Interreg

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Danube Transnational Programme

CAMARO-D

Report for OUTPUT T2.2

Pilot Action Clusters

Cluster 1 "*Land use and vegetation cover – protection of groundwater resources*"

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1. Introduction

This report provides a comprehensive overview of the specific characteristics of Cluster 1 *"Land use and vegetation cover – protection of groundwater resources"* In contrast to previous cluster reports, DT 2.3.2 is strongly focussing on practicable solutions mitigating the relevant identified risks.

Highlighting the common risks of partner countries involved in the Cluster 1, 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 DT 2.2.2 (Transnational cluster-manuals for practitioners) and DT 2.3.1 (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 groundwater protection and flood prevention. 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 1 *"Land use and vegetation cover – protection of groundwater resources"* encompasses following Project Partners:

- LP Lead Partner Austrian Federal Ministry of Sustainability and Tourism (BMNT),
- PP1 Agricultural Research and Education Centre Raumberg-Gumpenstein (AREC),
- PP2 Municipality of the City of Vienna Department 31 – Vienna Water (MA31),
- PP3 University of Ljubljana (UL),
- PP4 Public Water Utility JP VODOVOD-KANALIZACIJA Ljubljana (JP-VO_KA),
- PP10: Croatian Geological Survey, HGI-CGS and
- PP12 Forest Research Institute Baden-Württemberg (FVA-BW).

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2. Risks

Risk, as an existent or possible threat of negative impacts on natural resources, ecosystems and human health, is present regardless of national borders and thus its efficient prevention and mitigation is dependent on strong transnational cooperation. Sustainable risk management requires identification of main risks and issues (from local to transnational level) as well as the development of strong scientific knowledge base, legislation and policies as a crucial first step.

In the DT 2.1.3 "Report of foreseen pilot actions and their characteristics as well as definition of the requirements for the pilot actions", all project partners participating in Cluster 1, identified current risks within their pilot action areas (Table 1.) in order to elaborate and recommend best solutions in the form of best management practices related to the existing land-use categories.

Table 1: An overview of current risks within the pilot areas of Cluster 1

Types of risk	LP	PP1	PP2	PP4&PP3	PP10	PP12
Erosion	+	+	+	+	+	/
Soil compaction and soil quantity	+	+	+	/	+	/
Floods	/	+	/	+	+	/
Water pollution	+	+	+	+	+	+
Surface runoff	/	+	+	+	+	*
Groundwater recharge and quantity	/	+	+	+	+	/
Surface water and groundwater interaction	/	+	+	+	+	+
Invasive plant species	+	+	**	+	+	**
Other risks: drinking water shortage	/	/	+	/	/	/

* Surface runoff is a not covered in Cluster 1 in the pilot area

** Invasive plant species is relevant but is not be processed in Cluster 1 as specific pilot action

/ was not addressed as a risk by the project partner

In the DT 2.2.2 *"Transnational Cluster Manual for Practitioners",* an overview of current transnational risks on cluster level was given.

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2.1. Erosion

Erosion as a form of soil's morphological characteristics degradation is an ongoing issue in all of the Cluster 1 countries, either as a result of natural processes or various anthropogenic activities such as intensive agriculture e.g. crop management or unsustainable forestry. For example, in some countries torrential floods, inadequate pasture practices, clear-cuts and spreading of invasive plants (side erosion at river banks caused by *Fallopia japonica, Impatiens glandulifera*) indirectly pose an erosion risk, while in others use of heavy machines and ploughing directly boosts soil erosion on sloped terrains.

2.2. Soil compaction and soil quality

Compacted soil can be characterized with reduced water infiltration rate and nutrient movement, increased potential for surface ponding and waterlogging, surface runoff and erosion. More or less problems with soil compaction can be observed in majority of involved countries caused by minimal or no crop rotation, improper drainage of arable land, inadequate use of heavy agricultural/forestry machinery and equipment. Those activities especially degrade soil morphology in case of their application on water saturated or frozen soil. In countries with strong animal husbandry sector, grazing of cattle can also entail soil compaction risk.

