

PROLINE-CE

WORKPACKAGE T1, ACTIVITY T1.2

REVIEW OF BEST MANAGEMENT PRACTICES FOR DRINKING WATER SUPPLY ISSUES

D.T1.2.1 Country-specific best management practice reports

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1. Introduction

Best practices mentioned below are included (although named differently - here CCWare and Orientgate nomenclature is used) in Code of Good Agricultural Practice, The National Agri-environmental Programme, National Water and Environmental Programme, as well as in the programmes designed by

State Forests of Poland- 'Increasing retention capacities and preventing floods and drought in forest ecosystems in the lowlands' and 'Counteracting the effects of rainwater runoff in mountainous areas. Increasing retention and maintenance of pipelines and related infrastructure in good condition'.

National Water and Environment Programme

Directive 2000/60/EC of the European Parliament and of the Council issued on 23 October 2000 establishing a framework for community action in the field of water policy (Water Framework Directive) committed Member States to develop programs of measures which are designed to achieve the environmental objectives established in accordance with the provisions of Article 4 of the WFD. In Poland, the fulfillment of this commitment is the National Water and Environment Programme , which is one of the main planning documents for the protection and management of water resources in Poland. It is updated cyclically every 6 years.

National Water and Environment Programme update (aPWŚK) is one of the planning documents prepared for the programming and coordination of activities aimed at achieving the environmental objectives set out in Article 4 of the WFD, i.e. :

- not deteriorating status of the water body,
- achievement of good water status: good ecological and chemical status for natural surface water body, good ecological potential and good chemical status for artificial and heavily modified bodies of water, and good chemical and quantitative status of groundwater,
- meeting the special requirements contained in other EU acts and Polish legislation in relation to protected areas (including areas exposed to pollution with nitrogen compounds from agricultural sources, for recreational purposes, to collect water for public supply water intended for human consumption, for the protection of habitats or species for which the maintenance of the status of water is an important factor in their protection)
- the cessation or phasing-out of the discharge of priority substances into the environment or reduction of discharges of these substances.

The result of the analysis carried out in the framework of National Water and Environment Programme update (aPWŚK) is a structured set of activities for the bodies of surface water (rivers, lakes, transitional and coastal), groundwater bodies and protected areas under Article 6 of WFD.

APWŚK action in accordance with the WFD is divided into two groups: basic operations and complementary activities. Basic measures are required under the provisions of Art. 11 paragraph



3 WFD and the named directives (Council Directive of 21 May 1991 on Urban Wastewater Treatment 91/271/EEC, Council Directive 98/83 / EC of 3 November 1998. On the quality of water intended for human consumption, Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources 91/676/EEC Directive of the European Parliament and of the Council 2006/118/EC of 12 December 2006 on the protection of groundwater against pollution and deterioration, and commission Directive 2014/80/EU of 20 June 2014. amending Annex II to the Directive of the European Parliament and of the Council 2006/118/EC on the protection of groundwater against pollution and deterioration).

Complementary measures, according to the WFD, are any other measures that may be adopted in order to achieve the environmental objectives by water bodies. They are aimed at reducing the pressures and have been indicated for the water bodies at risk of failing to achieve environmental objectives.

Table 1. Examples of activities included in the aPWŚK

Action category	Examples of activities
Urban areas	<p>implementation of the National Programme for Urban Wastewater Treatment</p> <p>actions resulting from the need to organize a system of wastewater management</p> <p>optimizing water consumption (eg. searching of alternative sources of drinking water, reduction of consumption of groundwater in areas with possible ascent and the ingress of water with a higher salinity level to enable the maintenance of the chemical composition specified for drinking water)</p>
Agriculture	<p>Limiting nutrient runoff from agricultural areas - eg. implementation of the program of activities aimed at reducing the outflow of nitrogen from agricultural sources (restrictions on fertilization on saturated, flooded, frozen or snow-covered soil; control of agricultural sources of pollution and implementation by carrying out agricultural activity on Nitrate Vulnerable Zones obligations set in the program; compliance with the conditions of storage of natural fertilizers and handling of leachate, the principles of fertilization, the use of proper fertilization in the vicinity of watercourses)</p>
Organizational and legal activities	<p>developing quality assessment of water used for public supply of water intended for human consumption</p> <p>review of water permits for water discharge into water or land by users</p> <p>review of the water permits associated with the consumption of groundwater</p> <p>developing conditions for the use of the waters of the basin</p> <p>establishment of a protection zone of inland waters</p>
Industry	<p>optimizing water consumption (eg. rational management of water intended for human consumption, analysis of the use of water drainage and surface water)</p> <p>reducing the spread of contaminants (eg. reclamation of pits in a way that minimizes the risk to groundwater quality)</p>



In addition, throughout the country there is an obligation regarding control of drinking water, information about the quality of water intended for human consumption, supervision of materials and products used in the processes of water treatment and distribution, supervision of laboratories performing tests, provision of measures preventing or limiting inputs of pollutants into groundwater, taking into account the spatial planning and development requirements of environmental protection, including water management and protection of agricultural land and forests, and a ban on discharge of sewage into the water and soil within the water intake protection zone, and - if that would contradict the conditions of protection - establishing water intake protection zones. Summary of the activities indicated in aPWŚK is adopted by the Council of Ministers regulations updating management plans for the river basin.

