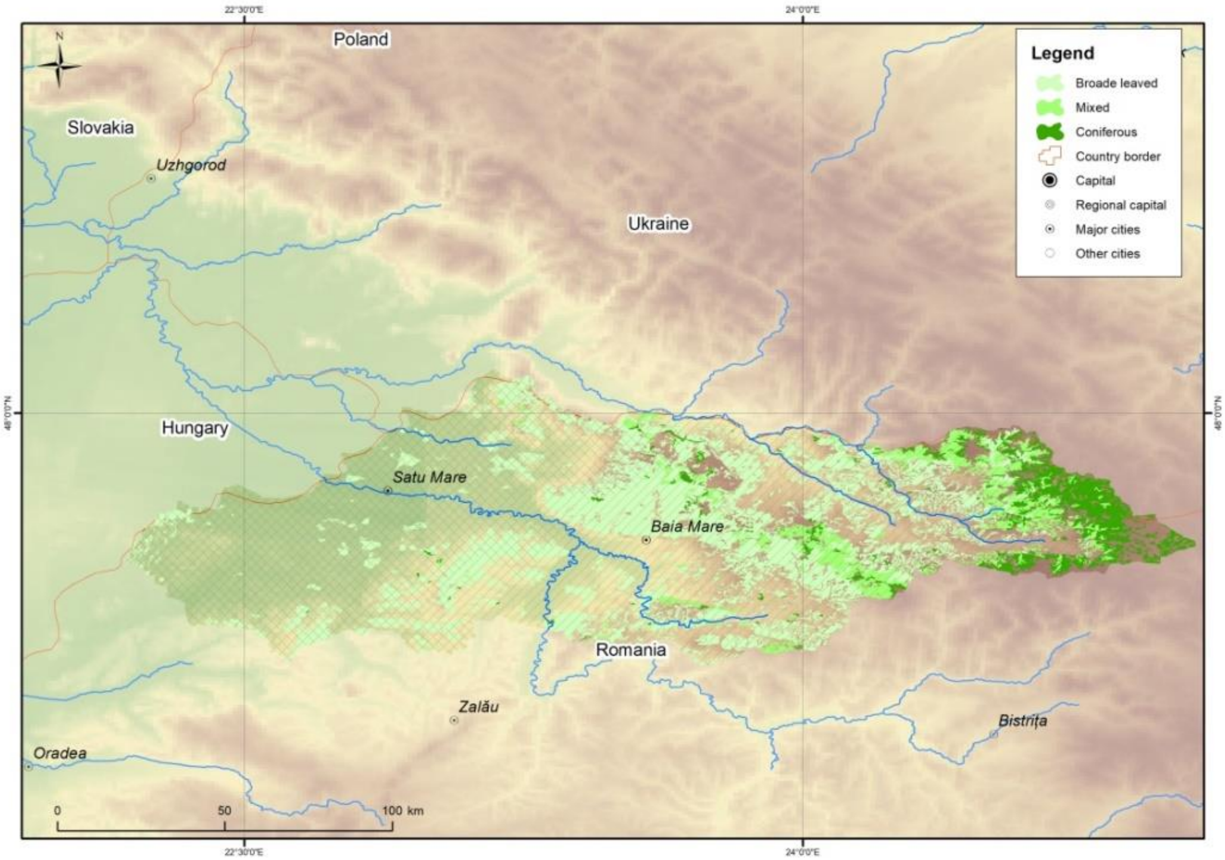

Figure II.29. *Forests - study are from Romania*

Forest fires in Hungary

Hungary is situated in the Carpathian basis. It is dominated by lowlands (67 %) and hilly regions 200-400 m high (29 %). The mountainous area (above 400 m) represents 4 %. The highest peak in the country is in the Matra Mountains (1015 m above sea level) (http://www.fao.org/).

In Hungary there is a total forest area of 2 million hectares, so the forest cover index is 20.5 % of the total country area. Around 600.000 ha of forest was planted between 1950 – 1980, resulting that more than 59 % is younger than 40 years.

One of the characteristic features of Hungarian forest stand composition is the absolute dominance of broadleaved forests. They make up a total of 85% of the total forest area; coniferous forests contribute to 15%.

Significant broadleaf species are oak *(Quercus petrea, Q. robur)* and Turkey oak *(Quercus cerris),* black locust *(Robinia pseudoacacia)* and poplar species *(Populus* sp.). The most important conifer species are Scots pine *(Pinus sylvestris)* and Austrian pine *(Pinus nigra)* (Figure II.30). The pine stands are occupying the area of the poorest sand-soils in the Hungarian lowlands and the dolomitic bleaks in the Hungarian lower mountain ranges. Nearly 65% of all fires are started in broadleaved stands. 50% of all fires in broadleaved stands are in oak and Turkey oak forests.

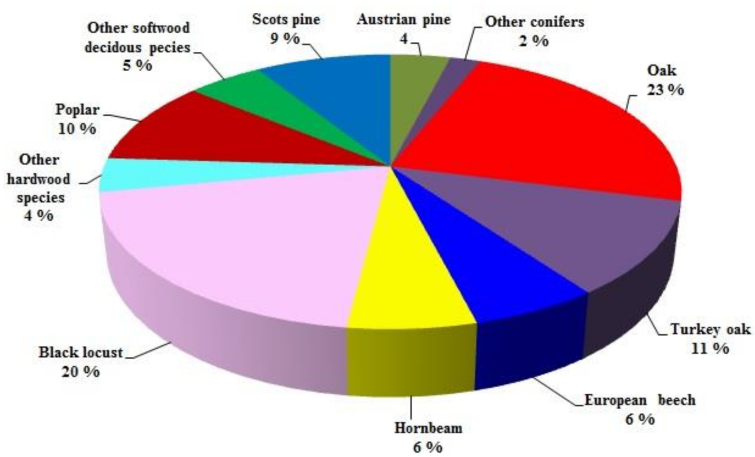

Figure II.30. *Distribution by species group (forest area in Hungary)*

(Source: Fire Situation in Hungary)

Unfortunately 99 % of forest fires in Hungary are caused by human’s negligence. Almost 65 % from forest fires started in broadleaved stands and 50 % of all fires in broadleaved stands are in oak and Turkey oak forests (Fire Situation in Hungary).