Excessive application of chemicals such as fertilizers and pesticides, inappropriate or missing manure storage are most common negative impacts on soil quality. Some of the countries pointed out issues that arise with lack of maintenance of drainage and sewage systems (e.g. settlements without sewage systems and unmaintained cesspits), illegal waste disposal and pollution originating from industrial sites.

2.3. Floods

Floods as natural hazards that can result in severe consequences for the environment and human well-being will probably intensify in future due to climate change. Some of the Cluster 1 countries are already facing flooding events on a seasonal level. Current inadequate anthropogenic activities such as urbanization, development and farming in floodplains, clear-

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cut in forests, forest fires caused by carelessness and inadequate maintenance of regulative and protective water infrastructure will further directly or indirectly amplify those serious natural events. Certain countries brought up the potential pollution risk related to flooding of former landfill and illegal dump areas.

2.4. Water pollution

Unsustainable application of agricultural chemicals, sewage sludge, liquid manure in too high concentration or on water-saturated soils, slurry spreading close to water edge strips, missing or inadequate and unmaintained drainage systems, poorly sealed or too small slurry pits, seepage water due to poorly stored silos, inappropriate land use (industry, landfills, mining etc.) especially near water sources negatively affects water quality *in situ* but also downstream. In a few countries industrial and agricultural activities near drinking water protection zones as well as outdated road and railroad infrastructure pose risk of water pollution. Certain countries pointed out how existing legislation isn't sufficient for the avoidance/prevention of mentioned risks while lack of control further negatively reflects on water quality challenges.

2.5. Surface runoff

Intensive precipitation or abrupt melting of snow in combination with high percentage of sealed impermeable surfaces within urban areas lead to a higher risk of surface runoff and flash floods. Moreover, drainage of wetlands, forest clear-cut and intensive agriculture, no vegetation adapted to the location or areas without vegetation on steep slopes, are also factors that contribute to the increase of surface runoff and shorter retention of water in the catchment area. In some Cluster 1 countries construction of forest roads and ski infrastructure may have negative effects on surface runoff. New buildings also change the surface runoff regime.

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2.6. Groundwater recharge and quantity

Conversion of wetlands, wet grasslands and meadows into agricultural or urban land greatly affects groundwater recharge. Furthermore, lower recharge is present in areas with poor or no vegetation cover due to increased surface runoff, lower retention and infiltration rate. Future generations will probably have to face with reduced water quantity due to climate change, which some of the countries in Cluster 1 are already experiencing during dry season.

2.7. Surface water and groundwater interaction

Morphological and lithological terrain characteristics determine surface water and groundwater interaction. Degradation of water quality or depletion of quantity (caused by land-use activities or natural processes) of either of these resources will affect the other. A clear understanding of hydrological and biogeochemical interaction of surface water and groundwater is a prerequisite for their efficient management and protection. Some of the Cluster 1 countries pointed out problem of wastewater discharges and illegal waste disposal which is particularly serious in karstic environments and during high water levels.

2.8. Invasive plant species

Invasive plant species affect biodiversity and ecological stability, but also indirectly impact water regime and quality. They usually tend to appear and thrive on overgrown, neglected or abandoned land, such as meadows, pastures or post-industrial sites. In addition their uncontrolled presence in the riparian areas might result in disturbed water balance and stability of river banks. In Cluster 1 following invasive species occur: *Solidago canadensis*, *Solidago gigantea*, *Robinia pseudoacacia*, *Ailanthus altissima*, *Pseudotsuga menziesii, Impatiens glandulifera* and *Fallopia japonica*. Some countries stated how cultivation of potentially invasive species without given permits is a major problem.

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2.9. Drinking water shortage

This risk is only described for the Pilot area "Catchment areas of Vienna Water" (PP2) as other risk. It could become a risk due to the increasing drought and the associated reduction of water reserves for the city of Vienna which obtains the most important drinking water requirements from the protection forests of Rax, Schneeberg and Schneealpe.

