The Imnati Mire in the Kolkheti Lowland in Georgia

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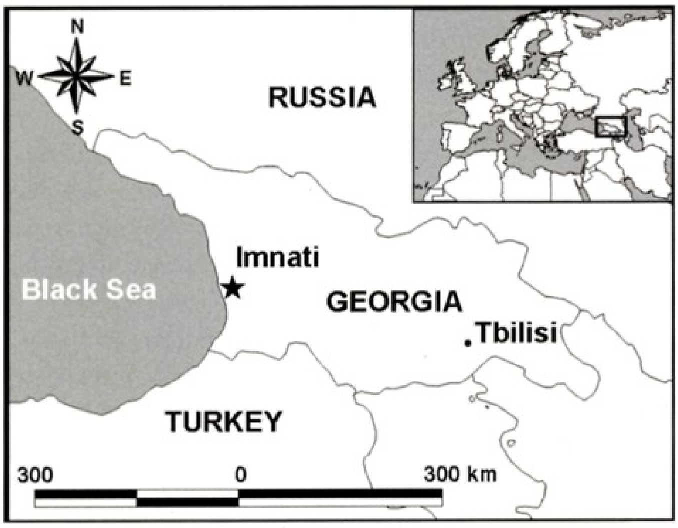

Imnati, the largest mire in Georgia, is a worldwide unique percolation bog with a characteristic vegetation of Saw grass and peat mosses. In spite of its status as a National Park and Ramsar site, the mire is threatened by human activities.

The Kolkheti (Colchis) area in Western Georgia (Caucasus) at the coast of the Black Sea is known for its extensive and special mires that - situated between citrus groves and tea plantations - form a structural and functional transition between the mires of the boreal and those of the tropical zones (Joosten et al. 2003). The special character of the area and its mires brought Botch & Masing (1983) and Succow & Joosten (2001) to the distinction of a specific Kolkheti mire region within Eurasia.

The characteristic mire type of this region is the percolation bog (Joosten & Clarke 2002), a dome-shaped Sphagnum mire only fed by precipitation, that – in contrast to bogs in other parts of the world - has slightly humified and highly permeable peat over its total depth. This allows water to percolate through the whole peat body (Lamme 2006). The absence of substantial surface-water flow prevents the differentiation of hummocks and hollows (Couwenberg & Joosten 2005) giving these mires their typical smooth surface.

The existence of percolation bogs in the Kolkheti lowland was - on theoretical grounds - predicted on the basis of the prevailing extremely high and continuous precipitation (Couwenberg & Joosten 1999). The worldwide first percolation bog that was discovered and intensively studied was the mire Ispani 2 near Kobuleti in the southern part of the Kolkheti lowland (Kaffke et al. 2000).

In order to test and improve the concept of percolation bog, the Imnati mire, with similar morphological features, was focus of further research.

Imnati is situated in the centre of the Kolkheti lowland 30 km north of Ispani 2 close to the Black Sea (Fig.1). The climate is characterised by continuous precipitation (1661 mm a^{-1}) and a high humidity (80%), with a high mean annual temperature (14.1°C) and hardly any frost.

Imnati constitutes, with 5000 ha of non forested mire, 11% of the peatland area in Georgia. It is part of the "Wetlands of Central Kolkheti" Ramsar site designated in 1997 and is incorporated in the Kolkheti National Park which was established in 1999.

Imnati consists of two separate bog cupolas. The western cupola (Fig.2) was studied in detail in 2004 and 2005 by Greifswald University (Germany) in cooperation with the Integrated Coastal Zone Management (ICZM) Centre Tbilisi, the Kolkheti National Park, and the Georgian botanist Izolda Matchutadze (Kahrmann & Haberl 2005).

