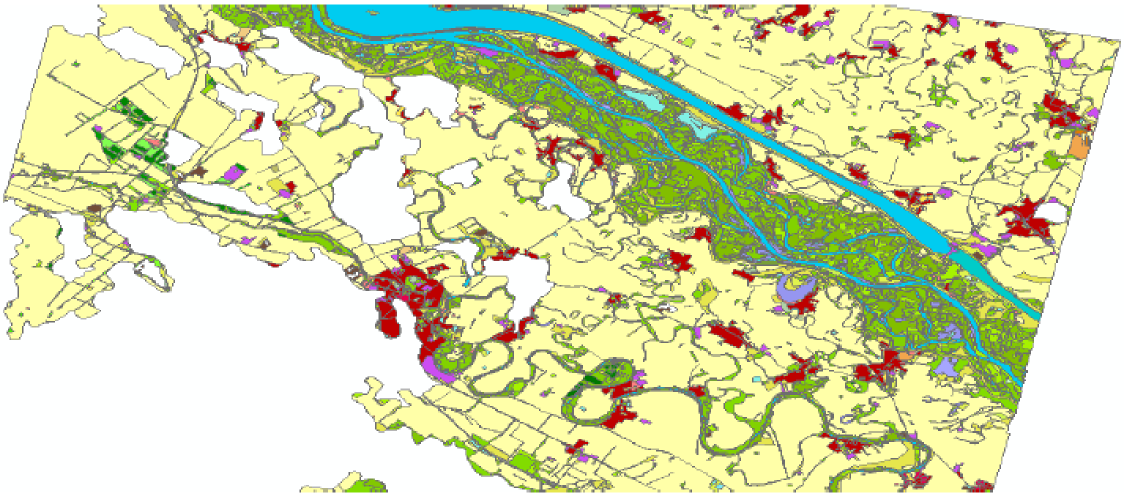
TOWARDS A RIPARIAN DANUBE FOREST CORRIDOR



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1. INTRODUCTION

Riparian forests are habitats serving multiple functions for flora, fauna and humans. In the past century, around 90% of the original Danube wetlands have been lost due to human activities. Today, most of the last remaining large-scale floodplain forest complexes are protected by the Danube Protected Areas, famous for their richness in biodiversity.

Riparian forests are of great ecological importance, playing an important role in both nature and human populations. Among their many functions are, preserving plant and animal species, preventing bank erosion, and helping to prevent flooding by retaining water. Riparian forests are categorically associated with rivers and thus have a naturally limited distribution. Historically, rivers have dwindled as a result of loss of area to agriculture and intensive cultivation of poplar trees.

The biggest causes of loss and destruction of riparian forests can be attributed to land use change for agricultural use; replacement with hybrid Poplar and Willow plantations for intensive timber production; river bed correction and aggregate mining, which subsequently lead to dramatic changes in the flow regime and to bank erosion; unauthorized and improperly conducted logging; and construction of hydroelectric plants.

2. PURPOSE OF THE DOCUMENT AND METHODOLOGY FOR ITS ELABORATION

Building on the cooperation with the European Environment Agency, expressed by a Letter of Support, the Copernicus Land Monitoring Services provided DANUBEparksCONNECTED with unique data on Riparian Zones, to be used for the first time on a macro-regional dimension.

This document now intends to merge experiences and to formulate joint principles for Danube-wide status of riparian forests along the Danube based on available Copernicu data as well as to contribute to the implementation of ecological networks in the Danube. Its conclusions are the results of the communication between experts of the Danube Protected Areas. The document doesn´t present a comprehensive study, but it aims to be a base for further discussion, to highlight perspectives for the Danube riparian forests and the development of concrete actions. The Danube case study will also generate relevant feedback to the EEA, to learn more about the relevance and quality of the data set and to further improve the methodology.

As a first step, the DANUBEparksCONNECTED WP6 working group in Wachau, Austria (5th to 7th April 2017) intended to discuss the framework and tasks given acording to project aplication form. Under the lead of Public Enterprise „Vojvodinašume" project partners worked together on the defining the indicators as the analysis tool, which would help to assess status of riparian forests along the Danube as well as to define the zones with the significant loss of riparian forest surface coverage and the gaps between forest complexes. The indicators represent different influencing factors. Each indicator has a specific value that indicates if it has a positive or a negative role in ecological connectivity. All partners were asked to write provide inputs (available data on indicators) and to share them with Vojvodinašume who overtake leading responsibility for providing expertise on specific topics linked to ecological connectivity, especailly in terms of forest corridors. A follow-up project workshops implemented during 2017 and 2018, taking into account provided data, brought significant consideration and further remarks given by project partners resulting in shaping of this document.

3. GEOGRAPHICAL SCOPE

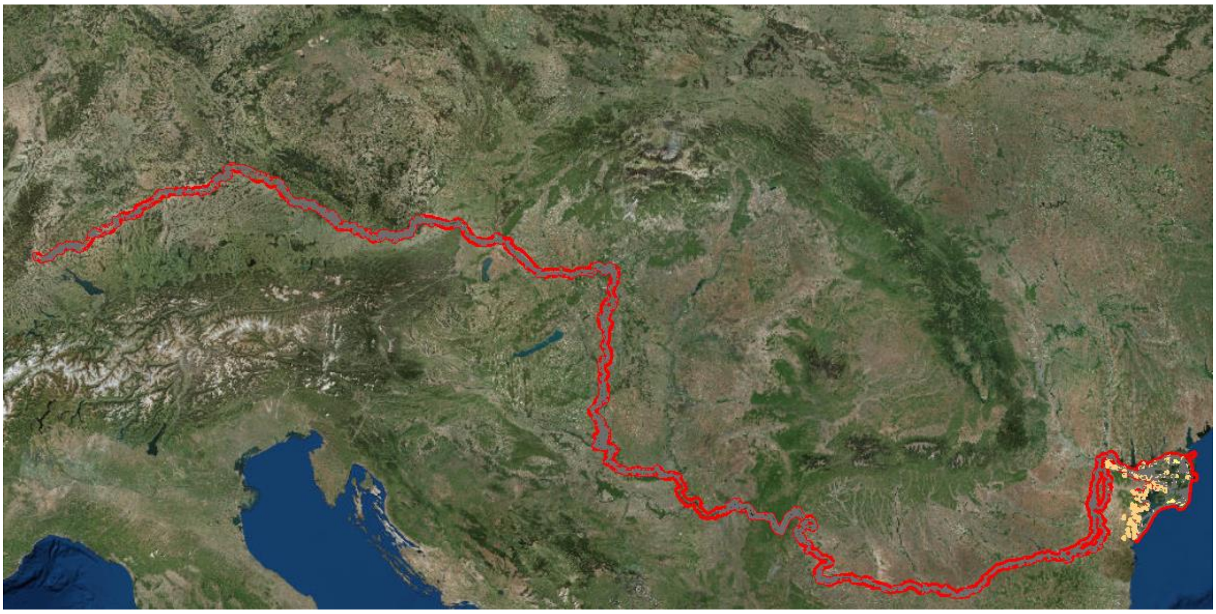
Taking into account basic definitions of the riparian forests, we can freely say that riparian forest or riparian woodland is a forested or wooded area of land adjacent to a body of water (river, stream, pond, lake, marshland, estuary, canal, sink or reservoir). Riparian forests form the transition between the aquatic and the terrestrial environment.

In some regions the terms riparian woodland, riparian forest, riparian buffer zone, riparian corridor and riparian strip are used to characterize a riparian zone.

This document is defined for the floodplain forests under the regime of the Danube River.

Since that this document elaborate data available from Copernicus data base, we decided to use following definition given by Copernicus: "*Riparian zones represent transitional areas occurring between land and freshwater ecosystems, characterised by distinctive hydrology, soil and biotic conditions and strongly influenced by the stream water. They provide a wide range of riparian functions (e.g. chemical filtration, flood control, bank stabilization, aquatic life and riparian wildlife support, etc.) and ecosystem services.*"

Image No. 1 – Danube region



For the analysis, the buffer around the Danube stream has been created. Buffered feature is created as a polygon feature 6 km wide at each side of Danube. Full size of protected areas were included in the polygon, therefore the width of the polygon is not equal everywhere. Wide distant of 6km from each side of Danube has significant lack especially for upper Danube part (e.g. German) while in lower Danube (Danube delta) it is even narrow distant. In general, for the greatest part of the Danube this 12km (on both side) wide distant is still appropriate.

4. LEGAL FRAMEWORK FOR DANUBE FOREST HABITAT CORRIDOR

Availability of the Riparian Zones products will support the objectives of several European legal acts and policy initiatives, such as the EU Biodiversity Strategy to 2020, EU Forest Strategy, the Habitats and Birds Directives and the Water Framework Directive.

Often, policies for ecological connectivity are relatively weak instruments in riparian forest habitats. The effect of Natura 2000 is limited due to missing habitat connectivity and coherence. Consequently, innovative strategies have to be developed and new partnerships have to be established within this process of establishing Riparian Danube Forest Corridor. In this context, synergies with the Danubeparks Association partnerships will be essential like forest conservation on Danube islands, sustainable ground management of electricity lines in Protected Areas which are one very good development way.

This EU Forest strategy aims to put forests and the forest sector at the heart of the path towards a green economy and to value the benefits that forests can sustainably deliver, while ensuring their protection. Beside different forestry laws, specific for each Danube country, the EU directives as well as forest management plans and management plans of protected areas were identified as important legal framework for the management of riparian Danube woodland. Forest Management Plans (FMPs) or equivalent instruments based on the principles of sustainable forest management are key instruments in delivering multiple goods and services in a balanced way. FMPs are at the core of both the EU 2020 Biodiversity Strategy and EU Rural Development funding. The Danube floodplain forests are considered as habitats of common European conservation interest. 230 NATURA 2000 areas have been designated to ensure the conservation status of the habitat types concerned (ICPDR 2011). Floodplain forests belong to the endangered habitats on European level and are therefore listed in the FFH directive: 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae), with key species like Black poplar and 91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers of the Atlantic and Middle- European provinces (Ulmenion minoris). The NATURA 2000 network is still waiting for full implementation in all EU-countries along the Danube river.

At pan-European level, the focus is on the ongoing negotiations on establishing a legally binding agreement on forests, with the EU as a key actor. Through this agreement, the EU aims to improve sustainable forest management across the region. The new strategy forms a suitable vehicle for the implementation of the agreement. At global level, the EU is at the frontline of work on combating deforestation and forest degradation. It promotes sustainable forest management as a way of protecting biodiversity, fighting desertification and responding to climate change, whilst ensuring that forest ecosystems deliver goods and services. In this way it contributes to sustainable development and to eradicating poverty. REDD+, FLEGT27 and the EU Timber Regulation28 aim towards these goals. By 2015, the Commission will review the functioning and effectiveness of the EU Timber Regulation.

5. DANUBE RIPARIAN FOREST FITNESS CHECK

Forests provide ecosystem services on which rural and urban communities depend, and host an enormous variety of biodiversity. Pressures on forests, such as habitat fragmentation, spread of invasive alien species, climate change, water scarcity, fires, storms and pests call for enhanced protection. EU rules cover the movement and trade of certain plants, plant products and objects that can threaten plant health. Protection efforts should aim to maintain, enhance and restore forest ecosystems' resilience and multi-functionality as a core part of the EU’s green infrastructure, providing key environmental services as well as raw materials. Further emphasis should be put on preventing negative impacts on forests rather than on damage mitigation and restoration. For forests to be able to react to future threats and trends, genetic diversity must be enhanced and endangered genetic resources protected. River corridors serve as optimal habitat for many animal species, as they contain both water and tree vegetation that can provide food. They are often the only connection between isolated forests and thus the survival of a large number of plant and animal species depends on them. When uninterrupted, a strip of riparian vegetattion serves as a main corridor for wildlife.The destruction of riparian forests leads to a decrease in species diversity – there is a direct correlation between the decreased number of old trees and that of nesting birds. The clearing of trees on river banks results in a decrease in species diversity and impact insect populations, a food sourcefor many fish species. Due to their ability to retain water, forested river banks play a role in both flooding and drought. When flooded, they provide breeding sites for amphibian, reptile and bird populations. The alluvial waters absorb various particles, organic substances and small organisms from the forest. As waters retreat, these materials are carried away and become a food source for water plants and microorganisms which in turn become food for fish of various size. Flodplain forests are directly connected to other territories by the river and its catchment area, which that can often lead to the occurence of alien, invasive species. Besides their huge ecological significance, alluvial forests bring a number of direct economic benefits too, such as timber and medicinical plant production, income from fishing and recreation.

Today lowland forests are fragmented and small in area. They are dispersed amongst large areas of agriculture and urbanization, interrupted by roads, etc., creating impassable obstacles for forest wildlife. The problems faced by riparian forests are often associated with loss of area and with changes in their structure and functions.

