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WATER AND LANDSCAPE MANAGEMENT ASPECTS IN THE NEUSIEDLER SEE REGION

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Abstract

The "Neusiedler See-Seewinkel" is the first and biggest Ramsar Site in Austria designated in 1982. In 2009 a transboundary Austrian-Hungarian site "Neusiedler See-Seewinkel-Hanság" was inscribed to the List of Wetlands of International Importance including present Ramsar Sites in both countries. Aside from that, a national park "Neusiedler See-Seewinkel" was founded in 1993 and co-managed with the Hungarian national park "Fertő-Hanság", founded in 1991. These sites consist of the lake Neusiedler See itself, small saline lakes, salt meadows and fens. The Neusiedler See is a steppe lake with an extensive reed area and marshes. It is one of the biggest wetlands in Central Europe covering a total area of 321 km², whereof the free water surface covers 143 km² and the reed belt covers 178 km² (Csaplovics, 1997). The water balance of the lake is dominated by precipitation and evaporation and just minor inflow of the river Wulka. Originally, the lake has no natural outflow, but at the end of the 19th century an artificial channel for access water drainage was constructed. Nowadays, the lake water level is regulated by a weir according to operation rules and supervised by an Austro-Hungarian committee for water bodies. The operation rules define a water level range; however the lower limit is prone to draught conditions. For this reason, an important aspect of water management actions, like building of small weirs or closing of channels, is the water retention in the area. For improvement of lake water management a cooperation project "New Geodetic Survey of the Lake Neusiedl–Hanság-Channel System" between Hungary and Austria was initialised in order to provide a homogeneous topographic data base of the Neusiedler See basin and the Hanság-Channel including the investigation of the huge, stratified mud body of the lake and the reed bed. For the detection of the sludge layer and the lake bed echo sounding techniques of spatial and vertical high resolution were used for the free water surface. Single-point measurements were conducted as a reference with a new adapted measuring technique. They provide a high-resolution vertical profile of the sludge distribution and the bottom layer. Further single-point measurements were conducted in shallow water areas below 60 cm, where the use of echo sounding is limited, as well as in the hardly accessible reed belt.
The acquired knowledge about the state of the lake is essential for an appropriate lake and wetland management and overall landscape preservation.

Keywords: shallow lake, transboundary water management, water level regulation, lake survey

1 INTRODUCTION

The Neusiedler See (Hungarian: Fertö) is the westernmost steppe lake in Europe located in the western part of the Little Hungarian Plain. The lake basin covers a total area of 321 km² at the boundary line of 166.50 m above Adriatic Sea level, of which 233 km² are on the Austrian and 88 km² are on the Hungarian Territory (Bácsatyai et al., 1997). Just 143 km² of the total area are open water body. It is surrounded by an extensive reed belt of about 178 km² (Csaplovics, 1985), which is the second largest connected reed belt in Europe. The Seewinkel, which is also designated to the Ramsar Site and the national park, extends on the Eastern shore of the lake bordering Northern Hungarian and contains salt soils and about 45 saline lakes, salt meadows and fens. The Hanság extends on 460 km² in the South of the Seewinkel mainly on Hungarian Territory, just 70 km² from the total area are on Austrian Territory so-called Waasen. Until the 16th century the Hanság had been part of the lake but was subsequently drained so that it became a swampy area in the 18th and 19th century and nowadays it is almost dry (Nationalpark Neusiedler See – Seewinkel, 2012). The lake is quite shallow with a huge stratified mud body consisting mainly of fine sediments. The water balance of the lake is dominated by precipitation and evaporation and just minor inflow of the river Wulka. Due to that the lake is prone to strong water level fluctuations and even to draught conditions especially in summer at high evaporation rates; however the extent of the lake varies with the water level and ranges from complete desiccation to an area of about 500 km². In the 18th century the lake had dried out four times and the last vanishing was from 1864 to 1870 (Nationalpark Neusiedler See – Seewinkel, 2012). During draught conditions the lake basin was cultivated but the salt soils are not very fertile. Even more distinctive are water level fluctuations of hay meadows but especially of saline lakes in

the Seewinkel that dry out periodically. They stay water logged due to less permeable soil and precipitation during winter period, but most of them will dry out during summer period.
Because of the environmental diversity the Neusiedler See region is habitat for many wildlife species especially birds and an important wetland in Central Europe. For conservation and wise use of the wetland and its resources the "Neusiedler See-Seewinkel" is designated to the Ramsar Convention on Wetlands in 1982 as the first and biggest Ramsar Site in Austria. In 2009 a transboundary Austrian-Hungarian site "Neusiedler See-Seewinkel-Hanság" was inscribed to the List of Wetlands of International Importance including present Ramsar Sites in both countries. Aside from that, for nature and natural resources conservation a national park "Neusiedler See-Seewinkel" was founded in 1993 and co-managed with the Hungarian national park "Fertő-Hanság", founded in 1991.

