Interreg
EUROPEAN UNION
Danube Transnational Programme
CAMARO-D

Report for OUTPUT T2.2

Transnational cluster specific characteristics

Cluster 3 "*Land use and vegetation cover along rivers & accumulation lakes – erosion, floods, surface runoff, invasive plant species and water* pollution"

Final version 25.02.2019

Project co-funded by the European Union funds (ERDF, IPA)

Interreg
Danube Transnational Programme
CAMARO-D

Contents

Project co-funded by European Union funds (ERDF, IPA)

1. Introduction

This report provides a comprehensive overview of the specific characteristics of Cluster 3 "Land use and vegetation cover along rivers and accumulation lakes – erosion, floods, surface runoff, invasive plant species and water pollution".

In contrast to previous cluster reports, DT 2.3.2 is strongly focusing on practicable solutions mitigating the relevant identified risks.

Highlighting the common risks of partner countries involved in the cluster, this report outlines the best transnational applicable practices, which were identified during the implementation of pilot activities and through the feedback of stakeholders received during workshops, dialogues and cluster-specific training sessions. The findings are also based on the most important cluster-specific outcomes of DT2.2.2 (Transnational cluster-manual for practitioners) and DT2.3.1 (Evaluation report of the pilot activities).

The solutions presented in this report provide a wide scope of applicable measures and related challenges and necessary learning processes in the field of water protection and flood prevention in rivers and accumulation lakes. As these best practices were developed on a transnational basis, the main issues are also applicable by other regions with similar problems within the whole Danube river basin.

Cluster 3 "Land use and vegetation cover along rivers and accumulation lakes – erosion, floods soil compaction, surface runoff, invasive plant species and water pollution" encompasses the interdependencies between land use and vegetation cover along rivers and accumulation lakes. The following project partners participate within the Cluster 3 with their pilot areas and implemented activities:

- **LP:** BMNT Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management / *catchment area Raab/ Gnas;*
- **PP1:** AREC Agricultural Research and Education Centre Raumberg Gumpenstein / *Upper Styrian Enns Valley, catchment areas Enns River;*
- **PP7**: NMA_RO National Meteorology Administration of Romania (Cluster 3 leader) and **PP8** EPAC Environmental Protection Agency Covasna / *Black River - Hydrographic basin from Covasna County;*

Project co-funded by European Union funds (ERDF, IPA)

- **PP11:** CTU Czech Technical University in Prague / *Reservoir Brno watershed / Svratka River basin;*
- **IPA PP1:** JČI The Jaroslav Cerni Institute for the Development of Water Resources / *Catchments of Gruža and Grosnica Reservoir & Catchment of the Garaši and Bukulja reservoirs in central Serbia;*
- **PP5:** HOI Herman Ottó Institute / *no pilot area.*

The assignment of the planned pilot actions (divided in direct and indirect interventions) in the CAMARO-D project was described:

- *Direct interventions*: management activities, case studies, research activities, monitoring;
- *Indirect interventions*: public awareness, knowledge transfer actions, workshops, excursions, training activities, handbooks, PR material, exchange of knowhow with stakeholders.

2. Risks

2.1. Erosion

All countries have long term experience in erosion control, but in some vulnerable areas the problem still exists. The erosion of land/soil is a process which can occur both slowly and at a more rapid pace causing the loss of fertile topsoil. Certain characteristics of soil such as the organic matter content, soil structure and soil compaction can all influence the rate of erosion. Erosion, regardless of the type of erosion process, involves the detachment and movement of soil particles. One area which could be noted as a hot spot is the lack of implementation of a source protection framework within the context of land use management in the relevant catchments. In a general term, the erosion defined in Cluster 3 is:

- Side erosion along rivers based on extremely flood events and instable shores, wrong or missing bank vegetation (incl. invasive plants), depending on on the amount of

water and the occurrence of high and low water during one year, the slope of a river, the debris carried along and the hardness of the rock;
- Deep erosion based on missing bedload material due to retention basins in the tributaries (torrents) of the rivers;
- Soil erosion from arable land and soil erosion caused by deforestation.