Fragmentation is a main limiting factor which has to be overcome. Other causes for the loss of natural riparian forests are:

- land use change (e.g. transformation of land into agricultural plots);
- changes in the hydrologic regime as a consequence of infrastructure construction (mini HPPs, dykes, roads, drainages, etc.);
- wild fires;
- erosion processes caused by the Danube River, the constant changes in the bank outline, the disappearance of old islands and the formation of new ones;
- climatic changes which lead to elemental fl oods and droughts.
- human-related causes of changes in the structure and functions of riparian forests are: invasion of alien species such as boxelder maple, green ash, false indigo-bush, ailanthus etc.;
- dumpsites and water pollution.

The Fitness Check creates the basic understanding while the roadmap defines necessary actions.

5.1 Remote Land Service and GIS offise setting up

The Riparian Zones products of the European Environment Agency aim to support the objectives of several European legal acts and policy initiatives, such as the EU Biodiversity Strategy until 2020. The unique data on Riparian Zones are used in the Danube Riparian Forest Fitness Check for the first time on a macro-regional dimension, to identify the status of ecosystems and the some of services they provide.

5.1.1 Cooperation platform with European Environmental Agency

The Letter of Support by the European Environment Agency underlines the big interest in the case study at the Danube. Close cooperation is planned for data interpretation and analyses. The Danube case study could also generate relevant feedback to learn more about the relevance and quality of the dataset and could help to further improve the methodology. The Danube region acts as pilot area for a European approach. Its task is to provide sound, independent information on the environment. The EEA is a major source of information for those involved in developing, adopting, implementing and evaluating environmental policy, and also for the general public.

Thanks to the Cooperation platform with European Environmental Agency it was decided to test data from the Copernicus Land Monitoring Service. The Copernicus Land Monitoring Service is part of the Copernicus Programme, which is an EU Programme managed by the European Commission (EC) and implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for medium-range Weather Forecasts (ECMWF), the European Environment Agency (EEA), the European Maritime Safety Agency (EMSA), the European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the EU (Frontex) and Mercator Océan. The Programme is aimed at developing a set of European information services based on satellite Earth Observation and in-situ (non-space) data. The Copernicus Land Monitoring Service provides geographical information on land cover, land use, land cover-use changes over the years, vegetation state or water cycle. Applications that are built upon and integrate the information supplied by the service can provide support in areas such as spatial planning, forest management, water management, agriculture and food security and emergency management, amongst others. Service priorities and their relevance to users are defined and validated by the EC and the Member States. The service is implemented by the European Environment Agency (EEA) and the Joint Research Centre (JRC) since 2011. The Copernicus data policy promotes the access, use and sharing of Copernicus information and data on a full, free and open basis. There is no restriction on use or reproduction and redistribution, with or without adaptation, for commercial or non-commercial purposes. This data policy applies to the data and information generated within the Copernicus programme, i.e., Sentinel mission data and Copernicus service information.

5.1.2 Remote Land Service and GIS tools and GIS interpretation and gap analyses of Copernicus Monitoring Services

The Copernicus Land Monitoring Services provided unique data on Riparian Zones. For the first time, the data set is used on a macro-regional dimension in the Danube Region. GIS experts of PE „Vojvodinašume“ were trained by experts (Vekom ltd.) on a specific remote census software (ERDAS Imagine) to build up capacity for long-term Danube-wide forest corridor activities.

Copernicus Land Monitoring Service provides three data components: Global, pan-European and Local. To achieve the tasks objectives, data from the pan-European and Local components were used. The pan-European Component is coordinated by EEA and produces mosaics of satellite images, land cover/land use information.

For the forestry analysis, the most imortant set of data is the High Resolution Layer Forest. The HRL Forest with reference year 2015 (± 1 year) has been fully produced in the European Terrestrial Reference System 1989 (ETRS89) and in Lambert Azimuthal Equal Area (LAEA) projection with one harmonised set of products (no split in different service elements and geographic lots) by a consortium of well-established European service providers. For the first time, the product portfolio includes a set of new change products at pan-European scale. Multitemporal satellite data in 20m spatial resolution, mainly Sentinel-2A data from the European Space Agency (ESA) as well as Landsat 8 data from the United States Geological Survey (USGS), represent the primary input data source for the 2015 products. Additionally, the 2015 production includes the correction and re-processing of the historical 2012 HRL Forest products to allow a full harmonisation across Europe. The two primary status layers Dominant Leaf Type (DLT) and Tree Cover Density (TCD) at 20m spatial resolution are sharing the same spatial extent and provide information on the leaf type (broadleaved /coniferous) and the proportional tree cover at pixel level. The Copernicus HRL Forest defines Tree Cover Density as the „vertical projection of tree crowns to a horizontal earth’s surface“ and provides information on the proportional crown coverage per pixel. This information is derived from multispectral High Resolution (HR) satellite data using Very High Resolution (VHR) satellite data and/or aerial ortho-imagery as reference data. Tree Cover Density is assessed on VHR sources by visual interpretation following a point grid approach and subsequently transferred to the HR data by a linear function.

Image No. 2 –Distribution of broad-leaved and coniferous tree species

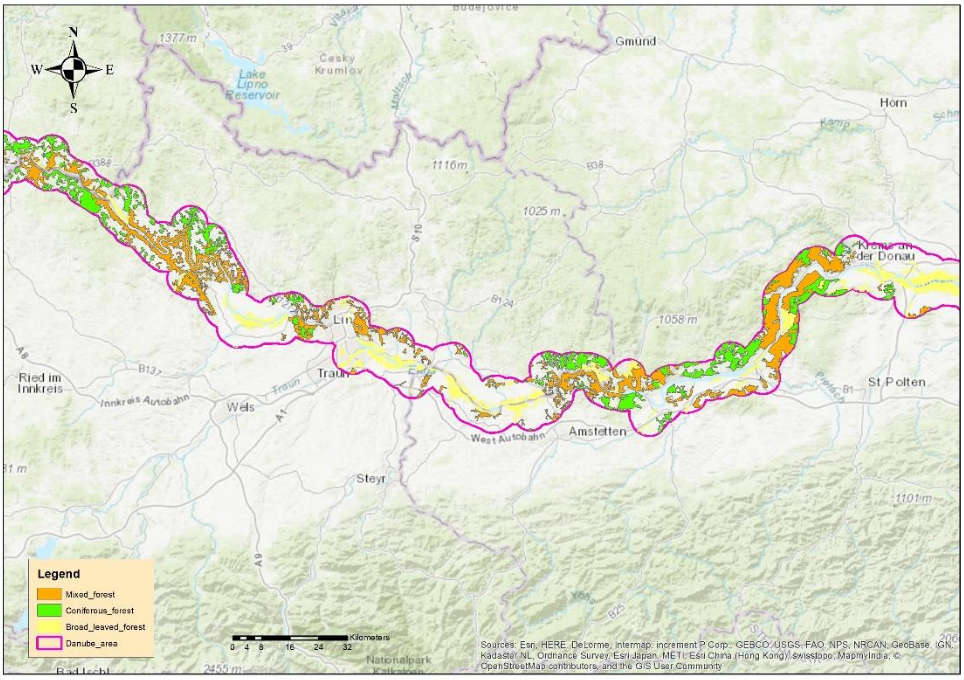
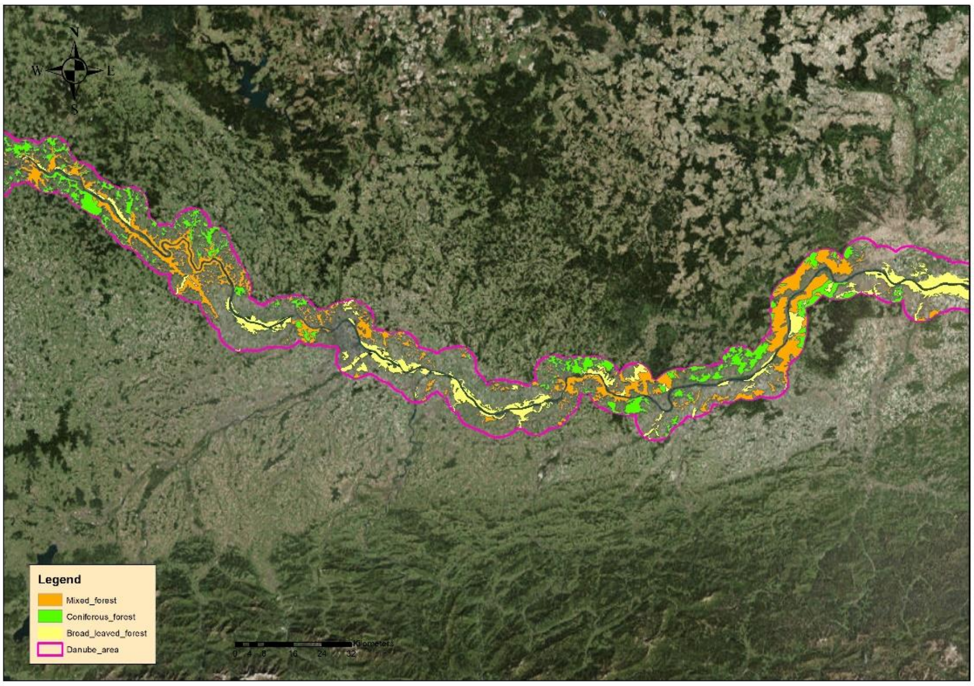


Image No. 3 –Distribution of broad-leaved and coniferous tree species (orthophoto)



The Tree Cover Density represents one of the primary status layers of the HRL Forest product portfolio and has the following main specifications:

- 20m spatial resolution
- Tree Cover Density range of 0-100%
- No Minimum Mapping Unit (MMU); pixel-based
- Minimum Mapping Width (MMW) of 20m
- Monotemporal coverage

In particular, information on crown cover, which is provided with the continuous-scale (0-100%) Tree Cover Density product for the whole of Europe, can be generally used by different countries, even if different national forest definition regards the crown/canopy cover exist (e.g.

Austria with 3%, Spain with 5%). In this sense, the TCD product largely supports the user-specific derivation of forest-related products according to the European-wide different understandings of forest. The Tree Cover Density product is also available as aggregated version in 100m spatial resolution, fully aligned to the EEA 100m reference grid.

The Dominant Leaf Type is another primary status layer of the HRL Forest, derived from multitemporal satellite image data using Support Vector Machine (SVM), and has the following main specifications:

- 20m spatial resolution
- Fully identical in its outline extent with the Tree Cover Density product
- Providing information on the dominant leaf type: broadleaved or coniferous
- No Minimum Mapping Unit (MMU); pixel-based
- Minimum Mapping Width (MMW) of 20m
- Multitemporal coverage

In combination with the Tree Cover Density product, the Dominant Leaf Type is suitable to serve various national forest definitions.

With the Forest Type product the HRL Forest already provides one type of forest products following a forest definition. Contrary to the Tree Cover Density product non-forest trees are excluded following the forest definition of the Food and Agriculture Organization (FAO). This is e.g. specified in the terms and definitions of the Global Forest Resources Assessment (FRA) The forest definition of the FAO includes and excludes the following features/elements:

1. Includes (FAO): forest nurseries and seed orchards that constitute an integral part of the forest; as well as forest roads, cleared tracts, firebreaks and other small open areas < 0.5 ha and/or < 20m width. Forest in national parks, nature reserves and other protected areas such as those of specific scientific, historical, cultural or spiritual interest; windbreaks and shelterbelts of trees with an area of more than 0.5 ha and width of more or equal than 20m; plantations primarily used for forestry purposes, including cork oak stands.
2. Excludes (FAO): land predominantly used for agricultural practices. In this sense fruit trees and olive groves are also excluded. Gardens and urban parks are also not considered as forest.

The 20m Forest Type products are produced applying a minimum „Forest“ definition, largely following the FAO definition, whereas tree cover in traditional agroforestry systems such as Dehesa / Montado is explicitly included for EEA purposes. The product is derived through a spatial intersection of the HRL Forest Product Specifications Document Page 12 two primary status layers Tree Cover Density and Dominant Leaf Type and has the following main specifications:

- 20m spatial resolution
- Tree Cover Density range of ≥10-100%
- Minimum Mapping Unit (MMU; minimum number of pixels to form a patch) of 0.52 ha (equivalent to 13 pixels); applicable both for tree-covered areas and for non-tree-covered areas in a 4-pixel connectivity mode, but not for the distinction of dominant leaf type within the tree-covered area for which no such minimum is set. The potentially available leaf type information for areas below 10% density within non-forest patches smaller the MMU is explicitly kept from the pixel-based DLT product to ensure consistency.
- Minimum Mapping Width (MMW) of 20m

GIS data interpretation of the Copernicus Monitoring Services is done, to analyse the Riparian Zones dataset according to defined indicators (e.g. size of forest complexes, fragmentation and gaps, habitat typology, etc).