Agri-environmental programme (environmental payments)

Agri-environmental programme is an EU instrument used to encourage farmers to use agricultural practices leading to the greening of agricultural production. Implementation of the program in Poland was divided into two stages. The first of these steps was implemented in 2004-2006, the implementation of the second fell on 2007-2013. This structure is associated with a seven-year programming period of the Rural Development Plan (RDP) and it was established within its' framework. A farmer who voluntarily undertakes to implement this program receives an agri-environmental payment, which is meant to compensate the additional costs incurred by the implementation of the program. Many packages included in the program consist of limiting or ban on the use of nitrogen fertilizers, reducing the number of cuts in the meadows , etc.

The main objective of the program is:

- restoring the values or the maintenance of habitats valuable for agriculture and the preservation of biodiversity in rural areas;
- promoting sustainable management system;
- appropriate use of soil and water conservation;
- protection of endangered local breeds of farm animals and local crop varieties.

The program comprises of nine agri-environmental packages. Within each package, there are agri-environmental variants, which contain sets of tasks that go beyond the applicable basic requirements and which do not overlap with other instruments of the Common Agricultural Policy (CAP).

Package 1. Sustainable farming

Package 2. Organic farming

Package 3. Extensive permanent grassland

Package 4. Protection of endangered bird species and natural habitats outside Natura 2000 areas

Package 5. Protection of endangered bird species and natural habitats in Natura 2000 areas

Package 6. Preservation of endangered plant genetic resources in agriculture

Package 7. Preservation of endangered animal genetic resources in agriculture



Package 8. Protection of soil and water

Package 9. Buffer zones

Code of good agricultural practice

Code of good agricultural practice provides practical advice on how to reduce the risk of water contamination and pollution control practice which can be used on the farm. Through this, farmers should be informed and instructed about the need to raise the value the landscape in which they live and work, because of their dominant influence on the development. The main objective of the Code is to raise the level of basic knowledge about the protection of water - the main resource of the environment, as well as other elements: soil, air, the landscape and the opportunities to contribute to their protection. In terms of water protection, the Code proposes action to:

- protection of water dotted by pollution (including the requirements for boards and tanks for the storage of natural fertilizers)
- protection of water pollution by additional area (including the requirements for dosage and application deadlines natural and mineral fertilizers, application of wastewater and sewage sludge, the use of chemical pesticides, agro-technical methods for the prevention of water pollution)
- protection of arable land

KDPR is recommended as vital for the whole farming community.

The State Forests

State Forests coordinated individual project "Increasing retention capacities and preventing floods and drought in forest ecosystems in the lowlands" within Priority III of the Operational Programme Infrastructure and Environment.

- Project budget: approx. 189 million zł.
- Duration: 2007 - 2015 r.
- Beneficiary: The State Forests National Forest Holding. The project was carried out in 175 Forest Divisions in 17 Regional Directorates of State Forests.

The aim of the project was retention of surface-water in areas administered by State Forests within the basin streams, while maintaining and supporting the development of the natural landscape. The implementation of the project contributed to the retention of excess rainwater in forest areas, the flattening of the flood wave in the lower parts of the catchment, restoration of natural water conditions of peat bog wetlands, and maintenance of the level of groundwater and underground power springs.



Achieved results:

- creation of 3644 objects such as: reservoirs, dams, weirs, culverts, valves, weirs, fish passes and fords
- thanks to the abovementioned objects - approx. 42 million cubic meters of water were retained.

State Forests coordinated individual project "Counteracting the effects of rainwater runoff in mountainous areas. Increasing retention and maintenance of pipelines and related infrastructure in good condition" within Priority III of the Operational Programme Infrastructure and Environment.

- Project budget: approx. 185 million zł.
- Duration: 2007 - 2015 r.
- Beneficiaries: State Forests National Forest Holding.

The project implemented in the 55 forest districts in the four Regional Directorates of State Forests. The aim of the project was to slow down water runoff and increase the possibility of retention of mountain catchments, thereby reducing the effects of flooding, destructive activities of flood and drought. The activities carried out in the project: the retention and restoration of permanent watercourses and wetlands, control of surface runoff, as well as leveling and slowing down runoff flood.

Achieved results:

- 3553 objects were funded: ponds, reservoirs, wetlands and floodplains. Restoration of water courses. Additional actions to protect the embankments of streams, slope protection, protection of forest roads and logging trails from excessive runoff of surface waters
- investments ensuring ecological continuity through the modernization of existing buildings, construction of fish passes and ramps for living organisms
- thanks to the abovementioned objects - approx. 1.5 million cubic meters of water were retained.