About 90 km² of the national park are on Austrian Territory and out of that 50% of the area is a Nature Reserve Zone and therefore remains without human activities. The remaining part consists mainly of cultural landscapes designated to Conservation Zones that undergo special landscape conservation measures. The inherent habitats are: Neusiedler See and its reed belt, saline lakes that dry out periodically, hay meadows, pasture land and small sand habitats (Nationalpark Neusiedler See – Seewinkel, 2012).

2 WATER MANAGEMENT STRATEGIES

2.1 Water level regulation

Originally, the Neusiedler See has no natural outflow, but at the end of the 19th century an artificial channel for access water drainage was constructed. A weir at the main regulation channel Hanság regulates nowadays the lake water level according to operation rules and supervised by an Austro-Hungarian committee for water bodies. Since 1965 the mean water level is about 40 cm higher than before due to a change of water level regulation rules (Figure 1) (Eitzinger et al., 2005). The weir can only prevent flooding (drainage of excess water) but not raise the lake water level, thus the lake water level is predominated by precipitation and evaporation. If evaporation in summer cannot be compensated by precipitation in winter the water level already drops in spring. The water level can vary 60 cm within one year (Nationalpark Neusiedler See – Seewinkel, 2012).

Since 150 years drainage activities by a channel system has taken place and lowered the groundwater level in some places. Nowadays, the national park undertakes measures to increase water level to flood former water-logged areas and to re-establish higher groundwater level again. Other interventions in the water balance of the lake are irrigation and wells, gravel pits, area for infrastructure, fishery and hunting as well as tourism.