Based on existing satellite images, deeper remote census is tested for local interpretations. For reference in the data interpretation, local satellite images from selected PA regions were considered.

Building on the Copernicus Riparian Zone data by the EEA, the deeper GIS interpretation, remote census, local interpretation based on local satellite images and on-the-ground know-how resulted in Fitness Check of the Danube Riparian Forests.The Fitness Check resulting in a better understanding in terms of quantitative parameters (e.g. surface coverage) of the riparian forest.

Forest corridors are areas of forest vegetation that allow animals to travel from one patch of native forest to another. A corridor provides shelter, food and protection from predators by imitating the structure and diversity of native vegetation. Birds, reptiles, amphibians, mammals and insects that would otherwise be isolated in one native forest patch, can utilise corridors to move between patches with relative ease and safety. Our landscape was once covered by a mosaic of different vegetation types such as swamps, grasslands, forests and heath. This mosaic supported many species of animal that moved, mated and dispersed throughout their territories and beyond. Disturbance such as clearing has left only isolated fragments of vegetation. Species unable to move across this changed landscape are vulnerable to local extinction. Local incidents of fire or disease can devastate populations existing in tiny native fragments, with species unable to recolonise the area as they once had. Corridors can help species to repopulate an area following local disturbances, assisting the long-term survival of the species. Ideally, areas of vegetation are retained between larger blocks of native forest to allow for animal movement. Around 40m is a reasonable guide for corridor width, however wider corridors are more likely to be utilised by shyer species. Direct seeding can be used to quickly establish large areas of vegetation. Using local species of plants will ensure the seeding is successful in the local conditions, and will also help provide the food and other resources that wildlife need. Hand planting trees allows to space them as they would be in native forest, so that trees grow quickly without competing against each other. Forest corridors are aimed to increase the exchange/movement of individuals between forest fragments, promote new foraging areas for many animals, act as refuges for several plant and animal species, act as wind barriers diminishing edge effects, and can stop the desiccation of rivers and streams.

Measurement gaps were analysed in terms of spatial resolution, revisit time, precision and temporal continuity.

For initial analysis and forest fitness check, Copernicus data related to forests was used. There is Pan-European High Resolution Layers (HRL) which provide information on specific land cover characteristics, and are complementary to land cover / land use mapping such as in the CORINE land cover (CLC) datasets. Regarding forest, tree cover density and forest type products (2012) were available and used as well as tree cover density and dominant leaf type and forest type products (2015).

5.1.3 Methodology and objectives of the Fitness Check

For the conduction of the Fitness Check, the partners were involved in the finalisation of the common methodology and defining the indicators. During this process 11 indicators has been defined:

- *Land use*
- *Fragmentation and infrastructure.*
- *Wilderness*
- *Environmental Protection (Protected Areas)*
- *Hydrological conditions*
- *Habitat patches/corridor/habitat network*
- *Dead wood*
- *Historic forms of forestry*
- *Biodiversity*

- *Population.*
- *Patchiness and patch cohesion*

5.1.3.1. Land use

Land use is one of the main indicators which can have a big impact on connectivity. However, we are intersted mainly for forest type of land use. For evaluation, data from Copernicus have been used.

The Copernicus Land Monitoring Service (CLMS) provides geographical information on land cover and its changes, land use, vegetation state, water cycle and earth surface energy variables to a broad range of users in Europe and across the World in the field of environmental terrestrial applications. For land cover and land use mapping Copernicus produces land cover classifications at various level of detail, both within a pan-European and global context. At the pan-European level, these are complemented by detailed layers on land cover characteristics, such as imperviousness, forests, grassland, water and wetness and small woody features. At global level, the land cover mapping follows the modular-hierarchical Land Cover Classification System of FAO.

Image No. 4 –Land use

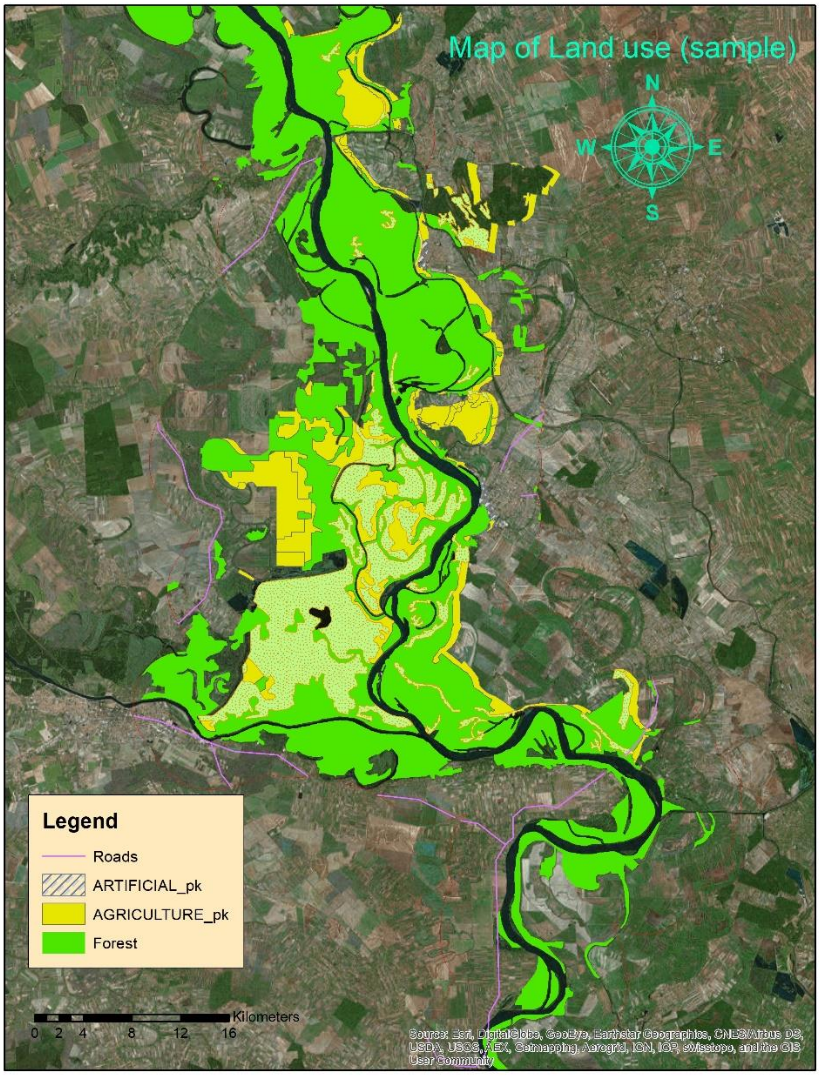
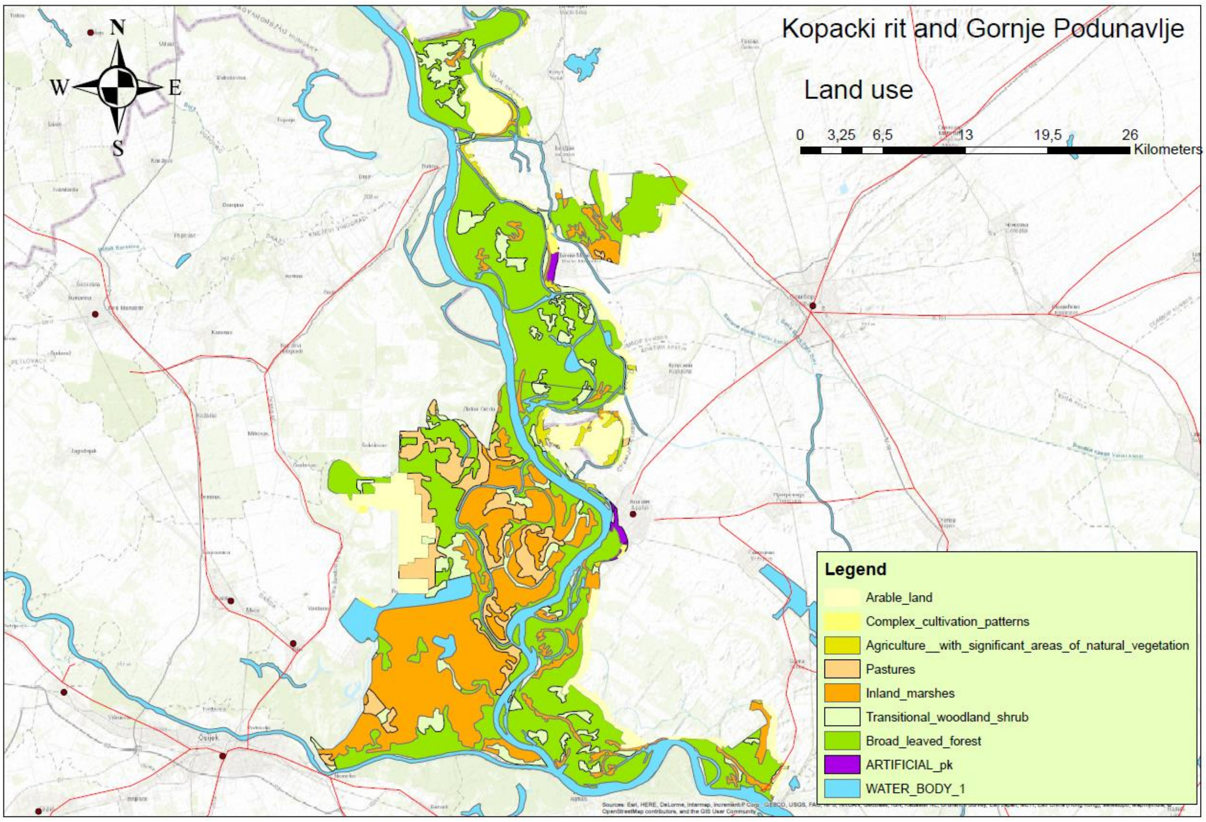


Image No. 5 –Land use (detailed)

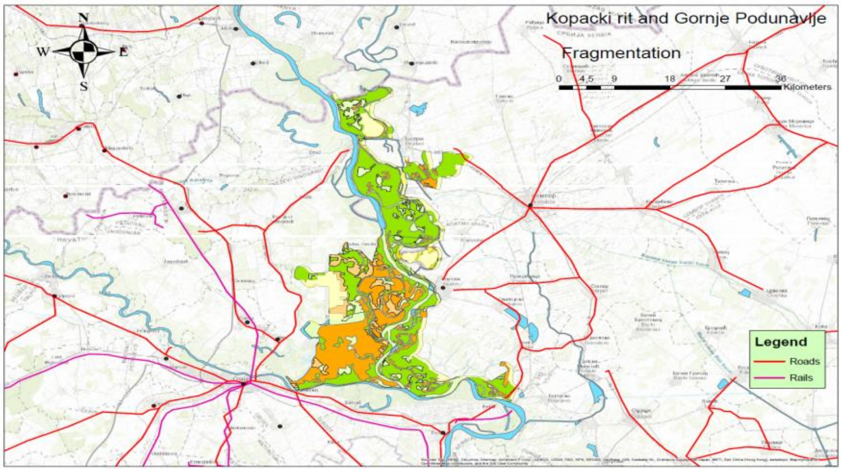


5.1.3.2. Fragmentation, infrastructure and patchiness (patch cohesion)

Fragmentation of the landscape describes the degree of fragmentation by roads, dams, railroads etc. The degree of fragmentation is expressed by the size of the area between the barriers. If this area is large,then it is not so fragmented and it is easier for wild animals to cross it. Therefore, a big fragmentation means the area is not so fragmented and that indicates good conditions for connectivity. Fragmentation leads to the loss of connectivity among forested landscapes.

Data that were obtained are actually SHP files of existing infrastructure - roads, forestry roads, powerlines and especially embankments (dykes). For this indicator, there are already availabe main roads on European scale, so focus in delivering data should were on forestry roads, dykes or other specific structure on local/regional level.

Image No. 6 – Infrastructure in Kopački rit and Gornje Podunavlje



Patchiness and patch cohesion - this indiccator is modeled based on existing data related to forest coverage. Describes the linkage between areas of one land use type. The more connected the areas (with few interruptions or barriers), the higher value. The only aspect that is considered is the size and shape of the area.

In order to check the fragmentation, classification by size of the forest polygons from Pan-European High Resolution Layer, has been done. Forest area has been classified in Erdas and ArcMap in four size classes (represented in different green colours) , and based on that initial analysis on fragmentation has been conducted.

After the software analysis was carried out, the following results were obtained:

Size of polygons (ha)	Number of polygons
0 -100	1817
100 - 500	854
500 - 1000	146
1000≤	172
Total	2989

The total area of all polygons, or the total area of the forest within the area under analysis, is 14301,9 km2. The area under analysis was 63338.22 km2, and the percentage of forest within that area is 22.6%. The average area of a forest polygon being of 478 hectares.