The lack of water can have two causes, too little quantity (e. g. due to climate change) or the quality is not suitable for human use and water must be drained off. This definition of risk complies with the requirements of the above guidelines and other documents for drinking water areas. In CAMARO-D no special interventions are foreseen. The report DT222 "Mountain grassland management towards groundwater protection" as BPM for Cluster 2 describes that many alpine pastures need e.g. foil ponds, wells for drinking water.

3. Best solutions

As stated in Chapter 1, the transnational approach used on cluster level means that certain "issues" were identified in several countries of the Danube River Basin. Best management practices were elaborated by the whole project consortium. These best transnational practices (Table 2.) were summarized in a form of specific manuals targeted at practitioners from different sectors (e.g. agriculture, forestry, spatial planners, public service providers etc.).

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

BPM / Risks	Groundwater protection through targeted silviculture	Mountain grassland management towards groundwater protection	Restrictions for drinking water quality in agricultural land and aspects of climate change	Control of invasive plant species	Awarenes s raising
Erosion, land slides	✓	✓		✓	✓
Soil compaction and soil quantity	✓	✓			✓
Floods	✓				✓
Water pollution	✓	✓	✓		✓
Surface runoff	✓	✓		✓	✓
Groundwater recharge and quantity	✓		✓		✓
Surface water & groundwater interaction	✓	✓	✓		✓
Invasive plant species	✓			✓	✓
Drinking water shortage	✓	✓	✓		✓

As this report deals with Cluster 1 Land use and vegetation cover – protection of groundwater resources, and focus is laid on practicable solutions mitigating the relevant identified risks, one project partner also demonstrated how vulnerability mapping (of Kupa River Catchment area) can be a viable tool in achieving cluster objective – groundwater protection. This intervention identifies vulnerable parts of the catchment due to their intrinsic characteristics, based on several parameters which are most appropriate according to several well-known methods. Ultimately, intrinsic vulnerability map will be overlapped with hazard map in order to produce final risk map.

3.1. Groundwater protection through targeted silviculture

To support efficient and sustainable protection of groundwater resources, forest ecosystems have to be managed according to the water resources protection principles. Forest ecosystems with high-level water protection functionality provide (1) good infiltration conditions for

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precipitation water, (2) storage capacity for the water infiltrated in the soils and also on plant surfaces, (3) snow storage capacity, (4) prevention or mitigation of erosion processes like mudslides, rock-fall or snow-avalanches, (5) stabilization of soil and humus layers and (6) filtration of precipitation water. In order to achieve adequate groundwater protection, mentioned forest ecosystem functions have to be maintained or restored in a sustainable form.

Only stable forest ecosystems can contribute to the water protection and in this context the most important factor is tree species diversity. In drinking water protection zones (DWPZ) forest management should be orientated towards the tree species diversity of natural forest community, which provides the highest level of stability, especially under climate change conditions.

One of the most important general best management practices is the avoidance of clear-cut technique due to its negative impact on water quality and quantity. Also essential BMPs are the implementation of continuous forest cover systems; the creation of structured, multi-layered and uneven-aged forest stands; the conservation of old strong and stable tree individuals and safeguarding of natural regeneration dynamics through forest-ecologically balanced wild ungulate densities.

Stable virgin forest ecosystems should be protected and conserved. In other forest stands, silvicultural regeneration techniques should be carried out on a small scale (e.g. small gap-cuts or single tree cuts) and with utmost care to the forest soils through skyline-crane applications. Construction of forest roads should be minimized or avoided as well as the application of chemicals like fertilizers or pesticides.

The overall purpose of BMPs application in DWPZ is the sustainable improvement of the forest ecosystems functionality which is the basis for a reliable protection of the groundwater resources.

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 silviculture, identified best practices as well as lessons learnt through the implementation of direct and indirect interventions will be given below.

In **pilot area "Groundwater Field Dietacher Holz – Steyr and Dietach"**, Austrian project partners carried out the direct intervention "Forest Hydrotope Model (FoHyM) for the drinking

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water protection zone". The main objective of this model is the creation of a database which allows adaptive silviculture approach focused on establishing stable and resilient forest ecosystems and maintaining their drinking water protection functionality. The forest data set can be regarded as a basis for any future silviculture strategy development. The model based on management of more "natural", versatile tree species along with other recommendations was presented to stakeholders during various events.