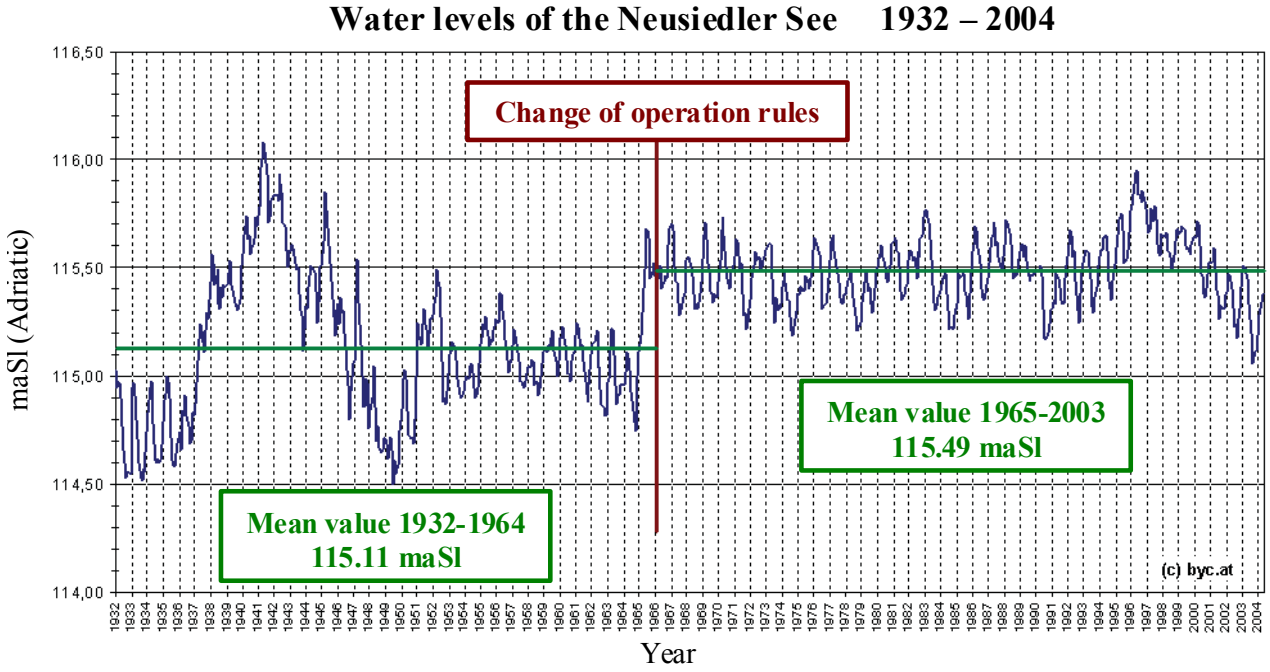

Figure 1. Water level fluctuations of the lake from 1932 – 2004 (BYC Chronics; in Eitzinger et al., 2005)

2.2 Saline lakes and ponds

About 45 saline lakes and ponds (so-called Lacken) are located on the east shore of the Neusiedler See between the lake and the Hanság. They are highly characteristic for the Seewinkel but also unique as such landscapes are rare in the European inland. Some of the central saline lakes are even older than the lake. A depression with an impermeable bottom and a soda-carrying horizon supports the development of the saline lakes and a regular desiccation maintains them. At groundwater levels close to the bottom of the saline lakes, salts reach the system by capillary rise (Figure 2). A drop in groundwater level will reduce delivery of salts, the salinity of the lakes will decrease and the saline lakes will disappear. Therefore an artificial drop in groundwater level due to human interference needs to be prevented. Saline lakes differ in their chemical composition due to different soil substrates, thus the preservation of each saline lake is important.