2. Mountain sites

2.1. Forest

Table 2. Mountain sites: Forests - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP MF01	Limitation of Clear Cuts	The prohibition of clear cuts assures the prevention of the most endangering management measure for water quality and water supply security. Clear cuts provoke erosion processes (water quality) and increase the risk for floods (water quantity).	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF02	Establishment of a Continuous Cover Forest System	Continuous Cover Forest Systems are the most appropriate management systems for drinking water protected areas (DWPA)	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF03	Defined Crown Cover Percentage of Forest Stands	Forest stands should provide a defined crown cover percentage in order to be stable and resistant towards disturbances and in order to possess natural regeneration dynamics	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF04	Limitation of the percentage of timber extraction	The limitation of the percentage of timber extraction in the course of forest management measures provides a low disturbance regime in DWPA. The limitation is defined with the range of 10-25 % of the timber volume of a fully stocked forest stand.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF05	Continuous Regeneration Dynamics	The continuous regeneration dynamics guarantee stability and resiliency of the forest ecosystems and enhance their adaptive potential (The natural regeneration process is preferred in forests, as it provides more stable tree individuals)	Enhance and preserve water supply ESS		yes/high	low	long	
BP MF06	Foster Stability and Vitality of Forest Stands	Ensuring the stability and vitality of the forest stands is compulsory to guarantee the water protection functionality of the forest ecosystems in drinking water protected areas (DWPA)	Enhance and preserve water supply ESS		yes/high	medium	long	



BP MF07	Tree species diversity according to the natural forest community	Tree species diversity according to the natural forest community is the basic precondition for forest stand stability and an excellent starting point for an enhanced adaptive capacity of forests under climate change	Increase adaptive capacity to reduce water supply vulnerability		yes/high	medium	long	
BP MF08	Improve structural diversity of the forest stands	Structural Diversity of the forest stands is a pre-condition for the continuous cover forest system and improves the stability and resiliency of the forest stands. Uneven-aged and multilayered forest stands are desired for water protection	Enhance and preserve water supply ESS		yes/medium	medium	long	
BP MF09	Forest Ecologically sustainable wild ungulate densities	Forest Ecologically sustainable wild ungulate densities are the most important boundary condition in order to allow the establishment of the overall tree species diversity in the course of natural forest regeneration dynamics	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF10	Protection of the gene pool of the autochthonous tree species	The gene pool of the autochthonous tree species is very important, as these trees survived the climate changes of past thousands of years at their growing sites. This genetic material becomes even more important under climate change, as high genetic varia	Increase adaptive capacity to reduce water supply vulnerability		yes/high	low	long	
BP MF11	Foster old, huge and vital tree individuals	Foster old, huge and vital tree individuals	Increase adaptive capacity to reduce water supply vulnerability		yes/high	low	long	
BP MF12	Adequate dead-wood content	Dead wood is an important feature of biodiversity in forests, it improves the ecological conditions and hence is a pre-condition for the establishment of stable and vital forest ecosystems	Enhance and preserve water supply ESS		yes/high	low	long	
BP MF13	Buffer Strips along streams, dolines and sinkholes	Buffer Strips along streams and dolines limit erosion processes and are a very effective way to prevent the entrance of various substances into the water body	Enhance and preserve water supply ESS		yes/very high	medium	long	
BP MF14	Adaptive forest management	Adaptive forest management under climate change has to ensure the provision of the ESS over space and time. This has to involve the assessment of tree species changes due to climate change for all specific forest types within a DWPA and the related action	Increase adaptive capacity to reduce water supply vulnerability		yes/high	high	long	
BP MF15	Natural Forest Succession in Case of Stable Forest Ecosystems	Natural Forest Succession in Case of Stable Forest Ecosystems	Increase adaptive capacity to reduce water supply vulnerability		yes/high	high	long	



BP MF16	Small-Scale regeneration techniques	Small Scale regeneration techniques like single tree cutting, small gap cutting or group selection system assure a low disturbance regime within the context of forest management measures and give advantage of the natural seed regeneration.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF17	Structural Thinning Operations	Structural Thinning Operations	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF18	Artificial Recruitment Principles	Artificial Recruitment Principles encompass the use of autochthonous plant material and diversity in accordance with the natural forest community and/or the use of new tree species on a forest site triggered by cc-conditions.	Increase adaptive capacity to reduce water supply vulnerability		yes/high	medium	long	
BP MF19	Forest Fire Prevention	Forest Fire Prevention can contribute to essential aspects of source water protection, like e.g. forest ecosystem preservation, soil and humus protection , etc.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF20	Limitation of Forest Roads	Forest Road Construction and maintenance can cause several adverse impacts on water bodies and should hence be limited in DWPA. The best solution is the prevention of their construction and the application of alternative techniques.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF21	Adequate timber yield techniques	In DWPA the timber harvesting techniques should prevent the disturbance of the soil- and humus layers.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP MF22	Prohibition of the use of chemicals in forestry practices	The use of chemicals like fertilizers, pesticides or herbicides in forestry practices should be forbidden, as these substances form a threat for water quality and hence should not be present in forested DWPA.	Enhance and preserve water supply ESS		yes/high	low	long	
BP MF23	Source Water Protection Policy and Institutional Implications	Enhancing collaboration between forest and water decision-makers and stakeholders and improvement of the integrated forest- and water management via the establishment of an adequate legislative and administrative frame	Enhance and preserve water supply ESS		yes/high	low	long	
BP MF24	Preservation of the forests at the tree line and timber line (Subalpine Forest Belt in mountainous regions)	The uppermost forest communities (in the subalpine forest belt) have a high degree of water protection functionality. In mountainous regions this BP will enhance the water protection, water retention and water regulation functions of forests	Increase adaptive capacity to reduce water supply vulnerability		yes/medium	low	long	

