Dynamiques environnementales

Journal international de géosciences et de l'environnement

42 | 2018

Du glint baltique au lac Peïpous

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Electronic version

URL: <https://journals.openedition.org/dynenviron/2485>

DOI: 10.4000/dynenviron.2485

ISSN: 2534-4358

This article is a translation of:

Les territoires limniques estoniens : une originalité baltique ? - URL : <https://journals.openedition.org/dynenviron/1965> [fr]

Publisher

Presses universitaires de Bordeaux

Printed version

Date of publication: 1 July 2018

Number of pages: 352-357

ISSN: 1968-469X

Electronic reference

Pascal Bartout, "The estonian limnic territories, a baltic originality?", *Dynamiques environnementales* [Online], 42 | 2018, Online since 01 June 2019, connection on 03 March 2022. URL: <http://journals.openedition.org/dynenviron/2485> ; DOI: <https://doi.org/10.4000/dynenviron.2485>

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The estonian limnic territories, a baltic originality?

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Version française p. 166

Abstract

Place of presence of the main European lakes by their surface, the Baltic limnic area cannot be summed up with its tens of lakes of continental extent because it shelters tens of thousands of lakes morainic, thermokarstic and other artificial water bodies. Through limnosystemic and limnoregional approaches, temporal, spatial and anthroposystemic dimensions, the author endeavors to frame the 5 articles present in this thematic sub-part and questions the Estonian limnic territories through the prism of their limnic footprint index.

Key words

Limnic territory, lakes, geography, Baltic, Estonia.

Bog pool in Viruraba (Lahemaa National Park) (photo: Pascal Bartout).

The Limnology, a science that studies lakes and all other forms of water masses such as ponds, pools, swamps or marshes, has a rich European scientific history. Born in Switzerland under the pen of François-Alphonse Forel in 1892, the Limnology or “Geography of the Lakes” was first devoted to studying Alpine and Jura lakes, giving the Swiss and Germanic researchers a fair share around the Lake Geneva and the Bodensee (Forel, 1892-1904, and its monograph of Lake Geneva, but also Penck, 1894, or Halbfass, 1923).

In this glacial logic, Scottish and Irish lochs (Murray and Pullar, 1910) have also been studied, and then other geographical and morpho-

logical facets of the old continent have been explored as the karstic lakes of the Balkans, along the lines of Poljes drowned in Ohrid and Prespa Lakes (Tancev, 2012), salty Transylvanians lakes such as Bear Lake (Radulescu et al, 2018) or lakes and limans like those of the Danube delta (Gâstescu and Sencu, 1968, Güttler, 2012). But it is towards the northern fringe of Europe that will converge most of the other limnological works, namely the perimeters of the Baltic Sea with its morainic and thermokarstic lakes.

Map 1 below is the cartographic visual gap between these natural and very large North Baltic lakes (Sweden, Finland, Denmark, north-

ern Germany and Poland, the Baltic States and the north-western fringe of Russia) and the weakest concentrations in the south of the Würm moraine from Schleswig-Holstein in Germany to the Arkhangelsk region in Russia and beyond to the North-East. The main characteristic of this region is to have lakes of relatively shallow relative depth in relation to the other lakes of glacial origin existing in Europe.

Figure 1: European water bodies of more than 100 m² (from Bartout2018 Database) (p. 168).

With a wide range of horizontal dimensions, this geographic area nevertheless hosts the largest natural European lakes (excluding the particular case of the Caspian Sea), namely Ladoga (Russia), Onega (Russia), Vänern (Sweden), Saimaa (Finland), Peipsi (Estonia/Russia), Vättern (Sweden), Beloye (Russia), Vygozero (Russia), Mälaren (Sweden), Inari (Finland) and Päijänne (Finland) to name more than 1000 km². To these, we must add these lakes of smaller size but which concentrate on their shores and in their waters decades of limnological works, like Müritze Lake in the Land of Mecklenburg-Western Pomerania in Germany or even Sniardwy Lake in the Warmie-Masuria Voivodeship in Poland.

However, most of the research focuses on a single objective, namely the understanding of the internal functioning of the lake. It can then be considered as an isolate disconnected from the other elements but more frequently it is envisaged as a receptacle of the upstream basin and possibly the researchers study the impacts of it on the downstream river continuum as the works of P. Olszewski in 1961 on Kortowo Lake in Olsztyn (Poland) (Barroin, 1999): this is a limnosystemic approach (Touchart and Bartout, 2018a).

This approach will marry one of the five original contributions of this part devoted to Estonian water bodies, namely that proposed by L. Touchart and his co-authors on

the contribution of the limnosystemic study of Peipsi Lake on the Russian but also global limnology.

