A landscape biography of the 'Land of Drumlins': Vooremaa, East Estonia

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2 The study region – Vooremaa in East Estonia

Vooremaa is situated in the Eastern part of Estonia. The region measures 55 km from south to north and 25 km from west to east, with a total surface cover of almost 1000 km^2. The highest point of the region is the top of the Laiuse drumlin at 144 m above sea level (Arold 2005, 205). The region includes the counties of Jõgevamaa and Tartumaa.

Drumlin fields are rhythmic landscapes, which are comprised by parallel oblong moraine elevations with low swampy basins or lakes in between. The land use is "composed" on this rhythmic structure as well. Agricultural lands are situated on the slopes of the drumlins, and wet forest lands in the basins. Altogether there are around 1000 drumlins in Estonia, of which Vooremaa region is the most outstanding.

In geology and geography the landscape region of Vooremaa has also been addressed as the Saadjärve drumlin field (Rõuk 1974; Rattas 2004). The drumlin field functions as a watershed between the basin of Lake Peipsi and the Central Estonian Plain. The drumlins are oriented in NW – SE direction, reflecting the course followed by the glaciers during the Late Weichselian (Rattas 2004, 15).

The word ***drumlin*** (1833, diminutive of *drum* (1725)) in English comes from the Gaelic *druim*, meaning "back or ridge", "ridge or long, narrow hill", often separating two parallel valleys (OED: *drumlin*). In Estonian the term for drumlin is *voor*, borrowed from the Finnish *vuori*, which means a hill or hillock (ETY: *voor*). The Dictionary of Physical Geography (Thomas et al. 2000, 149) defines "drumlin" as follows: *an oval-shaped hill, largely composed of glacial drift, formed beneath a glacier or ice sheet and aligned in the direction of ice flow*.

The Saadjärve drumlin field, which is also known as the Vooremaa landscape region, comprises of up to 120 drumlins or drumlin-like features. The drumlin field is one of the most characteristic and largest drumlin fields in Eastern Europe. It especially features giant drumlins (*hiidvoor*) intermitted by swamps and lakes. Although the drumlin field formed under various circumstances during different periods of icesheet expansion and meltdowns (Arold 2005, 139), most of the drumlins were shaped during the general melting of the Late Weichselian glacier around 13,500 – 11,000 years ago during multiple ice advances (Rattas 2004, 9). The highest density of drumlins, and therefore of lakes, occurs in the southern part of the Vooremaa region. The largest lakes in the region are Saadjärv, Raigastvere, Kaiavere,

Elistvere, and Soitsjärv (Figure 4). This part of Vooremaa is also a landscape conservation area.