BP MF25	Integrative planning strategy for watersheds, especially for vulnerable areas with regard to water resources	Consolidation and afforestation of degraded lands, alluvial sources (slopes, ravines, land slides) .	Enhance and preserve water supply ESS		yes/high	high	long	
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2.2. Grassland

Table 3. Mountain sites: Grassland - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP MG01	Establishment of grassland in DWPA I. (inner zone)	Grassland is the most appropriate land use for inner DWPA. Total cover is requested, except already built in areas and forests (if risk of damage is low).	Enhance and preserve water supply ESS		high	low	medium	
BP MG02	Establishment of grassland in DWPA II. (outer zone)	Grassland zone in the DWPA II. assures filtering surface runoff or cleaning recharge in particular in the surrounding area of the DWPA I.	Enhance and preserve water supply ESS		medium	low	medium	
BP MG03	Establishment of grassland in DWPA III. (recharge area or catchment)	Grassland is a preferable land use in recharge zone, since less risk of pollution than from agriculture and more recharge than from forest.	Enhance and preserve water supply ESS		medium	medium	medium	
BP MG04	Prohibiting use of chemicals, limiting irrigation in the DWPAs on grassland	Use of chemicals (fertilizer, pesticides, herbicides) is prohibited in DWPA I. and II. because infiltrating into the soil they can reach well fields or transported into surface waters, the abstraction sites. Mechanically controlled weeds only.	Enhance and preserve water supply ESS		high	medium	short	
BP MG05	Establishment of buffer zone along rivers, lakes and sinkholes	Buffer zones filter surface runoff .	Enhance and preserve water supply ESS		high	medium	long	



BP MG06	Promoting the application of buffer strips of grass between plots of arable lands	Grassland strips between plots of arable lands can retain pollution, spreading of weeds.	Increase adaptive capacity to reduce water supply vulnerability		medium	medium	medium	
BP MG07	Enhancing self-regenerating capacity of grasslands fitting the ecoregion, supporting native species	Appropriate grass land management can enhance the transformation of existing GL-system to natural one. Cost of self-preservation is lower than implementation of agricultural techniques.	Enhance and preserve water supply ESS		medium	low	long	
BP MG08	Promoting the occurrence of species adaptive to CC.	Adaptive grassland management under climate change has to ensure the provision of the ESS over space and time.	Enhance and preserve water supply ESS		medium	low	long	
BP MG09	Grassland management only with maintenance purposes (nature protection schemes)	Saving natural structure and dynamics by extensive grassland management practices include: - grasslands must be utilised by grazing and/or mowing at least once a year, - rotation of the mowing/grazing sites, - leave unmowed strips and rotate their lo	Enhance and preserve water supply ESS		medium	medium	long	
BP MG10	Avoiding permanent injury of the surface, compaction of soil	No irreversible damage to the surface of grassland. Avoid use of heavy harvester/mechanics, no cultivation on damp soil. Ploughing is prohibited.	Enhance and preserve water supply ESS		medium	low	short	
BP MG11	Removal of invasive weeds	Mowing more times, weeds/shrubs should be removed at their flowering stage.	Enhance and preserve water supply ESS		low	low	short	
BP MG12	Groundwater regulation by drainage	Regulation of groundwater level can optimise the water supply of the grassland by eliminating the long wet period with appropriate drainage system. The measure is expensive, so it should be supported by economic assessment (CBA).	Enhance and preserve water supply ESS		low	high	long	
BP MG13	Promoting regular flooding, permitting mandatory irrigation, avoiding too long water cover	Proper water supply of grassland supports grassland growth thus can reach maximal grassland ecosystem services. Grasslands are proper places for water retention but resistance, sensitivity against water cover should be considered.	Enhance and preserve water supply ESS		medium	medium	short	