Image No. 7 - Classification by size of the forest polygons

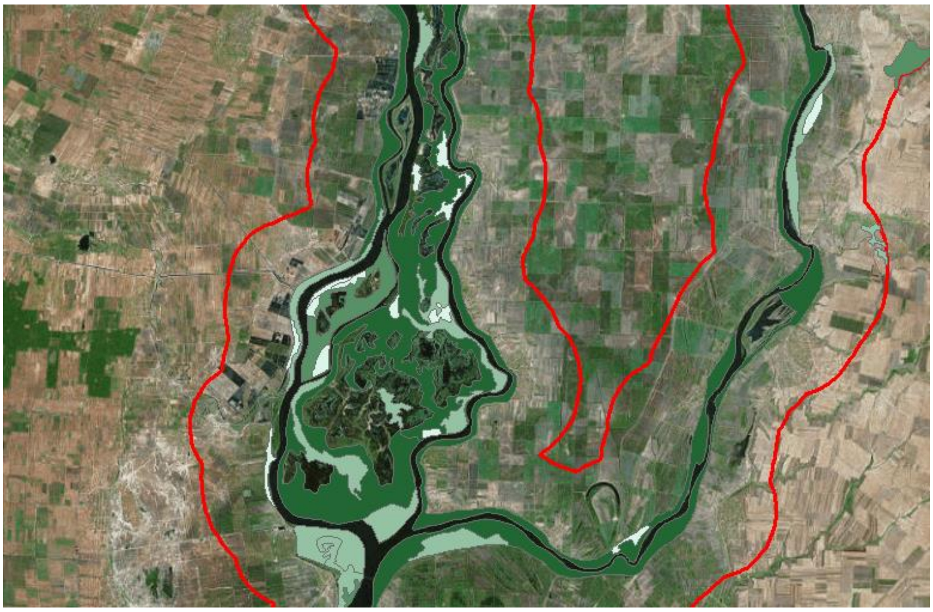
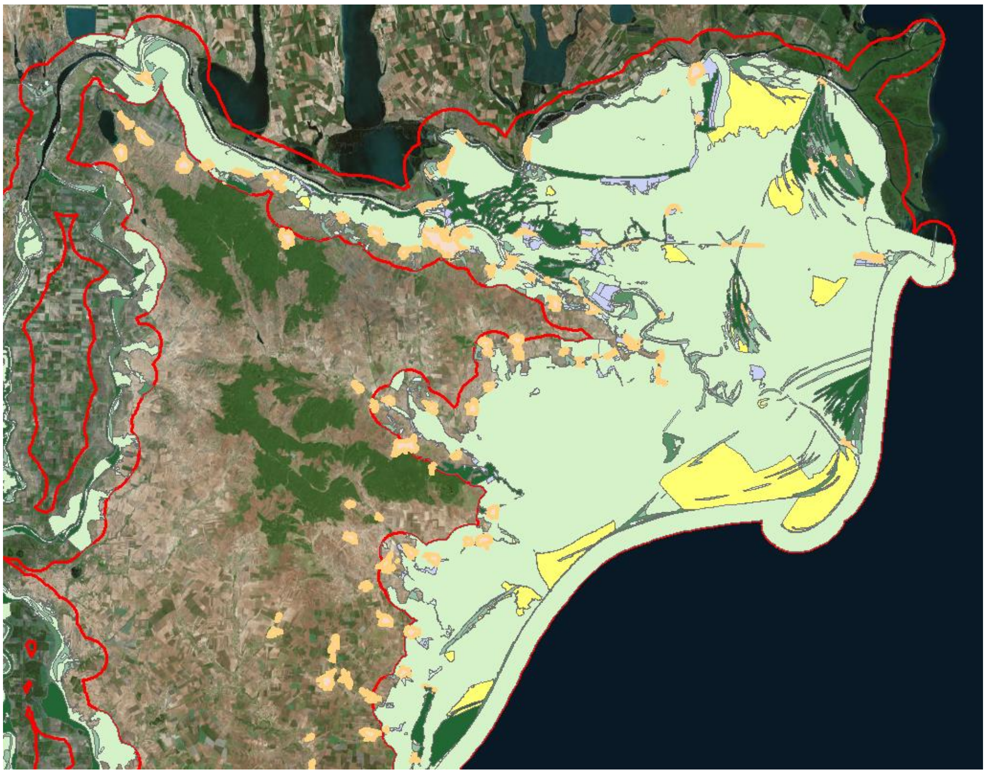


Image No. 8- Danube Delta



This analysis supports the attitude which states that land use changes had negative impacts to forest corridors as there are great decline of forests that have been converted into other land uses such as agriculture. The increased conversions of forests had negative impacts on wildlife as the habitat of wildlife is lost especially to bushland, woodland dwellers and grassland habitats. The new types of land uses such as agriculture which have occupied large space have lead to destructions of natural vegetation and reduced area available for wild animals grazing and movements. The rate of conversion of forests to cultivation is high and is accompanied by increased human populations. As cities grow, they can create gaps and barriers between one area of wildlife habitat and another. Urban sprawl can destroy entire forests, grasslands, and wetlands. One of the key threats to them is habitat loss.

Not all settlements have the same influence on the forest corridors.

In Germany, the following cities have a very strong impact on forest corridors in terms of large gap formation: Ingolstadt, Regensburg.

The following cities have a very strong impact on forest corridors in terms of a very large gap formation: In Germany - Ingolstadt and Regensburg, in Austria Vienna and Linz, in Hungary Budapest, in Slovakia Bratislava, in Serbia Novi Sad, Belgrade, Smederevo, in Romania Giurgu and Galati, in Bulgaria Ruse.