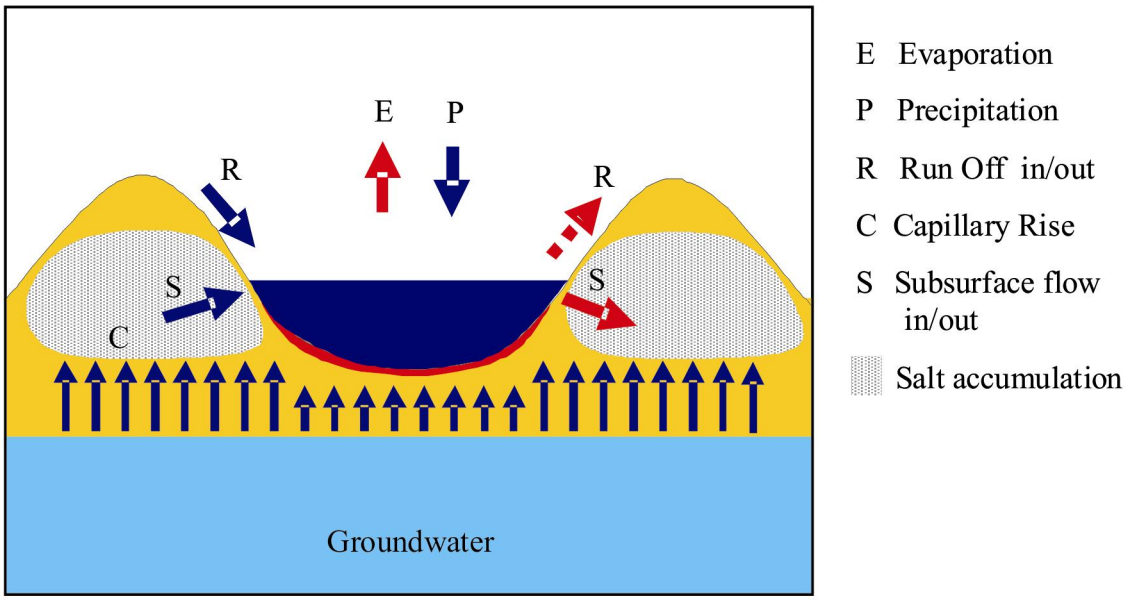

Figure 2. Water balance of a saline pond

2.3 Reed belt

The reed belt of the Neusiedler See covers 178 km². The shallow basin of the Neusiedler See encourages the growth of distinctive reed habitats, which are multi-functional ecotopes high in biodiversity (Schmidt&Csaplovics, 2010). Impacts of economical regional development concerning industry, agriculture and tourism expansion as well as environmental pollution subsequently harm the reed habitats. For this reason management strategies must consider spatial planning of both nature conservation and sustainable regional development (Csaplovics&Schmidt, 2011). But also the development of the reed belt from 1872-1967 (Figure 3) points at the necessity on management strategies because the increase in reed covered areas is significant. Kopf calculated on the basis of the reed expansion since 1926 that if the reed is unmanaged, it will entirely overgrow the lake by 2120 (Burian&Sieghardt, 1979). Often occurring periods of low water level especially after the regulation by the Hanság Channel and increasing eutrophication due to agriculture and settlements are stated to be main factors of extensive reed growth. Therefore a reed survey "Mapping the austrian reed bed of Neusiedler See by means of Airborne Optical Scanner Imagery" (Schmidt&Csaplovics, 2010) was conducted including recent areal photographs of the reed stand from August 2008. The application of various sensor systems, such as hybrid methods of airborne and spaceborne remote sensing coupled with detailed ground sampling enables spatial data acquisition over large wetland areas with very high geometric resolution of ground land cover and land use (Csaplovics&Schmidt, 2011). Spatial monitoring and mapping of the reed provided information of the extent and structure of reed stands classified according to parameters of vegetation height and density as well as fraction of old and young reed stands. Young and vital reed occurs on the shoreline water-reed whereas old reed of low density occurs within the reed belt (Schmidt&Csaplovics, 2010). Overall, the implementation of reed habitat management activities is more and more taken into account by administrative and research institutions since a few years.

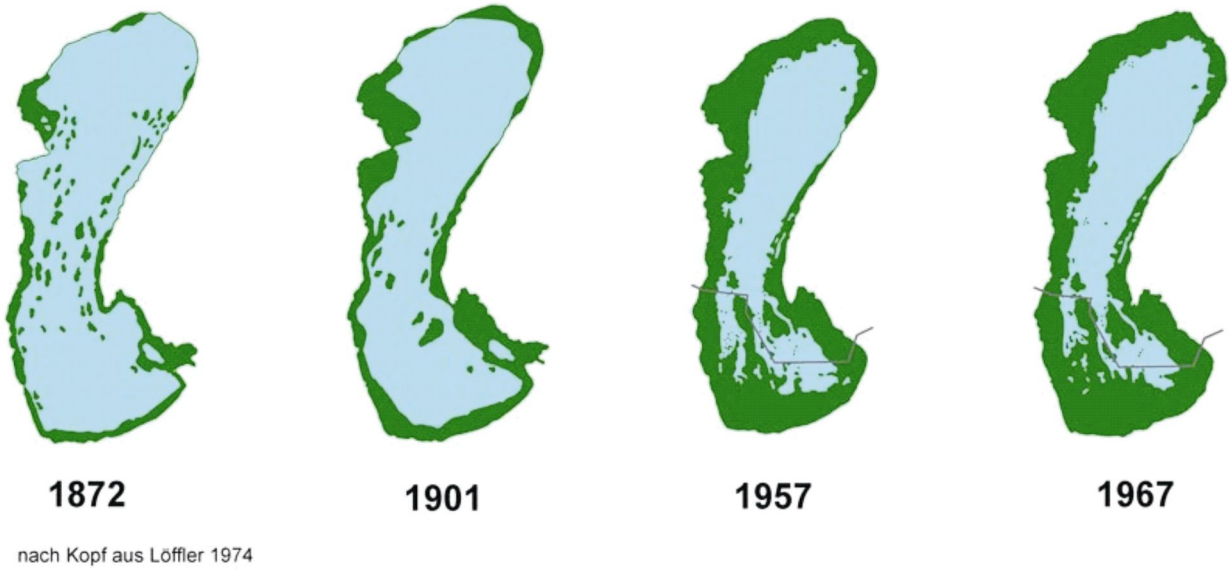

Figure 3. Evolution and change of the reed belt from 1872-1967
(Burian&Sieghardt, 1979; online: Nationalpark Neusiedler See – Seewinkel, 2012)