2.2. Floods

All pilot areas are torrent water catchments, where floods and river rising often occur and the nearby settlements are endangered. In all countries, the risk planning and management documents are based on the EU Flood Directive.

The vulnerability of water resources depends on climate changes at different degree. Climate change (trends and extreme events) and land use changes (erosion, land degradation, soil compaction, forest fires, etc.) decline water retention capacity and increase flood and drought risk.

Flooding in rivers and tributaries (wetlands) occur because of high construction density, partly missing natural retention areas or too low dimensioning of the channels for surface drainage. Floods affect large towns and municipalities, water reservoirs and agricultural land in the pilot areas.

Key factors in determining the flood risk potentials are:

- Analysis of physiographic features;
- Assessment of availability of data necessary for applying the hazard determination method;
- The presence of potentially endangered sites.

Concerning the pilot areas in Serbia flood risk is an absolute minimum risk due to the presence of adequate water reservoirs. No hot spots in terms of flood risk have been identified.

2.3. Soil compaction and soil quality

Soil compaction can be observed in almost all involved countries which is caused by intensive agricultural use or settlements.

Project co-funded by European Union funds (ERDF, IPA)

The compaction of the soil can cause or accelerate other soil degradation processes, such as erosion or landslides. Compaction reduces the infiltration rate, which results in increased scaling on sloping surfaces. Also, the presence of a low permeability layer makes the layer superior soil is more prone to saturation with water and hence more difficult. This upper layer presents the risk of landslides.

A sign of compaction is temporary accumulation of water on the soil when rainwater no longer seeps away sufficiently in compacted soil. If the rainwater then drains off predominantly at the surface, it can lead to the washing off and loss of soil during heavy rainfall. This can lead to local flooding and water pollution.

2.4. Surface runoff

All types of land use (forests, pastures, arable lands, grasslands, wetland areas, settlements, traffic infrastructures) influence quantity and quality of surface runoff in every partner pilot area. In general the risk of runoff is greatest when poor soil structure is near the soil surface. Soil structure deteriorates when structural units are deformed producing a dense single mass of soil (or large soil units). This occurs when pressure is applied to a wet and soft soil. Grazing of agricultural and forest land (compaction) decreases infiltration potential, increases surface runoff and erosion potential on substrates / soils rich in fines. Also, soil sealing and suboptimal management practices (soil compaction, reduction of vegetation cover, etc. by development of settlements, agriculture, tourism) causes an increase in surface run-off and thus leads to a higher risk of flooding and flash floods.

2.5. Invasive plant species

Missing natural vegetation or invasion of aggressive invasive plant species causes collapse in ecological stability, land character changes with other consequences, including for instance riverbanks stability. Arable farming is increasing in wetlands due to climatic change (monoculture, intensive and inappropriate manure application, heavy machinery, exuberant using of fertilizers and pesticides). Some consequences of invasive plant species are loss of biodiversity, erosion and soil degeneration.

Project co-funded by European Union funds (ERDF, IPA)

In Cluster 3 pilot areas invasive plant species such as: *Impatiens glandulifera, Fallopia japonica, Solidago* sp., *Acer negundo, Amorpha fruticosa, Galinsoga parviflora, Lupinus polyphyllus, etc.*

2.6. Water pollution

In the pilot areas, the pollution of surface water and contaminated waste waters, particularly in settlements, touristic sites and traffic infrastructure is taken into consideration. The settlement areas are vulnerable to contamination of surface water, flooding, artificial deposits along rivers, tributaries and accumulation lakes, increased danger of flash floods and contaminated waste water. Main risks in the drinking water reservoirs are e.g. lack of maintenance of the anti-erosion barriers, eutrophication problems and associated water quality problems primarily as result of land use in the catchment, conversion to grassland, use chemical fertilizers on agricultural lands.

2.7. Surface and groundwater interaction

If agricultural areas are fertilized too intensively or buffer strips to the flowing water are missing or the distances are not maintained or intensive fertilization is used in case of high soil compaction.