However, a compilation of limnosystemics approaches of large lacustrine entities reflects an accumulation of particular cases but creates a scientific distortion with the limnological reality of fields, where bodies of water are of very varied origins and morphologies, and with the new limnological stakes of this early 21st century. Indeed, since the work of R.G. Wetzel (1990), which has hypothesized a major role of small bodies of water on the global climate through the carbon burial, the interest in small limnic entities (natural and artificial) and wetlands keeps growing. The taking into account of these new scientific objects and the more globalizing environmental dimension of the current research have led to highlight three underutilized dimensions so far.

The first one is the temporal dimension, allowing better explaining the life of the body of water, both in terms of its genesis and its development. This temporal dimension can be considered at the long time scale of the geologist as well as the shorter one of the historian. E. Vandel and T. Vasmaa propose in this issue to apprehend this question with the study of the development of small Estonian lakes from a paleolimnological approach.

The second is the spatial dimension, offering the possibility to better control the limnic components of its near or distant environment. Initially envisaged on a global scale for the world Great Lakes (World Lake database), the question of the distribution of water bodies and the composition of the limnic corpus has become more crucial at the national, regional or local scales.

Three reasons have led to an important development of this spatial knowledge of all types of water bodies: the first is what we have seen previously, namely the ecological and fundamental climatic importance of

small limnic entities; the second is the development of satellite imagery and thus with it easier access to photographic and cartographic supports allowing to study ever wider spaces with an ever more precise pixelisation; lastly, the third is linked to the problem of water management, its quality and quantity, in order to better assess the potential and adapt management to the concerned territories, whether they are international, national, regional or local.

In this issue, J. Terasmaa proposes a synthesis of these spatial approaches by highlighting all the unknowns concerning the Estonian lentic panel up to the inventory of 2014 and the new problematics that this generates, both in institutional than scientific terms.

The third and last one is the anthroposystemic dimension, opening the field of possibilities to the human sciences. It is in fact a return to the limnological sources because F.A. Forel (1892) conceived the limnology as a global science, a "geography of the Lakes", before it turned exclusively to the exact sciences under the ferrule of Thienemann (1925) what many biogeochemists researchers regretted elsewhere (Dussart, 1966).

The reflections that surround the limnological and hydrological sciences in general were impacted by the opening of the Occident to the Russian world at the end of the Cold War, world where the geosystem was king and where the human sciences could treat equal to equal with the exact sciences. Similarly, management logics and the opening of studies towards artificial water objects have led to the appropriateness of economical, sociological and geographical concepts. Concepts such as anthroposystem (Lévêque et al, 2003), hydraulic space (Béthémont et al, 1972) or water territory (Laganier and Davy, 2000) have strongly influenced scientific thought patterns but also state and hydrological water management methods (Ghiotti, 2006, Bartout and Touchart, 2017).

Two articles in this issue are in this management movement. First of all, G. Kapanen will be interested in managing the largest transboundary lake in Europe, Peipsi Lake, or how is the lacustrine environment apprehended in border hydropolitics: "marche" or collaboration?

The second contribution is the fact of M. Vainu and his co-authors who will be interested in the district of Kurtna lakes, in north-eastern Estonia, a place studied for decades by the scientists of Tallinn University, and assess whether this "natural pearl" suffers from anthropogenic pressures that might alter its functioning.

By combining naturalistic approaches, anthropogenic pressures, geopolitical relationships, historical retreat, positioning of Estonian research in a wider, past and present context, and by focusing on lakes of different morphology, these five contributions make it possible to draw up a first observation leading to classifying Estonia as a water territory from the perspective of its bodies of water, which we have named "limnic territory" (Bartout, 2015, Bartout and Touchart, 2017). This limnic territory has three scales of apprehension: limnosystem (Touchart and Bartout, 2018a) at the scale of a body of water, limnoregion (Bartout and Touchart, 2017) at the scale of an accumulation of water bodies and limnosphere (Touchart and Bartout, 2018b) on a global scale. Since this special issue is devoted to the study of the Estonian environment, the first two dimensions of the limnic territory will be at the heart of the general reflection.

Through the articles of L. Touchart and its co-authors and G. Kapanen, the limnosystemic dimension will be at the heart of the demonstration, that of L. Touchart and its co-authors also providing a reflection on the limnosphere.

The other three contributions will bring different and complementary limnoregional lighting: if M. Vainu and his co-authors

study a limnic micro-region, E. Vandel and T. Vasmaa would position themselves on a truncated state-scale reflection as focused only on the natural and small elements of the limnic corpus, and J. Terasmaa will bring an overall perspective of the "Estonia" limnoregion by qualifying it.

However, in order to identify the scientific extent of the work carried out in Estonia, it is necessary to replace them in a wider environment by comparing several regions and to see whether the state artificial caesuras actually correspond to different modes of operation from the limnic point of view. Here we propose to enlighten a little the reader in this reflection allowing to determine whether originality there is or not within a coherent natural set, the perimeters of the Baltic Sea.

