

- *Lake water quality – Human impact – Contamination – Siltation – Persistent organic pollutants*

**Brigitta Schütt and Bernd W. Wenclawiak**

## **Off-Site Effects of Soil Erosion in the Environment of Lake Abaya, South Ethiopia**

*Off-site-Effekte der Bodenerosion auf die Umweltbedingungen  
des Abayasees, Süd-Äthiopien*

With 6 Figures and 3 Tables

Ever since *Wolfgang Weischet* published his seminal book "*Die ökologische Benachteiligung der Tropen*" (which translates as "The ecological disadvantage of the tropics") in 1977, the scientific community as well as actors in the area of environmental planning and conservation have been aware of the high ecological sensitivity of tropical environments and feedback loops triggered by various types of impact. For *Weischet* the fundamental problem of tropical ecology resulted from the fact that nutrients are not stored in the soil substrate but essentially circulate in the biomass and organic matter. There are, however, other aspects. The following article analyses the side-effects of soil erosion in the drainage basin environment of Lake Abaya in the Ethiopian Rift Valley. It examines the series of reactions triggered by soil erosion as a geomorphological process due to maladjusted land use, affecting the ecological balance. The case study shows that soil erosion by water not only causes soil degradation and formation of badlands but, due to the clayey character of the soils, also affects the quality of the receiving waters. The eroded soil serves as carrier of pollutants and nutrients, absorbed by the clays. High soil erosion rates cause a high overall sediment load in the drainage system. In the receiving lake this high sediment load accelerates siltation processes. In addition, as the sediment load is composed of clays as the products of intensive chemical weathering, the settling rate in the drainage basin is low. The resulting poor visibility of the lake water negatively affects the lake's primary production which in turn has a negative influence on fish production.

*Summary: Off-Site Effects of Soil Erosion in the Environment of Lake Abaya, South Ethiopia*

Lake Abaya is part of the Abaya-Chamo lake system, a graben fill in the southern section of the Main Ethiopian Rift Valley. The catchment of the Abaya-

Chamo lake system covers approx. 18 600 km<sup>2</sup>. Soil erosion processes in the catchment result in off-side effects such as a high sediment load of the tributaries and high deposition rates of fluvio-lacustrine sediments. Hence, lake turbidity of Lake Abaya has increased distinctly during the last four decades

and widespread delta sediments have been deposited. These sediments are predominantly composed of clay minerals and detrital organic matter which are both ideal adsorbent material for pollutants. Whereas heavy metals in the delta sediments were not detected above geogenic concentrations, high levels of DDT and metabolites were recorded. While at first sight Persistent Organic Pollutants (POP) sequestered to fluvio-lacustrine sediments seem to have been taken out of the food web, initial eutrophication must be assumed for Lake Abaya, indicating a likely remobilisation of POPs.

*Zusammenfassung: Off-site-Effekte der Bodenerosion auf die Umweltbedingungen des Abayasees, Süd-Äthiopien*

Der Abayasee ist Teil des Abaya-Chamo-Seesystems und ist ein Grabensee im südlichen Teil des äthiopischen Haupt-Rift-Valleys. Das Einzugsgebiet des Abaya-Chamo-Seesystems umfasst ca. 18 600 km<sup>2</sup>. Hohe Sedimentfrachten der Zuflüsse sind eine Folge von Bodenerosionsprozessen im Einzugsgebiet und führen zu hohen Ablagerungsraten fluvio-lakustriner Sedimente. Hierdurch wird in den letzten vier Dekaden eine merkliche Zunahme der Seewassertrübung verursacht, ebenso wie weitverbreitet die Ablagerung von Deltasedimenten. Die Deltasedimente setzen sich vornehmlich aus Tonmineralen und Pflanzendetritus zusammen, welche beide ideale Adsorbenten für Umweltschadstoffe sind. Während die Schwermetallkonzentrationen in den Deltasedimenten im Bereich des geogenen Hintergrundrauschens liegen, können erhöhte Konzentrationen DDT und seiner Metabolite nachgewiesen werden. Zwar scheinen solche Persistent Organic Pollutants (POP) mit der Sedimentation aus dem Nahrungsnetz herausgenommen zu sein, die nachgewiesene initiale Eutrophierung des Abayasees lässt jedoch eine Remobilisierung der POPs erwarten.

*Résumé: Effets hors site de l'érosion des sols sur les conditions environnementales du lac Abaya, Éthiopie méridionale*

Le lac Abaya appartient au système des lacs Abaya-Chamo, formés dans la partie méridionale du fossé d'effondrement éthiopien de la Rift-Valley. Le bassin de réception des lacs Abaya-Chamo comprend environ 18.600 km<sup>2</sup>. L'érosion des sols dans le bassin entraîne un transport considérable de sédiments par les affluents; il en résulte un taux élevé de dépôts en milieu fluvio-lacustre. On observe par conséquent une augmentation perceptible de la turbidité de l'eau ainsi que la formation de sédiments deltaïques. Ces sédiments sont surtout composés de minéraux d'argile et de détritiques organiques. Tous deux sont des matériaux absorbants de toxiques environnementaux. La présence de concentrations élevées de DDT et de ses métabolites a été prouvée. Il semble que ces polluants organiques persistants (POPs) aient été éliminés de la chaîne alimentaire par la sédimentation, mais il faut s'attendre à ce que l'eutrophisation initiale du lac Abaya cause une nouvelle mobilisation des POPs.

*Prof. Dr. Brigitta Schütt*, Freie Universität Berlin, Fachbereich Geowissenschaften, Physische Geographie, Malteserstr. 74-100, Haus H, 12249 Berlin, Germany, brigitta.schuett@fu-berlin.de

*Prof. Dr. Bernd W. Wenclawiak*, Universität Siegen, Fachbereich 8 – Analytische Chemie, Adolf-Reichwein-Str. 2, 57068 Siegen, Germany, wenclawiak@chemie.uni-siegen.de

Manuscript submitted: 02/04/2009

Accepted for publication: 10/02/2010