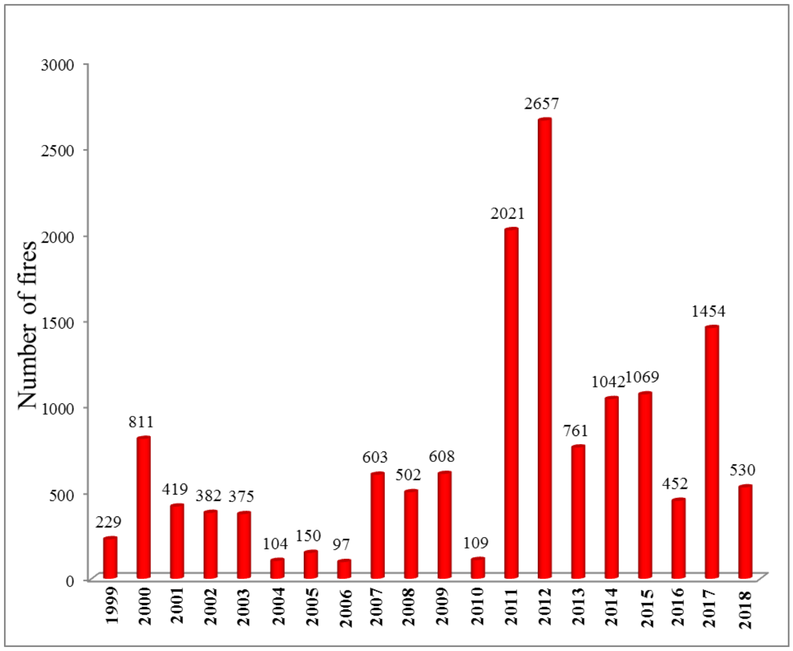

Figure II.31. *Number of fires in Hungary between years 1999 - 2018* (JRC Technical Report – Forest Fires in Europe, Middle East and North Africa 2018)

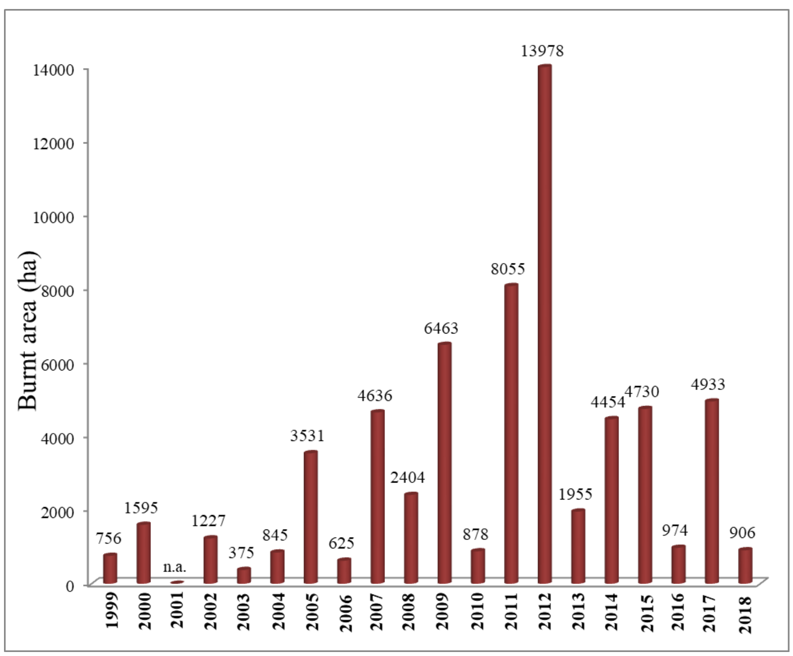

Figure II.32. *Burnt area in Hungary between years 1999 - 2018* (JRC Technical Report – Forest Fires in Europe, Middle East and North Africa 2018)

As it can be observed in Figure II.31 and Figure II.32 the worst year in case of fires respectively burnt area was 2012 when were registered a number of 2657 fires and 13978 ha of burnt area. This was due to the fact that 2012 was the year with highest extreme weather situations (in the last 100 years until then) (http://erdotuz.hu/forest-fires-in-hungary/).

Regarding the forest fires classification in Hungary, according to the characteristics of fire regimes they have:

- Spring fires in broadleaved stands – not region specific, depend on the fuel type, the size of the fire is seldom larger than 5ha;
- Summer fires in broadleaved stands – surface fires, low intensity with high spread it can happen fires also in coniferous stands which usually are developing in crown fires;
- Summer fires in juniper –poplar stands – this are fires with medium intensity and and high fire spread.

The Hungarian forest-act classifies the stands in three categories.

The first category (high danger) comprises:

- Dry oak stands (Orno *Querco pubescenti cerris)* in the mountains;
- Young and middle age conifer stands in the lowlands;
- Park forests in the lowlands;
- Broadleaf regeneration and plantation stands in the lowlands;
- Stands with recreational-oriented use in the lowlands;
- Stands in neighbourhood of railways and main roads in the lowlands.

