

Reservoir lakes in the Upper Harz Mountains (Germany): GIS Implementation and hydrochemical development

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Introduction

Dam reservoirs were used for the continuous water supply to the ore mines in the Upper Harz Mountains. The first reservoirs were built in the 16th century. The dam heights reach up to 15 m and the stored water volumes are between 10,000 and 600,000 m³. There are about 70 of such lakes around Clausthal-Zellerfeld now. Today the lakes are technical monuments belonging to the World Heritage Site “Upper Harz Water Management System” and are a popular tourist attraction. Some of them are used as important reservoirs for drinking water for some higher located towns.

Hydrogeochemical data and specific electrical conductivity (SEC) of the lakes have been investigated for about ten years (Bozau et al., 2015). A data management system combining GIS and hydrochemical data was prepared to facilitate data collection and interpretation.



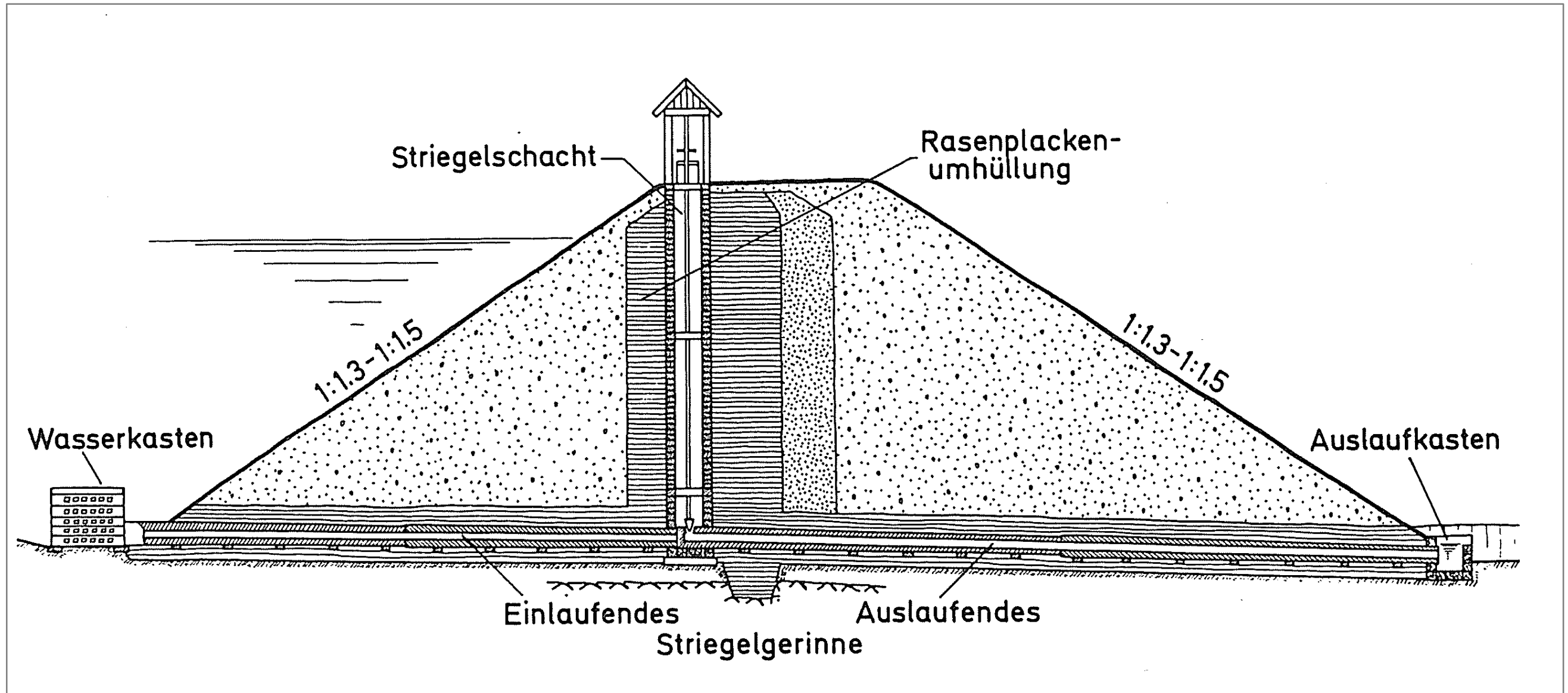
Technical monument Carler Teich in Clausthal-Zellerfeld.



