Influence of Storm "Kyrill" Induced Deforestation on the Silicon Supply of the Sorpe Dam

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Abstract

The storm Kyrill in 2007 fell an huge amount of timber in North Rhine-Westphalia, Germany and produced areas with uncovered soil. It is assumed that bare soil leads to an increased leaching of minerals, which could influence the Si concentration in the receiving waters. We were able to proof this by finding a slight positive correlation between the relative area of Kyrill clearances and the Si content of the draining streams on several forest covered areas on the western shore of the Sorpe dam. Each 10 % of Kyrill clearances increases the Si content of the draining streams about 0.25 mg/L (SiO_2).

1. Introduction

In the night of january 18th, 2007, the storm "Kyrill" with maximum velocities of more than 225 km/h drew over Europe.More than 37×10^6 m^3 of timber fell alone in Germany [2], almost 50 % of that figure only in North Rhine-Westphalia: 18×10^6 m^3 on an area of 31102 ha (areas smaller than 0.25 ha excluded) [1]. A decrease in trees is followed by a decrease in evapotranspiration, which has as consequence an increased surface and subsurface flow [4], what means an increased leaching of minerals. The effect of the removal of vegetation and forest coverage on the erosion and runoff of nutrients can lead to a loss of up to 0.6 kg of soil m^{-2} yr^{-1} [3].

This observation raises the question wheather or not clearances in the forest due to Kyrill could remarkebly increase the elution of silicon and influence the algae population in the Sorpe dam. An increase of the trophic rating from 1.5 to 1.8 according to LAWA 2001 has already been observed in 2007 [7].

2. Investigated area

The Sorpe reservoir forms part of the dams which supply the Ruhr industrial region with water (fig. 1). The dam lies in the mountains of the Sauerland (North Rhine-Westphalia, Germany) in a catchment area of about 100 km^2, of which 66.7 % are forest. It consists, similar to the remaining dams of the Ruhr basin, of a pre- and a main basin.

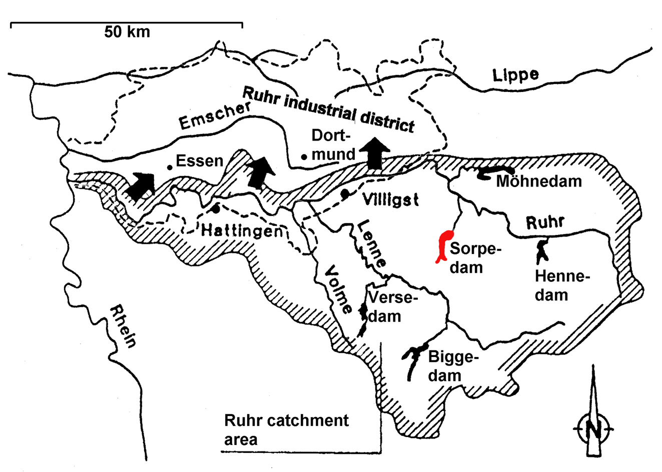

***Figure 1:** Reservoirs in the Ruhr catchment area (from [6], modified)*

The small pre-basin receives effluents rich in nutrients from two streams, running mainly through agriculturally used area. The nutrient status of the pre basin is highly eutrophicated.

The surface of the oligo- to mesotrophic main basin spreads over 3.38 km^2, the maximum depth is 57 m, while the mean depth measures 21 m.

The total volume is 70.8×10^6 m^3. The theoretical filling time is 1.53 years. It receives the waters of the pre-basin and the nutrient poor waters of contributing small streams arranged around the main basin.

The majority of the flora of both basins are diatoms. In the pre basin *Asterionella formosa* and *Synedra acus* are dominating, whereas in the main basin *Asterionella formosa*, *Melosira (Aulacoseira) varians* and *Fragilaria crotonensis* are the most common diatoms.