In the second category (medium danger) are:

- Conifer stands;
- Other park forests;
- Regeneration and plantation stands;
- Stands in neighborhood of railways and main roads.

The third category (low danger) refers to all other stands.

In conclusions of a country report regarding the Forest fires in Hungary (Daniel Nagy-GFMC) the importance of cooperation at regional and international level is underlined

”The major, most difficult task in connection with wild land fires probably is not the fire suppression and the firefighting in the field, but creating cooperation between all agencies and landowners concerned with wild land fire. It is not sufficient to set up this cooperation at the administrative level only, but it must be effective on the operational level, too. Besides the projects on the national level collaboration in research and in operation on regional and international level would be very important.”

Spring vegetation fires usually burn with low or medium intensity in broadleaf forests, juvenile growths, shrubs and grasslands. Fire totally or partially consumes forests and causes serious harms. 40-45 % of spring fires burn in northern areas (Borsod-Abaúj-Zemplén County, Heves County, Nógrád County) which indicates these areas as high forest fire danger zones. In these areas not only traditional grassland management methods, but other social-economic factors add to forest fire danger.

Forest litter, needles, dead twigs and branches get totally dry in arid **summer periods** (June- August) without rainfall and start easily burning as a consequence of negligently lighted fire. Coniferous forests are highly endangered, as a small litter layer fire can even result in canopy fire in this period.

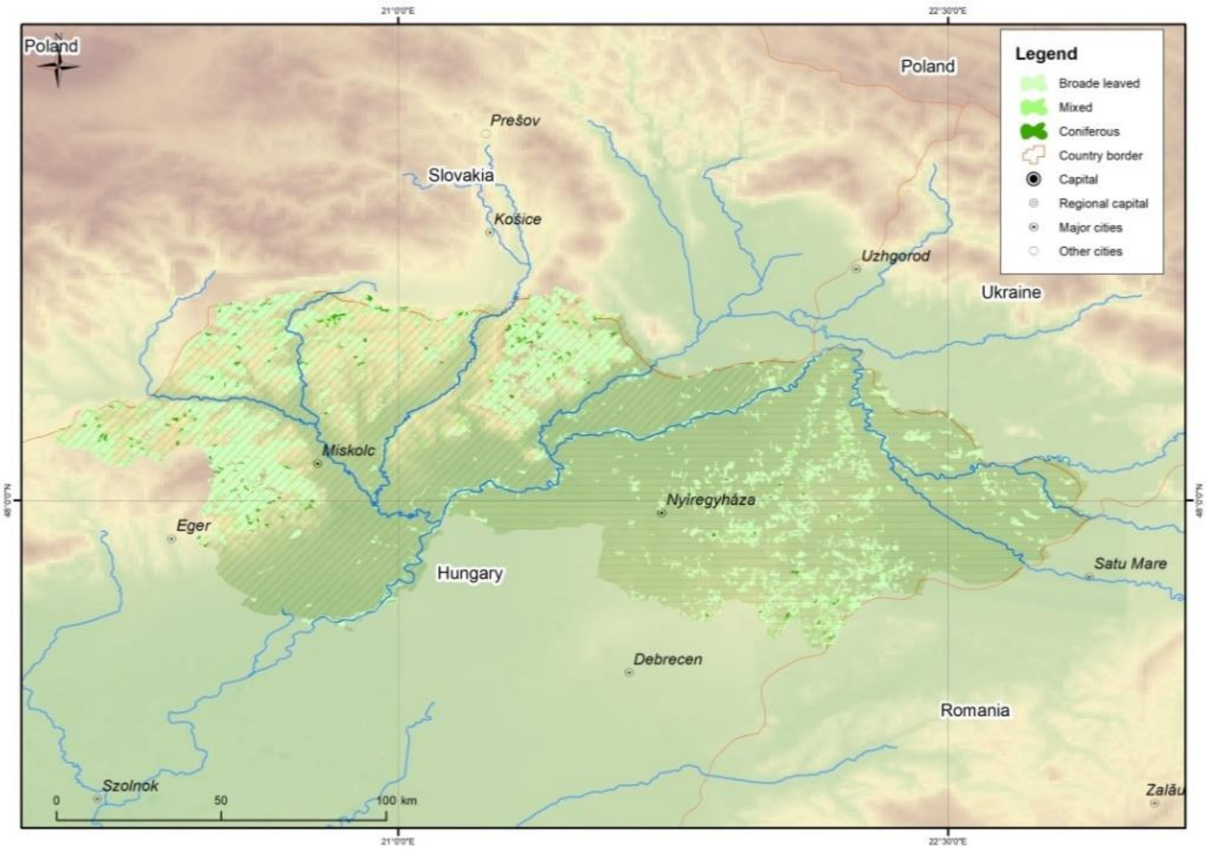

Figure II.33. *Forests - study are from Hungary*

Forest fires in Slovakia

Slovakia is locates in Central Europe having a total area of 49.035 km^2. The neighboring countries are: Hungary – south, Czech and Austria – west, Poland – north, Ukraine – east (Ambrusova et al., 2013).

Slovakia is dominated by the Carpathian Mountains, the main rivers being Danube, Vah and Hron.

Regarding the forest sector in Slovakia there is a total forest area of 2.019 million hectares, around 41 % of the total land area (Green Report, 2017).

