# Editorial: Do We Need a Journal of Soils AND Sediments (Part 2)?

## A Comment from the Soil-science Perspective to the Editorial 'New and recent developments in soil and sediment management, policy and science' by Sabine E. Apitz

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### 1 Origin and Development of Soils and Sediments

Indeed, there is no clear borderline between soils and sediments, because both are interlinked by hydrological and terrestrial phases, which will be explained by three examples.

(1) **Underwater soils.** In soil classification, terrestrial and aquatic soils are distinguished. To the latter group belong the underwater soils, which were first described by Swedish scientists. They observed the growth of bogs out of the stagnant water of lakes and ponds, based on the detritus of plant material, grown in water. These soils are, for example, 'Dy', 'Gyttia', and 'Sapropel', which show different physical, chemical and biological characteristics, and form a kind of sediment at the bottom of stagnant surface-water systems. They mainly consist of organics, with some mineral components. Through the further development, these sub-water soils may grow up to the water surface, even growing above the water level, as peat material, forming huge bog areas, which happened during the last 10–12,000 years, since the end of the last ice age, especially in countries of the northern hemisphere.

(2) **Terrestrial soils.** In contrast, there exist terrestrial soils which are intentionally flooded for food production, e.g. for rice production in large parts of Asia (and other regions of the world). These flooded soils behave like sediments during flooding, because their aeration status, and concomitantly their oxygen content, decreases with the development of reductive conditions, which correspond more to underwater sediments than to terrestrial soils. Since this is only a transitional status during the years' cycle, and all these soils will dry again, e.g. after harvest, nobody would define those paddy soils as underwater soils or sediments, even if describing them during the highest irrigation stage.

(3) **Alluvial soils.** A third example concerns alluvial soils, which develop on river sediments, distributed alongside waterways including estuaries and river deltas (e.g. Mississippi and Niger delta), in which alluvial soils with abundant vegetation covers develop through flooding, inundation and deposition. The latter are more commonly called 'wetlands' and provide important ecosystem services (Constanza et al. 1997). The parent material of these soils is exclusively sediment material, which was, often for a very long time period, river sediment, before it was brought to the surface by flooding.

These alluvial soils testify to the maximum flooding stages of rivers, which were reached during the last 10–12,000 years. Therefore, they contain most important information for protecting human settlements and other economic and technical infrastructure against flooding and severe damage, as experienced in the last decade, through disastrous events in Europe and other parts of the world. By observing this information, a sustainable land-use planning can be performed, avoiding constructions in areas which are potentially prone to flooding.

These three examples clearly show that soils and sediments have many characteristics in common. The main difference between them is caused by the prevailing ecological conditions under which they develop and perform. When these materials develop and perform under terrestrial conditions, they are predominantly soils, and under aquatic conditions, they are sediments, with some overlapping, due to different time scales and different classification systems, as explained above.

If we look at soils and sediments from this point of view, it can be said that soils or sediments can only be defined for time intervals, during which they are either under hydrological or under terrestrial conditions. Changes between both conditions seem to be quite normal in hydrologically defined physio-geographical areas, such as river basins or watersheds, in which soils may develop through weathering and other processes, and afterwards become sediments again through erosion and transport into open water systems. These sediments may become soils through transport, flooding and deposition. The main active medium in this cycle is water, which defines, based on gravity, which stage is predominant in a certain area and a certain time interval.

### 2 Management of Soils and Sediments

Thus it becomes clear that all kinds of soils and sediment management should be based on hydrologically defined, physio-geographical units (watersheds and river basins, see above).

However, this does not imply that soil and sediments should be managed in a similar way. Since historical times, tremendous changes have taken place in the management of both media, as explained in Apitz 2005. Due to enormous human impacts, both media were strongly influenced or even changed through different threats, such as erosion, local and diffuse contamination, loss of organic matter, salinisation, sealing, compaction, floods and landslides and loss of biodiversity (European Commission 2002), which impose, on one side, increased threats to sediments of aquatic systems, leading to problems in waterways, especially those which were used for navigation and other purposes. Due to enormous human impacts, both media have been strongly influenced or even changed through various threats, such as erosion, local and diffuse contamination, loss of organic matter, salinisation, sealing, compaction, floods and landslides and loss of biodiversity (European Commission 2002), and agricultural practices including the intentional addition of fertilizers and pesticides. These land use activities impose, on one side, increased threats to sediments in aquatic systems, leading to problems in waterways, especially those which are used for navigation and other purposes. On the other hand, the accessibility of soils and the ability to change agricultural and land management actions results in there being more direct management options for soils, which can protect both soils and sediments. On the other side, soils were severely changed or even destroyed, impairing their functions, as explained by S.E. Apitz (Apitz 2005), even to such an extent that in extreme cases they are converted into sediments by erosion. However, there exist differences: Under terrestrial, subaerial conditions, soils can accumulate much higher amounts of organic matter, while still remaining aerobic, than can subaquatic sediments. This accumulation of organic matter in soils allows a high biological activity under aerobic conditions, expressed by the amount of living organisms in soil, which exceed several times all above-ground biota in number and quantity. Although anaerobic microbial processes and bioturbation extend biological activity in organic-rich sediment systems to some depth in the sediments, the zone of extensive, aerobic biological activity, although equivalent in density to soil systems, extends to much shallower depths.

In an average meadow soil in Central Europe, about 25 t of organisms live in one ha (100 x 100 m) and 30 cm of soil depth, which corresponds to about 2.5 kg of living organisms per m² soil and 30 cm of depth. 10 t thereof are bacteria and actinomycetes, about 10 t fungi, about 4 t earthworms and one further ton are other soil biota, ranging from mice to little insects. The variety and activity of these biota undergoes an annual cycling, which in most cases is more extreme than changes in biological activities of sediments, which occur, predominantly, under anaerobic conditions and are of great ecological importance.

### 3 New Scientific Approaches Bringing Soils and Sediments Together

Under these conditions, strong links between soil and sediment research should be established, co-operating within hydrologically defined physio-geographic areas, such as watersheds and river basins.

This was also clearly expressed in the last and 4th Call within the 6th Research Framework Programme of the European Union, where proposals were submitted with titles such as 'Risk-based management of the soil-sediment-water system at river-basin scale', showing that, especially in the field of targeted research, a clear paradigm shift has taken place, looking more into the complexity of terrestrial and aquatic ecosystems, instead of following specialisation in sciences, which is certainly not helpful for solving complex environmental and technical issues. Not only scientists are interested in understanding complex systems. Also politicians and decision makers are looking forward to solutions in the field of steering complex cultural, social, economic, ecological and technical systems, aiming at a sustainable use of natural resources. Due to this, new research approaches were defined within the European Thematic Strategy for Soil Protection (Blum et al. 2004a, 2004b), which were partly discussed under the title 'Soils and Climate Change' (Blum 2005, Editorial).

This new approach distinguishes between five main research clusters in ecological research, opening the possibility for co-operation between different sciences, not only soil and sediment science.

Concluding, I fully agree with the statements made by Sabine E. Apitz (Apitz 2005), underlining once more the necessity of a co-operation between sediment and soil sciences, despite differences in specific domains.

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