BP MG14	Promoting reasonable nutrient and water balance management (regular oversowing) in planning process.	Limitation of application of fertilizers and irrigation but satisfaction of demands for maximum grass production. Environmentally and economically sustainable solutions in the frame of a plan.	Enhance and preserve water supply ESS		high	medium	long	
BP MG15	Controlling the use of manure (amount, timing)	Nutrient supply e.g. max. 90kg/ha nitrogen active substance. Manure cannot be applied on frozen ground, land filled with water or covered completely with snow.	Enhance and preserve water supply ESS		medium	low	short	
BP MG16	No storage of manure in grassland	Point source pollution by manure storage/dump should be avoided, too much nutrient cauterize grasses, (flash) flood washes manure into surface water.	Enhance and preserve water supply ESS		medium	low	short	
BP MG17	Sustainable production (no overmowing, promoting self regeneration processes and oversowing too)	Sustainable maintenance: Mowing or forage crimping should leave a stubble of at least some cm. Grasses should be mowed at least once a year after main blooming.	Enhance and preserve water supply ESS		medium	medium	long	
BP MG18	Appropriate treatment of the mowed material	Hay should be collected in time after mowing and removed. Utilising green manure with mowed grass before winter (leave mowed material but this cannot be applied if hay is too much).	Enhance and preserve water supply ESS		low	low	short	
BP MG19	Limited use of chemicals	Decreasing the load of pesticides, nutrients, yield-enhancing chemicals which can be harmful for human consumption	Enhance and preserve water supply ESS		low	low	short	
BP MG20	Appropriate establishment of infrastructures (transport and social service infrastructures)	Rules on drinking water protection zones for leisure infrastructures should be respected.	Enhance and preserve water supply ESS		low	medium	short	
BP MG21	Limited number of grazers	No injury of surface, no overgrazing to ensure grass cover. Decreasing of load of nutrients	Enhance and preserve water supply ESS		medium	medium	long	
BP MG22	Establishment and application of grazing plan	For avoiding overgrazing: appropriate frequency, rotation, mixture and/or sequences of grazers type. Grazing density proper to grass growth possibilities.	Enhance and preserve water supply ESS		medium	low	short	



BP MG23	Manuring only by the droppings of animals grazing on the land	Diffuse pollution by manure should be avoided, too much nutrient cauterize grasses, (flash) flood may wash excess manure into water.	Enhance and preserve water supply ESS		medium	low	short	
BP MG24	Alternating grazing and mowing.	Regular variation of the grazing and mowing can strengthen the dynamics of the regeneration. This way selective loss of grass species and proliferation of weeds can be reduced.	Enhance and preserve water supply ESS		medium	low	long	

2.3. Agriculture

Table 4. Mountain sites: Agriculture - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP FA01	Convert arable land to unfertilized and ungrazed grass	Measure which takes plowable areas out of agricultural production	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA02	Arable reversion to low fertiliser input extensive grazing	Measure which takes plowable areas to grazing grasslands	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP FA03	Convert arable/grassland to permanent woodlands	Measure which extends areas under forest on account of grasslands	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA04	Convert land to biomass cropping (i.e. willow, poplar, miscanthus)	Conversion of plowable land to permanent cellulose crops for biomass production	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA05	Establish Cover crops in autumn	Measure which prevents direct soil exposure to wind and water erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA06	Early/Late harvesting and establishment of crops in the autumn	Measure which prevents direct soil exposure to wind and water erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA07	Adopt reduced cultivation systems	Plant crops without plowing or shallow plowing only	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP FA08	Cultivate compacted tillage soils	Under reduced/conservation/minimum tillage soil is tilled but with less disturbance. Includes ridge tillage, shallow ploughing and rotovation or scarification. By leaving crop residues on soil surface water flow and soil erosion is reduced.	Increase adaptive capacity to reduce water supply vulnerability		yes/medium	low	short	
BP FA09	Cultivate and drill across the slope	Measure to prevent soil erosion by water	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA10	Irrigate crops to achieve optimum yields	Irrigation on dry soils to increase biomass cover and reduce wind erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA11	Establish and maintain artificial wetlands	Creation of wetlands as traps to pollutants	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA12	Establish new hedges	Control of runoff and erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP FA13	Fence off rivers and streams from livestock	Prevent pollution by livestock by controlling livestock access to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA14	Incorporate manure into the soil	Prevent nutrient wash by runoff	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA15	Do not apply manure to high-risk areas	Reduction of pollution generation	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA16	Store solid manure heaps on an impermeable base and collect leachate	Control fugitive pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA17	Compost solid manure	Reduce nutrient loading of water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP FA18	Anaerobic digestion of livestock manures	Reduce nutrient loading of water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA19	Maintain and enhance soil organic matter levels	Improve soil water retention	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA20	Establish in-field grass buffer strips on tillage land	Control nutrient losses and pollution by runoff	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA21	Establish riparian buffer strips	Control and reduce surface water pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA22	Maintain/improve field drainage systems	Control and reduce groundwater pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP FA23	Ditch management	Control drainage systems and reduce pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA24	Use plants with improved nitrogen use efficiency	Prevent nutrient losses to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA25	Fertiliser spreader calibration	Control excess application by fertilizer	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA26	Do not apply manufactured fertiliser to high-risk areas	Control excess application by fertilizer	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP FA27	Reduce dietary N and P intakes	Manage nutrient losses to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP FA28	Extend the grazing season for cattle	Improve nutrient conversion and control export to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
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3. Plain sites