2.4 Habitat Management

The various forms of habitats in the Neusiedler See region − inherent and man-made, such as saline lakes, fens, sand habitats, meadows and pasture are highly influenced by human interference. They are inhabited by many plants and wildlife species especially birds for breeding and nesting. For this and other reasons, the preservation of the cultural landscape and the biodiversity of the Neusiedler See region including the Seewinkel due to special management activities are important. These activities include pasturing and mowing, reed harvesting, water retention and domestic animal preservation and are coordinated and conducted by the national park. Within the Conservation Zone the national park even aims an improvement of the biotope quality in cultivated areas by habitat management taking into account latest research projects as well as traditional farming and extensive agriculture (Nationalpark Neusiedler See – Seewinkel, 2012). Examples of habitat management are listed:

Water Retention

Wet and water logged areas such as wet meadows and pasture land were systematically drained and transferred into farmland and vineyards in former times causing enormous environmental harm. But lately also due to different demand on modern farming, farmland area in the national park area has been given up and so the drainage channels lost their function. Retention measures are now undertaken in some areas of the Conservation Zone by slowing down water run-off due to several locks at drainage channels built in 2008 or by rewetting and flooding areas periodically or even permanent (Nationalpark Neusiedler See – Seewinkel, 2012).

Reed farming

Reed farming and harvesting is another important habitat management activity that supports a variety of structure within the reed in order to provide high biotope diversity. It is mostly undertaken by local companies under supervision of the national park. The reed is harvested every year in winter until March 15th on alternating selected reed areas on the landward side of the lake's reed belt, some wet meadows and the shore of saline lakes. At some saline lakes and reed overgrown meadows habitat management aims to remove the reed by reed cutting, to recreate open land which is important for pasture and mowing.

Meadows and pasture

The steppe-like landscape of meadows and pasture is characteristic for the Neusiedler See region and has developed over the time by pasturing and mowing — two measures that are nowadays undertaken by the national park and local farmers in order to preserve the habitat.

Sand habitats

Due to dry climate conditions and low precipitation sand habitats could develop in the region and some of them even remain open and not overgrown. The sand habitats diminished because of afforestation and transformation into vineyards but the national park ensures the preservation of the remaining areas.

3 TOPOGRAPHIC INVESTIGATIONS

The cooperation project "New Geodetic Survey of the Lake Neusiedl–Hanság-Channel System (GeNeSee)" between Hungary and Austria was initialized in order to provide a homogeneous topographic data base of the Neusiedler See basin and the Hanság-Channel including the investigation of the mud body of the lake and the reed bed. Moreover, the project aims for a better understanding of the system Neusiedler See to improve management activities such as optimizing the operation rules for water level regulation by the weir, improving flood risk prevention, adopting agricultural use of the lake shore, optimizing regional reed farming and a long-term provision of nature conservation.

The working packages of the project include: project management, data inventory, echo sounder measurements, single-point measurements, Airborne Laser scanning, evaluation of the lake basin and the Hanság Channel, data provision and dissemination of information for regional users (GeNeSee, 2011). In the following single-point measurements conducted and preliminary results of first field investigations will be discussed.

One essential task is the determination of the water level–volume ratio of the lake. The shallow steppe lake consists of a huge, stratified mud body and thus, the water content in the mud supports to some extent the water volume of the lake. For the detection of the sludge and the bottom layer echo sounding techniques of spatial and vertical high resolution are used for the open water body. Thus, a vast expanse of the lake is rapidly acquired. However, in already weak sludge layers this echo sounder returned multiple signals which are hardly to be classified. For this reason, single-point measurements are additionally conducted as a reference with an adopted soil physical measuring technique synchronized with a GPS positioning system that enables rapid in-situ survey with a height resolution of ± 2 cm. Hence, a high-resolution vertical profile of sludge distribution and the bottom layer is provided. The measuring system consists of a capacitive sensor measuring the water content and a penetrometer measuring the pressure resistance. Certain criteria to delineate the layer boundaries between water, sludge and lake bottom should be preliminary stated in order to produce consistent data to calculate the lake volume including the sludge water content. Further, single-point measurements are also conducted in shallow water areas below 60 cm, where the use of echo sounding is limited, as well as in the hardly accessible reed belt areas covering more than 50% of the lake.

For its applicability the soil physical equipment was tested during field investigations and laboratory calibration. First results of the field investigation where obtained in a regularly dredged harbour. Figure 4 shows a profile of sludge and the bottom layer at one point. A huge soft sludge layer of about 200 cm height can be identified due to volumetric water content for 3 replicate measurements (triangles). The upper boundary water-sludge is indicated by a sharp decline of water content and a second decline indicates compact sludge. The same trend is given for all replicas, just slight variance due to spatial variability occurred. Pressure resistance is the significant factor for more compact layers. A sharp increase in pressure resistance of the penetrometer (dashed or continuous blue line) indicates a compact dense layer, much more compact than a sludge layer where pressure resistance is too low to be measured.