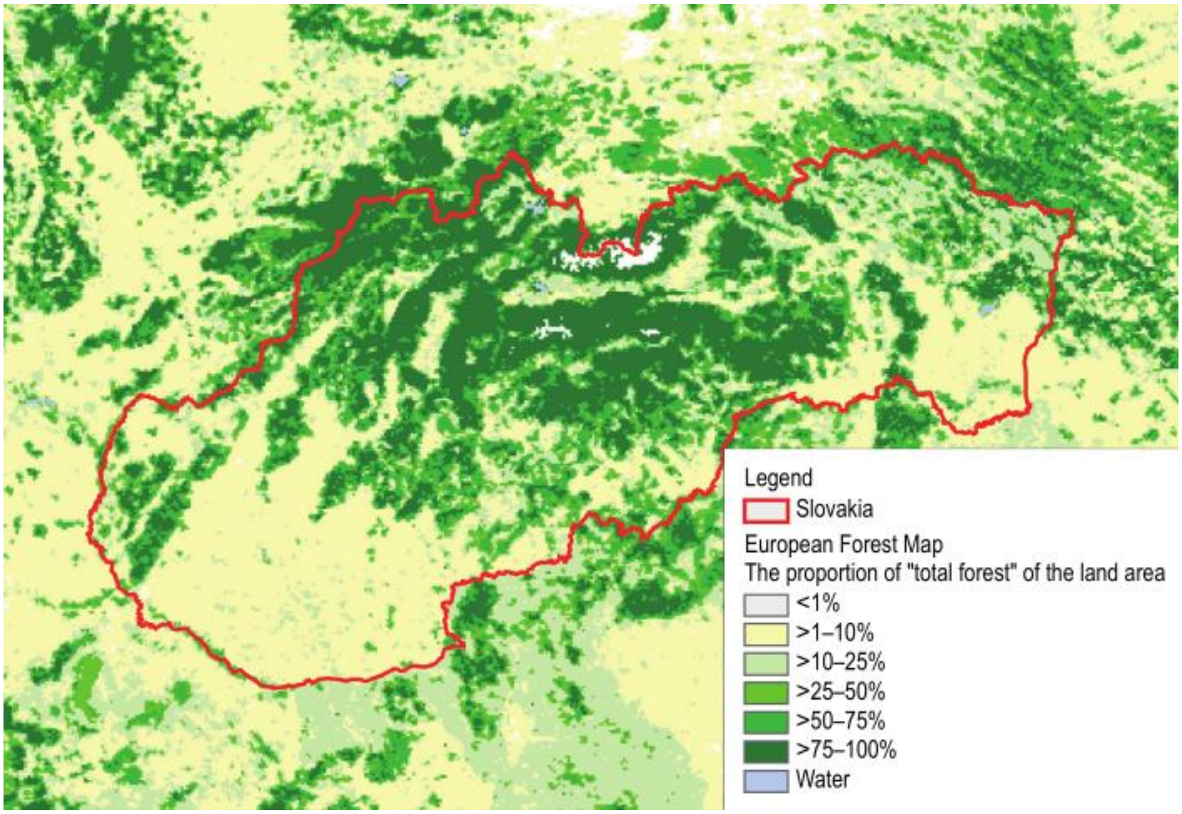

Figure II.34. *Slovakia on the European Forest Map* (Ambrusova et al., 2013)

As can be seen in Figure II.35 in Slovakia the most dominant tree species are European beech (33.6 %), Norway spruce (22.7 %) and English/sessile oak (10.5 %) (Green Report, 2017). In the Atlas of the forest sector in Slovakia is mention that in Slovak Republic 39.8 % of forest land is cover by conifers and broadleaved species cover 60.2 %. Natura 2000 protected area represent 48.8 % of total forest land (the third of EU member countries) (Ambrusova et al., 2013).

Slovakian forests comprise also primeval beech forests in the Carpathian Mountains in Bukovec and Vihorlat Mountains. These are part of a continuous arc of beech forests in eastern Slovakia and the western Ukraine. These types of old forests are rare in Europe due to the long-lasting, continuous human use of it and make them more valuable as complex ecological systems

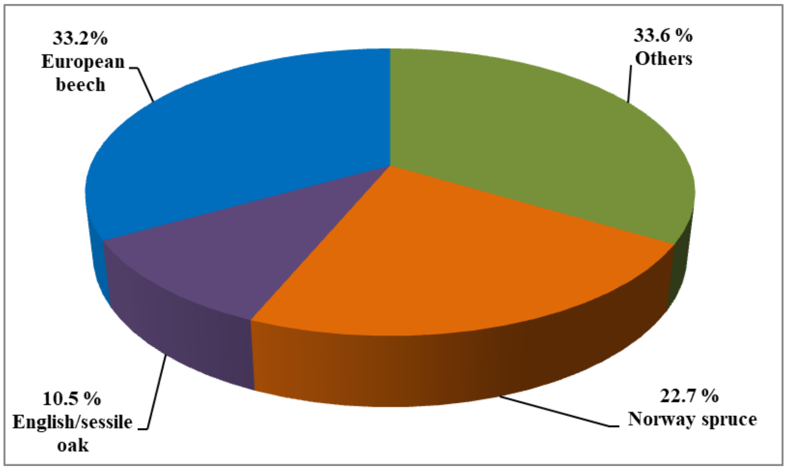

Figure II.35. *Forest composition in Slovakia*

(Source: Report on the Forest Sector of the Slovak Republic 2017 – GREEN REPORT)

Regarding the JRC Technical Report and Green Report from Slovakia, in 2017 there were 162 forest fires, which affected 297.66 ha and economic losses were estimated at around 410330 euro. Unfortunately in 2018 the number of fires increased (262 fires) and the main cause of the fire was negligence (Figure 36). On 3th of May occurred the biggest fire occurred around the Vysoké Tatry which damaged 10 ha of coniferous forest. Like in almost all cases the cause of the fire was negligence (Green Report, 2017; JRC Technical Report - JRC Technical Report – Forest Fires in Europe, Middle East and North Africa, 2018).

