Working Group "GREEN"
Creating ecological corridors to support sustainable development based on a long-term approach (ECORR)

ABSTRACT

The general objective of the project is to create a common database as decision support tool based on a long-term approach. Based on the crucial past experience, it will help establish ecological corridors as an excellent example of sustainable future management.

KEYWORDS

Ecological corridor
Historical change
Modelling
Ecological conservation
Spatial decision support tool

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1. PROJECT BACKGROUND

DESCRIPTION OF THE PROBLEM AND JUSTIFICATION OF THE PROJECT

Rivers play a vital role in the social and economic welfare of regions worldwide, but also for the natural habitats that depend on them. Extensive research has shown an inextricable linkage between river channels and floodplains and a strong connection between floodplains and the health of the river ecosystems (*Bayley, 1995; Danube Pollution Reduction Programme, 1999*). However, the bidirectional ever changing pressure – the current increase in flood events and the human generated pressure (change in land use and land management, loss of habitats due to the intensification of agricultural and industrial activities, extension of built-up areas, pressure of massive tourism development, lowering of water tables, fragmentation by infrastructure, changed frequency of extreme weather events) has become an issue of high importance to be recognized and addressed. Present landscapes, especially in the Danube River Basin, are dominated by human-induced dynamic habitats, while most natural and semi-natural habitat sites are now smaller units, remnants of former intact natural forested and riparian areas. Fragmentation and destruction of natural habitats is now a primary threat for many species because isolation can result in inbreeding, reducing the fitness and hence survival of a species. Therefore, the creation and protection of ecological corridors (be they linear, stepping stones or landscape corridors), buffer zones and other connections between protected areas are crucial in order to support the exchange of genetic material, to ensure adequate feeding areas, breeding grounds and allow animals, plants and ecological processes to move from one habitat to another. Ecological corridors can also perform other functions such as topoclimate regulation, flood risk mitigation, prevention of erosion, biofiltration, recreational, educational and research functions. This is the main reason why ecological connectivity has become a new paradigm for the delivery of nature conservation in the 21th century.

Research activities and efforts to create/restore ecological linkages between dispersed patches have been already initiated at local, regional, national or transnational level, such as the *Pan-European Ecological Network* covering Euroasia, whose main purpose is to provide connectivity for species during migration and to facilitate dispersal between the core areas. Different methods and techniques have been employed for the identification of core areas (e.g. zoning for inventory, conservation, regulatory or management purposes; presence of species and/or habitats; environmental permeability; multicriteria analysis etc.) and corridors (e.g. analysis of ecological continuities; conflict analysis; expert knowledge and opinion etc.). However, the long-term approach has been little or even not taken into consideration when trying to create or restore ecological linkages. The project will be a contribution to fill in the above-mentioned gap, to take an integrated hindsight on the physical, biological and social processes that shape the riparian landscape by using data and information on the past and present dynamics of the natural riparian areas, land use practices, dynamics of the riverbed and riverbanks, dynamics of the built-up areas and infrastructures. When creating/restoring sustainable ecological corridors it is compulsory to understand the conditions and lessons of the past in order to attain a better understanding of the past and the present and take the appropriate actions for the future (*Winiwarter, Knoll, 2007*).

RELATION TO HORIZON 2020 AND ICPDR CHALLENGES AND PRIORITIES

The ECORR project is consistent with the *HORIZON 2020 Social Challenges* priority focused on *Climate Action, Environmental, Resource Efficiency and Raw Materials*. The project contributes to the assessment of the river and riparian area dynamics and the long term impact of human activities on the riparian environment, including land use change. The development of a decision support tool meant to create a database, to run simulations and assess the integrated effects based on long term approach is considered compulsory for creating/restoring sustainable ecological corridors. Research has proven that databases containing long chronological series can in many cases contribute to sustainable future decision making (*Winiwarter, Knoll, 2007*). Thus, the project will improve the understanding of the complex interactions between natural resources and social, economic and ecological systems, will examine how biodiversity and ecosystems function and react to natural and anthropogenic impacts and how they can be restored. It will also investigate solutions for addressing resource challenges in a cross-border context and will contribute to practices that ensure that social and economic activities operate within the limits of the sustainability and adaptability of ecosystems and biodiversity.

The project is also consistent with some of the challenges identified in the *European Union Strategy for the Danube Region*: safeguarding the Danube's Water resources for the future generation, healthy and sustainable river systems, damage-free floods. The project proposal addresses the need to assist societies in the borderland areas to have a joint approach and a common vision on the river and riparian area protection.

