European Commission

NWRM

Natural Water Retention Measures

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Individual NWRM

Overland flow areas

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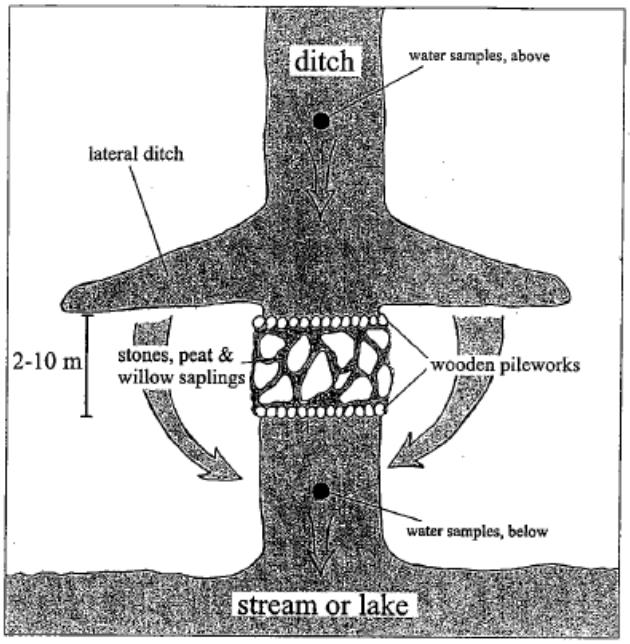
I. NWRM Description

Typically, overland flow areas are set asides used to minimize the negative impacts of forest management on water quality. They are most commonly associated with peatland forestry in Finland but could be applicable in other areas of Europe. Overland flow areas collect some of the excess sediment produced during ditch maintenance and other forest management operations such as road building or harvesting. Overland flow areas are created by building a semi-permeable dam in a forest ditch. Upstream of the dam, lateral ditches are constructed to transport water into the surrounding catchment. During periods of high flow, water will overflow the lateral ditches and travel across land to reach the receiving lake or stream. As the water travels across land, its velocity will be slowed and much of the sediment being carried will be deposited. At periods of low flows, the permeable dam will slow water flow and cause deposition of sediment. Existing wetlands may function as overland flow areas but the use of ecologically valuable and endangered mires should be avoided due to possible changes in vegetation composition. Overland flow areas can also be part of more complex system for water treatment from agricultural areas and landfills.

II. Illustration



Schematic of a constructed overland flow area (from Liljaniemi et al. 2003)

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Possible	Overland flow areas may be used as part of water treatment systems from, e.g., re-cultivated landfills.
Agricultural Areas	Possible	While this measure is primarily associated with forest management it may also be used in agricultural areas. Theoretically it should be possible to apply this

		measure also in agricultural areas, for example, with a wetland downstream of the field
Forests and Semi-Natural Areas	Yes	Overland flow areas are a forest management practice to deal with increased runoff following clearcutting. It is not likely that the measure would be relevant in other semi-natural areas unless human activity leads to a significant disruption to the hydrologic cycle where evapotranspiration is reduced and runoff increased.
Wetlands	Possible	Existing wetlands may function as overland flow areas under some circumstances, for example if they are downstream of clearcuts. This measure may also be relevant in wetlands that have been drained to facilitate forest production.

Region	**Applicability**	**Evidence**
Western Europe	Possible	Overland flow areas are likely to be applicable in the cooler, wetter regions of Western Europe where precipitation exceeds potential evapotranspiration and large increases in runoff following clearcutting are possible.
Mediterranean	No	Overland flow areas are not likely to be relevant in areas where potential evapotranspiration exceeds precipitation and large increases in runoff following clearcutting of forests are not likely to occur.
Baltic Sea	Yes	Overland flow areas are likely to be applicable in the cooler, wetter regions of the Baltic Sea drainage basin where precipitation exceeds potential evapotranspiration and large increases in runoff following clearcutting are possible.
Eastern Europe and Danube	Possible	Overland flow areas may be applicable in the cooler, wetter regions of Eastern Europe and the Danube basin where precipitation exceeds potential evapotranspiration and large increases in runoff following clearcutting are possible.

IV. Scale

	0-0.1km²	**0.1-1.0km²**	**1-10km²**	**10-100km²**	**100-1000km²**	**>1000km²**
Upstream Drainage Area/Catchment Area	Yes	Yes	Possible	No	No	No
Evidence	Overland flow areas are a measure designed primarily to deal with local forestry effects. As such, they need a limited upstream drainage area but can have beneficial effects in much larger downstream areas. The spatial scale of overland flow areas mean they are only suitable for application in relatively small areas such as that drained by a single ditch or small ditch network. Also					

	as a part of a larger water treatment system, their spatial impact will be limited.