2.8. Cyanobacterial blooms and toxins in drinking water supply reservoirs

This risk was described in the Serbian Pilot areas. The reservoirs in the pilot areas are under the risk of occurrence of cyanobacterial blooms which can endanger their use for water supply. The management of these risks through the implementation of best practices in relation to land use will be the focus of our studies in the pilot areas and interventions to be initiated within this project (The role of the TN:TP ratio as a control mechanism for the potential of occurrence of cyanobacterial blooms and its relationship and dependence on land use within the pilot areas and their catchments). The identification of gaps and the direct link between land use management and water quality, along with recommendations regarding best land use

Project co-funded by European Union funds (ERDF, IPA)

management practices will lead to risk minimization and prevention. Historical data capture and analyses (different land use change scenarios considered) are carried out in an attempt to create a direct link between different land uses and water quality in the pilot areas. Long term monitoring data of water quality parameters within water reservoirs is carried out by several institutions including the Republic Hydro meteorological Service according to the yearly monitoring programme and is publicly available. Since 2011 water quality monitoring is handled by the Agency for environmental protection. This monitoring is expected to be continued.

Table 1: Overview of current risks within the pilot areas of Cluster 3

Types of risk	LP	PP1	PP7 & PP8	PP11	IPA PP1	PP5
Erosion	X	X	X	X	X	X
Floods		X	X	X		X
Soil compaction and soil quality		X	X	X		X
Surface runoff	X	X	X	X		X
Invasive plant species		X	X	X		X
Water pollution			X	X	X	X
Surface and groundwater interaction			X			
Other risk: Cyanobacterial blooms and toxins in drinking water supply reservoirs					X	

Project co-funded by European Union funds (ERDF, IPA)

3. Best solutions

3.1. Adapted agriculture for optimal surface water and soil protection under climate change

Agricultural crops are exposed to risk from extreme meteorological events each agricultural year. Promoting a sustainable agriculture requires that farmers / practitioners apply the new agricultural practices based on the most advanced scientific knowledge technologies, especially those environmentally viable. Therefore, it is necessary to elaborate and implement codes of good agricultural practice on a transnational basis. These are a set of scientific and technical knowledge that are available to agricultural producers and farmers and applied or can be applied in practice at a transnational level.

It is recommended to apply a system with grass buffer strips, whose width varies depending on the slope. Buffers and filter strips are areas of permanent vegetation located within and between agricultural fields and the water courses to which they drain to interrupt sediment fluxes and allow infiltration and sedimentation of eroded material.

Terracing is generally used to make agriculture possible on inclined terrain, where the slope and the depth of the soil layer do not allow the cultivation of the plants. Maintaining good terraces on the slopes reduces water leakage on the slopes, ensures better water retention in the soil and prevents soil erosion.

In addition to this, another problem faced is the direction of tillage. Examples have been documented of land tillage in such a manner which maximizes surface runoff and with it, a loss of soil and nutrients from the soil's surface layer. This leads to the degradation of soil quality and to an increase in the amount of nutrients entering water bodies. Tillage on sloping land must be carried out parallel to the contour lines so as to minimize soil erosion and run-off.

In order to prevent the soil compaction processes determined by the sowing machines especially on the slopes, on thin or peaty soils, in fact all soil types that show sensitivity to this process, will keep vegetal remains or other organic matter at the surface of the soil, where possible. Attention will be increased where irrigation channels, access ways and roads are installed.

Soil contamination should be avoided. The application of waste products, wastewater, sewage sludge or similar products should be avoided.

Project co-funded by European Union funds (ERDF, IPA)

The most correct administration of chemical fertilizers is direct incorporation into the soil. It is recommended to avoid fertilization on freshly grounded soils (deep loosening, immersion) to prevent the penetration of nitrates into the groundwater.

The practical implementation of practices, solutions, measures, methods, etc., included in this code for the agricultural producers and farmers can lead to obtaining profitable productions, harmonized with the requirements of environmental protection and preservation.