3.1. Agriculture

Table 5. Plain sites: Agriculture - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP PA01	Convert arable land to unfertilized and ungrazed grass	Measure which takes plowable areas out of agricultural production	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA02	Arable reversion to low fertiliser input extensive grazing	Measure which takes plowable areas to grazing grasslands	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP PA03	Convert arable/grassland to permanent woodlands	Measure which extends areas under forest on account of grasslands	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA04	Convert land to biomass cropping (i.e. willow, poplar, miscanthus)	Conversion of plowable land to permanent cellulose crops for biomass production	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA05	Establish Cover crops in autumn	Measure which prevents direct soil exposure to wind and water erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA06	Early/Late harvesting and establishment of crops in the autumn	Measure which prevents direct soil exposure to wind and water erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA07	Adopt reduced cultivation systems	Plant crops without plowing or shallow plowing only	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP PA08	Cultivate compacted tillage soils	Under reduced/conservation/minimum tillage soil is tilled but with less disturbance. Includes ridge tillage, shallow ploughing and rotovation or scarification. By leaving crop residues on soil surface water flow and soil erosion is reduced.	Increase adaptive capacity to reduce water supply vulnerability		yes/medium	low	short	
BP PA09	Cultivate and drill across the slope	Measure to prevent soil erosion by water	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA10	Irrigate crops to achieve optimum yields	Irrigation on dry soils to increase biomass cover and reduce wind erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA11	Establish and maintain artificial wetlands	Creation of wetlands as traps to pollutants	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA12	Establish new hedges	Control of runoff and erosion	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP PA13	Fence off rivers and streams from livestock	Prevent pollution by livestock by controlling livestock access to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA14	Incorporate manure into the soil	Prevent nutrient wash by runoff	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA15	Do not apply manure to high-risk areas	Reduction of pollution generation	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA16	Store solid manure heaps on an impermeable base and collect leachate	Controlle fugitive pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA17	Compost solid manure	Reduce nutrient loading of water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP PA18	Anaerobic digestion of livestock manures	Reduce nutrient loading of water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA19	Maintain and enhance soil organic matter levels	Improve soil water retention	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA20	Establish in-field grass buffer strips on tillage land	Control nutrient losses and pollution by runoff	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA21	Establish riparian buffer strips	Control and reduce surface water pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA22	Maintain/improve field drainage systems	Control and reduce groundwater pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP PA23	Ditch management	Control drainage systems and reduce pollution	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA24	Use plants with improved nitrogen use efficiency	Prevent nutrient losses to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA25	Fertiliser spreader calibration	Control excess application by fertilizer	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA26	Do not apply manufactured fertiliser to high-risk areas	Control excess application by fertilizer	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
BP PA27	Reduce dietary N and P intakes	Manage nutrient losses to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	



BP PA28	Extend the grazing season for cattle	Improve nutrient conversion and control export to water bodies	Enhance and preserve water supply ESS		yes/high to very high	location specific	short to medium	
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3.2. Grassland

Table 6. Plain sites: Grassland - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP PG01	Establishment of grassland in DWPA I. (inner zone)	Grassland is the most appropriate land use for inner DWPA. Total cover is requested, except already built in areas and forests (if risk of damage is low).	Enhance and preserve water supply ESS		high	low	medium	
BP PG02	Establishment of grassland in DWPA II. (outer zone)	Grassland zone in the DWPA II. assures filtering surface runoff or cleaning recharge in particular in the surrounding area of the DWPA I.	Enhance and preserve water supply ESS		medium	low	medium	
BP PG03	Establishment of grassland in DWPA III. (recharge area or catchment)	Grassland is a preferable land use in recharge zone, since less risk of pollution than from agriculture and more recharge than from forest.	Enhance and preserve water supply ESS		medium	medium	medium	
BP PG04	Prohibiting use of chemicals, limiting irrigation in the DWPAs on grassland	Use of chemicals (fertilizer, pesticides, herbicides) is prohibited in DWPA I. and II. because infiltrating into the soil they can reach well fields or transported into surface waters, the abstraction sites. Mechanically controlled weeds only.	Enhance and preserve water supply ESS		high	medium	short	
BP PG05	Establishment of buffer zone along rivers, lakes and sinkholes	Buffer zones filter surface runoff .	Enhance and preserve water supply ESS		high	medium	long	
BP PG06	Promoting the application of buffer strips of grass between plots of arable lands	Grassland strips between plots of arable lands can retain pollution, spreading of weeds.	Increase adaptive capacity to reduce water supply vulnerability		medium	medium	medium	
BP PG07	Enhancing self-regenerating capacity of grasslands fitting the ecoregion, supporting native species	Appropriate grass land management can enhance the transformation of existing GL-system to natural one. Cost of self-preservation is lower than implementation of agricultural techniques.	Enhance and preserve water supply ESS		medium	low	long	