RELATION TO OTHER POLICIES, PROGRAMMES AND PROJECTS

The project is also compliant with the *Pan-European Biological and Landscape Diversity Strategy* (1996), whose aim is to find consistent response to the decline of biological and landscape diversity in Europe and to ensure the sustainability of the natural environment. The project takes into consideration one of the *EU Water Framework Directive* (2000) recommendations for the Member States to "*provide information for use in the assessment of long term trends both as a result of changes in natural conditions and through anthropogenic activity*" by applying the hind data gathering approach. The project also takes into consideration the *ESDP* objective focused on wise management of the natural and cultural heritage and the results of the *Sava LIFE* project (2009) focused on the identification of sites of biological importance. The project supports the promotion and preservation of *Natural Protected Areas*, *Local protected Areas*, *Valuable Natural Features*, *Ecologically Important Areas*, *Common European Cultural Landscape Protected Areas*, *Natura 2000* network of protected areas consisting of *Special Areas of Conservation* established under the *EU Habitats Directive* and *Special Protection Areas* established under the *EU Birds Directive* seen as ecological core areas. In addition, it addresses the challenges emphasized in the *Territorial Agenda of the European Union 2020*: loss of biodiversity, vulnerable natural, landscape and cultural heritage and incorporates territorial priority 6: managing and connecting ecological, landscape and cultural values of regions.

PROJECT CONTRIBUTION TO THE IMPROVEMENT OF THE NATURAL HERITAGE AND SUSTAINABLE DEVELOPMENT IN THE DANUBE RIVER BASIN

The overall objective of the project is to create a new type of decision support tool, designed to assist specialists, planners and decision makers in their difficult task to identify crucial habitats, ecological designs and locations for connecting structures that show high ecological value and for reconnecting fragments with a focus on restoring the continuity of riparian corridors through the landscape (Figure 1), given the fact that "*continuity is critical for intercepting and filtering polluted runoff water and for providing corridors for the movement of wildlife*" (*Welsch, 1991; Crooks and Sanjayan, 2006,* cited by *Bentrup et al., 2012*).

Unlike the current decision support systems used for ecological evaluation and restoration, the ECORR decision support tool is based on long term approach, responding to the argument of social ecology that who thinks about

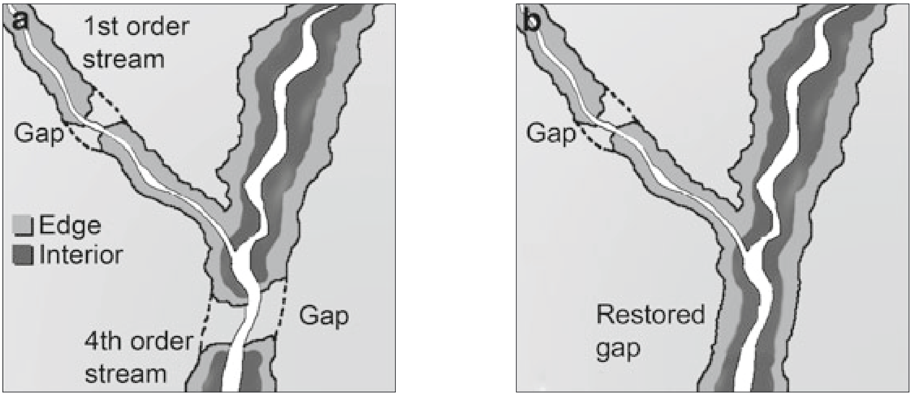

Fig. 1. Gaps in riparian vegetation along streams of all sizes are common in agricultural landscapes (a). Gaps along larger or higher-order streams should often be restored first to provide the greatest overall benefit for wildlife. These riparian zones have less negative edge effects and are more important regional corridors for wildlife movement (b).
SOURCE: *Bentrup et al., 2012*

present-day sustainability must take into consideration also the past because of the still present environmental and social legacies (*Winiwarter, Knoll, 2007*).

Collections of data referring to the recent development do not suffice for an appropriate planning of the future management of rivers and their neighbouring riparian zones. Environment has been changing all the time and will continue to change in different directions, thus long-term information and data gathered from different sources (natural archives, field remains and written sources) are compulsory for an appropriate planning of the forthcoming challenges. The tool is meant to be an interactive, computer-based spatial decision support system (SDSS), comprising a geographic information system (GIS), a decision support system (DSS), an expert system (ES) and artificial intelligence (AI). This entails the building and use of three databases: a geo-database, a model database and a knowledge database. The tool is to be created and developed starting from a real territory, namely the Kolpa/Kupa River, located at the border between Slovenia and Croatia, used as a pilot area to calibrate the tool. Because the riparian zone has been long shaped by a series of natural and social processes, the geo-database will include integrated long-term data and information (geological, geomorphological, hydrological, biological, ecological, palaeoenvironmental and environmental, chemical, archaeological, historical, demographical, economic, on land use and land change, infrastructure etc.), while the model database will include a library of hindcasting models that can be used as basis for explaining the past development, but also for predicting the possible outcomes of decisions and planning the creation/restoration of sustainable ecological corridors. The SDSS will be accompanied by the methodology for implementation and end users will have the possibility to use the given default parameters and also to edit the variables based on their needs and expert knowledge.

Thus, the project will not only represent a model of European transnational cooperation with view to support the creation/restoration of border ecological corridors, but it will also have a spatial decision support system as main output, which will offer the possibility to be easily adapted and applied for the restoration of other ecological river corridors in the Danube River Basin.