The apprehension of this question will be based on a new indicator, the Limnic Footprint Index (LFI) (Bartout and Touchart, 2018), which was conceived on the model of the Ecological Footprint Index. It is in the interest of a limnological geography approach (Touchart et al, 2014) to put at the same level of apprehension the naturalistic and anthropogenic approaches. To do this, we used two criteria: the extended limnic ratio (Bartout, 2012) that characterizes the surfacical footprint of a given territory and the density of water bodies that determines the numerical footprint of repetition of water bodies' impact on that same territory.

Thus, *"taking into account these two equally criteria does not determine a priori any domination of the natural part on the anthropogenic part, of the evaporating surface on the water drainage system or even of the singular limnosystem on the plural limnosystem"* (Bartout and Touchart, 2018). This systemic indicator is easily calculated once all the preparatory data is collected. To do this, it is a matter of having methodologically identical data on a space much wider than the territory studied in order to put the latter in a context of comparison. Here we have chosen two scales of comparison: Europe and then the borders of the Baltic Sea.

The average extended limnic ratio and densities of water bodies at the scale of these territories are the normal (indicator 1) and each subset will be able to position themselves in relation to these average numbers. Thus, each of them will have two indicators that we will add and then divide by two to determine the LFI of this territory. In this way, territories where limnic pressure is important will be highlighted, be it when a huge body of dormant water is present (by a strong surfacical footprint index), which is the traditional approach (not to say exclusive) of the limnology, or whether it is when the numerical footprint index is very high, highlighting all the new elements of the world limnology, namely the small water bodies.

At the European level, table 1 below makes it possible to understand the place of the limnical Estonia in the limnological sciences today since it is the treatment of the WISE Large Lakes Database which lists the Great World Lakes.

Table 1: The Limnic Footprint Indexes of the Baltic Sea edges states according to the WISE database (p. 172).

According to the WISE database, Estonia appears as a State which counts at the limnological level because it has the highest LFI of this Baltic Sea edges if we look at the scale of Europe with an index of 3.64 and the third most important of the Baltic Sea edges if we only select this set behind Denmark and Sweden with an index of 2.58. In fact, the presence of lakes Peipsi and Võrtsjärv puts Estonia in the category of Lake States with Finland, Sweden and Denmark and stands out very clearly from these Baltic States, Russian or Polish neighbours.

However, the reality of the limnic corpus is quite different from the vision granted by the WISE base, a vision that is found somewhat in the logics of management of the basin agencies with the bodies of water "water bodies" (more than 50 ha). In order to achieve a European-wide acceptable mapping, we

have based ourselves on three sources: the WISE Large Lakes base, the Ecr15 base of the European Environmental Agency and the processing of the data available on *Open-StreetMap*.

For all these bases, we have excluded all "water bodies" of less than 100 m², because too much uncertainty prevails over their inventories (Bartout and Touchart, 2013, Bartout et al, 2015). Although there are more reliable bases in some European States than those used, we have sought to use the same data-gathering methodology everywhere in order to establish an "objective" state of the European lentic panel. The results of this work are outlined in table 2 below.

Table 2: The Limnic Footprint Indexes of the Baltic Sea edges states according to the Bartout2018 database (p. 172).

Before commenting on the LFIs as such, it is useful to note that the analysis does not include a few hundred water bodies such as the analysis of the WISE Large Lakes Database. The number of water bodies has exploded as it exceeds the 720,000 at the scale of the countries studied (and even 1.5 million across Europe). In fact, the average densities of water bodies are all other (5000 times larger than in the previous table), but those of the average extended limnic ratio, while increasing, have only been doubling their values.

Thus, at the level of the LFI, States possessing a multitude of small bodies of water

will be further enhanced and those possessing above all some major water bodies will naturally regress in the hierarchy. That is what we are seeing in Estonia. Whether on a European or Baltic scale, its LFI, although greater than 1, thus characterizing a territory where the bodies of water are of a major character, has been divided by 2-2.5. Sweden is, in a slightly less significant way, in the same case, unlike Denmark and Finland previously quoted, which retain values substantially close to table 1, showing that they possess water bodies in quantity whatever the area concerned.

The country that is making the most progress in the hierarchy between these two tables is Germany, as it appears in the fourth "Baltic" position at European level and in the second largest intra-Baltic region behind Denmark, but in front of Finland and Sweden. Estonia, according to these figures, can no longer be attached to this dominant group in the Baltic Sea edges, and proposes numbers very similar to those of other Baltic States (in particular Lithuania) and Poland.

To which geographical limnic group then belongs Estonia, which, according to the historical vicissitudes, has passed from the Germanic and Fenno-scandian dominations to the Russian ones, while being called a Baltic country? This is the whole purpose of the five articles that will follow to determine the share of Estonian limnic originality in this Baltic ensemble.

References (p. 174)