Image No. 9 - A gap in forest corridors - Germany

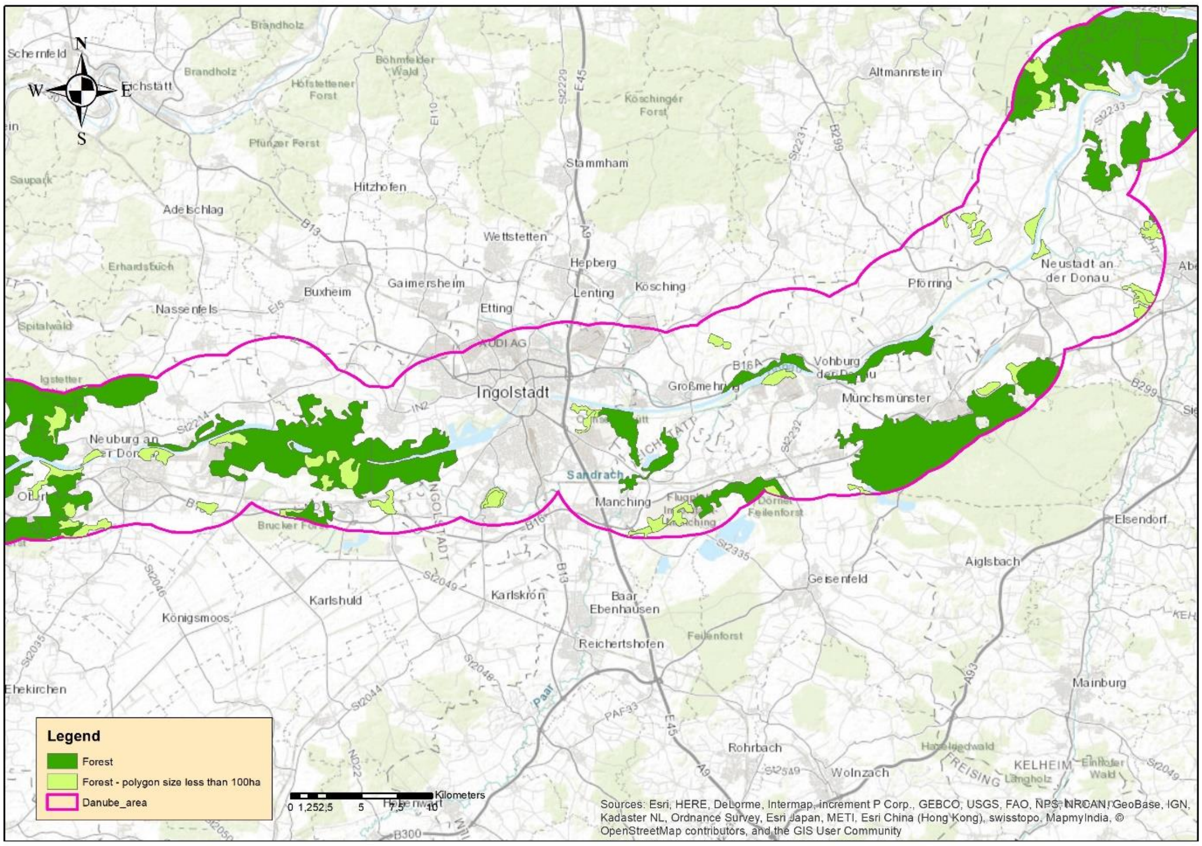


Image No. 10 - A gap in forest corridors - Austria

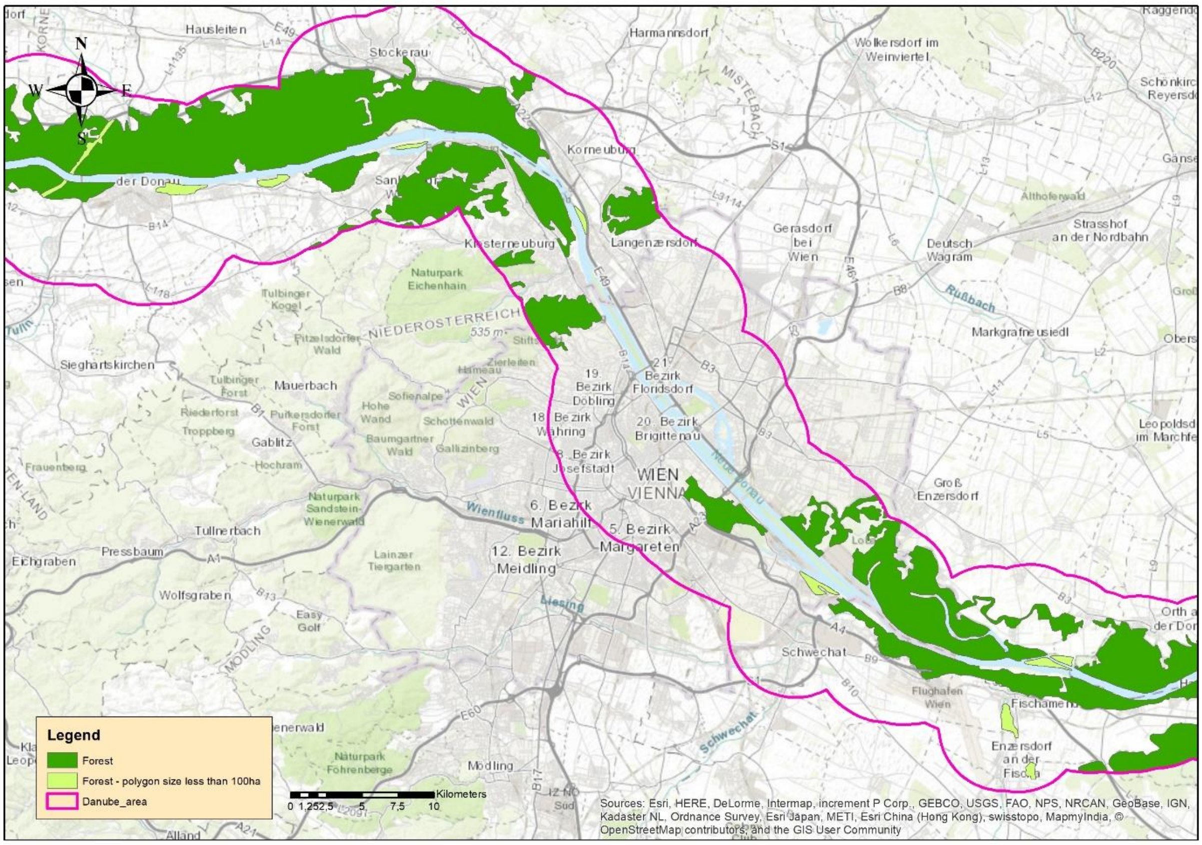


Image No.11 - A gap in forest corridors - Hungary

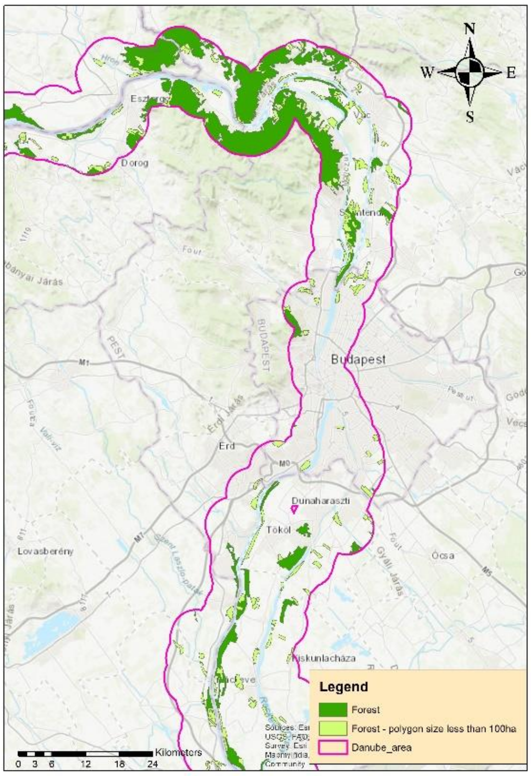
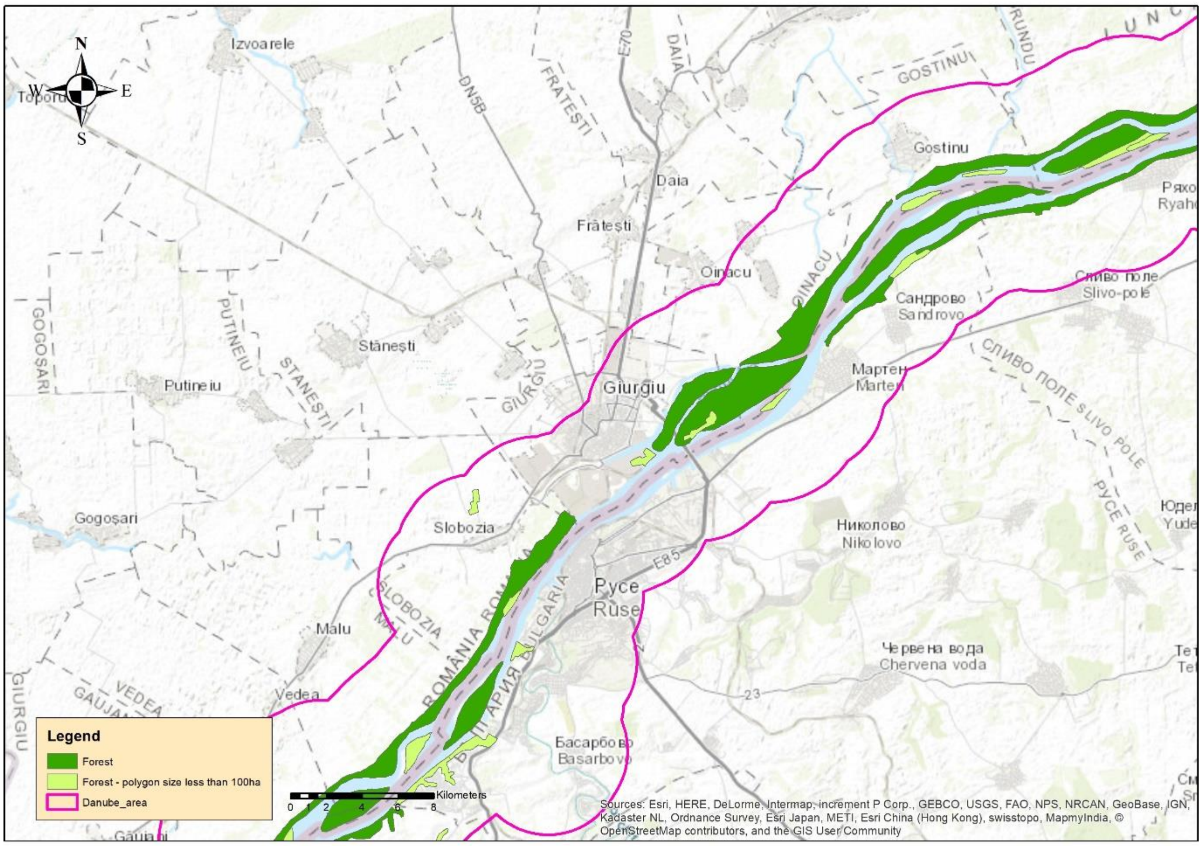


Image No. 12- A gap in forest corridors – Romania and Bulgaria



The following cities have a strong impact on forest corridors in terms of a large gap formation: In Germany - Donaueschingen, Ehingen, Erbach, Ulm, Blindheim, Riedlingen, , Neustadt an der Donau, Straubing, Osterhofen and Hengersberg, in Austria - Feldkirchen an der Donau, Au an der Donau, Ybbs an der Donau, Marbach an der Donau Krems an der Donau, in Slovakia –Hamuliakovo, in Croatia Dalj, Borovo, Vukovar, in Serbia – Grocka, Kovin, Veliko Gradište, Kladovo, in Bulgaria - : Lom, Kozloduy, Orahovo, Leskovets, Dolni Valdin, Somovit, Nikopol, Marten, Silistra, in Romania -: Drobeta Turnu Severin, Braila.

The following cities have a small impact on forest corridors in terms of a small gap formation: in Germany Neuburg an der Donau, Riedlingen and Vilshorfen an der Donau, in Austria - Eferding, Mauthauzen, Wallsee-Sindelburg, Emmersdorf an der Donau, Spitz an der Donau, , Donaudorf, Zwentendorf an der Donau, in Hungary Baja, in Serbia Bačka Palanka and Golubac, in Romania- Tulcea.

The following settlements are examples of cities and villages that do not or almost have no negative impact on forest corridors:

- In Germany: Tuttlingen, Kolbingen, Irndorf, Sigmaringen, Heudorf, Nersingen, Leipheim, Offingen, Dillingen an der Donau, Vohburg an der Donau, Saal an der Donau, Deggendorf, Passau,
- In Austria: Kirchberg ob der Donau, Grein, Sankt Nikola an der Donau, Hainburg an der Donau
- In Slovakia: Čunovo, Vojka nad Dunajom
- In Hungary: Visegrád, Dunaszentbenedek
- In Croatia: Bilje, Erdut, Ilok
- In Serbia: Bački Monoštor, Odžaci, Donji Milanovac
- In Bulgaria: Ostrov, Baykal; Belene, Sandrovo, Ryahovo
- In Romania: Silistoara, Garcov, Zimnicea