Because of the fact that in Slovak Republic the forest fires are also a problem, like in all the world, a wide range of measures were agreed regarding forest fire prevention and mitigation. The implementation of tools, programme environments, allowing the modellation in real time of fire behaviour is one of the measures. So since 2002 in Slovak Republic is used the FARSITE environment (Majlingova et al, 2018).

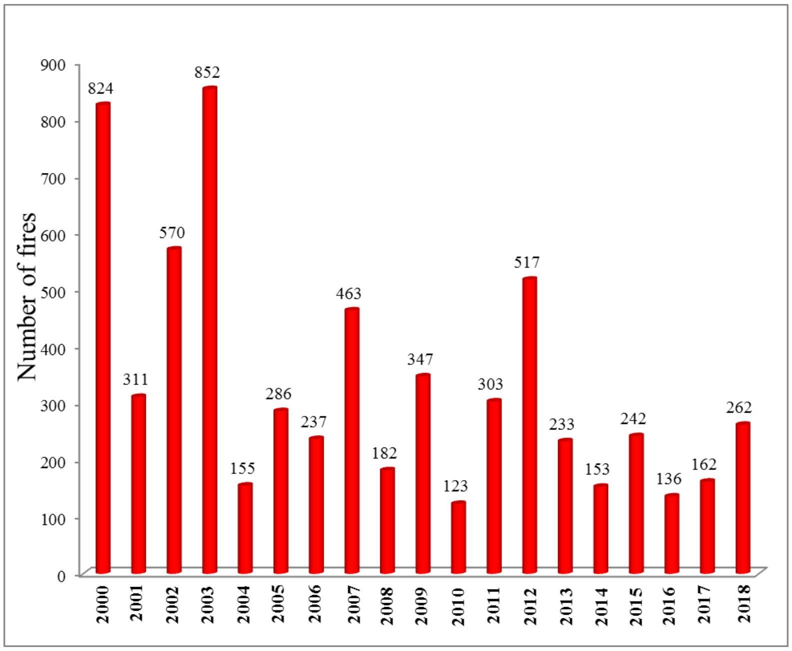

Figure II.36. *Number of fires in Slovakia between years 2000 – 2018* (Source: JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018; Report on the Forest Sector of the Slovak Republic 2017 – GREEN REPORT)

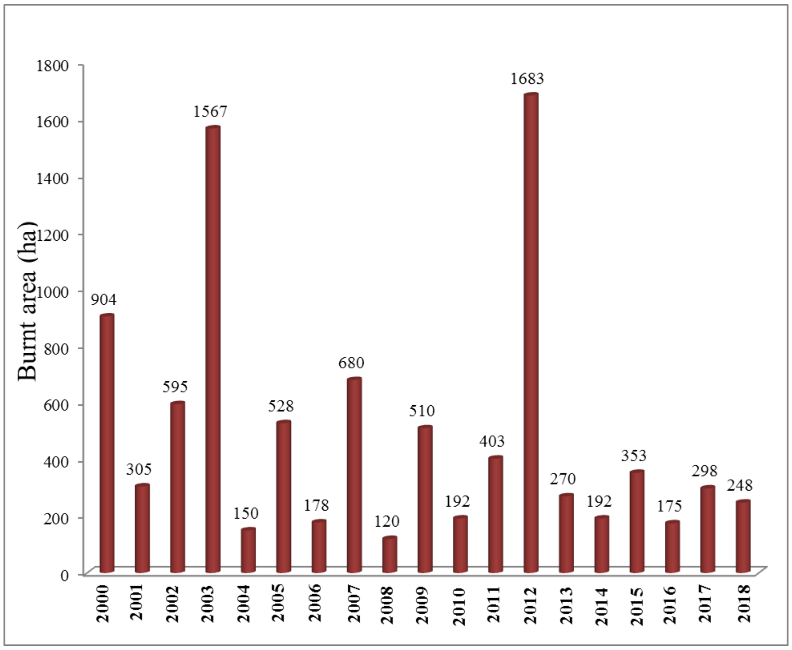

Figure II.37. *Burnt area in Slovakia between years 2000 - 2018* (Source: JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018; Report on the Forest Sector of the Slovak Republic 2017 – GREEN REPORT)

Like in case of Romania and Hungary, in Slovakia the most fires and the largest burnt area (Figure II.36 and Figure II.37) were in 2012 most likely due to high extreme weather conditions.