By means of field observations within **pilot area "Styrian Enns Valley"**, in which relevant stakeholders participated, endangered areas in forests (slope movement, drunken forest, sabre-growing trees) were identified and recommendation for reforestation with site specific trees for protective forests was presented. Young generations i.e. students had a chance to learn about floods, debris flows, avalanches, bark beetles and forest fires as well as protective measures (technical and biological). AREC also pointed out a need for good cooperation and knowledge sharing between authorities (forestry, water management, nature protection). The evaluation of the rural development programme shows that for protection of drinking water resources more support is needed for adapted forest management. Awareness-raising measures are implemented in the Training courses (theory and practice) at Agricultural Research and Education Center Raumberg-Gumpenstein. Many farmers are also foresters, a new adapted land use management in farmer forests is important.

In the course of pilot action in "**Catchment areas of Vienna Water",** forest sites where erosion dynamics were triggered during strong precipitation events were analysed along with water protection functionality of forest vegetation. Strong precipitation events which occur together with hail-formation as well as hot spots of erosion dynamics were documented. The developed method „Screening of the water protection functionality of forest vegetation, survey of hot spots of erosion dynamics" was presented to stakeholders and gave them essential information on strong precipitation events and related erosion dynamics.

By carrying out monitoring and research in **pilot area "Kleine Kinzig"**, German project partners identified possible impacts of forest liming on surface and groundwater quality. The results showed how Mn, Al and SO_4 concentrations are lower in the limed part of the pilot action area. Also, the acid buffering capacity, which is made visible by an acidification quotient ([Ca + Mg] / [NO3 + SO_4]), increases in limed areas. This parameter shows an area's vulnerability towards the negative impacts of possible acid input. The importance of

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cooperation between research institutions and practitioners such as the water suppliers is highly recommended.

In **pilot area "Ljubljansko barje – Well field Brest, Slovenia"** recommendations for improvement of drinking water resources protection in forests were implemented together with workshops and working meetings with different stakeholders. The modelling of surface waters and groundwater in relation to optimization of operation of Brest drinking water pumping facility is important in order to manage supply and demand.

3.2. Mountain grassland management towards groundwater protection

Alpine pastures occur frequently within drinking water protection zones, at least in Austria. Hence the application of "Best Management Practices" can be regarded as crucial for drinking water supply security. Also for the prevention of floods those BMPs are of relevance. The Best Practice manual provides a short overview about the most relevant BMP within alpine pasture areas in DWPZ and is dedicated to practitioners.

Many DWPZ are situated within karstic areas. The most vulnerable sites are *dolines* and sinkholes. Those karstic features are in direct contact with karstic aquifers, hence they are highly vulnerable to potential source water contaminations. Due to these facts *dolines* and sinkholes have to be fenced out in order to keep cattle or other grazing livestock at safe distance.

Grazing livestock, especially cattle, needs huge amounts of drinking water. For this purpose, water troughs are placed within alpine pastures. In many cases, area around those water troughs shows signs of erosion processes caused by intensive trampling activities. In order to avoid concentrations of grazing livestock, a higher number of water troughs should be placed. Also to avoid erosion processes around them construction of concrete base is proposed.

Unwanted grazing patterns usually occur on alpine pasture areas. This can lead to undesirable processes of erosion, over-grazing or under-grazing, which can threaten flood prevention. For this reason, specific grazing management has to be implemented. Moreover, liquid manure is a serious threat to source water quality. Bacteria, nitrate and parasites can contaminate the

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water in areas where it is applied. Therefore spraying of liquid manure has to be prohibited on alpine pasture areas within DWPZ.

For the purpose of grassland quality improvement and subsequently improved protection of groundwater, following measures should be considered: clearing of pasture areas from wooden plants; mowing of undesired grassland species; fencing of specific sectors of the alpine pasture; malleting of undesired grassland species like nard grass.

A stable vegetation cover (grass, shrub and or forest) should be preserved to prevent or mitigate erosion dynamics in mountainous catchment areas.