Image No. 13- A good example of forest corridors - Passau

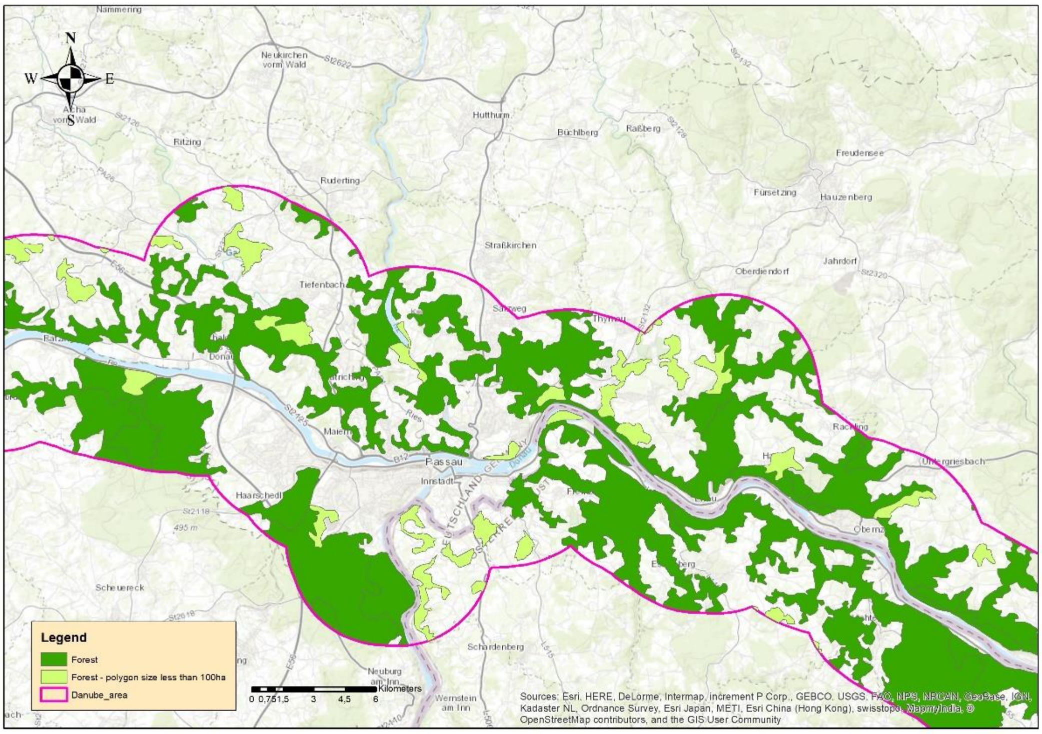


Image No. 14- A good example of forest corridors - Hainburg an der Donau

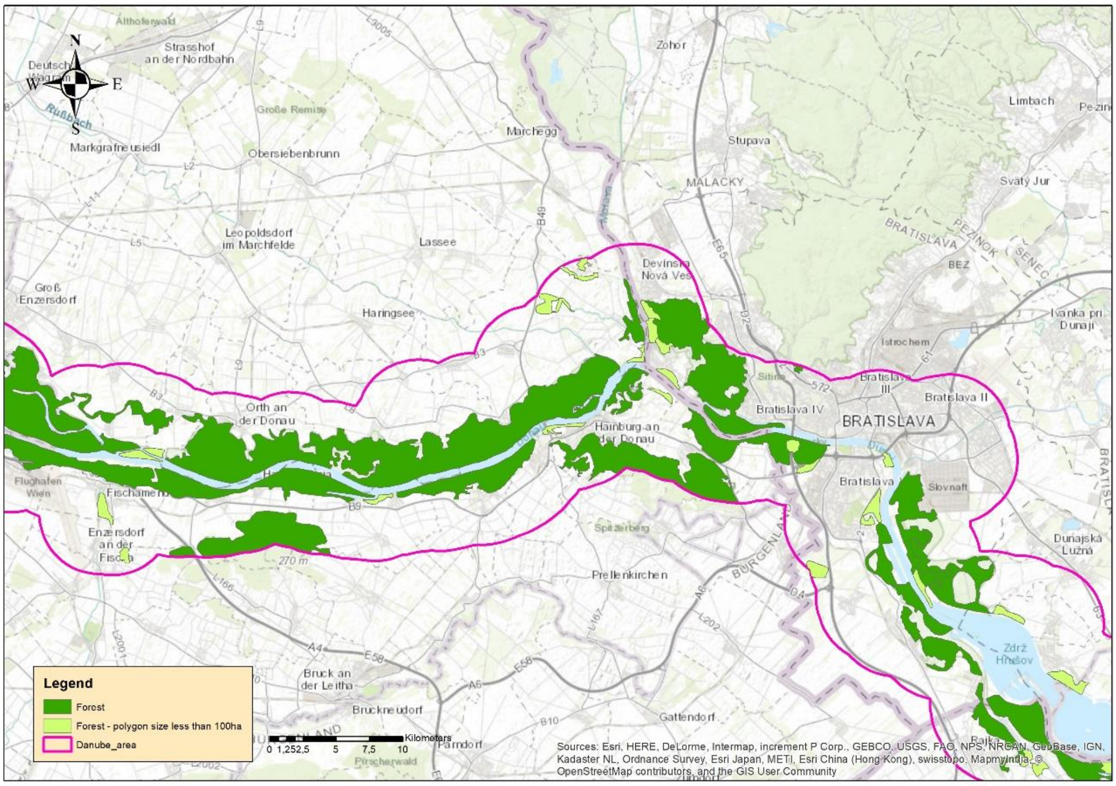


Image No. 15- A good example of forest corridors - Čunovo

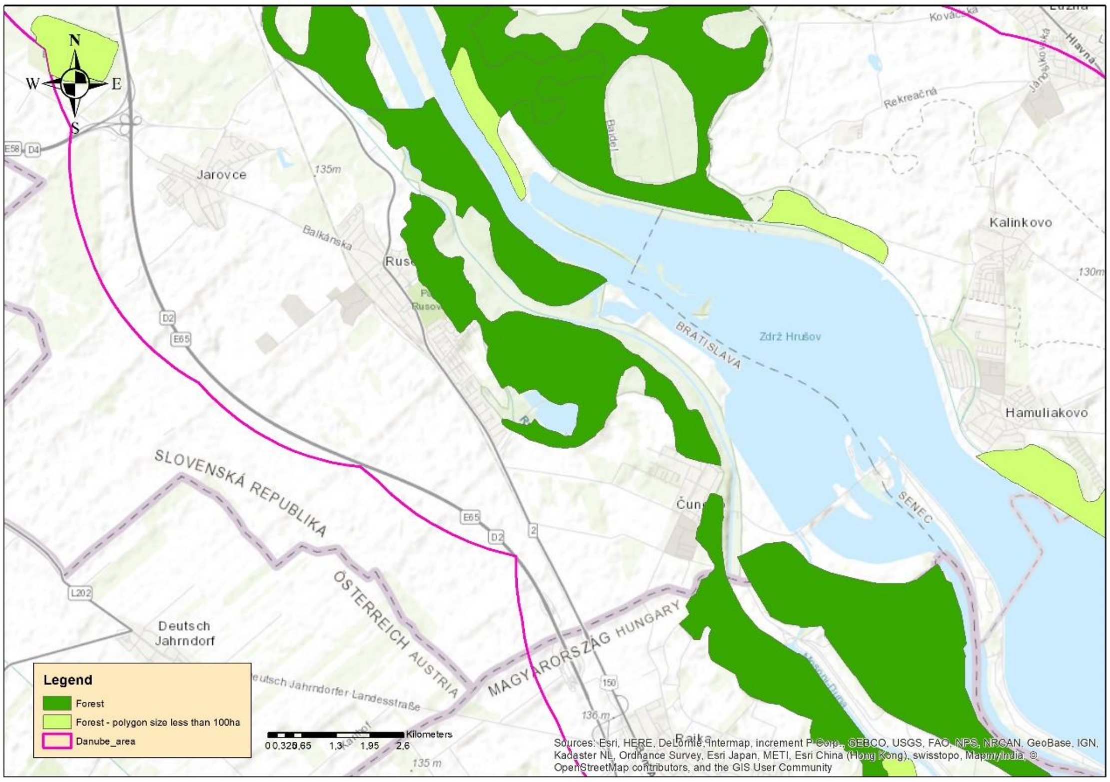
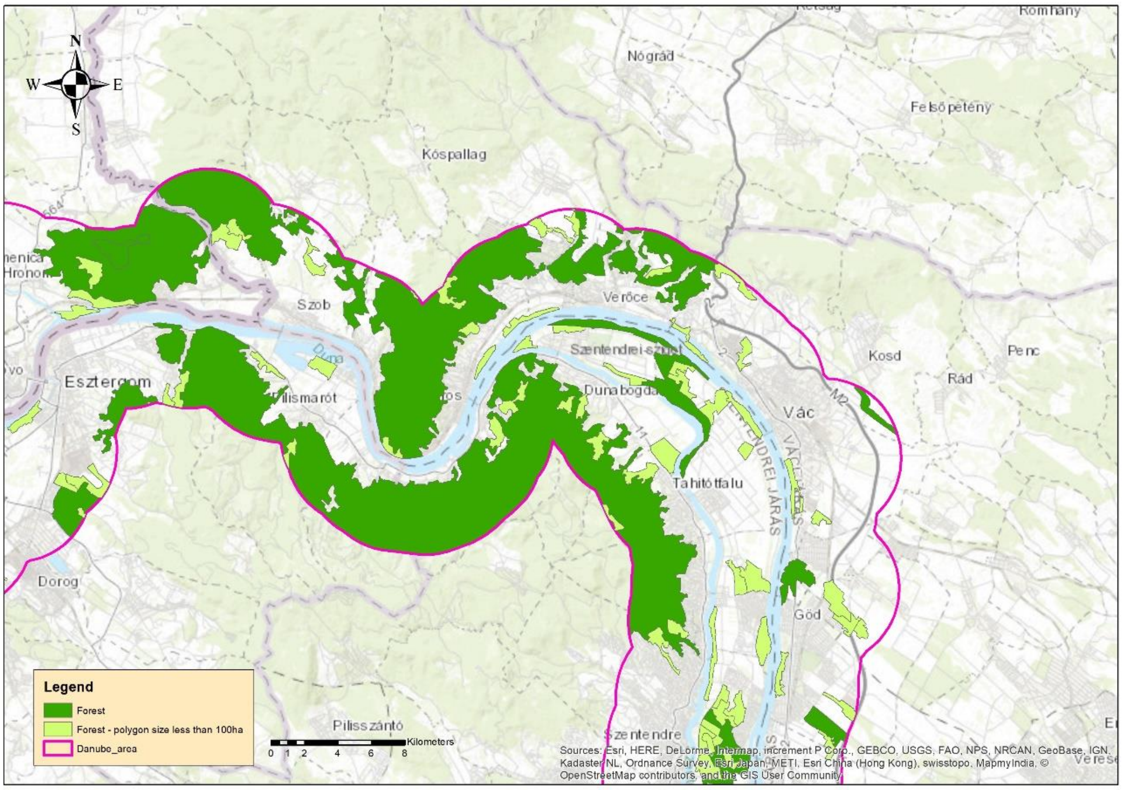


Image No. 16- A good example of forest corridors - Visegrad



It can be concluded that the biggest influences on forest corridors have the largest cities, especially with the developed industry. They physically occupy a large surface and thus break the corridors. Outside populated areas, there is generally continuity in corridors or the distance between forest fragments is smaller.

Also, analyzing the size of forest ranges, it can be concluded that polygons of category up to 100 ha are mostly represented in the vicinity of the settlement, which is another factor that suggests that settlements and urban planning have a decisive influence on the fragmentation of forest corridors. However, in some areas fragmentation has been alleviated by keeping smaller or larger forest fragments in the vicinity of the settlement. Whether these fragments were created as a result of the planning process, or the remains of former forests that were not removed because the development of the area was going in that direction, the current situation is more favorable in these cases and it can be concluded that there is a connection to forest corridors. Smaller settlements have no significant impact on forest corridors globally. Only some positive examples of settlements that do not have a negative impact on forest corridors are given. Nevertheless, at the local level it is certainly necessary to consider the level of their influence.

One of final conclusions is that work with Copernicus data highlighted the generally low accuracy of the data, particularly Forest High Resolution Layer. For the monitoring of land cover changes Copernicus data set shows sufficient quality and accuracy. However, in order to have an input data for specific environmental modelling tools and for mapping and assessment of ecological connectivity higher quality data are needed. The availability of up-to-date maps, with high resolution and thematic accuracy represents a substantial task towards environmental monitoring efficiency.

From the analysis of the spatial data comprised in the illustrative maps, it is not possible to perform an analysis of the forest vegetation structure in terms of composition, consistency, age etc. The data provided by the Copernicus Monitoring Services of the pan-European component for forests are irrelevant, being even erroneous. For the improved analysis, higher quality data is needed, for example 40 cm panchromatic resolution or better, and more than 1.5 m multispectral resolution or more.

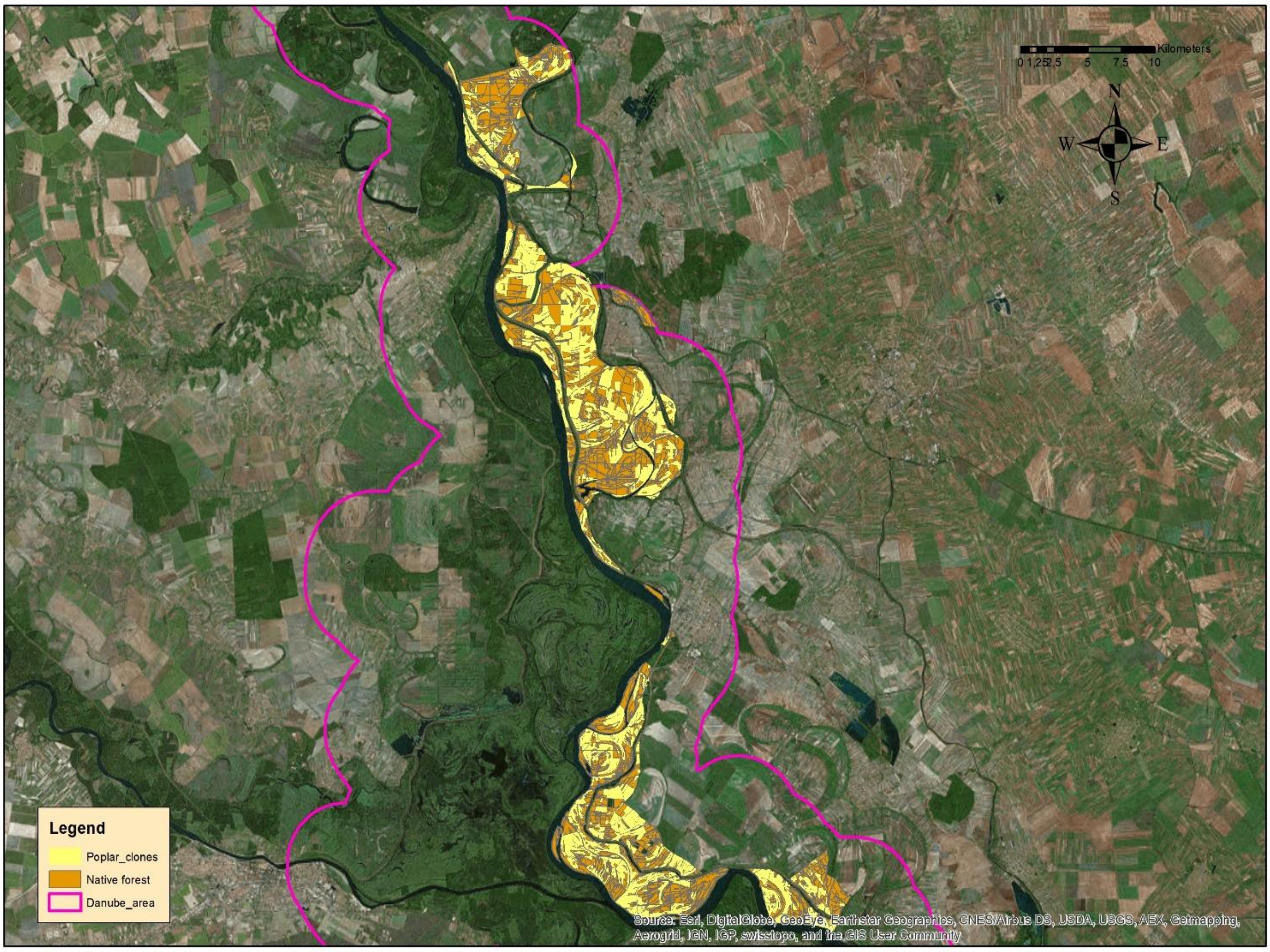
5.1.3.3. Wilderness

Wilderness data are SHP files with information of tree species composition. As minimum Vojvodinašume had idea that, spatial coverage of poplar clone plantations must be delineated. It is also posible to record this information in atributive table in existing SHP file for forest coverage in Danube region, in the field „TREE SPECIES“. Also highly protected stands, or purely natural stands must be recorded.

Unfortunatelly, satelite images resolution of 10m (and higher) can not be reliable for making clear difference between poplar clone plantations and natural forests.

Since that Vojvodinašume did not receive enough quality data from all partners, we decided to present only some examples with high quality data (SNR Gornje Podunavlje) gained by ortophoto aerial images (30cm).

Image No. 17 - Native forest and poplar clones



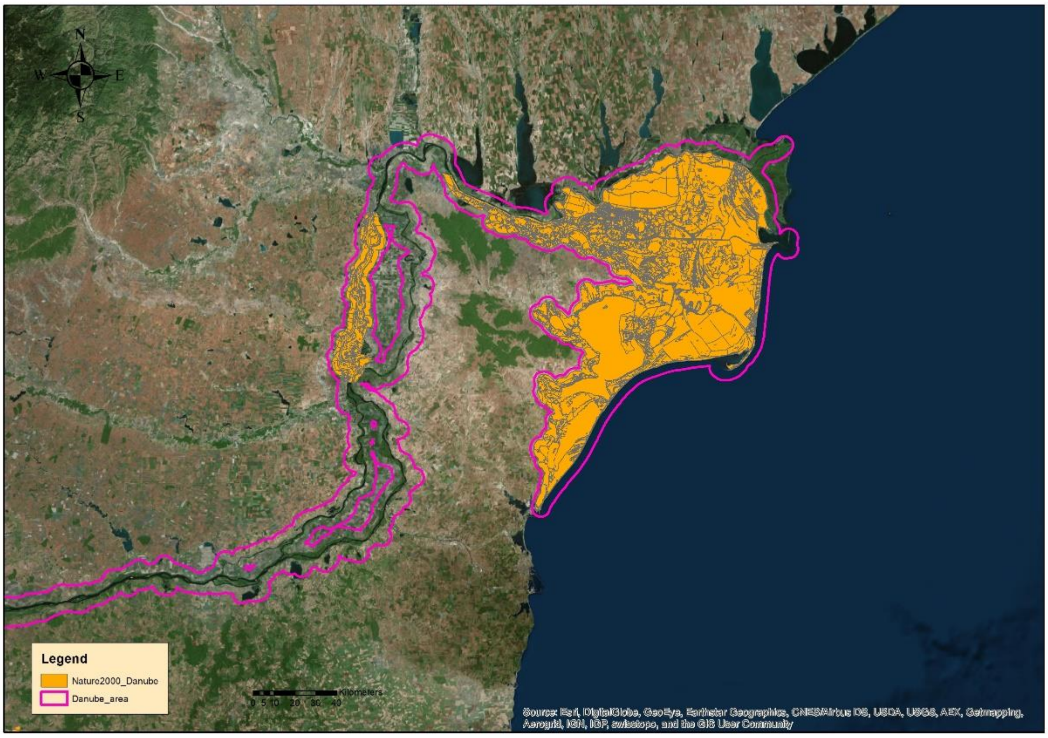
5.1.3.4. Environmental Protection (Protected Areas)

For this indicator, a mayority of data already exit and they are related to the boundaries of protected area. There are also available NATURA 2000 sites.