DESCRIPTION OF THE BENEFICIARIES/STAKEHOLDERS/TARGET GROUPS

The project addresses the practical needs of specialists (biologists, ecologists, environmentalists, engineers, landscape architects, landscape and spatial planners etc), research and planning institutions, NGOs that are involved in restoring or preserving ecological corridors, local, regional, national and international authorities. Local citizens, entrepreneurs and tourists will represent indirect beneficiaries of the project's results.

PROJECT PARTNERSHIP

The planned transnational project will involve 20 partners from four countries. All partners will have specific roles and tasks in the partnership and will also contribute actively to all five work packages. Our primary partners in this project have to be local authorities. We propose the municipalities Kočevje, Osilnica and Metlika in Slovenia and the municipalities of Neterić, Krasič, Pokuplje in Croatia. Regional authorities are also considered: the administrative unit of Kočevje and Černomelj in Slovenia and Promorsko – Goranska županija and Sisačko – Moslavačka županija in Croatia. The support of national and international agencies and research institutions that will provide the required information and offer expertise in order to fulfil the project objectives will be Slovenian Environment Agency, Croatian State Institute for Nature Protection and Institute of the Republic of Slovenia for Nature Conservation, Geological Survey of Slovenia and Croatia, Croatian Waters, Institute for Water of the Republic of Slovenia, Meteorological Services from both countries, Museum Hallstatt, Austrian Archeological Institute, other institutes and institutions to implement the methodology.

2. METHODOLOGICAL APPROACH

Because of the complex and multifaceted issues associated with the development of riparian zones, the project will be based on a long-term approach using interdisciplinary methodology.

The investigation will focus, on the one hand, on the former changes of the riverscapes themselves, on the other hand, it will focus on the past balances and imbalances in the relationship between environment and human related activities in the riparian zones in order to provide further data needed for decisions contributing to their sustainable future management. The importance of traditional knowledge to foster sustainability is emphasized in the report on *Science, Traditional Knowledge and Sustainable Development*, published by The International Council of Scientific Unions (2002) (*Winiwarter, 2006*).

1. HISTORICAL METHODS

Reliable registers of contents of considerable parts of archival collections containing important information on our topic are not available, which is for instance the case of a part of the collection of the provincial states of Carniola. Furthermore, as the time available for historical research will be limited, the investigation will primarily focus on the following main types of written sources:

a) The maps of the ***Franziscean land cadastre*** from the early 19th century (former Carniola; *Ribnikar, 1982*) and mid-19th century (territory of Croatia; *Jakopec, Jurić, 2012*) enable the GIS reconstruction of the then present riverbed, except for the small riparian structures (*Hohensinner et al., 2013*). Cadastral data on land use, property, as well as rights of pasture, wood and litter extraction, the environmental conditions and farming practices will be collected and analysed using GIS. The approach of socio-economic metabolism will provide an example of the complex picture of mutual material and energy flows between people and environment in pre-industrial agriculture at farm level at a specified moment in order to make clear whether the supply and demand on food and feed matched at that time (*Krausmann, 2008*) and to propose those components of the sustainable management from the past which are applicable to the forthcoming management of the analysed corridors despite the great difference of socio-economic systems.

b) The retrogressive approach using ***Josephinian land cadastre*** (mostly 1785-1789) (*Ribnikar, 1982; Hackl, 2004; Pleterski, 2011*) will provide further legacies of (un)sustainability in riparian zones. The comparison of this cadastre with the Franziscean one will enable to detect the changes in land use which took place in the meantime. The state of pastures and forests as well as lateral erosion will be addressed in particular. Unlike the present-day Carniolian part, also maps were produced and are available for a part of the present-day Croatian Kupa riparian zone (*Lapaine, 2001*). The comparison of the Josephinian cadastral maps for parts of Croatia and the almost contemporary but less accurate maps drawn on military purpose for the other parts of the observed territory with Franciscean cadastral maps will provide valuable insight in the dynamics of the lower course of the river, where its dynamics was higher.

c) The ***Theresian tax cadastre*** (1748-1756) (*Ribnikar, 1982*): cadastral municipalities were not yet established, territorially mostly dispersed seigneuries were in charge of the procedure. In order to find out to which seigneuries the farms on the territory under analysis belonged, the source *Alphabetische Tabelle aller Ortschaften des Neustaedtler Kreises in Krain* will be used. Among the three mentioned historical cadastres this one must be addressed with special caution (*Hackl, 2004*); its greatest importance lies in the records on tree species in forests as well as in recording flood-induced damage. Cadastral maps were not produced, but localisation of many pieces of land will be possible comparing recorded field names and cadastral maps from the 1820s. Theresian cadastre of Carniola also contains rich additional material from the period closely after mid-1750s (*Golec, 2009*), from which information on flood threat will be extracted.