BP PG08	Promoting the occurrence of species adaptive to CC.	Adaptive grassland management under climate change has to ensure the provision of the ESS over space and time.	Enhance and preserve water supply ESS		medium	low	long	
BP PG09	Grassland management only with maintenance purposes (nature protection schemes)	Saving natural structure and dynamics by extensive grassland management practices include: - grasslands must be utilised by grazing and/or mowing at least once a year, - rotation of the mowing/grazing sites, - leave unmowed strips and rotate their lo	Enhance and preserve water supply ESS		medium	medium	long	
BP PG10	Avoiding permanent injury of the surface, compaction of soil	No irreversible damage to the surface of grassland. Avoid use of heavy harvester/mechanics, no cultivation on damp soil. Ploughing is prohibited.	Enhance and preserve water supply ESS		medium	low	short	
BP PG11	Removal of invasive weeds	Mowing more times, weeds/shrubs should be removed at their flowering stage.	Enhance and preserve water supply ESS		low	low	short	
BP PG12	Groundwater regulation by drainage	Regulation of groundwater level can optimise the water supply of the grassland by eliminating the long wet period with appropriate drainage system. The measure is expensive, so it should be supported by economic assessment (CBA).	Enhance and preserve water supply ESS		low	high	long	
BP PG13	Promoting regular flooding, permitting mandatory irrigation, avoiding too long water cover	Proper water supply of grassland supports grassland growth thus can reach maximal grassland ecosystem services. Grasslands are proper places for water retention but resistance, sensitivity against water cover should be considered.	Enhance and preserve water supply ESS		medium	medium	short	
BP PG14	Promoting reasonable nutrient and water balance management (regular oversowing) in planning process.	Limitation of application of fertilizers and irrigation but satisfaction of demands for maximum grass production. Environmentally and economically sustainable solutions in the frame of a plan.	Enhance and preserve water supply ESS		high	medium	long	
BP PG15	Controlling the use of manure (amount, timing)	Nutrient supply e.g. max. 90kg/ha nitrogen active substance. Manure cannot be applied on frozen ground, land filled with water or covered completely with snow.	Enhance and preserve water supply ESS		medium	low	short	



BP PG16	No storage of manure in grassland	Point source pollution by manure storage/dump should be avoided, too much nutrient cauterize grasses, (flash) flood washes manure into surface water.	Enhance and preserve water supply ESS		medium	low	short	
BP PG17	Sustainable production (no overmowing, promoting self regeneration processes and oversowing too)	Sustainable maintenance: Mowing or forage crimping should leave a stubble of at least some cm. Grasses should be mowed at least once a year after main blooming.	Enhance and preserve water supply ESS		medium	medium	long	
BP PG18	Appropriate treatment of the mowed material	Hay should be collected in time after mowing and removed. Utilising green manure with mowed grass before winter (leave mowed material but this cannot be applied if hay is too much).	Enhance and preserve water supply ESS		low	low	short	
BP PG19	Limited use of chemicals	Decreasing the load of pesticides, nutrients, yield-enhancing chemicals which can be harmful for human consumption	Enhance and preserve water supply ESS		low	low	short	
BP PG20	Appropriate establishment of infrastructures (transport and social service infrastructures)	Rules on drinking water protection zones for leisure infrastructures should be respected.	Enhance and preserve water supply ESS		low	medium	short	
BP PG21	Limited number of grazers	No injury of surface, no overgrazing to ensure grass cover. Decreasing of load of nutrients	Enhance and preserve water supply ESS		medium	medium	long	
BP PG22	Establishment and application of grazing plan	For avoiding overgrazing: appropriate frequency, rotation, mixture and/or sequences of grazers type. Grazing density proper to grass growth possibilities.	Enhance and preserve water supply ESS		medium	low	short	
BP PG23	Manuring only by the droppings of animals grazing on the land	Diffuse pollution by manure should be avoided, too much nutrient cauterize grasses, (flash) flood may wash excess manure into water.	Enhance and preserve water supply ESS		medium	low	short	
BP PG24	Alternating grazing and mowing.	Regular variation of the grazing and mowing can strengthen the dynamics of the regeneration. This way selective loss of grass species and proliferation of weeds can be reduced.	Enhance and preserve water supply ESS		medium	low	long	



3.3. Wetland

Table 7. Plain sites: Wetland - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP PW1	Preservation and revitalization of wetlands on floodplains	Establishment of Constructed wetlands for water treatment	Enhance and preserve water supply ESS		relatively high	relatively high	long	
BP PW2	Creation and maintenance of riparian wetlands	Creation and maintenance of riparian wetlands	Enhance and preserve water supply ESS		high	medium	long	
BP PW3	Establishment of Constructed wetlands for water treatment	Preservation and revitalization of wetlands on floodplains	Enhance and preserve water supply ESS		high	medium	long	

3.4. Forest

Table 8. Plain sites: Forest - Best practices

Number	Measure	Description of the measure	Measure advantages	Challenges	Water protection functionality	Cost of the measure	Duration of implementation	Time interval of sustainability
BP PF01	Limitation of Clear Cuts	The prohibition of clear cuts assures the prevention of the most endangering management measure for water quality and water supply security. Clear cuts provoke erosion processes (water quality) and increase the risk for floods (water quantity).	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF02	Establishment of a Continuous Cover Forest System	Continuous Cover Forest Systems are the most appropriate management systems for drinking water protected areas (DWPA)	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF03	Defined Crown Cover Percentage of Forest Stands	Forest stands should provide a defined crown cover percentage in order to be stable and resistant towards disturbances and in order to possess natural regeneration dynamics	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF04	Limitation of the percentage of timber extraction	The limitation of the percentage of timber extraction in the course of forest management measures provides a low disturbance regime in DWPA. The limitation is defined with the range of 10-25 % of the timber volume of a fully stocked forest stand.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF05	Continuous Regeneration Dynamics	The continuous regeneration dynamics guarantee stability and resiliency of the forest ecosystems and enhance their adaptive potential (The natural regeneration process is preferred in forests, as it provides more stable tree individuals)	Enhance and preserve water supply ESS		yes/high	low	long	
BP PF06	Foster Stability and Vitality of Forest Stands	Ensuring the stability and vitality of the forest stands is compulsory to guarantee the water protection functionality of the forest ecosystems in drinking water protected areas (DWPA)	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF07	Tree species diversity according to the natural forest community	Tree species diversity according to the natural forest community is the basic precondition for forest stand stability and an excellent starting point for an enhanced adaptive capacity of forests under climate change	Increase adaptive capacity to reduce water supply vulnerability		yes/high	medium	long	