View from below the dam, with well maintained historical technical facility for water management in ore mining.

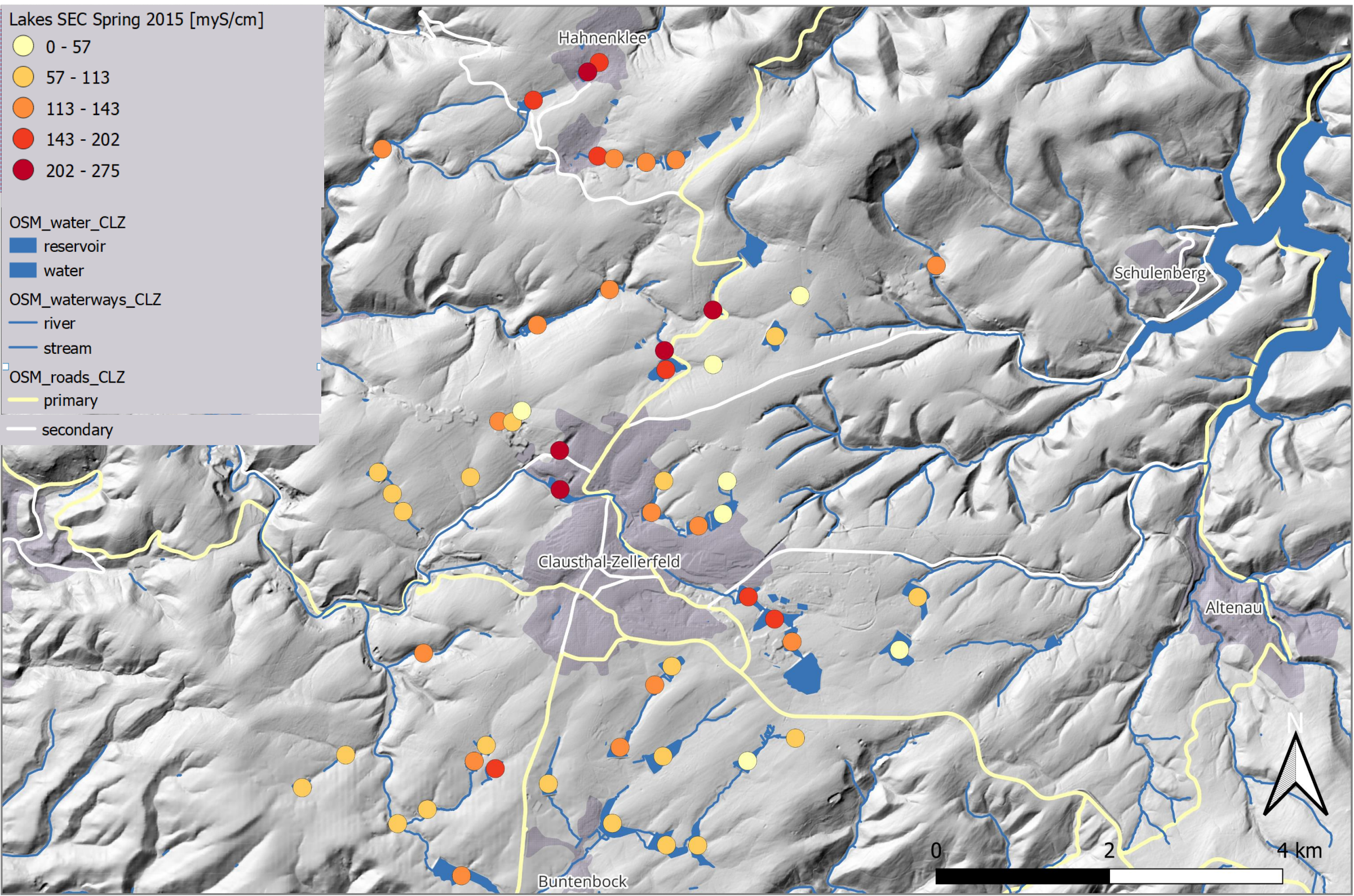
Outlook

Apart from continuing SEC and pH measurements of the lakes regularly, we start to investigate water samples of selected lakes by ion chromatography. Furthermore, water samples of the lake profiles and the outflow are involved in the study. In summer 2023, the development of a hypolimnion was found in some of the investigated lakes. Thereby we make use of the circumstance that the dams have a special technical facility (“Striegelanlage”) to channel water from the bottom of the lake through the dam.