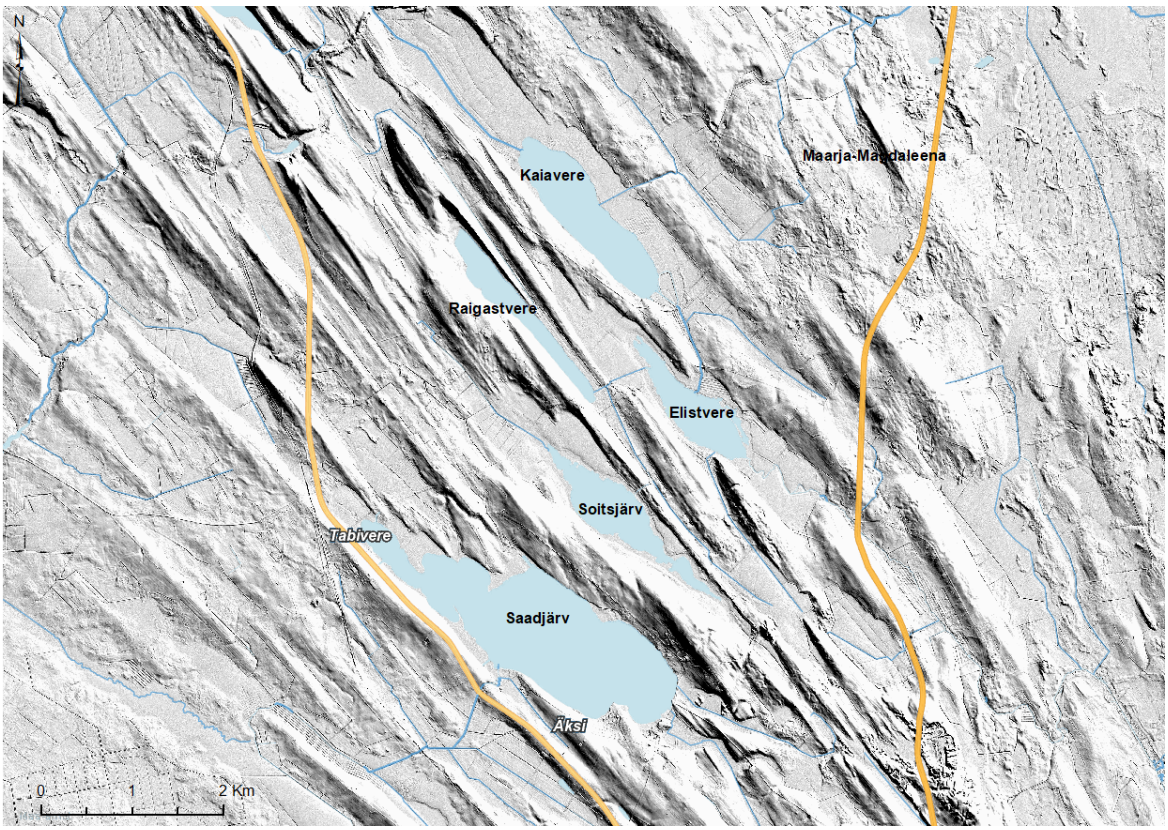

Figure 4. Long and narrow drumlins of the southern part of Vooremaa. LIDAR image: Estonian Land Board.

2.1 Shape and size of the drumlins

Typical drumlins are made of glacial deposits, and are oval oblong elevations, which have been shaped by the moving ice sheet. Based on their shape and size a distinction is made between drumlins and drumlinoids. Typically, the glacial end of a drumlin is higher and steeper; this is also named the “proximal end”. The “distal end” is lower and gentler. The drumlins can contain ice-pushed deposits from cold-stage rivers, and moraine from various glaciations. The geologist Maris Rattas has pointed out that drumlin research is essential for reconstructing glacier movements and past glaciations (Rattas 2004, 8).

