High Resolution Environmental Monitoring to Support the Development of Water Quality Legislation

Aquaread Ltd, an award winning British manufacturer of multi-parameter water quality test equipment, are supplying monitoring equipment and research funding to support the development of improved water quality guidelines across Europe. The research is being conducted in collaboration with scientists at the Aquatic Research Centre at the University of Brighton, and is already influencing environmental policy across Europe.

"The research has been selected for inclusion in Science for Environment Policy - the European Commission's environmental news service for policymakers, distributed to over 14,500 subscribers. The research is now stored on the EC's 'Science for Environmental Policy Repository'. The research has also featured on the SEDNET website. SEDNET is an international network, comprised of members from science, industry and policy backgrounds, established with the aim of incorporating sediment issues and knowledge into European strategies to support the achievement of a good environmental status and to develop new tools for sediment management."

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The research funded by Aquaread Ltd is focussed on providing new evidence to support the development of water quality guidelines, under the EU Water Framework Directive legislation (2000/60/EC), which seeks to restore waters to good ecological status. The water quality parameter of interest for this particular research project is suspended particulate matter. Suspended particulate matter (SPM), ranging from nano-scale particles to sand-sized sediments, is regarded as one of the most common causes for water quality impairment globally. It can have a range of detrimental impacts on freshwater ecosystems and ultimately can lead to a significant decline in the associated ecosystem services; which are estimated to have a global value in excess of $1.7 trillion per annum. As such it is crucial that SPM is monitored and managed effectively in order to avoid these detrimental impacts. However, at present there is very little scientific evidence as to what should be regarded as an appropriate SPM exposure for different freshwater ecosystems. Existing international water quality guidelines for SPM are often blanket values, not reflecting the specific requirements of the ecosystems for which they are designed to protect, and not recognising the natural temporal variations in SPM concentrations caused by naturally discontinuous geomorphological processes.

The Project Aim

Photographs from two of the catchments being monitored in this research project, highlighting contrasting environmental typologies of these reference-condition sites.

The main aim of this project is to collect the evidence required to link water quality guidelines for SPM to the natural characteristics of catchments in order for the guidelines to support good ecological status in contrasting environments. The principle behind this research is that the natural characteristics of a catchment provide a template that controls the background rates of hydrological and geomorphological processes operating within that catchment, which in-turn determines the background physico-chemical and hydro-morphological characteristics of the catchment's surface waters. Large differences in the natural characteristics of catchments (e.g. geology, topography, climate), lead to unique physico-chemical and hydro-morphological conditions that support unique freshwater communities. However, this uniqueness is not always recognised in current international water quality guidelines, which often attempt to apply blanket water-quality guidelines to 'protect' a wide range of ecosystems- as is the case for SPM guidelines. At present therefore, the management of SPM is hampered by a lack of understanding of the SPM conditions that water quality managers should aim to achieve in contrasting environments in order to support good ecological status.

The Research

The project is using the high-resolution dynamics of SPM recorded in contrasting high-ecological status river ecosystems, to inform future water quality guidelines. The SPM data is being collected using Aquaread's Aquaprobes (a state-of-the-art multi-parameter water quality probe) and Aqualoggers (a rugged field-deployed data logger), combined with a manual sample collection regime. The high-resolution monitoring is being conducted in ten contrasting reference-condition (i.e. minimal anthropogenic disturbance and high ecological status), temperate river ecosystems across the UK, between 2011 and 2013. Additional, time-integrated samples are also collected from the sites to allow an investigation of geochemical composition and particle size distribution of SPM in those environments.

Findings

The results of the project after one year, show that there are significant differences in the SPM exposures that are experienced in contrasting river ecosystems that are in reference conditions, and a huge variability in the SPM concentrations in those environments. Median SPM concentrations ranged from <1 mg L-1 to 19 mg L-1, and maximum concentrations ranged from 42 mg L-1 to 377 mg L-1. Furthermore, a frequency analysis of SPM concentrations showed that in one ecosystem type the SPM concentrations observed would not be regarded as being compliant with the current EU Freshwater Directive guidelines for SPM (25 mg L-1) for up to 40% of the time, despite being a site of high ecological status.