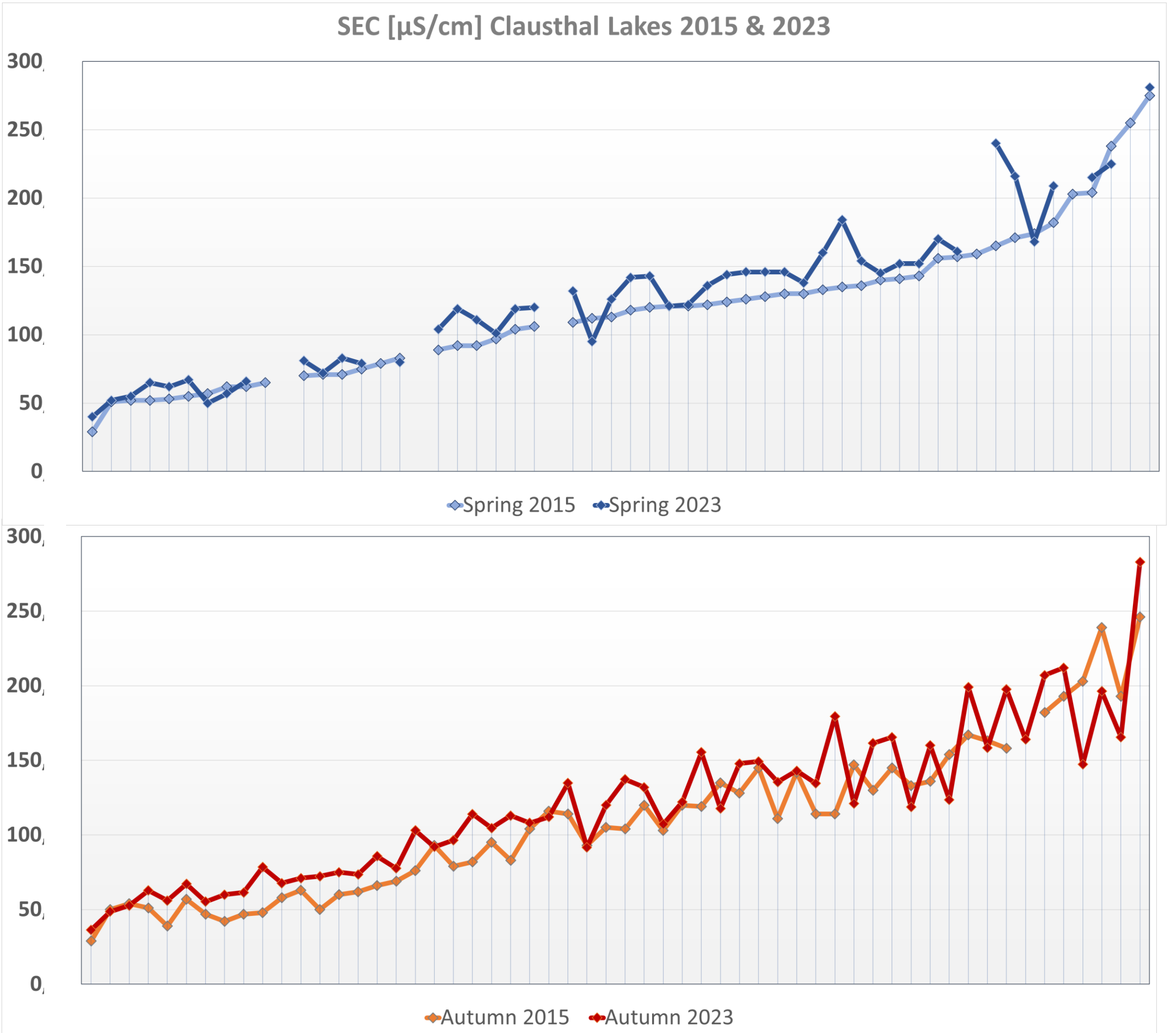


Sketch of a historical “Striegelanlage” to channel water through the dam (Schmidt, 1997)