Peat formation

Peat formation in Imnati began approx. 6000 BP (Nejstadt et al. 1965). Before that, the area was a lagoon separated from the Black Sea by a spit build up of sediments from the Rioni River. Over the clay and silt sediments of the lagoon, a peat body of 3 to 12 m depth accumulated (Fig.3). The peat

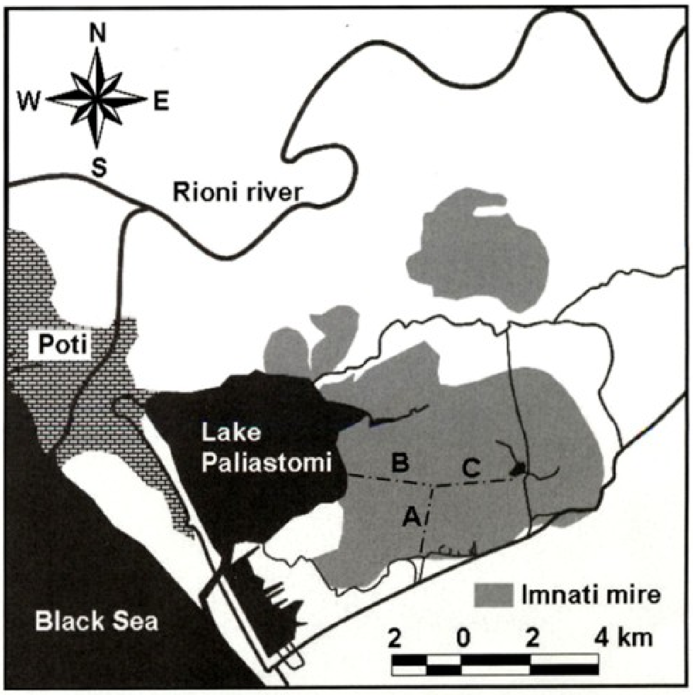

Fig. 1, top left: Imnati mire in the Kolkheti lowland (Western Georgia)
Fig. 2, above: Map of Imnati mire with the locations of the transects.

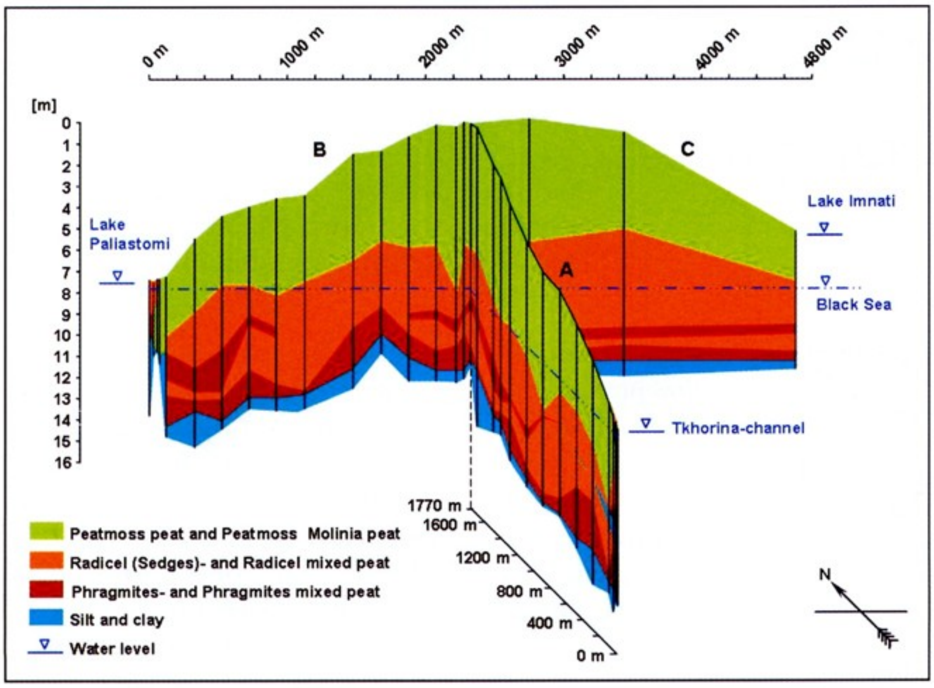

Fig. 3: Stratigraphy of the western part of the Imnati mire (Kahrmann & Haberl 2005).

stratigraphy reveals two main phases of mire development.