First field applications of single-point measurements were already carried out as reference for echo sounder measurements at the open water body. Based on the echo sounder results 60 points were selected for a measuring campaign in spring 2012. At each point at least 2 to 3 measurements with the capacitive sensor and the penetrometer were taken as repetition to proof the result and to detect occurring spatial variability. The measurements were performed from a small barge stabilized by two poles at calm wind conditions.

4 CONCLUSIONS

To maintain the fragile ecosystem Neusiedler See region well planned and careful interventions are needed. To leave the landscape without any management is not sufficient since the system was objected to anthropogenic influences over a long period and moreover created by these symbioses. Lake water management as part of it affects the surrounding areas as well and hence has to be seen in a holistic context. Landscape and water management activities need to be coordinated. For an appropriate water management the water level-volume ratio of the lake is needed and currently under investigation. This includes measurements of mud layers. Lake water management is important not only for the lake ecosystem, but also for the adjacent area and ground water management. The unique salt lakes and ponds are maintained only if groundwater regulation and water retention are provided.

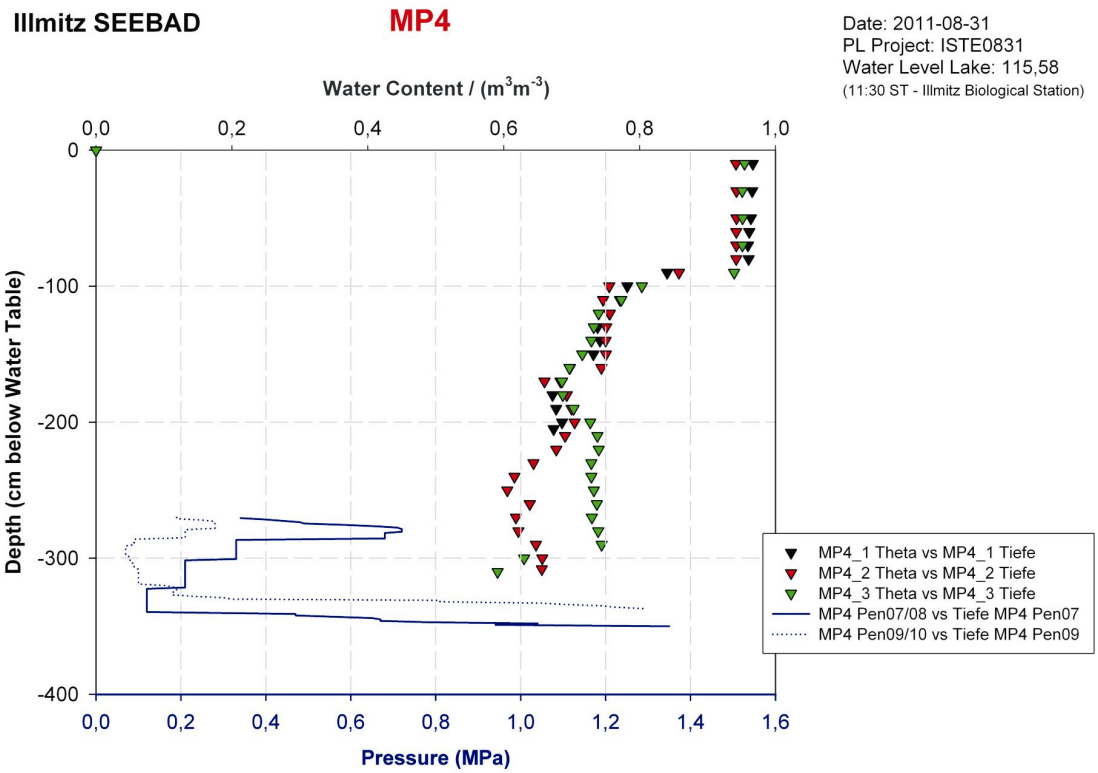

Figure 4. Profile of sludge and bottom layer at a dredged harbour (Illmitz Seebad)

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