Image No. 18- Danube protected areas

Image No. 19- Danube protected areas (orthophoto)

Image No. 20 - Natura 2000 sites in Romania – Danube delta

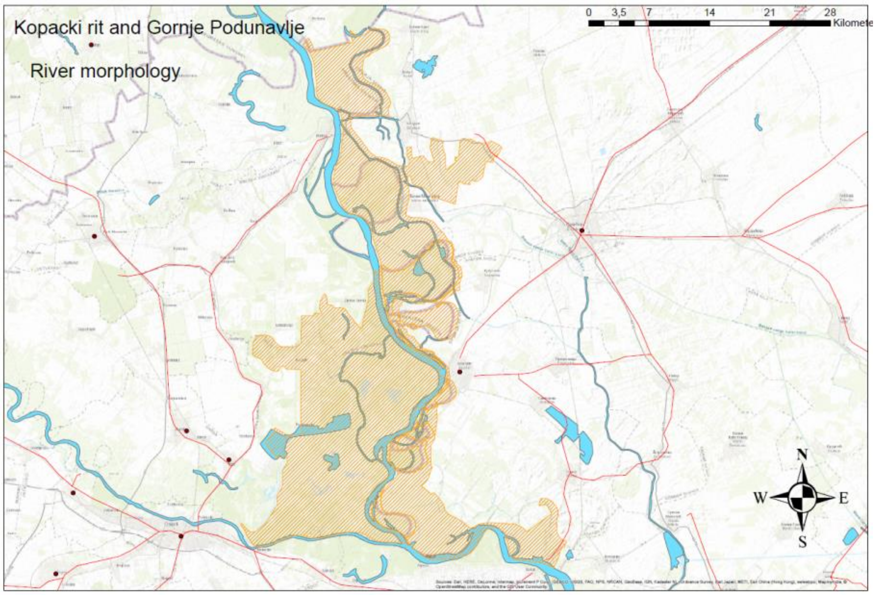


5.1.3.5. Hydrological conditions, Habitat patches/corridor/habitat network, Dead wood

These 3 indicators were poorly developed due to the lack of quality data. Description of the indicators is given below.

Hydrological conditions: Geographical information for Hydrological conditions were taken from European catchments and Rivers network system (Ecrins) and other sourcess. It is a geographical information system of the European hydrographical systems with a full topological information. Data Geographical (GIS) data on water coverage, especially on local level, were also used.

Image No. 21 - River morphology (Kopački rit and Gornje Podunavlje)



Habitat patches/corridor/habitat network: For this indicator, existing data from Copernicus were used.

Dead wood: For this indicator, descriptive data were sufficient.

5.1.3.6. Historic forms of forestry

Historic forms of forestry: Old maps representing forest coverage in analog and digital form are used in order to compare current status with the previous one. Also, descriptive data on forest area in Danube region in the past were useful.

Image No. 22- Locality Fajsz (Hungary) - XVIII century

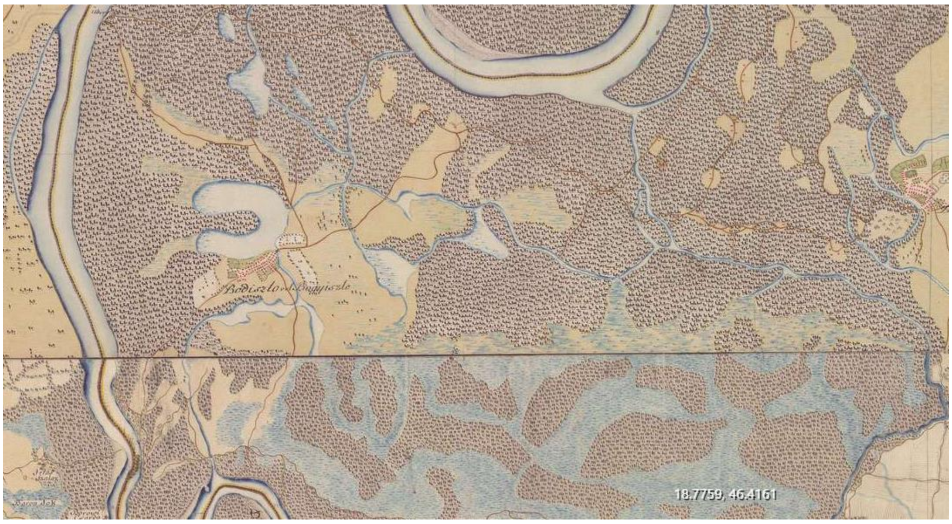


Image No. 23 - Locality Fajsz (Hungary) - XIX century

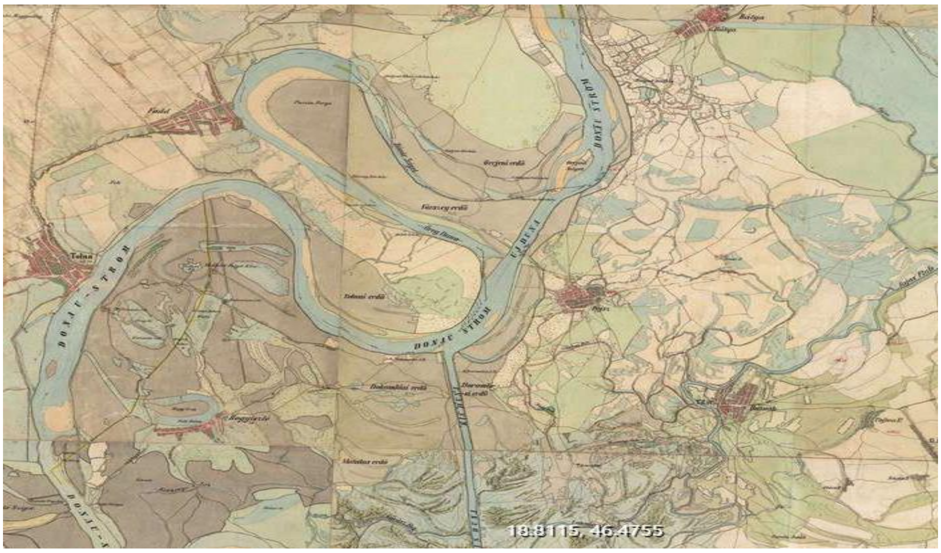
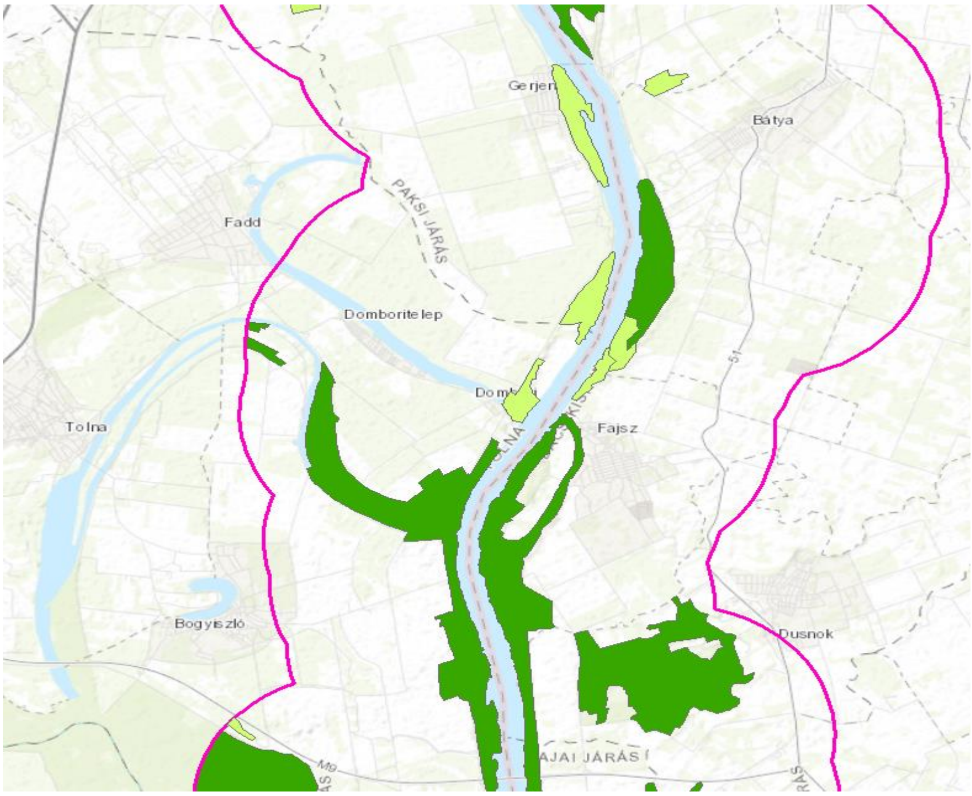


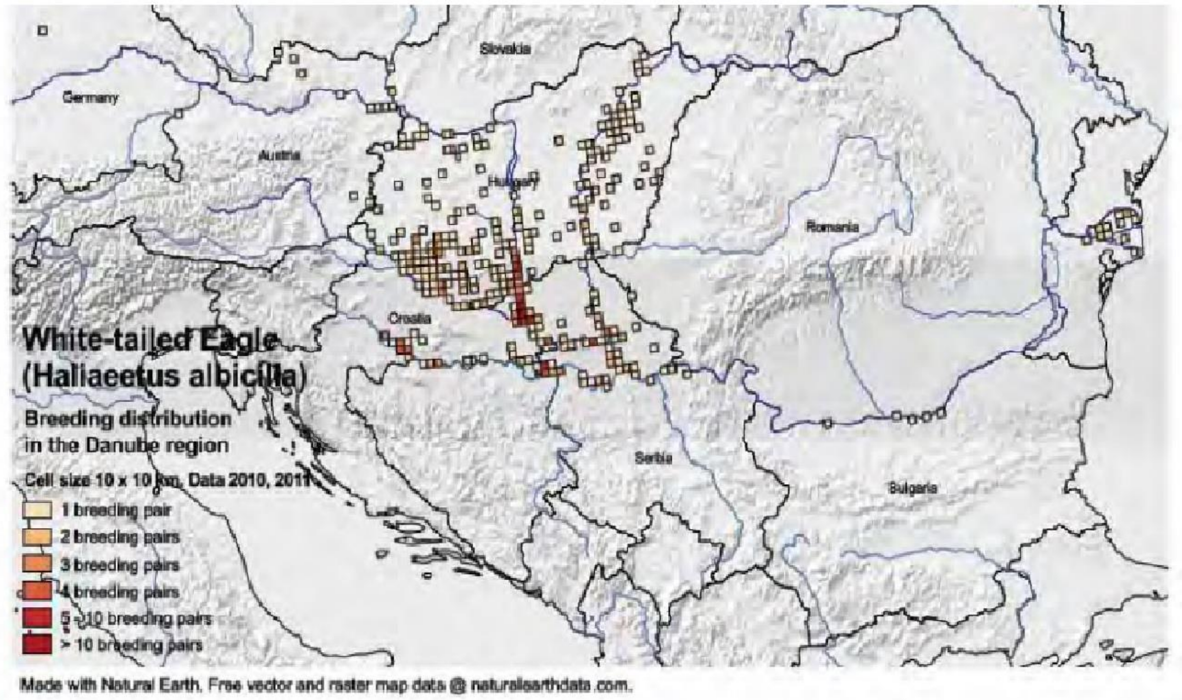
Image No. 24 - Locality Fajsz (Hungary) - XXI century



5.1.3.7. Biodiversity

Biodiversity: For this indicator, SHP files with locations of specific protected species (e.g. White-tailed Eagle, Black stork) were used.

Image No. 25 – White-tailed eagle locations



5.1.3.8. Population

Population: The population indicator refers to the density of inhabitants. Data on human settlements and population in Danube region, were possible, were used.