d) ***Land registers***: the edition referring to various seigneuries in Bela krajina (15^{th}-18^{th} century; *Kos, 1991*) will be studied in order to collect the data on land (over)use of cultivated and uncultivated areas in riparian zones. In the late middle ages and the early modern period, unsustainability caused by environmental, economic and social factors led to abandonment of numerous farmsteads near the Kolpa River. It was one of the causes leading to reestablishment of seignories without medieval continuity there in the 16th and 17th century (*Kos, 1987a*). In general, some of the land registers offer an incorrect insight in then-current conditions for various reasons; e.g. there is evidence of afforested areas still listed as fields so that dues referring to the former land use were still collected although the land use changed in the meantime (*Schöggl-Ernst, 2004*). In order to get a clear picture, the results will be compared with those from judicial protocols.

e) ***Judicial protocols*** of seigneurial and territorial courts, 16th-19th century: if the analysis is cautious enough (*Scheutz, 2004*), it provides valuable information on a pallet of aspects of past (un)sustainability, not contained in any other type of sources.

f) ***The archive of the provincial states of Carniola*** will be investigated from years of immediate importance due to extreme draught or excessive moisture in order to obtain information on severe floods as well as severe draughts due to ever-present climate change needed for sustainable future management of ecological corridors. According to the dendroclimatological data, on July, moisture conditions in the territory near the Kolpa river provincial protocols from the following years in the period 1506 (older sources in this archive were mostly destroyed by fire; *Deželni stanovi za Kranjsko*)–1747 (role of the states decreased; *Žontar, 1988*) will be studied: wettest conditions in 1510, 1511, 1521, 1524, 1542, 1553, 1568, 1572, 1581, 1608, 1617, 1628, 1656, 1662, 1681, 1691, 1705, 1712, 1735, 1738; driest conditions in 1519, 1536, 1540, 1546, 1580, 1616, 1651, 1676, 1734 (*Čufar et al., 2008*).

The main archival collections mentioned are preserved in the Archives of the Republic of Slovenia, Croatian State Archives, Kriegsarchiv in Vienna and further archives mainly in the three mentioned countries.

2. ARCHAEOLOGICAL METHODS

Archaeological data analysis primarily focuses on destructive and non-destructive methodological approaches by detecting and analysing environmental anomalies. Depending on the specific archaeological site excavations, nowadays, it primarily focuses on non-destructive methods because they preserve the site in situ and thus does not contribute to ancient cultural and natural landscape degradation. Basic methods range from simple field survey to modern aerometry methods like LIDAR (*Devereux et al., 2005*) and ground penetration radar (*Pettinelli, 2007*) or microscopic methods like x-ray fluorescence method that provides microscopic based analysis of the archaeological fragments (*Jannssens et al., 2000*).

On the other hand, some archaeological sites cannot be analysed only by non-destructive methods, but have to be approached with a destructive or semi-destructive methodology, where all or most of the stationary filed data is later destroyed. The basic semi-destructive method is probing. It is used to dig layers in the site itself and thus for gathering primary information. Actual filed excavation is considered to be the only destructive methodological approach in archaeology. Filed excavations can be carried out in several ways, accurately specified by *Barker* (1996) and *Drewelt* (2001).

Taking into the consideration the fact that the first archaeological remains along the Kolpa/Kupa River date back to the 19th century BC (*Istenić, 2003*), that the first settlements near Vinica, Metlika and Sisak were constructed in the Hallstatt and late La Tene period from the 8th century BC onward (*Božič, 1999*), a clear continuum into Roman and also medieval settlements is obvious (*Archaeological sites in Slovenia*).

Looking at the previous archaeological excavations several archaeological methods have already been used and some of them still have to be upgraded to detect the full extent of the early communities (architecture, burial grounds, villages, agricultural legacies, remains of road, bridge constructions and other structures in the vicinity). Thus, early human impact can be properly analysed and correlated with later development in the Kolpa/Kupa River ecological corridors.

So far, the sites and finds have been analysed by archaeologists and researchers at governmental and research institutions but also by individual archaeologists in Slovenia and Croatia. It is important to acknowledge that different administrations arrange the organization, preservation and analyses of archaeological data in a different way. In Slovenia, the excavations are mainly organized by the National Museum of Slovenia, the institution which together with the Agency for Preserving Cultural Heritage also takes care of the findings. In Croatia, the Ministry of Culture is the main institution that provides funding, while mostly regionally based archaeological institutes are in charge of the preservation and data analysis.

The biggest disadvantage at this point is the correlation of data gathered from both countries because the excavations are only confined to single sites without the investigation of their surroundings. The appropriate solution would be to create a common database and connect them in order to find the needed correlation. Most of the recent archaeological sites have already been analysed in AutoCAD (computer managing tool), which can easily be incorporated in the common GIS database enabling also the 3D representation.

According to the recently excavated sites, we can realize that specific analyses are lacking in some of them. These would give us accurate depiction on the everlasting changes within the Kolpa/Kupa River corridor. The project would also focus on specific Carbon dating analyses, dendrochronology for wooden remains and aerial photography, magnetometry as well as geophysical survey of cultivated areas.