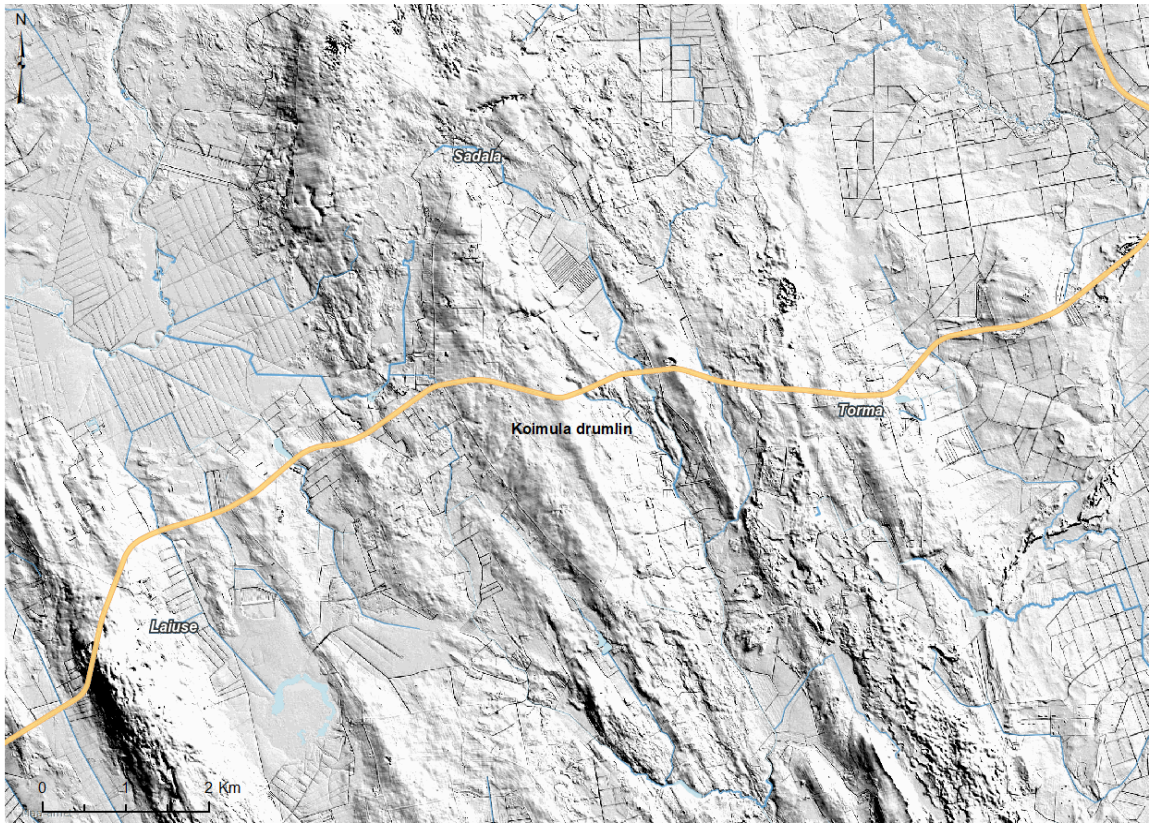

Figure 5. Koimula drumlin in the Northern part of Vooremaa is the largest in Estonia. LIDAR image: Estonian Land Board.

An "ideal" drumlin is shaped like an upside down spoon (Rõuk 1976) or half buried egg (Figure 6). Generally wider drumlins are with more gentle slopes, and narrow ones are steeper. Larger drumlins are around 2,5 – 5 km long and 0,4 – 0,8 km wide. The largest drumlin in Estonia is the Koimula giant drumlin (Figure 5), measuring 13 km in length and 3,5 km in width. The relative height of drumlins can be very different, spanning from several meters up to 80 meters. On top of the drumlins there can be higher moraine bumps or small depressions also known as kettle holes (*oit* or *söll* in Estonian), which are mostly filled with water and peat (Arold 2005, 140). One of the largest kettle holes of its kind is on top of the Laiuse drumlin, which place is also widely known in the oral tradition as Laiuse Blue Spring (*Siniallikas*). The natural elevation in Vooremaa is relatively low: most of the drumlins are in between 45 – 85 m above the sea level, the highest being 144 m (Laiuse), and lowest 34 m (a drumlin in the Amme River valley).