Result of the activity "Distributed balance model of sediment and phosphorus transport" carried out in the Brno watershed pilot area is knowledge on extent of soil loss and sediment and phosphorus transport (and siltation of reservoirs). The identification of problems at the end of system (for example in reservoirs) can be used for detailed analysis of sediment and nutrients inflow. This is current status (Status quo) and can be used for analysis of potential improvement of landscape function, water quality, soil quality and water balance.

Within the project, sites in the Brno watershed pilot area that are suitable for grassing have been identified. The main purpose of grassing of these sites is to reduce the erosion of agricultural land and consequently to reduce the transport of eroded material and bound phosphorus into watercourses and water reservoirs. The application of grass strips around watercourses and in paths of concentrated surface runoff is the most effective approach in terms of soil and water protection. It models the application of grass strips along waterways and drainage paths.

Investigation of the effect of conservation tillage on soil erosion rates in the **Gnasbach pilot area** by conducting an erosion plot trial. Conventionally tilled (CT) plots are compared with two variants of conservation tillage (RT and IC). The expected decrease in surface runoff as well as sediment yield for the conservation tillage plots should show the advantage of the respective techniques, which are promoted by the main cooperation partner (Agricultural chamber Styria). RT variant (reduced tillage) substitutes the plow with a cultivator, IC variant is the same plus wheat is sown simultaneously with the maize in order to achieve higher ground and plant cover. The reduction in sediment and nutrient yields are expected to have positive impacts on surface water quality. Both reduced sediment yield, reduced surface runoff, as well as dampening and delay of the surface runoff hydrograph should have positive impacts on flood risk management of downstream areas in case of adaptation throughout a catchment.

The analysis of the climate regime in the **Black River basin** was presented to the key stakeholders at the public event **“**Dialogue with stakeholders for the DTP1-1-096-2.1 project -" CAMARO-D - Cooperating Towards Advanced MAnagement ROutines for land use impacts on the water regime in the Danube River basin "on interdependencies between management practices of Natura 2000 sites and water management in the river basin of the Black River**”,** held in Sfantu Gheorghe, on 12th of December 2017. The event has reached its goal having a wide range of stakeholders present and active in discussions, willing to collaborate and contribute at the future CAMARO-D project activities that can lead to an improvement of water management and biodiversity conservation in the region.

Within the pilot action “Rain simulations and runoff coefficient at different land use areas” in the Styrian Enns Valley rain simulations were carried out, to investigate how much water flows at the surface at different land use units. According to the results, a runoff coefficient map will be established for the valley floor and the adjoining lower lateral hillslopes of the test region. These results and an adapted land use map are used to delineate hotspots with high risk of runoff damage to settlements, areas within the future settlement borders and infrastructure facilities. Areas with medium to high surface runoff potential (e.g. graded ski slopes, intensively pastured slopes, acres with poor ground cover, e.g. maize…) have a higher risk of soil erosion, surface runoff concentrates within short distances. Thus, also potential of linear erosion is significantly higher on such areas than on well-groomed pastures and forest sites. In addition, risk of damages to subjacent and downstream settlements and infrastructural facilities is higher because of mechanical impact and deposition of eroded material.

3.2. Conversion from arable land to grassland mitigating soil erosion

In general, identification of risk locations is very important and necessary for any further protection of both of water, soil and even landscape as a whole, which has higher priority nowadays. In recent conditions of the extreme drought / flash floods extremes, it is necessary to effectively protect agricultural land. This, of course, includes a certain limitation of the possible farming of agricultural crops and the establishment of a border where it is inappropriate to manage and accept protection, for example, by grassing.

Project co-funded by European Union funds (ERDF, IPA)

Conversion to grassland is the most effective soil erosion prevention in steep areas of arable land. High quality afforesting can be even more effective, but it is much harder to implement and it means complete structural changes in the landscape.

Conversion to grassland is not always preventing against pluvial floods, it effectively supports retention only for low intensity rainfalls. For extreme events (of low occurrence) the roughness of the grassed surfaces is low to stop rapid flow accumulation. On the other hands it always protects soil and potential floods are not muddy floods.