Sewage of the huts on alpine pastures like also for alpinist mountain huts is a true challenge for groundwater protection. Adequate sewage solutions for ski huts and stables like specific cesspits and compost toilets are a must within DWPZ.

3.3. Best practice restrictions for drinking water quality in agricultural land aspects of climate change

Access to high quality, safe and sufficient drinking water is crucial to human health and is a basic human right. Drinking water safety is an issue significant not only on local and regional but also on transnational level, given the climate change aspect.

Nitrogen pollution as a result of agricultural use of manure and fertilizers for crops and fields, represents a persistent threat to drinking water sources. Given how agricultural activities are present within drinking water protection zones (DWPZ), it is very important in such areas to know how to farm, what good practises are and how to implement them.

The restriction of fertilization in the inner DWPZ (Table 3.) is carried out by several measures, which include prohibiting the use of liquid livestock manure (slurry), digestate and compost from sewage treatment plants. The disposal or storage of livestock manure and compost is not permitted. Livestock manure and fertilizers suitable for organic farming can be used according to the fertilization plan. The allowed use of nitrogen (N) is 140 kg/ha/year from the matured farmed manure, taking into account that the maximum single dose is 30-80 kgN/ha.

The immediate benefit of this measure is preventing the leaching of nitrogen compounds into groundwater and thereby preventing water contamination. The disadvantage of the measure is

that it does not include forest areas where mineralization of organic matter can be high. For certain habitats, the permitted values for fertilizers are too high. The possible weakness of the measure is also that the fertilizer plan is not respected or the climatic factors that can trigger large mineralization of organic matter in the soil.

In middle and outer DWPZ, which usually cover large areas, inadequate use of fertilizers is a major threat to groundwater resources. The restriction of fertilization in the middle and outer DWPZ is carried out by several measures, which include the prohibition of large quantities of livestock manure and the prohibition of digestate and sludge and composting from treatment plants. Disposal and storage of livestock manure and compost is not allowed. The maximum total amount of nitrogen used is determined in accordance with the fertilization plan. Permitted use of nitrogen (N) is 170 kg/ha/year from livestock fertilizers, taking into account that the maximum single doses is 60-80 kg N/ha.

Table 3: General temporal prohibition of fertilization in continental climate

Type of fertilizer	**General temporal prohibition**					
	October	**November**	**December**	**January**	**February**	**March**
Liquid organic fertilizer		15th of November to 1st of March				
Farmyard manure			15th of November to 1st of March			
Mineral fertilizers with nitrogen (N)		15th of October to 1st of March				

Table 4: Action Programme Nitrogen in Austria

N fertilizer	**Culture**	**Prohibition period according to Nitrate Action Programme**
Nitrogenous mineral fertilizers, slurry, manure, biogas slurry, fermentation residues and non-dewatered sewage sludge (< 15 % dry matter)	Arable land with cultivated crop/crops/intercrops until 15 October	from 15th of November to 15th of February or 31st of January*.
	Arable land without cultivated crop/crops/intercrops until 15 October	from 15th November to 15th of February or 31st of January*.
Manure, compost, dewatered sewage sludge (> 15 % dry matter), sewage sludge compost	Arable crops	from 30th of November to 15th of February or 31st of January*.
Nitrogenous fertilizers	Grassland and arable forage areas	from 30th of November to 15th of February

*Fertilisation is permitted from 1 February for early crops such as durum wheat and spring barley and for green cover crops with early nitrogen requirements such as rape and winter barley, and for crops under fleece or foil.

The use of plant protection products (PPP) containing active substances from the "List of Prohibited Active Substances" is prohibited in the inner DWPZ. The person applying PPPs has to complete an obligatory educative training, while the spraying devices must be examined. Agricultural experts estimate how this measure is in general respected by the farmers. But

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nevertheless, financial resources for the compensation of farmers' loss of crop and income in those areas are needed.

In middle and outer DWPZ a comprehensive farming approach with a sustainable, moderate agricultural land use and transitions to organic food production should be applied.

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 protection of water resources quality, identified best practices as well as lessons learnt through the implementation of direct and indirect interventions will be given below.