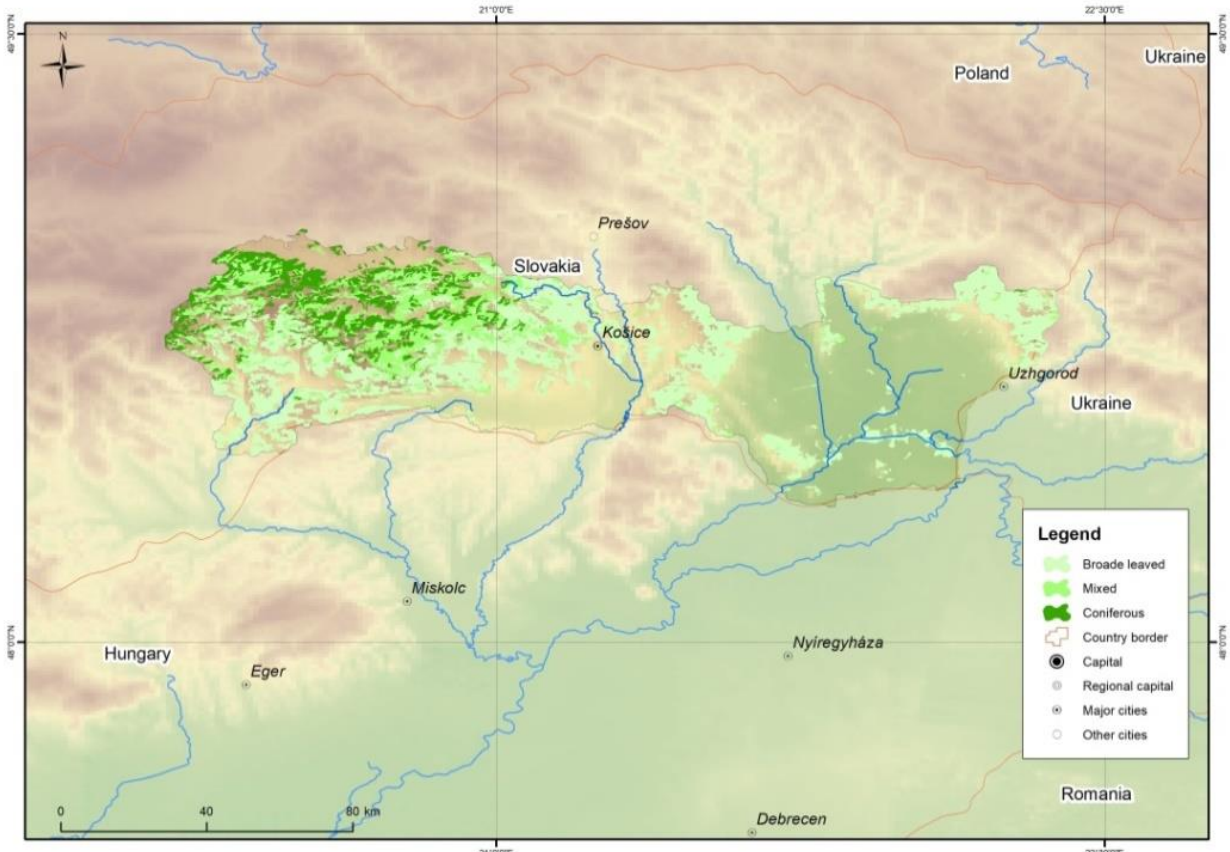

Figure II.38. *Forests - study from Slovakia*

Forest fires in Ukraine

Ukraine is located in Eastern Europe having a total area of 603.628 km^2. The neighbour are: Moldova, Romania and the Black Sea - south; Hungary, Slovakia and Poland - west; Belarus - north; Russia – north-east.

In regard to the encyclopedia of Ukraine and JRC Technical Report from 2018, in Ukraine is a total forest area of 10.4 million ha, so around 15.9 % is the total forest cover from Ukraine's territory. The majority of forests are in a state ownership (97 %)

(http://www.encyclopediaofukraine.com; JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018).

As it can be seen Ukrainian has a low percentage of forest cover comparing with other countries but still very important for rural areas in the project area.

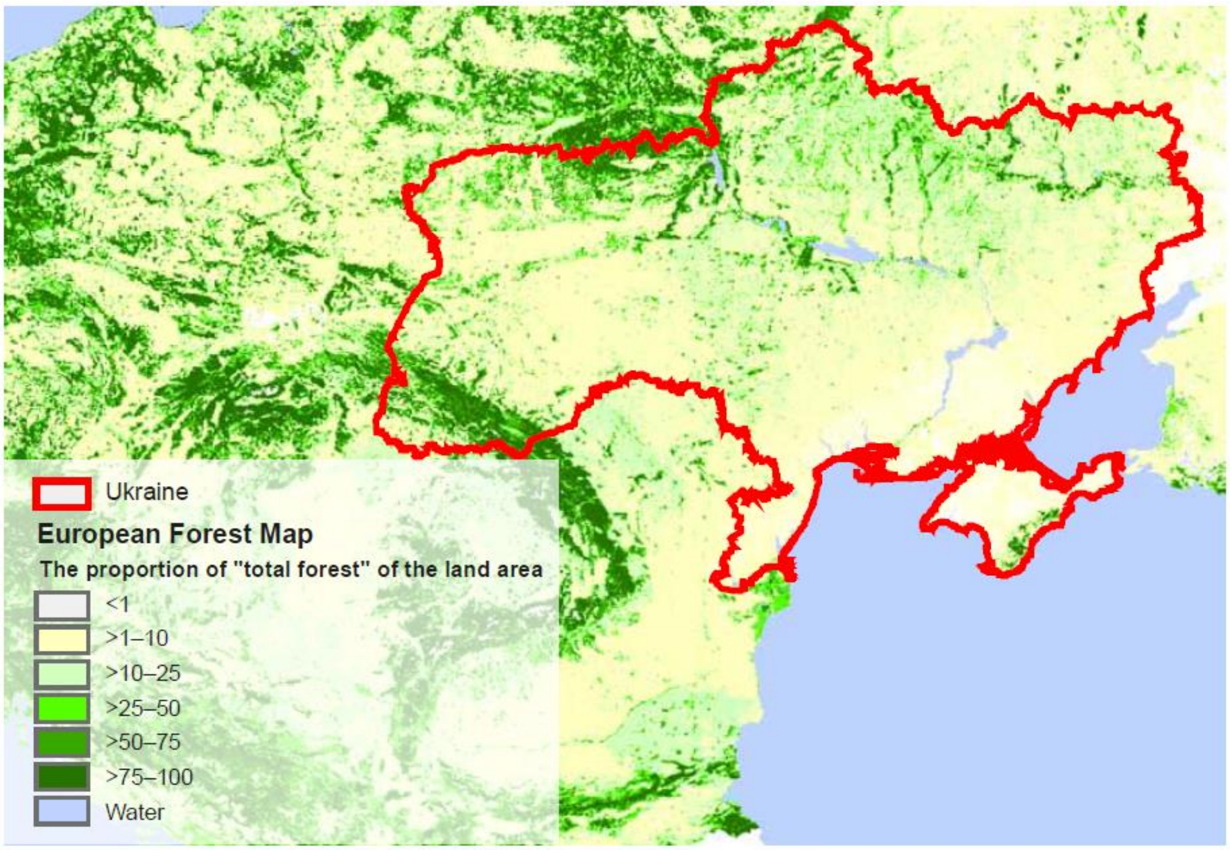

Figure II.39. *UKRAINE on the European Forest Map* (Schuck et al., 2013)