BP PF08	Improve structural diversity of the forest stands	Structural Diversity of the forest stands is a pre-condition for the continuous cover forest system and improves the stability and resiliency of the forest stands. Uneven-aged and multilayered forest stands are desired for water protection	Enhance and preserve water supply ESS		yes/medium	medium	long	
BP PF09	Forest Ecologically sustainable wild ungulate densities	Forest Ecologically sustainable wild ungulate densities are the most important boundary condition in order to allow the establishment of the overall tree species diversity in the course of natural forest regeneration dynamics	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF10	Protection of the gene pool of the autochthonous tree species	The gene pool of the autochthonous tree species is very important, as these trees survived the climate changes of past thousands of years at their growing sites. This genetic material becomes even more important under climate change, as high genetic varia	Increase adaptive capacity to reduce water supply vulnerability		yes/high	low	long	
BP PF11	Foster old, huge and vital tree individuals	Foster old, huge and vital tree individuals	Increase adaptive capacity to reduce water supply vulnerability		yes/high	low	long	
BP PF12	Adequate dead-wood content	Dead wood is an important feature of biodiversity in forests, it improves the ecological conditions and hence is a pre-condition for the establishment of stable and vital forest ecosystems	Enhance and preserve water supply ESS		yes/high	low	long	
BP PF13	Buffer Strips along streams, dolines and sinkholes	Buffer Strips along streams and dolines limit erosion processes and are a very effective way to prevent the entrance of various substances into the water body	Enhance and preserve water supply ESS		yes/very high	medium	long	
BP PF14	Adaptive forest management	Adaptive forest management under climate change has to ensure the provision of the ESS over space and time. This has to involve the assessment of tree species changes due to climate change for all specific forest types within a DWPA and the related action	Increase adaptive capacity to reduce water supply vulnerability		yes/high	high	long	
BP PF15	Natural Forest Succession in Case of Stable Forest Ecosystems	Natural Forest Succession in Case of Stable Forest Ecosystems	Increase adaptive capacity to reduce water supply vulnerability		yes/high	high	long	
BP PF16	Small-Scale regeneration techniques	Small Scale regeneration techniques like single tree cutting, small gap cutting or group selection system assure a low disturbance regime within the context of forest management measures and give advantage of the natural seed regeneration.	Enhance and preserve water supply ESS		yes/high	medium	long	



BP PF17	Structural Thinning Operations	Structural Thinning Operations	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF18	Artificial Recruitment Principles	Artificial Recruitment Principles encompass the use of autochthonous plant material and diversity in accordance with the natural forest community and/or the use of new tree species on a forest site triggered by cc-conditions.	Increase adaptive capacity to reduce water supply vulnerability		yes/high	medium	long	
BP PF19	Forest Fire Prevention	Forest Fire Prevention can contribute to essential aspects of source water protection, like e.g. forest ecosystem preservation, soil and humus protection , etc.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF20	Limitation of Forest Roads	Forest Road Construction and maintenance can cause several adverse impacts on water bodies and should hence be limited in DWPA. The best solution is the prevention of their construction and the application of alternative techniques.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF21	Adequate timber yield techniques	In DWPA the timber harvesting techniques should prevent the disturbance of the soil- and humus layers.	Enhance and preserve water supply ESS		yes/high	medium	long	
BP PF22	Prohibition of the use of chemicals in forestry practices	The use of chemicals like fertilizers, pesticides or herbicides in forestry practices should be forbidden, as these substances form a threat for water quality and hence should not be present in forested DWPA.	Enhance and preserve water supply ESS		yes/high	low	long	
BP PF23	Source Water Protection Policy and Institutional Implications	Enhancing collaboration between forest and water decision-makers and stakeholders and improvement of the integrated forest- and water management via the establishment of an adequate legislative and administrative frame	Enhance and preserve water supply ESS		yes/high	low	long	
BP PF24	Preservation of the forests at the tree line and timber line (Subalpine Forest Belt in mountainous regions)	The uppermost forest communities (in the subalpine forest belt) have a high degree of water protection functionality. In mountainous regions this BP will enhance the water protection, water retention and water regulation functions of forests	Increase adaptive capacity to reduce water supply vulnerability		yes/medium	low	long	
BP PF25	Integrative planning strategy for watersheds, especially for vulnerable areas with regard to water resources	Consolidation and afforestation of degraded lands, alluvial sources (slopes, ravines, land slides) .	Enhance and preserve water supply ESS		yes/high	high	long	