3. PALAEOENVIRONMENTAL METHODS

Climatic change is the primary factor which affects fluvial deposits and character of watercourses (*Demek et al, 2008*). It is particularly well visible in the alluvial deposits from the last glacials. During the Pleistocene period, huge amount of runoff, caused by reduced evaporation due to lower temperatures, led to increased seasonal discharge. The shallow, braided rivers transported huge amount of material that was a product of mechanical weathering induced by temperature changes.

Present day interglacial, the Holocene, is characterized by climatic amelioration and global ice melting that finished around 7 000 years ago (*Lambeck et al., 2004*). A major vegetative change has occurred: the dry, steppe plants were replaced by mixed deciduous forests. The intensified vegetation growth increased infiltration and evapotranspiration and caused decreasing in flow regime energy and sediment supply in streamflow. This resulted in meandering and migration of channels and in formation of flood plains (*Demek et al., 2008*). Climatic improvement is visible in faunal composition as well; taxa adapted to arctic-alpine habitats decreased, while those adapted to forest habitats and temperate climate increased.

The investigation of past environments requires interdisciplinary approach. Geological, geomorphological, palaeontological and pedological methods are used for the reconstruction of river basin evolution and palaeohydrological, palaeoclimatological and palaeoecological reconstructions (*Lowe and Walker, 1999*). Sedimentological and geochemical analyses provide information regarding the nature of the deposition environment (e.g. water energy, sediment provenience, geochemical properties), while evidence of faunal and floral remains provide the time depth needed for studies of biodiversity and human – environmental interaction (e.g. change in vegetation due to deforestation or river embedding).

When the required data is not available, direct field observations are needed. Multiproxy analyses combined with absolute dating of sediments and biological remains from the sediment core are the most effective way to get all the data for palaeoenvironmental reconstruction.

4. ECOLOGICAL METHODS

The majority of the research done on the rivers is highly specific, aimed at particular groups of organisms. Such is also the case with Kolpa/Kupa River. Therefore, developing a holistic approach was required. The aim of this part of the project is to assess the ecological status of the river Kolpa/Kupa using SERCON (System for Evaluating Rivers for Conservation) method, used for defining river conservation value. In this approach, scores are assigned to river features and impacts on river systems. Information on each attribute is used to create a picture of the river in terms of traditional conservation criteria such as Naturalness, Species Richness, and Rarity (*Boon et al., 1997, 1998*). Along with the conservation criteria, SERCON also includes information on: Physical Data, Catchment Land-use, Water Quality and Impacts. The SERCON evaluation requires a vast amount of data, obtained from different sources of information, including the data on Macrophytes, Macrozoobenthos, Fish Fauna and Birds. By setting rivers in their wider nature conservation context SERCON can contribute to the EC Habitats Directive and the EC Water Framework Directive, thereby increasing the benefits of both Directives to river conservation and management.

5. REGIONAL METHOD

The **regional method** will be also used. It is based on the selective and integrated study of phenomena and processes in the Kolpa/Kupa River area and includes plurifactorial analysis and correlative synthesis. The complex approach of the natural, demographic, social or economic components will be in accordance with the four principles of Geography, in general, and of Regional Geography, in particular: the principle of spatiality, the principle of causality, the principle of integration and the principle of historicism.

6. GEOGRAPHIC INFORMATION SYSTEMS (GIS)

The benefits of using GIS-based systems for decision making are increasingly recognised. GIS allows for new approaches that help us understand the relationship between systemic components (natural and human) and, hence, for a holistic and comprehensive approach to resolving planning problems, including those related to restoration of ecological corridors. GIS will support the storage of geospatial data (maps and plans in raster and vector format, geographical, biological, environmental, archaeological, socio-economic data, land use and land cover data etc), an efficient data retrieval, query and mapping. As a toolbox, GIS will also allow to perform spatial analysis using geoprocessing functions such as map overlay, connectivity measurement, and buffering, including modelling exercises. For this range of applications, GIS technology will make an important, although partial contribution to the creation of the decision support system (designed and developed based on ArcGIS Engine), together with the data and analysis functions of remote sensing (RS), decision support system (DSS), models and expert knowledge (Figure 2).