Initial situation: SEC in spring 2015



SEC in Clausthal Lakes 2015 & 2023



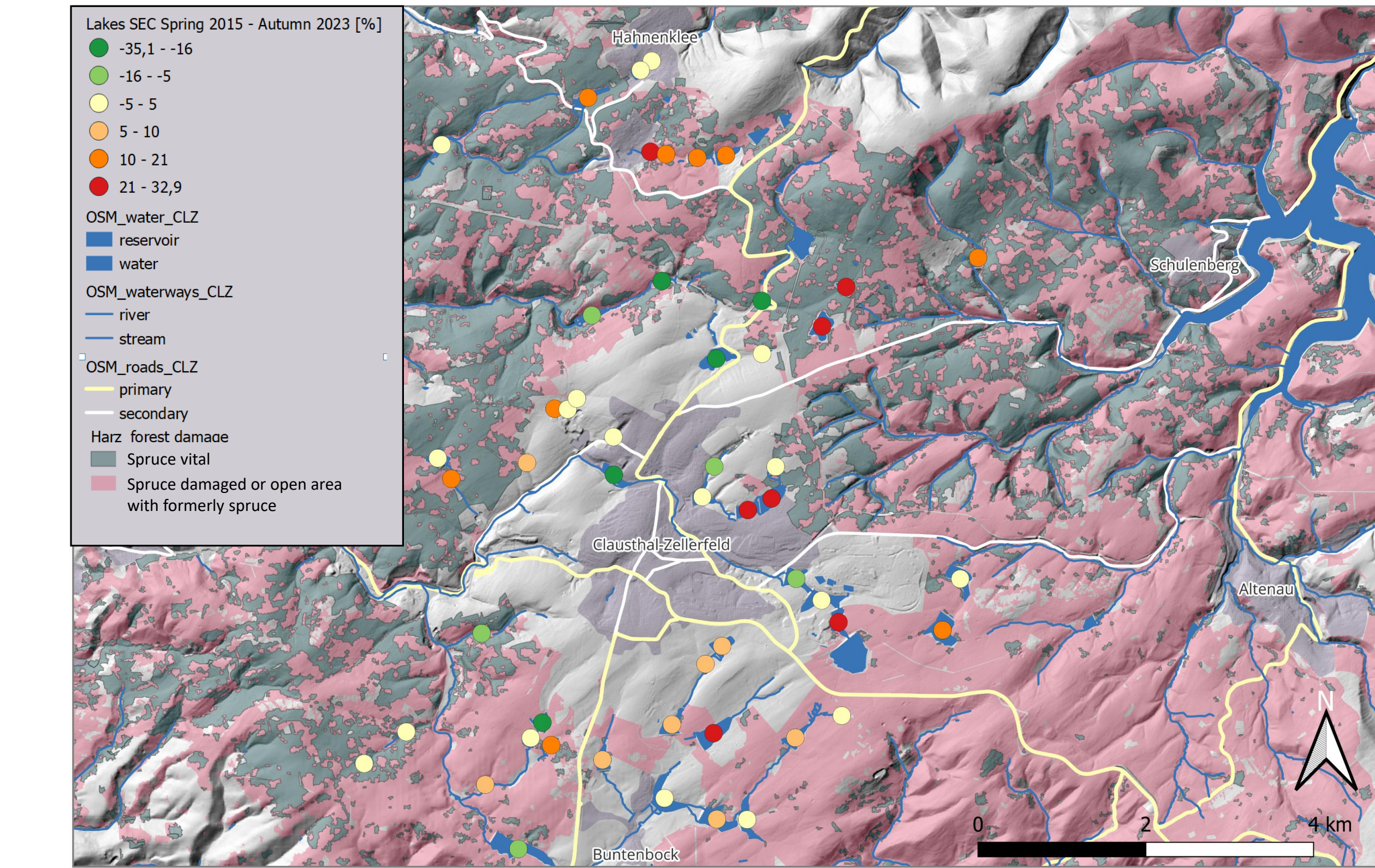
References

Bozau, E., Licha, T., Stärk, H.-J., Strauch, G., Voss, I., Wiegand, B. (2015): Hydrogeochemische Studien im Harzer Einzugsgebiet der Innerste. Clausthaler Geowissenschaften, 10, 35-46.
Schmidt, M. (1997): Wasserwanderwege. Piepersche Druckerei und Verlag GmbH, Clausthal-Zellerfeld.

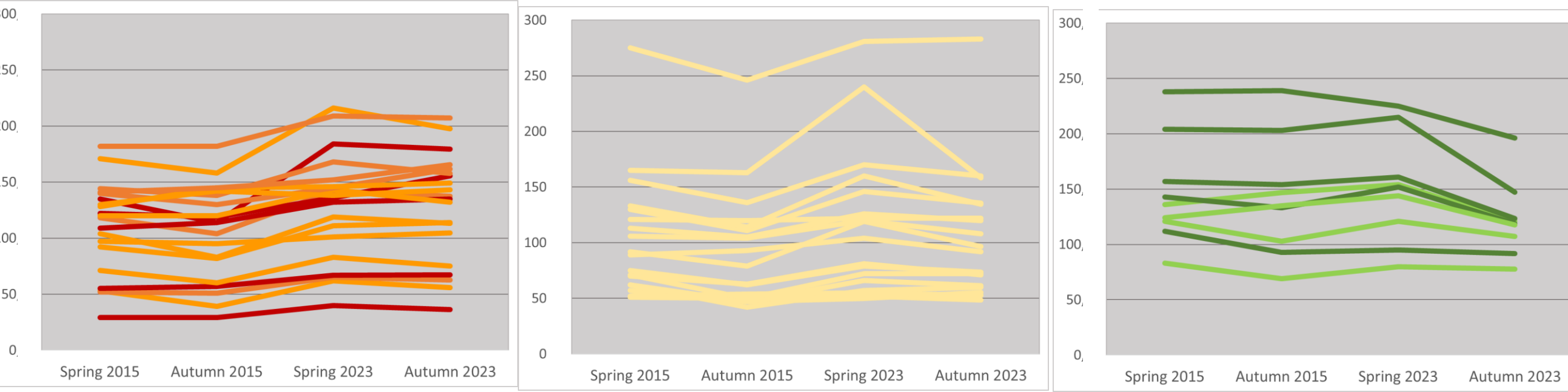
Maps & GIS

The shaded relief background map is licensed under DL-DE->BY-2.0: © GeoBasis-DE / BKG (2023), Datenlizenz Deutschland – Namensnennung – Version 2.0 (www.govdata.de/dl-de/by-2-0). Roads, water and waterways are based on OpenStreetMap data (openstreetmap.org/copyright). Shapes of urban areas are extracted from CORINE Land Cover 2018 data produced within the frame the European Union's Copernicus Land Monitoring Service information with funding by the European Union (<https://land.copernicus.eu/en/products/corine-land-cover/clc2018>). We thank „Niedersächsische Landesforsten, Forstplanungsamt“ for providing recent forest damage maps