The permanently grassed surfaces are most protective agricultural lands concerning soil loss and sediment transport mitigation, apart from complete change of land structure and without altering landscape fragmentation.

Grassed waterways are broad, shallow and typically saucer-shaped channels designed to move surface water across farmland without causing soil erosion. The vegetative cover in the waterway slows the water flow and protects the channel surface from the eroding forces of runoff water. Left alone, runoff and snowmelt water will drain toward a field's natural draws or drainage ways. It is in these areas that grassed waterways are often established.

Filter strips are areas of permanent vegetation located within agricultural fields to interrupt sediment fluxes and allow infiltration and sedimentation of eroded material. The strips must be designed with proper dimensions (width) according the field topography and have to be maintained (mowed).

Buffers strips are areas of permanent vegetation located between agricultural fields and the water courses to which they drain to interrupt sediment fluxes and allow infiltration and sedimentation of eroded material.

These buffers are intended to intercept and slow runoff thereby providing water quality benefits and to reduce the surface runoff and sediment connectivity to desired level.

The number of harmful practices related to arable and grass agricultural systems is variable within CAMARO-D countires, but generally it is quite high with impact on water and soil quality related issues.

Project co-funded by European Union funds (ERDF, IPA)

3.3. Practical guide to spatial planning in catchments and river stretches

Riparians of fluvial systems as well as torrents are linked by the gravitational flow of water. Flood control schemes aimed at protecting vulnerable areas, as well as the intensification of land uses (e.g. land development, soil sealing or drainage of wetlands) accelerate flood runoff and increase the downstream peak discharge. On the other hand, downstream riparians can benefit from upstream measures of flood prevention (e.g. flood polders) or the extensification of land uses (e.g. restoration of wet lands, natural retention areas) in the form of attenuated and delayed peak flows. Addressing these interdependencies – commonly referred to as upstream-downstream relations – calls for regional approaches in flood risk management and coordination at the scale of catchments or river stretches, as mandated by the EU Floods Directive (2007/60/EC).

This transnational best practice manual presents two types of regional coordinative approaches with regard to spatial planning:

- Regulatory instruments at regional planning level: regulatory spatial planning instruments (such as regional plans) may designate suitable areas to secure the necessary land resources for flood retention and flood runoff as well as for future flood control measures. Such top-down planning directives are legally binding and generally entail zoning restrictions, which have to be implemented in local land use plans.
- Upstream-downstream cooperation: voluntary cooperation between upstream and downstream riparians represents another option to encourage catchment-oriented planning. Such bottom-up cooperation is flexible in scope and in scale. Moreover, compensation mechanisms may be tailored according to the interests and needs of the cooperation members.

Unlike for fluvial catchments and river stretches regional planning is not that important for managing upstream-downstream relations in torrential watersheds, as those watersheds are often located within a municipal planning area. Voluntary cooperation, however, is a suitable instrument of catchment-oriented planning also in torrential watersheds.

Project co-funded by European Union funds (ERDF, IPA)

The manual introduces the organizational type of water cooperatives in Austria as a best practice example. Water cooperatives mainly comprise non-state actors, in most cases private landowners, who are affected by flood protection measures. Water cooperatives are based on the Austrian Water Act. The tasks of water cooperatives include construction, monitoring and maintenance of flood protection schemes (in most cases smaller schemes against torrential hazards) and fund raising from interested parties (mainly landowners who benefit from flood protection). According to the Austrian Water Act, water cooperatives are legal entities and represent the interests of their members. Usually affected landowners take the initiative for a water cooperative. Water cooperative members financially contribute to the protection measures in the sense of burden sharing. The major cost share of a flood protection scheme, however, is covered by governmental authorities. Cost sharing within the water cooperative depends on the advantage received (by the flood protection scheme) or on the degree of potential damage averted. Water cooperatives are self-governing organizations, however with a formalized character. Decisions are taken democratically and problems should be solved internally, against the background of a regulatory legal framework. Thus, the water cooperative stands between state administration and self-organization.

