SEVENTH FRAMEWORK PROGRAMME
THEME 6: Environment (including Climate Change)

Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems

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Deliverable 7.22: Policy brief on stronger need for maintaining environmental flow in streams in a changing climate

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PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
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Abstract

Changes in bed and bank structure and modification of water flow arising from human responses to climate change have become the main threat for ecological status of streams in the EU. Direct climate change impacts modify stream flow further. Experiments in REFRESH showed that stream ecosystems are vulnerable to both high and low flows and enabled to specify the tolerance limits. Storing water in the catchment is the principle measure to guarantee stable flow.

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Stronger need for maintaining environmental flow in streams in a changing climate

Synthesis

- ✓ Changes in bed and bank structure and modification of water flow arising from human responses to climate change have become the main threat for ecological status of streams in the EU. Direct climate change impacts modify stream flow further.
- ✓ Experiments in REFRESH show that stream macroinvertebrates are vulnerable for spates starting from 7-fold base flow but their vulnerability is strongly trait specific. Due to higher habitat heterogeneity, ecosystems of natural streams are more resilient to multiple spates than those of semi-natural streams.
- ✓ Rheophilic taxa are sensitive to low flow and disappear within days after onset of stagnation. In eutrophic streams stagnation brings about oxygen depletion and an additional loss of oxyphilic taxa. Both groups indicate high and/or good ecological status of streams.
- ✓ Pools remaining in a stream bed during droughts are no refugia for stream biota as often believed.
- ✓ Storing water in the catchment is the principle measure to guarantee stable flow. Substrate variability can be managed by restoring stream morphology, creating retention basins or wires. The principle should be to let the processes in the system to optimise the conditions for species.

Findings of the FP7 Project REFRESH contribute to the identification of the upper and lower boundaries of environmental flow requirements for small lowland streams.

Anthropogenic flow alterations threaten the ecological status of streams

Until now, pressures related to anthropogenic land and water use and hydromorphological modification of water bodies have a much stronger impact on aquatic ecosystems than the climate change. Changes in bed and bank structure and modification of water flow arising from human responses to climate change (e.g. dams for hydropower or water supply, embankments for flood protection) have become the main threat for ecological status of streams in the EU. Direct impact of climate change and especially the extremes – floods and droughts – modify stream flow further.

A key issue for improving quantitative water management is the identification of the environmental flow, i.e. the amount of water required for sustaining an aquatic ecosystem. So far, there is neither an EU-wide definition of ecological flow, nor a common understanding of how it should be calculated. To address this gap, European Commission has proposed developing a guidance document by 2014 in the framework of the WFD Common Implementation Strategy. The findings of the Project REFRESH in stream ecology represent a major contribution to the development of this guidance as they focus on the identification of the upper and lower boundaries of environmental flow for small lowland streams.

High flow extremes

Spate simulation experiments carried out in a natural and a straightened semi-natural stream in The Netherlands showed that a single spate with magnitude of 6-fold base flow had no effect on stream ecosystems. Multiple spates of a similar magnitude with 5-7-hour intervals simulating the effect of hydropeaking, flushed silt from the stream bed in both stream types but affected macroinvertebrates only in the semi-natural stream, which offered less refugia due to lower habitat variability.

Lab experiments with increasing flow rates showed that different invertebrate species had different vulnerability regarding high flows. The effects started at flow rates equal to 7-fold base flow whereas habitat heterogeneity providing shelter contributed to resistance of the macroinvertebrate community.

Low flows and drought

In stagnant reaches of a stream with experimentally simulate drought conditions rheophilic taxa disappeared within 1 week. At low nutrient load, oxygen levels remained high in the stagnant reach enabling survival of all other lowland stream taxa, despite major changes in substrates. If stagnation was combined with high nutrient load lowering dissolved oxygen levels below 6 mg/l, also the oxyphilic species disappeared. Loss of two most sensitive groups of animals used in the WFD assessment systems as indicators of high/good status, shows how intimately water quantity and quality are related within the concept of 'good ecological status'. After approximately one month of stagnation, typical standing water species appeared in the stagnant reach.

Pools remaining in a stream bed during droughts are no refugia for stream biota as often believed.

The experiments showed that, contrary to a wide-spread opinion, the remnant pools in the river bed do not serve as refugia for stream biota. Likely because of oxygen depletion and increased salinity levels due to evaporation, stream invertebrates disappeared from pools within two weeks and the pools were colonized by polysaprobic pool-dwellers such as *Culex* and *Chironomus* sp.

Management options

Hydrology is the key factor for running water systems and storing water in the catchment is the principle measure to guarantee stable flow.

Flow dynamics and substrate variability can be managed by restoring stream morphology, creating retention basins or wires. The principle should be to let the processes in the system to optimise the conditions for species.

A review of more than 450 climate change adaptation measures related to water carried out by the REFRESH has highlighted a number of land management and forestry measures for regulating stream flow and sediment transport.

Additional scientific information

Deliverable 2.14: Review on processes and effects of droughts and summer floods in rivers and threats due to climate change on current adaptive management strategies

Deliverable 2.21: Report on management options to deal with rising temperature, increasing discharge dynamics and enhanced nutrient and organic matter loads in European rivers, lakes and riparian wetlands

Nõges, T., P. Nõges & A. C. Cardoso, 2010. Review of published climate change adaptation and mitigation measures related with water. Scientific and Technical Research Series EUR 24682 EN, Joint Research Centre. Publications Office of the European Union. Luxembourg, 127 pp.

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http://www.refresh.ucl.ac.uk/