Column experiment for purification of clear-cut forest runoff using biochar

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In drained boreal peatlands, forest regeneration is typically done using a sequence of clear-cutting, ditch network maintenance, site preparation and planting. Following the forest regeneration, export of nutrients to water courses is increased. This results in degradation of water quality, eutrophication, and enhances the formation of harmful algal blooms. The aim of current research was to test a biochar reactor in forest runoff water purification, especially nitrogen recovery from runoff water. The biochar reactor was tested using a meso-scale laboratory experiment by circulating forest runoff water through biochar-filled columns and by monitoring water nutrient concentrations in the inlet and outlet of the columns. Adsorption rate ($K_{ad}$) and maximum adsorption capacity ($Q_{max}$) were quantified by fitting pseudo-first and second order as kinetic models to the experimental data. The results demonstrated that concentration of total nitrogen (TN) decreased by 58% during the 8 weeks experiment, and the majority of TN adsorption has occurred already within the first 3 days. In addition, $NO_3-N$ and $NH_4-N$ concentrations decreased below the detection limit in 5 days after the beginning of the experiment. The results demonstrated that the biochar reactor was not able to adsorb TN in low concentrations. The results suggest that biochar reactor can be a useful and effective method for runoff water purification in clear-cut forests and deserves further development and testing. This makes biochar reactor a promising water protection tool to be tested in sites where there is a risk for high rate of nutrient export after forest regeneration.

Keywords: adsorption, biochar reactor, column experiment, inorganic nitrogen, total nitrogen.