Temporal change of SEC between spring 2015 and autumn 2023

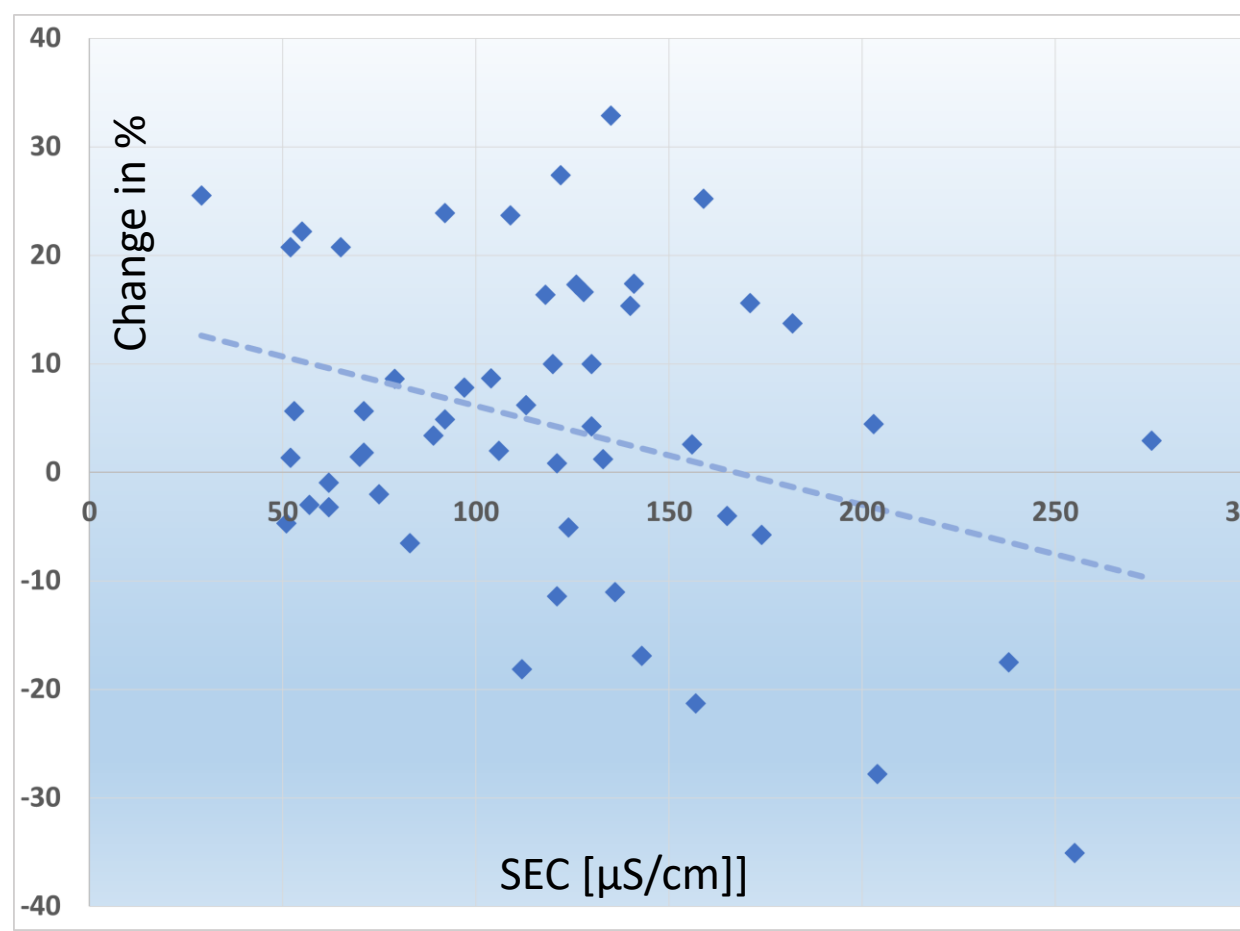


SEC Time series for lakes (colors as in map above)



Results & Conclusions

The SEC of the lake water ranges between approx. 30 and 280 µS/cm and can be used for the classification of these lakes. SEC lower than 50 µS/cm are typical for lakes mainly filled by rain water. SEC higher than 200 µS/cm are found in lakes near urban and anthropogenic influences. Due to the long dry periods of the last years an increase of the SEC is seen in the majority of lakes especially between spring 2015 and 2023.



Because of extraordinary high precipitation in autumn 2023 this trend stagnates or even decreases in some lakes, but is still observable in the comparison between autumn 2015 and autumn 2023. Only two lakes show a continuous decrease of the SEC. It is also indicated that lakes with generally low to intermediate SEC values tend to show higher increase of SEC between 2015 and 2023, whereas those with higher SEC values tend to decrease. We included forest damage maps by “Niedersächsische Landesforsten” in our GIS. These actually show no spatial dependence between the SEC values in lakes and forest damage areas. But nevertheless it gives an impression of spruce extinction over wide areas since 2018 in the region, which could also account for hydrochemical changes in the lakes.