Regarding the composition of the forest, in Ukraine are more than 30 wood species, most common being cots pine (Pinus sylvestris L.), European oak (Quercus robur L.), European beech (Fagus sylvatica) and Norway spruce (Picea abies) (Figure II.40).

Forests from Rakhiv Mountains and the Chornohirskyi Range in the Ukraine in Transcarpathia area contain primeval beech forests. These are part of a continuous arc of beech forests in eastern Slovakia and the western Ukraine.

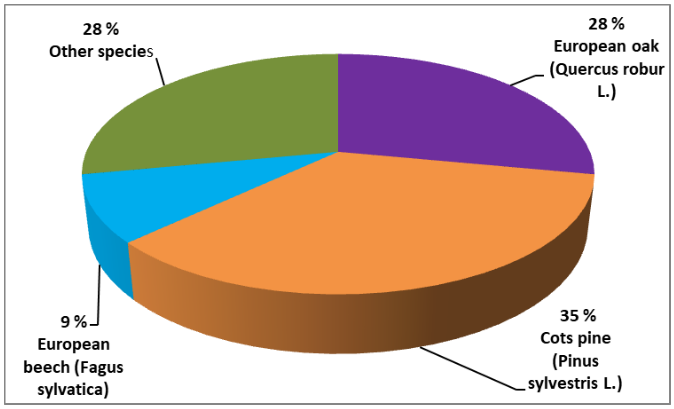

Figure II.40. *Forest composition in Ukraine* (Source: JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018)

In terms of wildfires in Ukraine there was a significant increase. In the 80s they were recorded between 792 up to 2377 fires per year while from 2008 to 2018 were recorded between 1297 up to 4922 fires per year (Table 8.). (Ukraine country forest fire report 2007, JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018)

Table II.8. *The number of fires in Ukraine*
(Source: Ukraine country forest fire report 2007; JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018)

Years/Period	**Number of fires/year**
80^{th}	792 - 2377
90^{th}	1818 - 6743
2000 - 2007	3205 - 5024
2008 - 2018	1297 - 4922

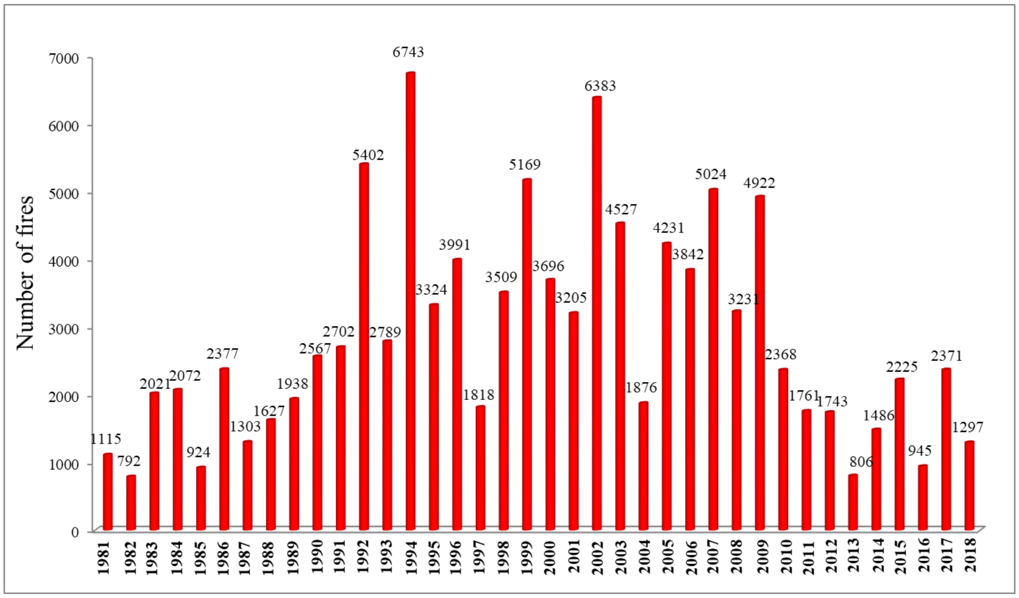

Figure II.41. *Number of fires in Ukraine between years 1981 – 2018*

(Source: Ukraine country forest fire report 2007; JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018)