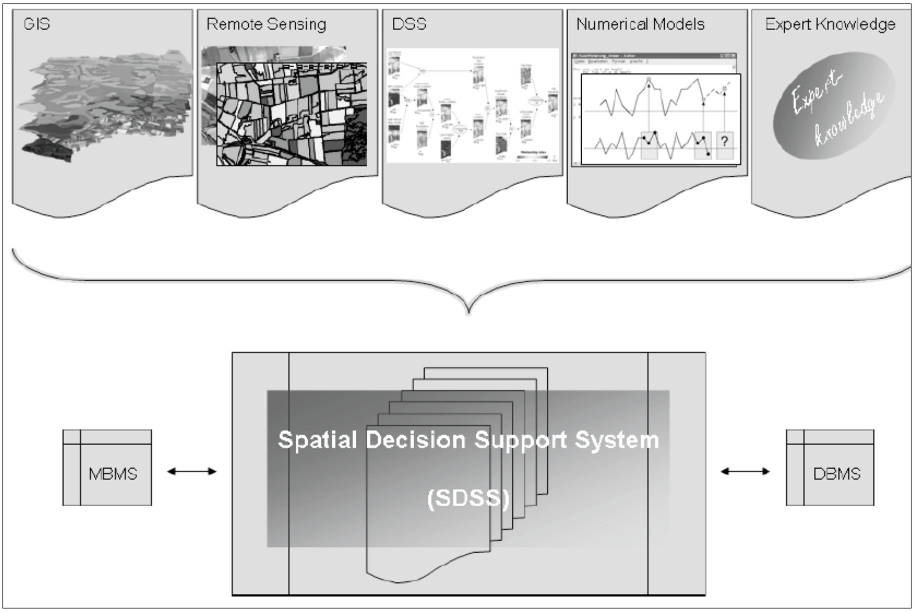

Fig. 2. Configuration of a modern Spatial Decision Support System
SOURCE: ***Laudien, Brocks, and Bareth, 2008***

3. PROJECT OBJECTIVES

O1. Collection and data analysis

O2. Creation of a joint database

O3. Development of the spatial decision support system

O4. Elaboration of methodological guidelines for the implementation of the ECORR SDSS

4. LOGICAL FRAMEWORK MATRIX

The **overall objective of the project** is to create a new type of decision support tool for the creation of ecological corridors based on long term approach.

The **purpose of the project** is to gather interdisciplinary and long term data for the creation of the decision support tool.

The **work program** consists of three research work packages (WP 2, 3 and 4), one management work package (WP 1), and one dedicated to dissemination (WP 5).

ACTIVITY PLAN AND IMPLEMENTATION METHODS

WP 1. Project Management

Description	The overall management will be carried out by the Lead Partner. The project management team comprises the professional project coordinator, the financial administrator and their assistance. The project coordinator is responsible for the professional management, monitoring of the project work and of the time schedules. WP leaders coordinate the work of each work package and give support to the project leader.
Act. 1.1. Elaboration of the Management Plan	A management plan will be elaborated in order to detail the tasks, responsibilities and the administrative rules of the project implementation. It will be prepared by the Lead Partner with the contribution of all project partners.
Act. 1.2. Overall project management	Project management activities will include project coordination, internal monitoring of the project progress, financial administration, assistance, elaboration of activity and financial reports, organization of internal meetings, public meetings and workshops.
Results and outputs	Project Management Plan; Joint Action Plan; agreed management structure; progress and financial reports.
Means	4 persons in charge for professional management and financial administration; technical equipment; office supplies.
Sources of verification	Project work plan.
Assumptions	Delay in partner reports and therefore delay in joint reports; internal communication problems.

WP 2. Spatial Decision Support System Development

Description	WP 2 aims to set up and manage the data collected into the ArcGIS platform.
Act. 2.1. Data and information collection	A methodology for gathering the information and data will be elaborated from the very beginning. It will include the evaluation of the current existing data and the selection of indicators and input data to be used, data sources, units of measurement, indicator typology and time period. LAU 2 level along the two banks of the river will be used for collecting the data.
Act. 2.2. Creation of the database	The database is to be created by collecting long term data from historical, archaeological, geographical, palaeoenvironmental, biological, ecological, cartographic and statistical sources, remote sensing data and field observations. Creation of the spatial decision support system.
Act. 2.3. Elaboration of the draft methodology	Before the start of the pilot project, all available data will be collected in order to create the initial database and determine the further steps required: data that is necessary to provide, and in compliance with them, researchers and methods will be considered.
Act. 2.4. Finalisation of the SDSS and the implementation methodology	The results of the pilot projects will be used in order to calibrate the SDSS, create hindcasting models, and finalize the methodology.
Results and outputs	Joint database; methodological guidelines.
Means	4 persons in charge for developing the tool; technical equipment; office supplies.
Sources of verification	Methodological guidelines published; one spatial decision support system developed.
Assumptions	Unavailable data; impossibility to collect the data; impossibility to homogenize the data; data available in inappropriate form.