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	High	One of the primary purposes of overland flow areas is to store runoff. Storing runoff on the land allows sediments to be deposited and this can help to prevent sediment pollution of downstream receiving waters
	Slow Runoff	High	Because overland flow areas store runoff, they will also slow runoff. Slowing runoff facilitates deposition of suspended sediments and can have a beneficial effect on water quality in downstream water bodies.
	Store River Water	None	
	Slow River Water	None	
Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	Medium	Because overland flow areas route water over land, they can contribute to increased infiltration or groundwater recharge. However, the increase is likely to be Medium as overland flows typically occur during wet periods (such as early spring) when soils are already at their wettest.
	Increase soil water retention	Medium	There is a potential for overland flow areas to increase soil water retention as they retain water on the landscape instead of routing it directly to ditches or streams. This effect is likely to be moderate as overland flows are most common when soils are at their wettest.
Reducing Pollution	Reduce pollutant sources	High	The main purpose of overland flow areas is to reduce sediment pollution primarily associated with forestry operations including ditch maintenance, road building and forest harvesting.
	Intercept pollution pathways	High	The mechanism by which overland flow areas reduce pollutant sources is through interception of particulate material suspended in the water column. By passing water over land areas, much of the sediment load can be deposited. Reducing sediment concentrations in waters draining managed forests can have beneficial effects on downstream water bodies.

Soil Conservation	Reduce erosion and/or sediment delivery	High	Overland flow areas limit sediment delivery by passing water from streams or ditches over terrestrial areas. This has the effect of slowing water flows. Slower water flows over rougher environments (terrestrial vs. ditch) will facilitate the deposition of suspended material.
	Improve soils	None	
Creating Habitat	Create aquatic habitat	Low	Overland flow areas can help to prevent deterioration of aquatic habitat associated with sediment pollution.
	Create riparian habitat	High	As they are located near water bodies, overland flow areas will create valuable riparian habitats that will help to increase biodiversity
	Create terrestrial habitat	Low to Medium	Depending on their size, overland flow areas may in some circumstances create or improve terrestrial habitat.
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	
	Absorb and/or retain CO2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Medium	Overland flow areas can have a moderate effect on water storage. Typically, the effect is quite local and short lived but it may be sufficient to mitigate some flood peaks during spring runoff.
	Fish stocks and recruiting	Medium	Preventing sediment inputs to receiving lakes and streams may help to preserve spawning habitat. This would help to maintain fish stocks through sustainable recruitment.
	Natural biomass production	None	
Regulatory and Maintenance	Biodiversity preservation	Medium	Preventing sediment inputs to receiving lakes and streams may help to preserve spawning habitat and the streambeds used by such species as freshwater pearl mussel. Excessive sediment inputs can smother the streambeds needed for spawning, or pearl mussel habitat. This can lead to local extirpation of both fish and invertebrates.

	Climate change adaptation and mitigation	Low	Increased emissions of N_2O and CH_4 are possible from overland flow areas, but they are most likely a minor source.
	Groundwater / aquifer recharge	Medium	By routing water over the land, there is a potential for groundwater aquifer recharge. However, the effect of overland flow areas on enhancing aquifer recharge is likely to be limited as this measure typically only works during high flow periods when soils are at their wettest.
	Flood risk reduction	Low	Overland flow areas may play a role in flood risk reduction as they will slow the transit of water through the forest landscape during high flow conditions. This may have beneficial effects on downstream flood peaks.
	Erosion / sediment control	High	Sediment control is the main purpose of overland flow areas.
	Filtration of pollutants	High	Overland flow areas control and limit downstream water pollution by intercepting suspended sediment and trapping it on the land. The suspended sediments in stream or ditch water settle out when the water passes over overland flow areas, thus the water leaving an overland flow area will be cleaner than that entering as sediment-related pollutants including phosphorus and heavy metals will have been filtered out and deposited onto land.
Cultural	Recreational opportunities	Low	Overland flow areas may potentially create habitats suitable for some bird species and provide opportunities for bird watching.
	Aesthetic / cultural value	Low	Through improving water quality, overland flow areas may have indirect effect on aesthetic properties of downstream water bodies.
Abiotic	Navigation	None	
	Geological resources	None	
	Energy production	None	