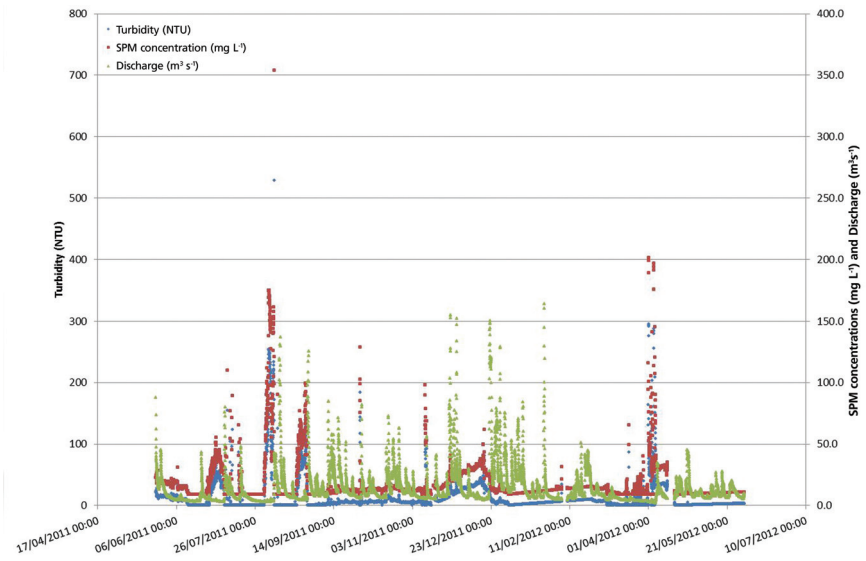
These preliminary findings highlight the need and importance of conducting water quality investigations with equipment that is designed to collect and record continuous data for extensive periods of time. Such an approach advances more traditional environmental

monitoring methods involving manual collection of water samples, which can be laborious and expensive. Additionally, spot sampling runs a risk of missing events that have effects on water turbidity and SPM concentrations, and therefore is often considered not to be fully representative of SPM dynamics in those environments.

Summary

Suspended particulate matter is an important pollutant in its own right as well as a carrier of many other contaminants that affect physical and chemical properties of water resources, and the aquatic biota found there. In the last few decades, some countries and their governing bodies have recognised that water quality guidelines should identify satisfactory concentrations of SPM in order to protect water resources from the negative impacts of this potential pollutant. In the majority of those countries, the SPM concentration targets are presented as a blanket value which does not recognise that SPM can vary between different environments in accordance to climatic, topographic and geological features. Additionally, there is a somewhat limited knowledge of what those SPM concentration targets should be in order to fully protect native aquatic flora and fauna. This ambitious and large-scale project funded by Aquaread Ltd aims to address those gaps in knowledge with the help of high-resolution monitoring data collected from Aquaread's multiparameter water quality sensors from ten reference condition sites around the UK.

Magdalena Grove, a researcher from the Aquatic Research Centre at the University of Brighton carrying out the fieldwork and monitoring work, says "The monitoring equipment has proved to be very reliable and is performing well. The equipment has given us an insight into the turbidity variations in those aquatic environments that are in reference conditions. The results will help us to improve the current guidelines, or develop new ones for SPM, that acknowledge inherent variations in contrasting environments".



Further research work will include the development of different approaches to defining acceptable in-stream SPM conditions such as concentration-frequency curves, which would recognise that other factors (e.g. duration of exposure) have impacts on the aquatic ecology and not just the average SPM concentration. In addition, the researchers involved in this project are planning to develop unique algorithms capable of converting the turbidity readings to an estimated SPM concentration, based on the physical characteristics of the SPM at the site being monitored.