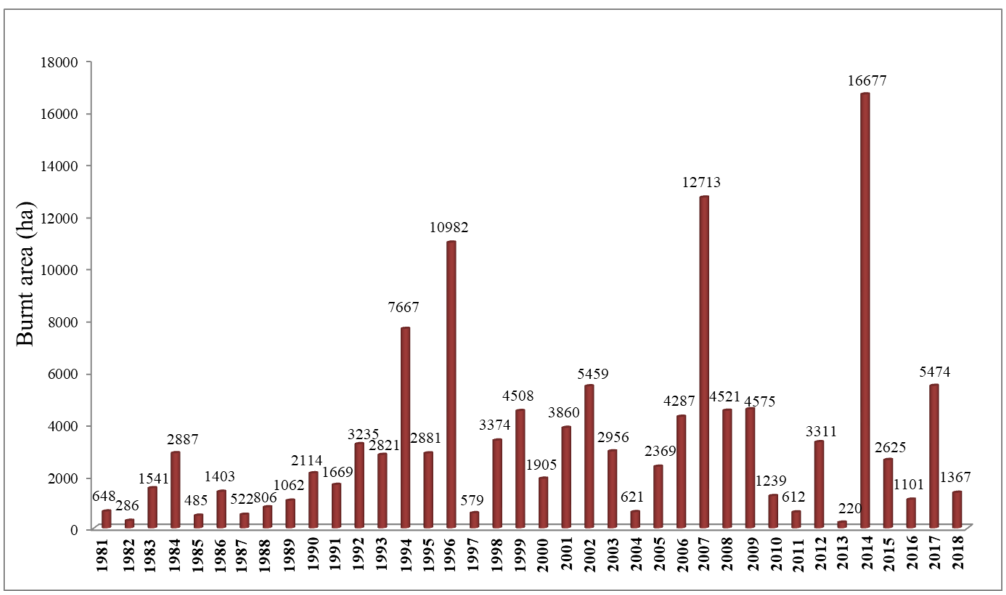

Figure II.42. *Burnt area in Ukraine between years 1981 – 2018*

(Source: Ukraine country forest fire report 2007; JRC Technical Report- Forest Fires in Europe, Middle East and North Africa, 2018)

As can be seen in Figure II.41 and Figure II.42 the biggest burnt area was in 2014 and the most fires were in 1994. Regarding the 2018, the last reported year, in June was recorded the biggest burnt area, 50% of the annual burnt area.

As in most countries the case of forest fires in Ukraine are mainly because of the negligence of local people (1074 from 1297 fires in 2018).

In Ukraine the forests are under protection of State Forest Resources Agency of Ukraine and the forest fire protection is provided by 307 state forest enterprises.

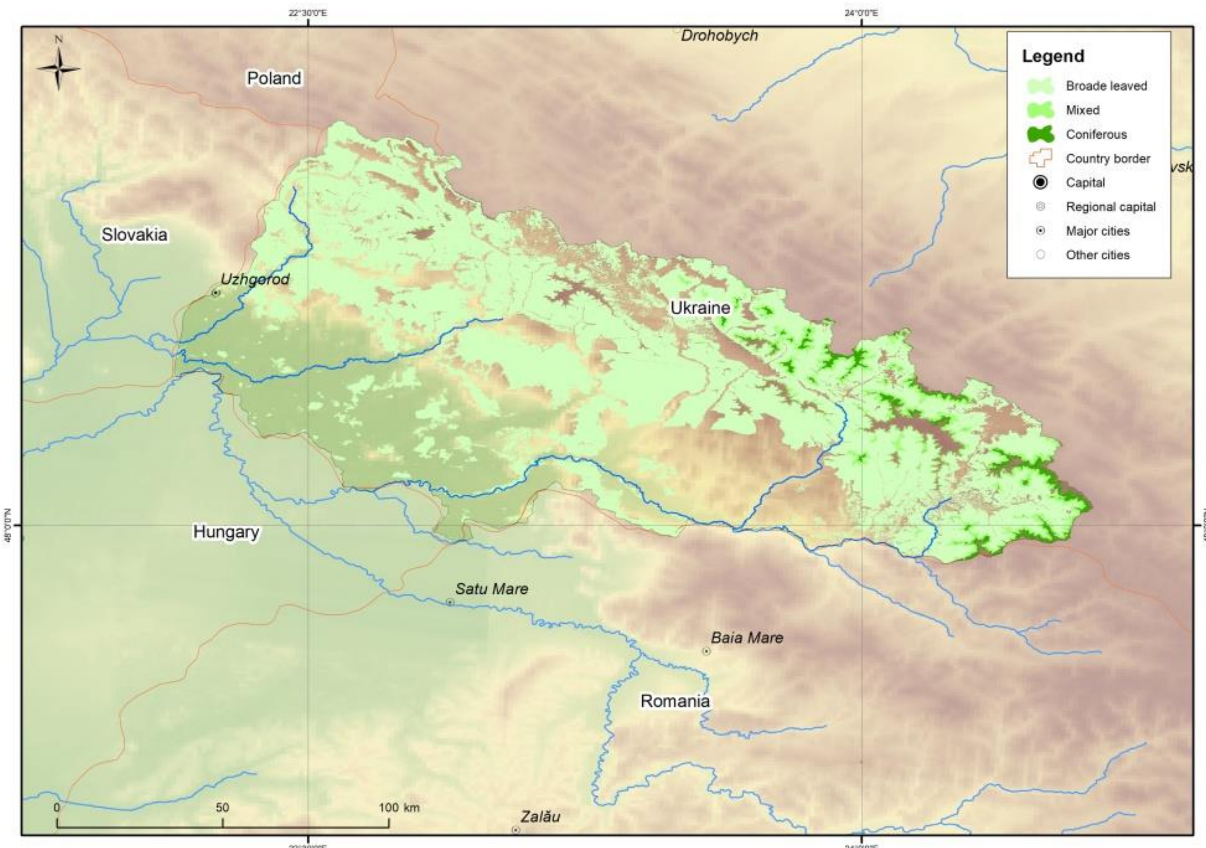

Figure II.43. *Forests - study from Ukraine*

Conclusions

Analyzing the level of exposure to fires in countries from the project Ukraine prove to be the most exposed country followed by Hungary, Slovakia and Romania. Unfortunately in most countries the cases of forest fires are mainly because of the negligence of local people.

Due to the fact that fires and floods do not respect the borders the effective cooperation at regional and international level is very important.

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