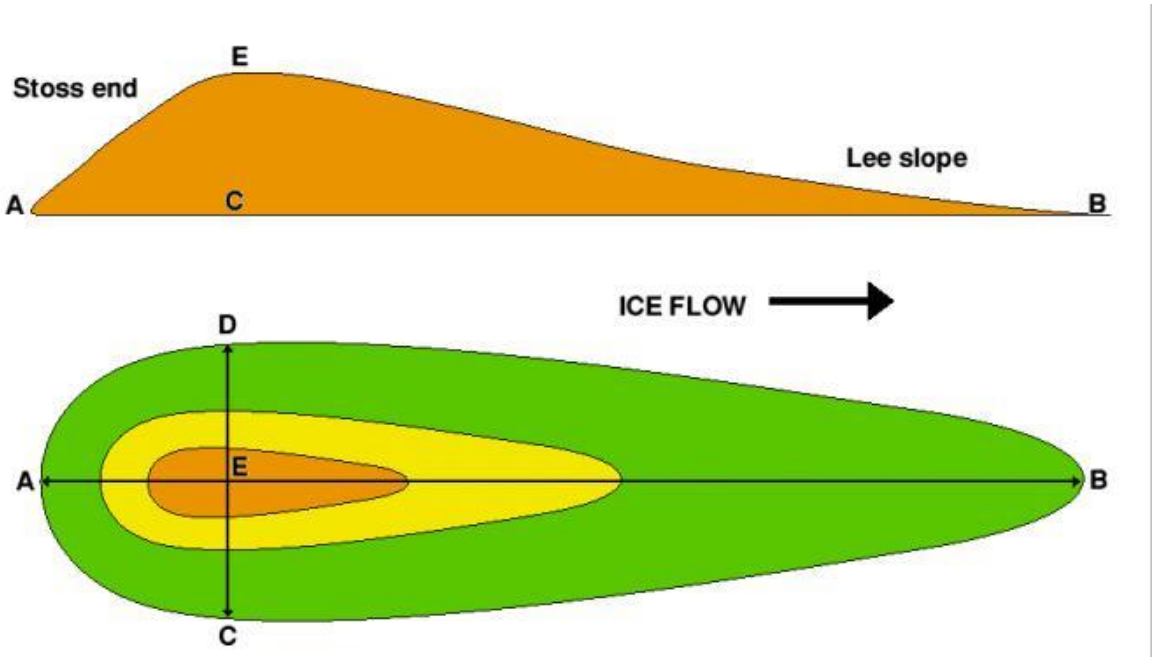

Figure 6. Typical drumlin, which resembles an upside-down spoon (http://www.geography-site.co.uk/pages/physical/glaciers/drum.html).

Within the Saadjärve drumlin field drumlins can vary quite considerably in shape, size and spatial arrangement. In between drumlins there can occur larger moraine plains. The most distinctive drumlin types according to Maris Rattas (Rattas 2004, 22) are as follows:

1) typical drumlins with well-defined streamlined outlines characterised by steep, high stoss sides and tapering low lee sides

(2) strongly elongated drumlins with isometric shapes often arranged in an echelon

(3) reversed drumlins which possess all the characteristics of classical drumlins, but whose stoss ends face down-ice

(4) complex drumlins with irregular shapes possibly consisting of multiple superimposed drumlins of different sizes. Twin and triplet drumlins are common. Several ridges have grown together at their proximal or in the middle to form a huge drumlin shield.

The upper layer or surfacing of drumlins can be up to 60 m thick, consisting of various moraine and glaciofluvial deposits. In lower drumlins moraine thickness remains between 10 – 20 m, in moraine plains it is 2 – 20 m. The large straggling drumlins mainly consist of Devonian and Silurian sand and gravel, which is covered by 10 – 15 m thick moraine. Small narrow drumlins consist of moraine only (Arold 2005, 205–208).

In the southern part of the Saadjärve drumlin field, the drumlins are smaller in size than elsewhere, and stretch out towards the glacial melting direction. The variation in size of the drumlins has very much to do with bedrock characteristics of Silurian and Devonian formations, which have different hydraulic conductivity, and therefore pose a different impact on the velocity of ice (Rattas 2004, 23).

2.2 The Vooremaa landscape conservation area

In 1964 the Vooremaa landscape conservation area was established in the south-eastern part of the district, and with an area of 9831 hectares it covers around 10% of the landscape region. The main aim of the conservation area is to protect the typical drumlin landscape and to sustain the heritage of this landscape, both for its natural values and for scientific research. Therefore, in addition to cultural landscape values, the conservation area aims to protect natural habitats and wildlife (Keskkonnaamet 2012). Allowed and prohibited actions in the conservation area are regulated by the code of conduct introduced in 2006 (RT I 2006).

2.3 Bedrock and soils

The bedrock in Vooremaa includes three different Palaeozoic (541 – 252.2 million years ago) sedimentary formations: the northern part of the region is made of Upper Ordovician (485.4 – 443.4 million years ago) and Lower Silurian (443.4 – 419.2 million years ago) limestone and dolomite, and the southern part of Middle Devonian terrigenous rock (Rattas 2004, 15).

Because the drumlin field comprises of oblong uplands and low damp depressions, the soils (Figure 7) and vegetation differ considerably depending on geomorphological location. In north and north-western parts of Vooremaa the typical soils on drumlins are *Mollic Cambisols* (K_0), *Luvisols* (K_I, K_{Ig}), and *Stagnic Luvisols* (LP). While the arable slopes of the drumlins contain slightly eroded soils (*Regosols*) of the same types, the feet of the drumlins consist of diluvial soil (D, D_g) deposits, which can be up to several meters thick. The lower depressions between drumlins are characterised by *Histic Gleysols* (G_{01}) and *Histosols* (M", M"'). Typical soils in eastern, central (Figure 7), and southern parts of the region are *Stagnic Luvisols* (LP), *Gleyic Albeluvisols* (LP_g) and also *Gleyic Luvisols* (K_{Ig}) (Arold 2005).