A fen phase started with the terrestrialisation of the lagoon by stands of reed (*Phragmites australis*) growing under nutrient rich conditions. Peat accumulation led to a decrease in nutrient availability and to a vegetation dominated by sedges (e.g. *Carex lasiocarpa*, *C. rostrata*) and Purple moor grass (*Molinia litoralis*). Also Saw grass (*Cladium mariscus*) was abundant in this period which led to the local formation of Cladium peat. The fen phase lasted for approx. 4000 years because of continuous tectonic sinking of the area. For a short time tectonic subsidence was even faster than peat accumulation leading to a renewed establishment of Phragmites.

Finally, at about 2000 BP, peat accumulation rates exceeded the rate of sea level rise, the influence of rain water increased, and the bog phase with dominance of peat mosses (e.g. *Sphagnum imbricatum*, *S. papillosum*) and Purple moor grass started. Molinia-Sphagnum peat of up to 6 m thick raised the surface of the bog to more than 5 m above the current Black Sea level.

The warm/humid climatic conditions led to the accumulation of very loose and hardly humified Sphagnum peats with a characteristic high proportion of rootlets and stem bases of Purple moor grass. These features explain the large active porosity and hydraulic conductivity of the peat.

Vegetation

The recent vegetation of Imnati is composed of a few vascular plants and peat moss species. The major area of the mire is covered by a peat moss carpet with Yellow Azalea (*Rhododendron luteum*) and Purple moor grass. Remarkable are the co-occurrence of high coverages of Purple moor grass and sedges (50%) where peat mosses still cover 90%. Despite its southern location and warm-temperate climate, boreal mire flora elements like Round-leaved sundew (*Drosera rotundifolia*), Bog bean (*Menyanthes trifoliata*), White Beak-sedge (*Rhynchospora alba*), and Wool fruited sedge (*Carex lasiocarpa*) are abundant. Invasive vascular plant species e.g. *Polygonum thunbergii*, Blackberry (*Rubus fruticosus*), Burr marigold (*Bidens tripartita*), and *Microstegium japonicum* and a lower coverage of peat mosses indicate human impact close to the margin of the mire.

Extraordinary is the frequent occurrence of Saw grass (*Cladium mariscus*) that is found in large and vital stands overlying peat bog deposits up to 5 m deep. Saw grass is known as a basi- and calciphilous species that grows in bogs only on shallow bog deposits where it is interpreted as a receding relict species of a former fen phase (Lutz 1938). Our measurements of electric conductivity and piezometric levels in the elevated parts of Imnati rule out that Saw grass reflects upward seepage of calcareous groundwater: the sites are fully ombrotrophic.

Fig. 4: The Imnati mire with the Minor Caucasus in the background.

Fig 5: High coverages of Purple Moorgras and sedges in a dense carpet of peat mosses.

The warm-temperate climate of the Kolkheti lowland seems to enable the thermophilic species to cope with acid and nutrient poor conditions naturally. But also human impact like frequent burning may have enhanced Saw grass. Human impact is also reflected in the peat stratigraphy in the uppermost 0.2 - 0.5 m, in which remnants of Purple moor grass prevail. Also the absence of *Sphagnum imbricatum*, a fire-sensitive species that was still abundant in the 1930s (Dokturovski 1936), points in the same direction.