Image No. 26 - Settlements in Germany

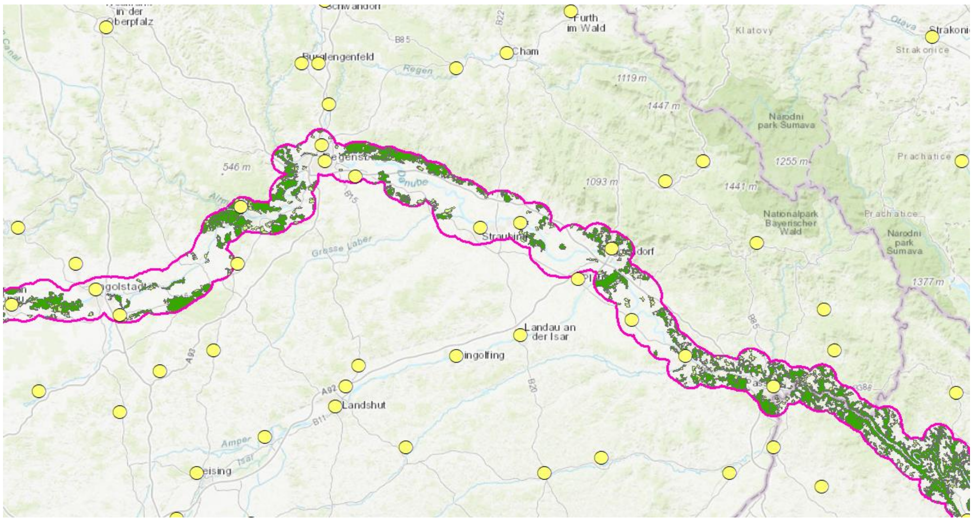


Image No. 27 - An impact of Settlements (buffers)

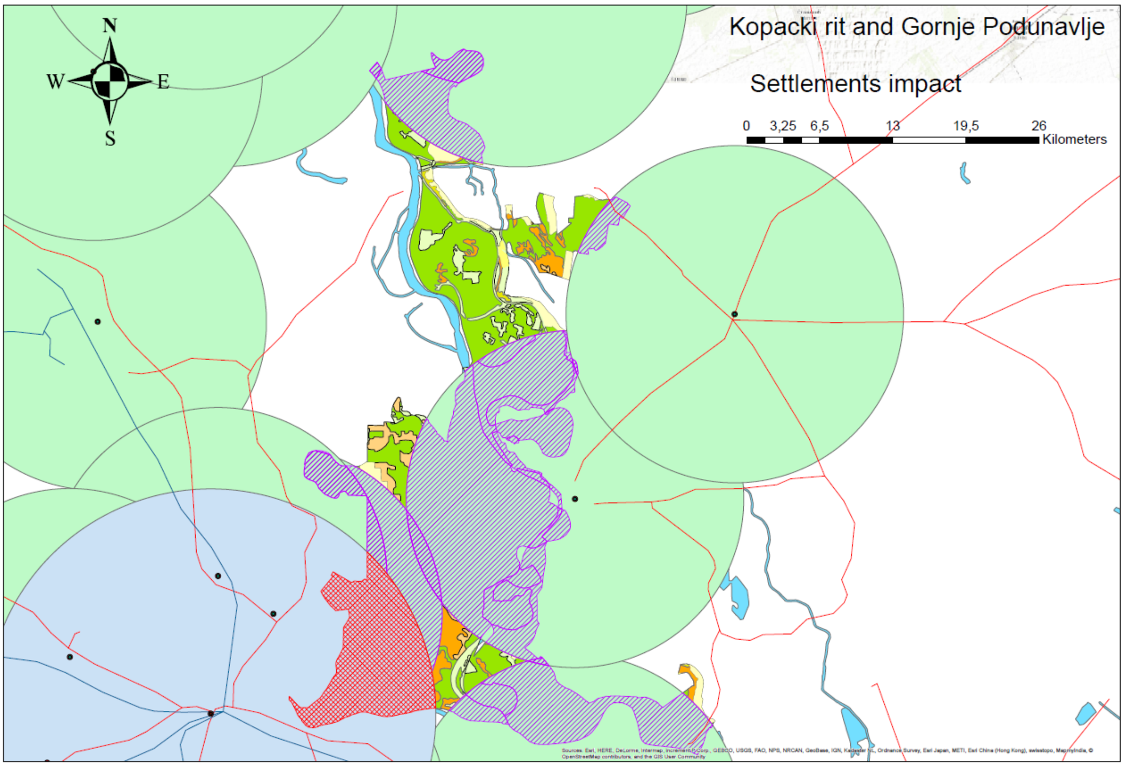
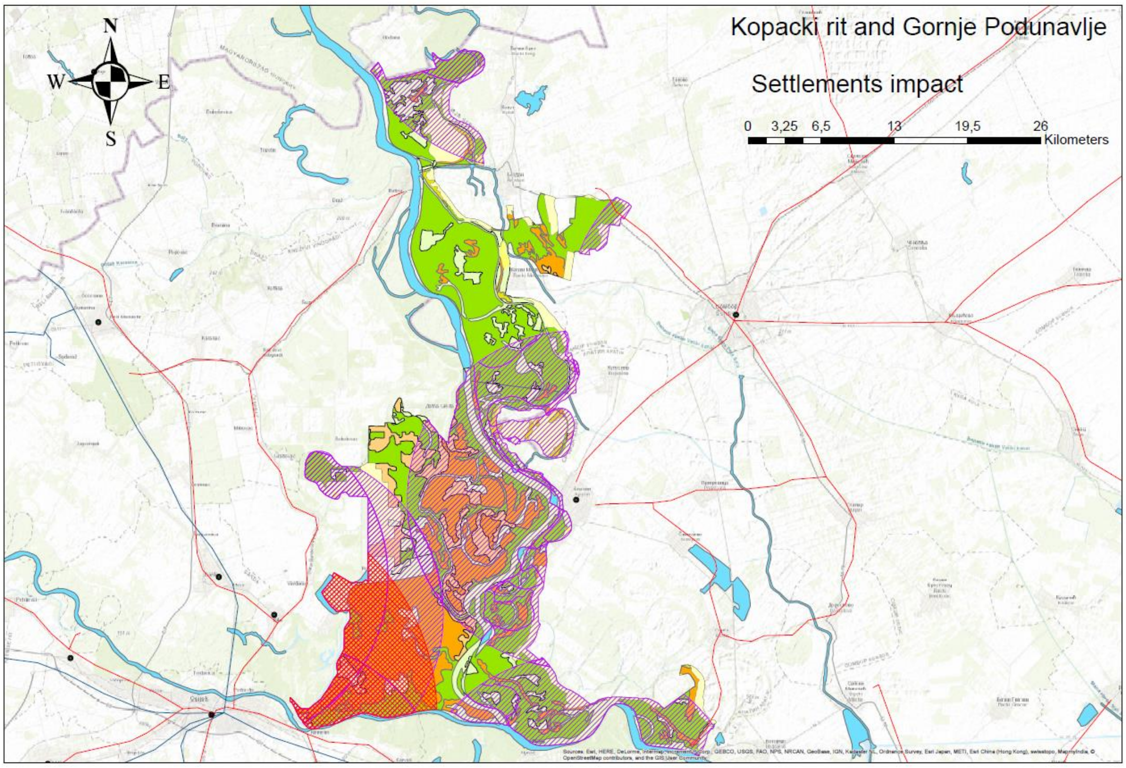


Image No. 28 - An impact of Settlements



5.1.4 Illustrative map of Riparian zones and forests along the Danube

Based on the Fitness Check, a roadmap towards a Riparian Forest Corridor was jointly developed. Deficits and gaps in the corridor were identified, priorities for conservation or restoration are defined on a macro-regional scale as a next step.

Using data that represent different indicators, available Danube-wide, it has been developed thematic maps. A preparation of initial data which has been used for a map production has been done in software Erdas Imagine that has been purchased from project budget. This software is an image processing software package that allows to process both geospatial and other imagery as well as vector data.

An information basis used in Erdas is based on satellite and in situ observations - the Copernicus services which deliver near-real-time data on a global level and which can also be used for local and regional needs, to help us better understand an environment.

These maps are attached to this documents as its Annexes.

6. DANUBE RIPARIAN FORREST CORRIDOR DEMONSTRATION

Actions to further develop the riparian forest corridor have to take place in remaining intact forest complexes (e.g. improving habitat quality, old growth stands network, natural tree composition).

But considering the great loss of surface coverage in the past, reforestation also has to be considered. A reforestation concept is be part of this roadmap and could contribute significantly to climate change mitigation by raising the capacity of the Danube riparian zones for carbon storage.

DANUBEparksCONNECTED welcomes the DTP initiative to compensate flight carbon emissions within the program. The roadmap for reforestation, including the definition of concrete actions and sites, could be a tool for CO2 compensation within the Danube region, and thus also where the CO2 emission took place.

The strong decrease of the surface due to many alterations in the past and various ongoing negative impacts even raise the necessity for efficient and coherent conservation efforts.

6.1 Danube Riparian Forest Corridor Roadmap

6.1.1 Fields of intervention (Conservation needs and restoration potential)

In the chaprter 5., we already made recognized and identified fields of intervention for almost all indicators. In this part we will present results of pilot activites that some of the project partners done.

Within the testing phase, the results of the Fitness Check are tested on local pilot sites, using bats as flagship species. Danube riparian forests are of outstanding importance for bat conservation. Scientific papers stress the preference of bats for old growth stands and forests rich in structure. A coordinated survey of bats as indicator species for habitat quality in riparian forests will be done at one site in the Upper (DINPI), in the Middle (DDNPD) and in the Lower Danube (PNPD), to test the results of the GIS data interpretation.

The huge ecological importance of Danube forests, the damage they have already suffered, and the threats they face today call for immediate efforts for their restoration. Including the creation of new riparian forests by means of forestation activities using typical local species, and improving the structure and functions of existing forests through the removal of invasive species.
In this document you can find a section on the success of project partners pilot activities along the Danube River:

- conversion of plantations as effect of intense forestry into native stands (BROZ)
- management of invasive alien tree species to improve conditions for autochthonous species (SNC SR, FH)
- reforestation to counteract the loss of riparian forest surface coverage and to fill gaps between forest complexes (Vsume, CFPPRL, DDBRA)
- promoting relevant tree species with bat conservation status (PNPD)

SHORT DESCRIPTION OF ABOVE LISTED ACTIONS (PROVIDED BY PARTNERS)

6.1.2 Concrete steps for future implementation

The demonstrating phase is to implement best practices together with the forestry sector: "Learning by cross-sectoral doing" will strengthen the riparian corridor by local actions, and help establish partnerships for follow-up implementations also in areas outside the direct influence of PAs - the key to ensuring corridor functionality on a large scale.

The implementation of pilot actions together with the forestry sector forms an agreement to work jointly on the further development of the Riparian Forest Corridor. Testing best practice examples, delivering visible results, and using bats to illustrate the status quo, corridor gaps and effects of restoration in the Upper, Middle and Lower Danube establish the Corridor step by step.

High-Priority Conservation Actions for Riparian Wooded Corridors/Streams Habitat protection through regulation:

- Provide technical assistance to regulatory programs regarding impacts to SCGN in forest relative to projects conducted under state permit or receiving public funds. Habitat protection on public lands
- Protect existing riparian forest and forest corridors to provide habitat for different species. Habitat protection incentives (financial)

- Provide financial incentives to protect existing riparian forest and riparian forest corridors to provide habitat for different species. Habitat restoration through regulation
- Provide technical assistance to regulatory programs regarding forest restoration measures beneficial to SCGN different species in forest relative to projects conducted under state permit or receiving public funds. Habitat restoration on public lands
- Reforest bottomland areas to provide habitat different species. Habitat restoration incentives (financial)
- Promote funding programs that support the reforesting of bottomland areas to provide habitat for different species. Succession control (fire, mowing)
- Develop and implement methods of vegetation control that provide an ecologically-functional riparian wooded corridors/streams with native plants. Corridor development/protection
- Develop and implement BMPs for the development and maintenance of ecologically functional riparian wooded corridors/streams. Pollution reduction
- Promote the use of BMPs relative to pesticide application, soil erosion control and silviculture in areas immediately adjacent to riparian wooded corridors/streams to benefit SGCN dependent on aquatic invertebrates.
- Modify survey and monitoring, research and other conservation actions and activities in response to new information to improve habitat conservation efficiency for different species.

In and outside of Protected Areas in the last decades, forestry was and still is a main influencing factor for Danube riparian forests. For the implementation of WP6 and its long-term capitalisation, the forest sector is indispensable. Forestry is a main factor in the floodplain forests along the Danube, in and outside PAs.

7 LITERATURE AND REFERENCES

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