Table 5: Restrictions & recommendations in DWPZ - NATURA 2000 sites on agricultural land

Measure	All DWPZ	Inner DWPZ	Middle and outer DWPZ
Fertilization	up to 170 kg N/ha/year from livestock fertilizers banning the storage of livestock manure the prohibition of the digestate, compost or sewage sludge the prohibition of fertilizing without a fertilization plan	the prohibition of fertilization with manure and slurry up to 140 kg N/ha/year from old farmed manure single dose up to 30-80 kg N/ha	the same as all DWPZ
Plant protection products (PPP)	professional use of PPP completed course examined devices for the application of PPP recommended use of substances allowed for organic farming control of PPP record registered substances	prohibited use of PPPs containing active substances from the List of Prohibited Active Substances	the same as all DWPZ
Good agricultural practice	immediately bury the fertilizer fodder from meadows in the form of hay the growth of invasive plants are limited minimal processing of arable land buffer belts along the watercourse the disposal of dangerous substances agromeliorations are limited	banning the re-ploughing of the meadows prohibition of livestock grazing the fields are covered with plants all year round	transferring animals on pasture to avoid concentration of excreta

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3.4. 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 gigantea*, *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.

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.

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

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 and trainings, 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 coperatives, students and population and municipal employees. 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

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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.

3.5. Awareness raising

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 project, 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.

Within Cluster 1 **Austria** conducted several specific consultations of different sized stakeholder groups, special trainings and workshops, action days, hands-on activities, excursions, study visits, science days and traineeships for students. Stakeholders are selected at the beginning on local, regional and/or national level, according to the particular topic and to the area of the pilot action. For involvement of stakeholders in pilot actions personal contacts and co-operations from previous or current projects and activities are most fruitful methods. At workshops "carousel discussion" proved to be an effective mean of information gathering, while for students, the best integration in the thematic are hands on workshops or a combination between theory and practice. According to Vienna Water all involved stakeholders showed a high level of interest especially at stakeholder training (Cluster training) organized in Steyr on 13th of November 2018 nearby **Pilot Area "Dietacher Holz",** where many local and regional stakeholders from different field of actions (water supplier, forestry, agriculture) participated. According to **AREC** the interest and acceptance of proposed

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measures in **Pilot area Styrian Enns valley** was also very high. Publishing of reports on project activities enabled informing of a large number of people. Online consultations although time and cost saving weren't so effective.

Croatia identified all relevant target groups prior to first significant project's communication activity. **HGI-CGS** held specific meetings with relevant practitioners and stakeholders within Pilot action **Kupa River catchment area,** primarily aimed at acquiring information about the area's status quo and issues it is coping with and measures for their mitigation/prevention (on local and regional level), but also at best practices exchange. Direct stakeholder dialogues yielded most of the stakeholders' feedback. Young generations as future stakeholders were engaged through number of educative workshops organized by the HGI-CGS, aimed to promote the Camaro-D project, popularize science and raise awareness on water resources protection, flood mitigation and prevention of environmental risks.

German project partners stated how events such as presentations and seminars are held on a regular basis, the data from monitoring and research is prepared for the internet and print publications for members of land user associations. They also emphasized the role of field trips and discussions between experts and land users on site. Furthermore, The FVA is appointed to advise land owners in the state of Baden-Württemberg. This is usually done via e-mail or telephone. Consultations concerning liming are usually done over the telephone.

Slovenian project partners prepared and presented an article about project results at the Slovenian Geological Congress. Also meetings with relevant stakeholders were held where information about current situation, challenges and best management practices were exchanged. Workshop for the identification and feedback on best practices regarding managing the water regime was organized as well as an excursion with Slovenian Forest Service and river supervisor. All relevant information was distributed through brochures with presentation of project objectives, media releases on Facebook page, presentation on geological congress, group meetings and workshop.

Recommendations for improvement of land use and spatial planning management as well as for improvement of drinking water resources protection (intervention in pilot area "Ljubljansko barje – Well field Brest, Slovenia" are important for all areas in Danube river basin.

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