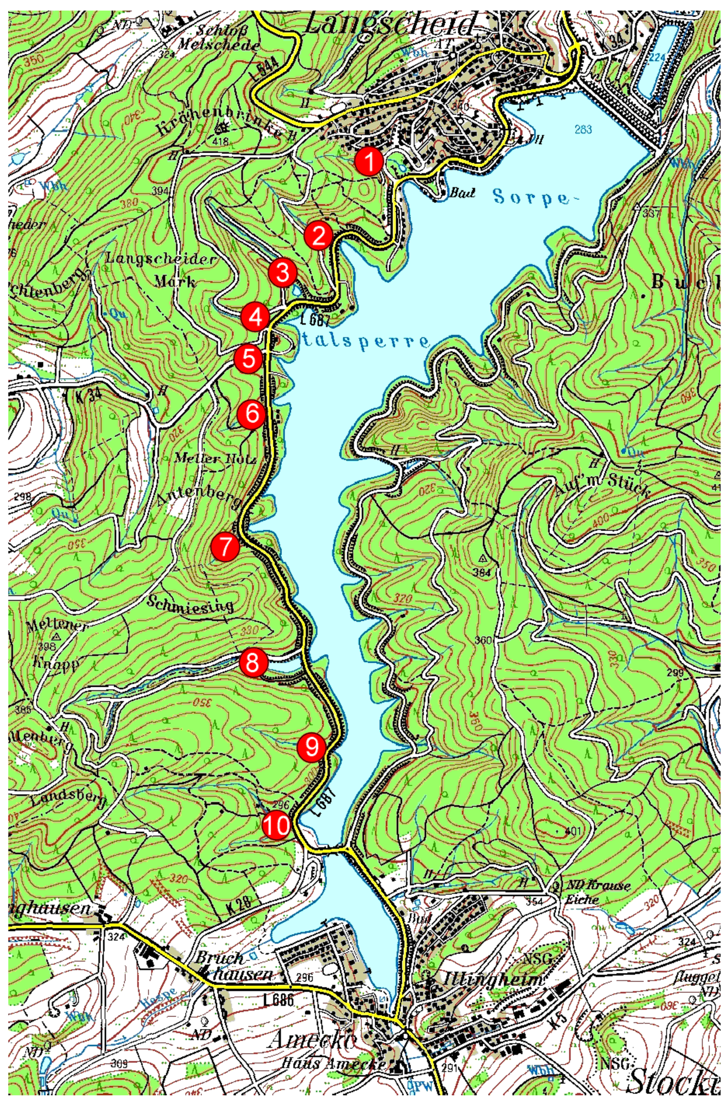

***Figure 2:** Sorpe dam with sampling sites*

The forests on the slopes of the Sorpe valley consist mainly of *Picea abies*, together with a small fraction of *Fagus sylvatica*. The age of the trees is about 100 years.

3. Methods

To obtain an overview of the damages Kyrill made to the landscape, the forestry department of the Northrhine-Westphalian government mapped the forests by means of aerial infrared photographs [5]. These maps were the prerequisite to determine where water of the draining streams should be sampled to examine silicon content and conductivity (κ). Ten sampling points (fig. 2) were choosen according to accessibility and differences in the fraction of Kyrill clearances in respect to the total catchment areas of the draining streams. The Kyrill fractions ranged from 4.4 to 41.6 %. An example is shown in fig. 3. Each station was sampled in total three times, on the Jan. 14th, Jan. 21st and March, 3rd 2008, three days with foregoing rainy periods. An WTW conductivity meter (Cond 315i) and the Macherey-Nagel visocolor silicon test for water analysis (914224), together with Macherey-Nagel photometer PF-10, were used. Results were plotted against relative Kyrill area and regression curves were developed using the spreadsheet module of the OpenOffice.org software package (version 2.4). Significance was calculated by correlation analysis.

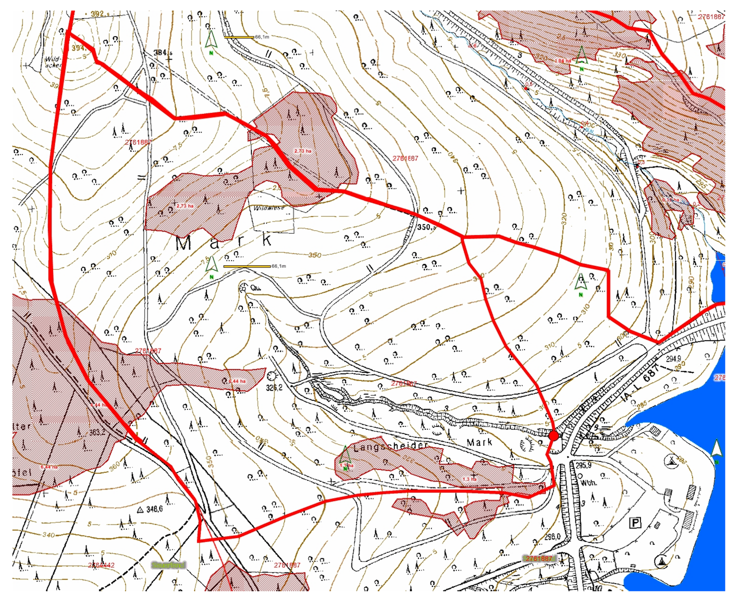

***Figure 3:** Map of a catchment area (32.9 ha, surrounded by thick line) with Kyrill clearances (4.4 ha, shaded), showing sampling point no. 4, indicated by dot (made using data from [5])*

4. Results

The ten streams, which drained the catchment areas, were examined as close to the dam as possible, depending on accessibility. The results are found in table 1. With the data of the three visits of the sampling sites pooled, regression analysis shows a correspondence between silicon content of the streams and the relative area of Kyrill clearances (fig. 4). An increase of the vegetation free area to 40 % lead to an increase of the silicon content of afflux of env. 1 mg/L (SiO_2). (The correlation coefficient is about r = 0.38, which states significance at α = 0.05).