Description	The Kolpa/Kupa River was chosen to collect the data, create the database, calibrate and develop the SDSS and finally elaborate the methodology due to its characteristics. It is a complex river, right tributary of the Sava River, with its mouth in the Dinaric karst region of Croatia, in the area of Risnjak National Park. It forms a natural border between south-east Slovenia and north-west Croatia and has its confluence with the Sava River on the Croatian territory. Its status as border river is to bring some challenges to the project development (e.g. language differences, different past and present administrative territorial organization, data gathering, different legislation and institutional administration and policies) This context will serve as a good example for other cross-border river and riparian areas in the Danube River Basin where the SDSS will be applied and implemented. The river has a total length of 118.3 km, a catchment area of 10,225.6 km^2 and an average flow of 201m^3/s at the confluence with the Sava. The river has three sectors with different characteristics, a reason for which the projects will be focused on three pilot projects located in each of the river sectors (Figure 3).
3.1. Pilot project 1 – Upper Kolpa/Kupa River	The Upper Kolpa/Kupa River, in the mountain region, is an almost intact river section in the Dinaric karst region, which is protected and has no structural intervention. Initial natural components are well preserved.
3.2. Pilot project 2 – Middle Kolpa/Kupa River	The main community in the Middle Kolpa/Kupa River sector is Karlovac (about 49,000 inhabitants). The human pressure on the river is higher because of the main economic activities: metal processing, construction, food industries in Karlovac and agricultural practices (e.g. cattle breeding in the upper hilly area). Contamination from barite mine tailings, agriculture, industries and sewage waters has attained an alarming state on some stretches. Influx of pollutants and their restricted circulation in many places have led to severe eutrophication with macroalgal blooms and generation of marsh vegetations.

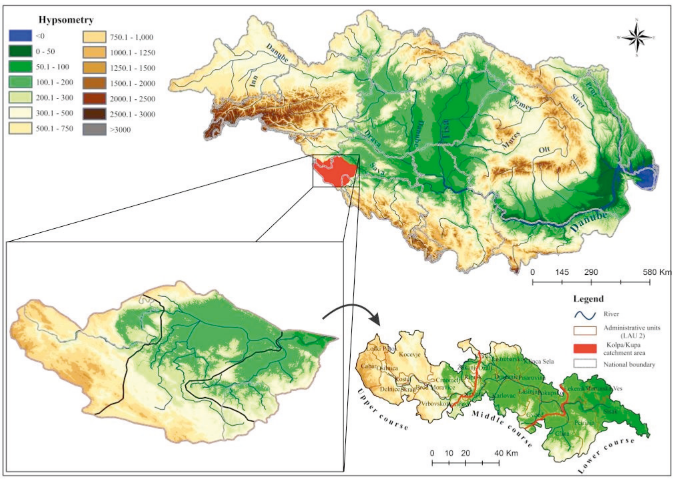

Fig. 3.
Location of the Kolpa/Kupa River in the Danube River Basin (a). The three sectors of the Kolpa/Kupa River (b)

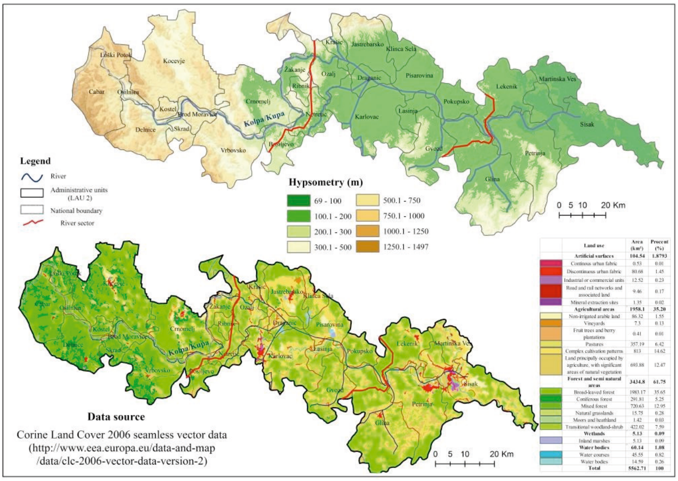

Fig. 4.
Relief (a) and land cover (b) in the three analysed sectors of Kolpa/Kupa River

3.3. Pilot project 3 – Lower Kolpa/Kupa River

The Lower section is characterized by flat, alluvial terrains with fertile covers, with a high pressure from small family estates with extensive agriculture (Figure 4), construction of weirs of hydroelectrical power plants, construction of embankments for bank protection together with stacking of rock boulders on river bed for angling, dredging and mining of riverbed in some places, latent eutrophication problems (in the groundwater and lower river section). The pilot projects will focus on the collection of data and information from a well-defined territory, completion of the joint database, calibration and development of the spatial decision support system in the pilot areas by using the bottom-up approach. The interdisciplinary approach will be intensively used during the activities planned within WP 3. For example, basic geological, pedological and hydrological data will be collected from Geological Survey of Slovenia and Croatia, Croatian Waters, Institute for Water of the Republic of Slovenia, Meteorological and Hydrological services and Institutes for Nature Protection from both countries. According to available scientific literature (e.g. Frančišković-Bilinski et al., 2012; Frančišković-Bilinski et al., 2011; Biondić et al., 2003), the present hydrological status of the river and aquifers is well researched, but there is lack of information about past hydromorphology and palaeontology, especially the long-term faunal changes. In order to provide this data sediment cores will be extracted from the river surrounding area. Where necessary test pits will be excavated in order to provide more data about past flora and fauna. From the ecological perspective, SERCON method will be applied for evaluating the conservation value of the rivers on previously determined ECSs (Evaluated Corridor Sections). The characteristics of vegetation along the three sectors of the Kolpa/Kupa River will be analysed also from a historical perspective (Table 1).