With reference to torrential watersheds the transnational best practice manual concludes with a recommendation to provide incentives for voluntary cooperation in catchments and river stretches. Incentives can on the one hand be financial, on the other hand assistance by (legally) formalized types of cooperation – e.g. water cooperatives – can be very helpful for municipalities or other stakeholders to take a decision for cooperation.

In the **Serbian pilot areas (Grošnica reservoir, the Gruža reservoir and the Bukulja, Garaši and Kačer system)** the following pilot actions were taken:

1. Identification of gaps in the current knowledge, data and regulation. This included a review of the monitoring programmes, monitoring frequency and extensiveness with recommendations for the necessary amendments.
2. Critical evaluation of existing water quality management regulations and recommendations for necessary changes
3. Preparation of recommendations for land use changes within the catchment

There is a need for much broader and more comprehensive stakeholder participation in the process of planning activities. Stakeholder motivation is one of the main obstacles in achieving more comprehensive stakeholder participation and is something that needs to be looked at in detail.

A long-term implementation of the public workshops should take place to reach further decisions makers, practitioners and citizens. The priority theme could change annually, to cover also other areas of nature conservation, natural hazard and risk management, spatial planning and sustainable agriculture and natural flood retention, water protection and optimization of recreation, science & education in nature.

3.4. Beaver management

It is widely known that when beavers and humans come into contact, problems and conflicts can and do occur. Most of these conflicts are related to flooding caused by beaver building activity, destruction and damage from gnawing. Trees can fall over and pose a danger to people and property in the vicinity of residential areas. Crop damage can also occur in agriculture.

The BPMs aims are:

- provide information on damage compensation,
- beaver management and beaver monitoring and
- approaches to minimize conflicts by different interest groups.
- Moreover, affected people will find information and effective solutions on what can be done and where to find help.
- The sharing of transnational best practice and a list of technical measures are listed.

The innovative methodology for cumulative environmental impact assessment at local and regional levels based on ecosystems services evaluation is promoted by the accepted conceptual document Convention on Biological Diversity (CBD) and Millennium assessment. In this respect, the environmental impact assessment procedures should refer to other national, regional and international legislation, regulations guidelines and other policy documents such

Project co-funded by European Union funds (ERDF, IPA)

as the national biodiversity strategy and action plan documents CBD, CITES, RAMSAR, European EIA directive, Convention of Environmental Impact Assessment in a Transboundary context. All cited documents are establishing the principles, rules and guidelines but not contain elements regarding agreed tools for a cumulative impact assessment for environmental impact integrating the individual one carried out for the EIA project or the strategic environmental assessment of policies, plans and programs (SEA).

Steps forward:

- Comparative analysis of results from future scenarios to identify the best solutions for pilot site of Black river basin
- Local simulation of habitat condition for beaver management plan
- Testing the local condition for beaver habitats conservation

The concluding message is that an integrated monitoring system for the catchments should:

1) address the needs not only of WFD, but also of other sectoral and cross-cutting acts relevant for the management of the natural capital,

2) cover the full range of parameters needed for quantifying the ES production at the (range of) scales envisaged by decision makers,

3) provide data coupled with knowledge bases (open access models) publicly available on the web,

4) capitalize on existing monitoring networks but transcend them by institutionalized coordination, and

5) be coupled with investments in research projects and interdisciplinary human resource programs at basin scale.

Project co-funded by European Union funds (ERDF, IPA)

3.5. Hydrotechnical measures mitigating flood risks and establishing of flood forecasting maps in torrential watersheds and along rivers

The manual presents the process of identifying threatened areas where floods along the watercourses pose a risk of causing economical, physical, social or environmental threat.
The individual best management practice are structured in such a way that the legislation in the field are introduced first, then the problem and the measures, and at the end of each section a group of participants and monitoring.

Harmonization of risk mapping and risk management/reduction is recommended for better transnational comparison and further analyses.

Flood scenarios catalogue is not an obligatory document but could be beneficial to decision makers and stakeholders from different professions, such as spatial planning, civil protection, water management, etc. Intervention maps based on flood hazard maps lead to better civil protection and rescue actions.