Assumed an average loss of 20 % forestry area due to Kyrill in the total catchment area (100 km^2) of the Sorpe dam, this would match an increase of 0.3 mg/L SiO_2 in the contributing waters. With an annual influx of 52×10^6 m^3 this makes 15600 kg of SiO_2, what equals to an additional silicon load of 6825 kg.

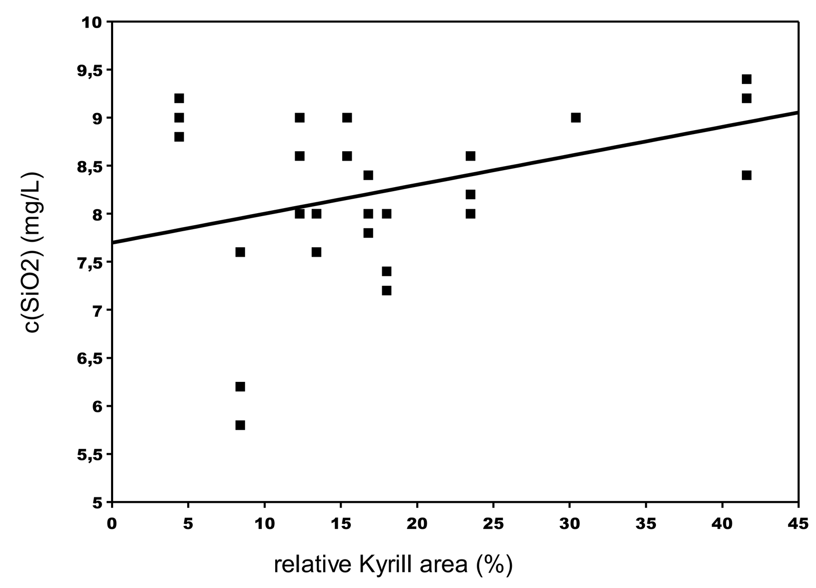

***Figure 4:** silicon content of the draining streams in relation to kyrill area with linear regression*

				Jan. 14th, 2008		Jan. 21th, 2008		March 3th, 2008	
No.	Area (total) (m^2)	Area Kyrill (m^2)	Area Kyrill (%)	c(SiO_2) (mg/L)	κ (µS/cm)	c(SiO_2) (mg/L)	κ (µS/cm)	c(SiO_2) (mg/L)	κ (µS/cm)
1	166648	14115	8.4	5.8	602*	6.2	264	7.6	263
2	382441	58866	15.4	9.0	129.2	8.6	116.5	8.6	116.6
3	563935	95009	16.8	8.4	114.5	7.8	106.4	8.0	105.1
4	329962	44211	13.4	7.6	90.5	8.0	87.5	8.0	86.9
5	154268	27785	18.0	8.0	153.6	7.2	136.6	7.4	136.2
6	170145	70536	41.6	8.4	97.2	9.2	94.0	9.4	93.2
7	277433	65142	23.5	8.0	104.9	8.2	103.2	8.6	105.4
8	1298190	394752	30.4	9.0	133.5	9.0	134.4	9.0	136.9
9	226583	10080	4.4	9.0	105.9	8.8	104.4	9.2	103.9
10	746526	92014	12.3	9.0	104.3	8.6	100.6	8.0	98.6

***Table 1:** Si concentration and conductivity of streams in some Kyrill areas on the west shore of Sorpe dam (*: Increased conductivity due to de-icing salt)*

References

[1] Asche, N. et al. (2007): Empfehlungen für die Wiederbewaldung der Orkanflächen in Nordrhein-Westfalen. (Brochure Landesbetrieb Wald und Holz NRW, Arnsberg)

[2] Bundesregierung (2007): Antwort der Bundesregierung auf eine Kleine Anfrage, 9. Juli 2007, Drucksache 16/6030

[3] Douglass, J.E./Goodwin, O.C. (1980): Runoff and Soil Erosion from Forest Site Preparation Practices. U.S. Forest and Water Quality: What Course in the 80's? Proceedings, Richmond, Virginia 1980, 50–74

[4] Elliot, W.J.; Page-Dumroese, D., Robichaud P.R. (1999): The Effect of Forest Management on Erosion and Soil Productivity. Proc. Symp. Soil Quality and Erosion Interaction, July 7, 1996. Moscow, Idaho

[5] LDS (Landesamt für Datenverarbeitung und Statistik Nordrhein-Westfalen) (2007): Geoserver (http://www.geoserver.nrw.de)

[6] Rissler, P. (1997): Wassermengenwirtschaft Ruhrtalsperren - hydrologische Randbedingungen für den Einsatz der Ingenieurbiologie. Jahrbuch der Gesellschaft für Ingenieurbiologie **8**: 39–48

[7] Ruhrverband (2008): Talsperrenuntersuchungen. Ruhrgütebericht 2007, p. 59ff, Essen

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