Hydrology

With respect to hydrological characteristics, Imnati shows an average phreatic water level of -8 cm below the mire surface and water table fluctuations of less than 14 cm in average. The hydraulic conductivity of the peat (also at greater depths) has values 0.1 – 5 md^{-1} higher than in other bogs worldwide. The hydraulic conductivity changes little over depth, with a decrease of generally only one order of magnitude from 0.4 – 3.9 m. This enables water to flow through the whole bog peat body (Lamme 2006). The high hydraulic conductivity of the porous peat prevents surface run off in periods with high precipitation and leads to better nutrient availability through water flow (rheotrophy sensu Kulczyński 1949). On the other hand it would cause a running dry of the mire in dry periods that frequently occur in summer and may last for several weeks. Desiccation, however, does not happen because of the high elasticity of the peat that results from its high root content and the low humification, which provide a good oscillation capacity of the mire surface. The mire surface sinks with the phreatic water level in dry periods and rises in periods of high rainfall (mire oscillation – "Mooratmung").

Peat, vegetation and water

Peat, vegetation, and water are in a steady state in Imnati today. The abnormally high proportion of vascular plants for Sphagnum bogs induces higher evapotranspiration rates and a consequent larger water table drop down, resulting in higher rates of decomposition, which destroy the pore space and elasticity of the peat. This again would increase the water table fluctuations. Extended periods of desiccation would hamper peat moss growth and would stimulate nutrient availability through decomposition, which would further boost the share of vascular plants (positive feedback loop). In Imnati, however, the vascular plants provide a "skeleton" for peat mosses whose extraordinary growth rates in this region (Krebs & Gaudig 2005) prevent them from being outcompeted by vascular plants. As a result, highly porous and elastic peat accumulates, whose high storage and oscillation capacity stops the escalation of the positive feedback loop.

Imnati is an impressive example that percolation bogs have resilience against irregular precipitation. The oscillation capacity is the decisive mechanism that helps this mire type to bridge dry periods "actively". The high hydraulic conductivity of the peat avoids a drowning in wet periods "passively".

Utilisation of the peatland

Mire utilisation only started 150 years ago with the cutting of marginal forests. In 1935, peat excavation started in the southern part of the mire, where it continued into the 1980s. The peat was mixed with phosphorus and other mineral fertilisers to be used for soil improvement in tea and citrus plantations (Tabadze 1963). Also the production of fuel pellets was tried out in 1955/56. Their quality was, however, worse than from other peatlands in the

Fig 6: Typical aspect in the vegetation in Imnati - Yellow Azaleas flowering in spring.

Fig. 7: Human impact through subsistence economy - cattle grazing in the south of Imnati.

former Soviet Union and the exploitation stopped.

During Soviet times, hay for cattle was mechanically harvested in the southeastern part of the mire. After the collapse of the Soviet Union, the economic situation became worse. The forests at the mire margin were increasingly cut for fuel and private cattle more and more graze the Purple moor grass close to the settlements. To stimulate grass growth and to improve access for hunting (especially during the bird migration season!) the area is frequently burned.

Nevertheless, the largely pristine Imnati mire is, because of its extent and its unique biodiversity values, one of the peatland treasures of Georgia. Its importance, ironically, increases by the current construction of an oil terminal and an associated railway in other parts of the Kolkheti Ramsar wetlands and National Park (Salathé 2005). Despite its status as National Park and Ramsar site, from time to time ideas emerge to resume the utilization of the peatland.

Pilot area for Sphagnum farming?

Instead of concocting destruction of the world-wide unique Kolkheti mires for the production of horticultural substrates from peats, it is better to look for renewable alternatives. Because the climate guarantees year-round moss growth, peat mosses are highly productive in the Kolkheti lowland, with *Sphagnum papillosum* reaching a production of over 10 tonnes dry weight per ha per year (Krebs & Gaudig 2005).