Effective meteorological and hydrological monitoring system can improve quality of environment by providing better field data for understanding of environmental processes. Consequently, real-time monitoring can drastically improve hydrological and meteorological forecasting which allows for issuing warnings for hazard onset in real time and thus evacuation of endangered areas, contributing to flood risk mitigation.

The results of the analysis “Pluvial flood risk assessment” in the Brno watershed pilot area provide an easy to handle guide for large extent areas to evaluate the risk level related to flash-floods and sediment transport. The results show that common indices (e.g. land use, slope steepness) may be misleading in the risk analysis.
A long-term implementation of the public workshops should take place to reach further decisions makers, practitioners and citizens. The priority theme could change annually, to cover also other areas of nature conservation, natural hazard and risk management, spatial planning and sustainable agriculture and natural flood retention, water protection and optimization of recreation, science & education in nature.

Project co-funded by European Union funds (ERDF, IPA)

3.6. Control of invasive plant species

Invasive plant species are plants that are introduced either by accident or deliberately into an environment where they are not usually found. This has serious negative consequences not only as they are threat to native plants and animals, but also cause an enormous economic damage. Given how invasive plant species do not respect borders, coordinated action at the European level is more efficient than individual actions at the Member State level. Some of the invasive plant species are: *Impatiens glandulifera, Solidago canadensis, Solidago gigentea, Fallopia japonica, Alianthus altissima, Robinia pseudoacacia, Ambrosia artemisifolia,* etc. *Impatiens glandulifera* is a highly invasive annual herb, which once widely established is extremely difficult to eradicate. Individual plants may produce more than 2,500 seeds in a vegetative period with taller plants producing more seeds and pods. It thrives in riparian zones and disturbed areas. Its root system and characteristic dying back in the fall makes river banks more susceptible to erosion in the fall and winter, which results in damages and increased flood risk. *Solidago canadensis and Solidago gigentea* are invasive perennial herbs of vigorous growth which occur in poorly managed pastures and gardens, in areas of inappropriate use such as brownfields etc. They are propagated by rhizomes and seeds which are produced in very large number. *Solidago canadensis* is still used in gardens and botanical gardens due to its ornamental value thus leading to further spreading. *Fallopia japonica* is a fast growing, extremely invasive weed and is one of the 100 worst invasive species as identified by the IUCN. It is usually spread along river banks due to flooding events, by unintentional introduction as a result of inappropriate control measure, through use of contaminated soil on development sites etc. It can cause increased risk of flooding, modifies hydrology, alters ecosystems, reduces biodiversity etc.

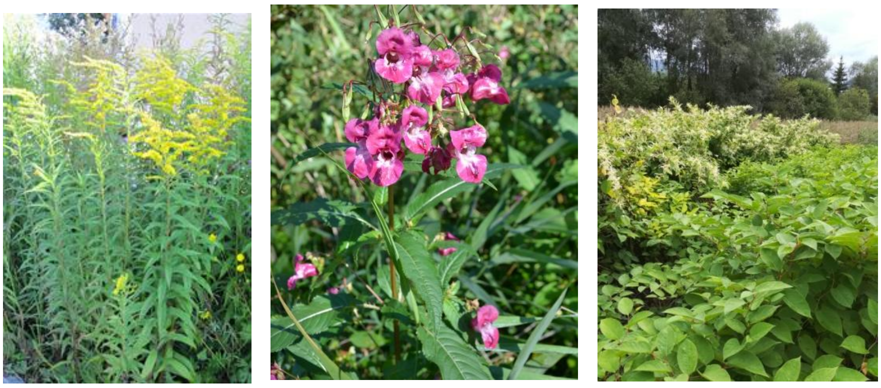

Figure 1., 2. and 3. Invasive plant species: *Solidago canadensis* (left*),* *Impatiens glandulifera* (middle), *Fallopia japonica* (right), © CAMARO-D, 2018

Project co-funded by European Union funds (ERDF, IPA)

Within Camaro-D project, project partners carried out various interventions in previously designated pilot areas, with the aim of current land use practices improvement. Concerning invasive species management, identified best practices as well as lessons learnt through the implementation of direct and indirect interventions will be given below.