VII. Policy Objectives

Policy Objective		Rating	Evidence
Water Framework Directive			
Achieve Good Surface Water Status	Improving status of biological quality elements	Low	As with many forestry measures, there is a scale mismatch between the zone of influence of overland flow areas and the size of Water Framework Directive (WFD) water bodies. Overland flow areas can lead to local improvements in biological quality elements, especially for benthic dwelling species. They can also lead to improvements in physic-chemical status as a result of lowered nutrient inputs and potentially also improve priority substance status if there is excessive mercury associated with sediments exported from forests.
	Improving status of physico-chemical quality elements	Low	
	Improving status of hydromorphological quality elements	Low	
	Improving chemical status and priority substances	Low	
Achieve Good GW Status	Improved quantitative status	Low	The effect of overland flow areas on groundwater recharge is limited, as this measure usually works during flood periods when soil is saturated with water.
	Improved chemical status	None	
Prevent Deterioration	Prevent surface water status deterioration	Medium	Overland flow areas are used to limit the potential negative consequences of forestry on downstream receiving water. As such, this measure can help to prevent deterioration of surface water body WFD status.
	Prevent groundwater status deterioration	None	
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Low	Overland flow areas will slow the velocity of water leaving the forest landscape during peak flow periods when soils are at their wettest. As such, they can make a limited contribution to reducing flood risks.
Habitats and Birds Directives			
Protection of Important Habitats		Medium	Overland flow areas can be important for preserving the habitat of aquatic species which depend on well-oxygenated stream beds. Overland flow areas can help to limit sediment inputs from managed forests which can later smother stream beds, destroying spawning habitat or extirpating benthic invertebrates such as freshwater pearl mussel. If wetlands are used as overland flow areas, they may also serve to preserve bird habitat.

2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	Medium	Overland flow areas offer increased protection for downstream aquatic ecosystems by limiting the potential for excessive sediment inputs from managed forests.
More sustainable agriculture and forestry	Medium	Overland flow areas will help to make forestry more sustainable as they can limit some negative impacts associated with sediment pollution.
Better management of fish stocks	Medium	By limiting the sediment pollution that will potentially smother streambed spawning habitat, overland flow areas can contribute to better management of freshwater fish stocks.
Prevention of biodiversity loss	Medium	By limiting the sediment pollution that will potentially smother streambed habitat, overland flow areas can contribute to prevention of aquatic biodiversity loss, especially for slow moving long-lived species such as freshwater pearl mussel. Overland flow areas may also help to preserve riparian biodiversity.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	The dimensions of overland flow areas will be dependent on the size of the upstream catchment. Larger areas will be needed with larger upstream catchments.
Space required	Ideally, the space needed for overland flow areas will not have impact on productive forest areas. If overland flow areas can be situated on mires or wetlands, their impact on forestry will be minimized while maintaining their sediment retention function.
Location	Overland flow areas will typically be located within the ditch network of managed boreal forests.
Site and slope stability	This measure is typically located on the flat forest landscapes of Fennoscandia.
Soils and groundwater	
Pre-treatment requirements	
Synergies with Other Measures	This measure can be part of a bundle of measures designed to minimize forestry impacts on water quality. Relevant measures include forest riparian buffers (F1), water sensitive driving (F7), sediment capture ponds (F9), appropriate design of roads and stream crossings (F8) and peak flow control structures (F13)

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		Typically there are no costs of land acquisition.
Investigations & Studies		The effectiveness of this measure will depend on how much flow velocities are slowed. Thus, investigations or studies should be conducted to determine the likely amount and timing of runoff to be processed by an overland flow area
Capital Costs		
Maintenance Costs		
Additional Costs		There may be opportunity costs associated with this measure if the overland flow area is sited on productive forest land. Using an area for overland flows instead of forest production may negatively impact tree growth and the income which could potentially be obtained from forest harvesting.

X. Governance and Implementation

Requirement	Evidence

XI. Incentives supporting the financing of the NWRM

Type	Evidence

XII. References

Reference	Comments
Neary, Daniel G., George G. Ice, and C. Rhett Jackson. "Linkages between forest soils and water quality and quantity." Forest Ecology and Management258.10 (2009): 2269-2281.	Good general reference on forest water issues

Liljaniemi, Petri, et al. "Effectiveness of constructed overland flow areas in decreasing diffuse pollution from forest drainages." Environmental Management 32.5 (2003): 602-613.	Empirical study of overland flow area effectiveness
Hynninen, Anu. 2011. Use of wetland buffer areas to reduce nitrogen transport from forested catchments: retention capacity, emissions of N2O and CH4 and vegetation composition dynamics. Dissertationes Forestales 129, 53 p.	Dissertation on performance of wetland buffer areas, with regard to nitrogen retention.
Hynninen, Anu, Hamberg, Leena, Nousiainen, Hannu, Korpela, Leila, Nieminen, Mika. 2011. Vegetation composition dynamics in peatlands used as buffer areas in forested catchments in southern and central Finland. Plant Ecology 212: 1803-1818	Study on changes in vegetation composition in peatland buffer areas
Carina Sundberg, Jenny S. K. Stendahl, Karin Tonderski, Per-Eric Lindgren. 2007. Overland flow systems for treatment of landfill leachates—Potential nitrification and structure of the ammonia-oxidising bacterial community during a growing season	Study on potential oxidation of ammonia and nitrite in overland flow areas constructed for leachate water treatment in landfills.