Results and outputs

Project meetings; study visits; training events for using the decision support tool; 3 public meetings for stakeholders; 1 joint database for the pilot areas; 1 study on pilot project results.

Means	Technical equipment; office supplies; permits for data gathering and analysis; 10 persons involved.
Sources of verification	Invitations; attendance register; memo; photos related to the meeting; presentations prepared for the meetings.
Assumptions	Natural and human-induced disasters; social conflicts; global economic crisis; language differences, different past and present administrative territorial organization, data gathering, different legislation and institutional administration and policies.

Tab. 1: Main characteristics of the history of vegetation in Bela krajina in the last two millennia

Time	History of vegetation
around year 100 AD	increase in extent of forest clearings & plant species diversity
early middle ages	further clearing of forest prevailed
mainly 12.-13. century	new wave of agrarian colonization, decrease in species diversity followed by its increase
15.-16. century	Short period of afforestation, old clearings restored shortly thereafter
17.-19. century	demographic increase (in general), lesser extent of forest clearings
2nd half of the 20th century	Afforestation, increase in species diversity

Sources: *Šilc, Andrič*, 2012; *Kos*, 1987a, b.

WP 4. Guidelines for the implementation of the methodology

4.1. Stakeholder analysis	The stakeholder analysis implies the identification of relevant persons, institutions, organizations and authorities that may be interested in implementing the spatial decision support system and in using the methodology for creating/restoring ecological corridors along different rivers in the Danube Basin. The stakeholder table will be filled in with relevant information, followed by the prioritisation of stakeholders according to their interest and degree of impact.
4.2. Methodological guidelines for the Danube River Basin	After the finalisation of the SDSS building and the methodology for its implementation in the Kolpa/Kupa River area, methodological guidelines to assist specialists, research institutions, NGOs and authorities in other river and riparian areas in the Danube Basin will be elaborated and published. Two training sessions will be organised in order to present the methodological guidelines and familiarize interested stakeholders with the new ECORR SDSS.
Results and outputs	Methodological guidelines; stakeholder table; project meetings; two training sessions.
Means	Technical equipment; office supplies; 4 persons involved.
Sources of verification	Guidelines published; invitations; attendance register; memo; photos related to the meeting; presentations prepared for the meeting.
Assumptions	Lack of stakeholders' interest in the project results.

Act. 5.1. Communication plan	Objectives of the communication plan are: • to keep awareness and commitment to the creation of ecological corridors high among all interest groups; • to promote the benefits of the project to all stakeholders and to gain their support; • to change attitudes and behaviours that are affecting selected ecological corridors; • to maintain consistent messages at all times; • to manage expectations and to keep them within the scope of the projects interests; • To educate people on the necessity of creating and preserving ecological corridors. Communication plan will be devised according to the different stakeholder groups whose interests are valid in this project and that are local, regional, national, and international authorities, specialists, research and planning institutions, local citizens, tourists, entrepreneurs, and NGOs. Communication will be implemented and led internally and externally. Formal part of internal communication will be done through status meetings: • internal status meetings – with the purpose of project team coordination in assignments, ac tivities and to share information; • advisory committee meetings – with the purpose to review project progress, risks and issues together with selected stakeholders; • status meetings and reports to stakeholders. Communication plan will be evaluated periodically on the selected indicators to measure effectiveness of communication activities at achieving objectives that will mainly be based on queries, suggestions contributing the program and negative feedback.

Act. 5.2. External communication

Results and outputs	External communication will be carried out through several communication media and mechanisms: • Website is a priority for the project because it will serve as the main point of information distribution. • Launching event – Project will be launched with an event that will point the main project purpose and communicate clearly to all stakeholders the benefits and the possible risks for the whole project period. • Brochure – Different types of brochures will be designed to inform all the interested public in the purpose and the implementation of the project and the possible areas for their involvement. Newsletter – A regular newsletter will be sent in order to keep all the interested parties informed of the development within the project. It will be produced electronically. The newsletter will also be sent periodically to the local media. • One-on-one Meetings with Key influencers – Before any public discussion one-on-one meetings will be arranged with politicians, educators and ministers of the local area in order to garner their support as key influencers.

	• Community forums – Community forums will be hosted in order to have interactive discussions with different target audiences, local population, local government, etc. • Seminar programs – There will be a series of seminars across the selected area of the project period done in partnership with the local government in order to inform and educate the local inhabitants.
Means	Technical equipment; office supplies; 1 PR person.
Sources of verification	Invitations, attendance register, memo, photos related to the meetings; presentations prepared for the meetings.
Assumptions	Natural and human-induced disasters; social conflicts; global economic crisis; language differences; lack of stakeholders' interest in the project.

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