The perennial rainfall and humidity cause the peat mosses to regenerate very well. This enables the production of Sphagnum biomass on formerly meliorated and excavated peatland and fallow mineral soil. Near Supsa, south of Imnati, a degraded peatland currently used as low-productive arable land, could be prepared as a pilot area for Sphagnum cultivation. These potentials will be assessed in further projects of the Institute of Landscape Ecology and Botany of Greifswald University. ■

Bibliography

Botch, M. S. & V. V. Masing, 1983. Mire Ecosystems in the U.S.S.R. In: Gore, A. J. P. (ed.): Ecosystems of the world 4B. Mires: swamp, bog, fen and moor. Regional studies. Elsevier. Amsterdam. 1983. pp. 95-152.

Couwenberg, J. & H. Joosten, 1999. Pools as missing links: the role of nothing in the being of mires. In: Standen, V., J. Tallis & R. Meade (eds.): Patterned mires and mire pools - Origin and development; flora and fauna. British Ecological Society. Durham. pp. 87 – 102.

Couwenberg, J. & H. Joosten, 2005. Self organisation in raised bog patterning: the origin of microtope zonation and mesotope diversity. Journal of Ecology 93: pp. 1238-1248.

Dokturowski, W. S. 1936, Materialy po isutscheniju torfjanikow Sakawkasja. (Beiträge zum Studium der Torfmoore Transkaukasiens). Potschwowedenie 2: pp. 183-202.

Joosten, H. & D. Clarke, 2002. Wise use of mires and peatlands – Background and principles including a framework for decision-making. International Mire Conservation Group / International Peat Society. 304 p.

Joosten, H., Kaffke, A. & I. Matchutadze, 2003. The mires of the Kolkheti lowlands (Georgia). IMCG Newsletter 2003/3. pp. 19 – 23.

Kaffke, A., J. Couwenberg, H. Joosten, I. Matchutadze & J. Schulz, 2000. Ispani II: the world's first percolation bog. In: Québec 2000 Millenium Wetland Event. Program with Abstracts. p. 487.

Kahrmann, M. & A. Haberl, 2005. Imnati - ein Regendurchströmungsmoor? Moorkundliche Untersuchungen in der Kolchis (Georgien). MSc thesis. Greifswald University. 101 p.

Krebs, M. & G. Gaudig, 2005. Torfmoos (Sphagnum) als nachswachsender Rohstoff – Untersuchungen zur Maximierung der Produktivität von Sphagnum papillosum im Regendurchströmungsmoor Ispani 2 (Georgien). Telma 35. pp. 171-189.

Kulczyński, M.St., 1949. Torfowiska Polesia (Peat bogs of Polesie, transl. by W.H. Paryski). Mémoires de l'Académie Polonaise des Sciences et des

Lamme, O., 2006. An eco-hydrological approach to peatlands: a search of a percolating bog in the Kolchis area. MSc thesis, University Utrecht. 65 p.

Lettres - Classe des sciences Mathématiques et Naturelles - Serie B: Sciences Naturelles, Krakov 15: 356 p.

Lutz, J., 1938. Geobotanische Beobachtungen an Cladium mariscus R. BR. in Süddeutschland. Ber. Bayer. Bot.Ges. 23. pp. 135 - 142.

Nejstadt, M. I., Chotinskij, N. A., Dewiri, A. L., Markowa, N. G. (1965): Imnatskoje Boloto (The Imnati bog). Paleogeografija i chronologija werchnewo plejstozena i golozena po dannym radiuglerodnowo metoda. K VII kongressu INQUA (SSchA 1965), pp. 105 – 112. (in Russian)

Salathé, T., 2005. Ramsar Advisory Missions: No. 54, Georgia, Central Kolkheti Wetlands. URL: http://www.ramsar.org/ram/ram_rpt_54e.htm. visited at 28.02.2006.

Succow, M. & H. Joosten (eds.), 2001. Landschaftsökologische Moorkunde. 2. ed. Schweizerbart, Stuttgart. 622 p.

Tabadze, F.N., 1963. Prirodnije resursij grusinskoi SSR. bd. 5. Isdatelstwo akademii nauk SSSR. Moskwa. 272 p.

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