Geophysical Research Abstracts
Vol. 18, EGU2016-249, 2016
EGU General Assembly 2016

Life cycle impacts of topsoil erosion on aquatic ecosystems: case study on Eucalyptus globulus forest

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High concentrations of suspended solids (SS), particularly in the clay and silt size fractions, reaching lotic environments and remaining in suspension can be a significant stressors to the biodiversity of these aquatic systems, degrading the water quality and directly affecting the aquatic biota, namely macroinvertebrates, algae and macrophytes. This damage is presently not considered in Life Cycle Assessment studies.
This study is devoted to the effects of SS into freshwater systems due to topsoil erosion by water (environmental mechanism), translated into damage to aquatic ecosystem diversity (endpoint impact category), namely to macroinvertebrates, algae and macrophytes. For this, we have developed a framework to conduct an erosion inventory using the WaTEM/SEDEM model and linked this with, a method to derive regional characterisation for endpoint damage on aquatic ecosystem diversity. A case study was performed for Eucalyptus globulus stands in Portugal, with a functional unit of one hectare of land under production forestry management. To demonstrate how this newly SS ecosystem method can help to improve the environmental assessment in forestry, results were compared with the earlier commonly used impact categories from ReCiPe method.
The relevance of the impact from SS delivery to freshwater streams is shown, providing a more comprehensive assessment of the SS impact from land use systems on aquatic environments. The SS impacts ranged from 15.5 to 1234.9 PDF.m3.yr.ha-1.revolution-1 for macroinvertebrates, and from 5.2 to 411.9 PDF.m3.yr.ha-1.revolution-1 for algae and macrophytes.
For some stands, SS potential impacts on macroinvertebrates have the same order of magnitude than freshwater eutrophication, freshwater ecotoxicity, terrestrial ecotoxicity and terrestrial acidification impacts. For algae and macrophytes, most of the stands present SS impacts of the same order of magnitude as terrestrial ecotoxicity, one order of magnitude higher than freshwater eutrophication, and two orders of magnitude lower than freshwater ecotoxicity and terrestrial acidification.
The SS impact results allow to conclude that the increase of SS in the water column can cause biodiversity damage and that the calculated impacts can have a similar or even higher contribution to the total environmental impact than the commonly established endpoint impact categories of the ReCiPe method (such as freshwater eutrophication, freshwater ecotoxicity, terrestrial ecotoxicity and terrestrial acidification). The present study proves that SS impacts on aquatic organisms can vary substantially when using a detailed regionalisation level such as the local resolution scale. A wide application of the framework and method developed at a local scale enable the establishment of a regionalised SS inventory database and a deep characterisation of the potential environmental impacts of SS on local aquatic environments.

Keywords: Eucalyptus globulus, land use, life cycle assessment, suspended solids, topsoil erosion