In **Pilot area "Styrian Enns Valley",** several types of strongly growing neophytes are recognized: *Impatiens glandulifera, Fallopia japonica, Solidago canadensis and Solidago gigantea.* Direct and indirect interventions associated with invasive species were carried out. Indirect intervention included awareness raising by conducting workshops, along with articles in journals and municipality newsletters. Knowledge and awareness of risks, species, spreading and best practice methods for removal of invasive species was increased and this important topic received necessary attention. Funding opportunities were targeted as the main challenge, which needs to be improved. As a direct intervention, during spring 2017 and 2018, distribution areas or "hot spots" were localized and documented, followed by removal of these plants from protected areas, forests, wetlands and along riparian strips. Main focus was laid on removal of glandular balsam, which had spread to the entire Enns valley floor and along the watercourses since the floods of 2013. Vegetation changes were documented before and after removal action. This action brought together experts from AREC, Styrian League for Nature Protection, Mountain Nature and Rescue Service, Office of the Provincial Government of Styria as well as farmers, water cooperatives, students, pupils, population and municipal employers. On trial pilots, measurements were carried to see how glandular balsam and Japanese knotweed regenerate after mowing. Overall reduction of invasive species was achieved in protected and wetland areas of the pilot and effectiveness of different elimination methods was tested. Finally, natural vegetation was able to spread again in these places and a diverse flora was established. As a conclusion, further research studies should be carried out, especially on the influence of *Impatiens glandulifera* and *Fallopia japonica* on runoff behaviour and (soil) water balance in wetland areas as well as the impact on water quality in water puffer zones, torrents and forests. Advisory facilities should promote the removal of invasive neophytes to a greater extent and funding opportunities need to be improved.

Project co-funded by European Union funds (ERDF, IPA)

3.7. Awareness raising

Raising awareness among relevant stakeholders is critical for the success of any initiative, as their participation and collaboration will be needed for the development and implementation of related policies and programmes. Adequate preliminary targeting of relevant stakeholders/practitioners will facilitate their timely involvement and effective ongoing communication. Their engagement is an integral part of good practices in modern policy-making, particularly in initiation stages and is crucial for the success of any project. During the implementation of Camaro-D, partners used different tools in order to raise the awareness of stakeholders and society and to involve them in the implementation of direct and indirect interventions within selected pilot areas. Their participation in on-spot activities was of great importance for establishing direct cooperation with public authorities, research institutions and decision makers on watershed level. The main objectives of awareness raising activities are transfer of knowledge and skills, promotion and implementation of measures as well as providing of tools for control and management of risks.

- The goals of stakeholder involvement
- Raise awareness of the problems on watershed level
- Provide stakeholders with relevant knowledge and skills
- Outlining the methods and approaches used within the Clusters for communication and stakeholders involvement
- Provide stakeholders with the tools to control and management of the risks
- Promote and implement measures
- Distribute “lessons learnt” among other relevant actors or general public

Project co-funded by European Union funds (ERDF, IPA)

Table 2: Allocation of Best Practice Manuals (BPMs) to the cluster-specific risks (Cluster 3).

BPM / Risks	Adapted agriculture for optimal surface water and soil protection under climate change	Conversion from arable land to grassland mitigating soil erosion	Practical guide to spatial planning in catchments and river stretches	Beaver management	Hydrotechnical measures mitigating flood risks and establishing of flood forecasting maps	Control of invasive plant species	Awareness raising
Erosion	✓	✓	✓	✓		✓	✓
Floods	✓	✓	✓	✓	✓	✓	✓
Soil compaction and soil quality	✓	✓					
Surface runoff	✓	✓	✓				✓
Invasive plant species	✓					✓	✓
Water pollution	✓	✓					✓
Surface and groundwater interaction	✓		✓				
Other risk: Cyanobacterial blooms and toxins in drinking water supply reservoirs			✓				✓