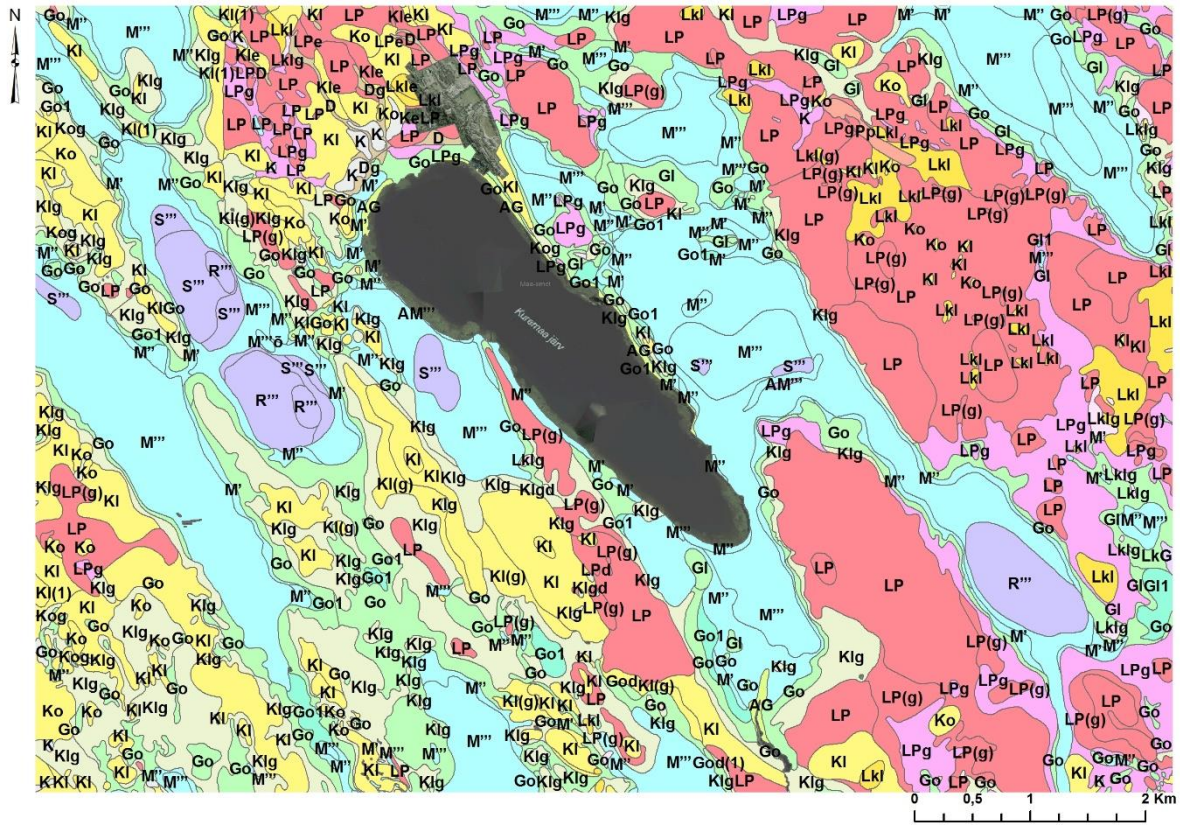

Figure 7. An example of soil types in the central part of Vooremaa around Leke Kuremaa. Soil map: Estonian Land Board.

2.4 Contemporary land use and vegetation

The present-day land use of Vooremaa is characterised by a combination of open agricultural fields (48%), and swampy forest lands (38%). Compared to other Estonian landscape regions in Vooremaa, cultivated land dominates. The drumlin slopes have traditionally been used as arable land, and the low wetlands in between drumlins have been exploited as meadows that were flooded regularly. The settlement pattern in Vooremaa is strongly tied to these land use features. In the past, human habitation has mostly concentrated around the lower slopes of the drumlins, where groundwater is close to the surface.

Traditionally, the most common village types in the Vooremaa region are linear (*ridaküla*) and semi – linear villages (*ahelküla)*, but occasionally also nucleated villages (*sumbküla*) occur.

The historic villages took their traditional form by the middle of the 19th century, as an outcome of land consolidation. Due to the land reform initiated in 1919 in the course of the Estonian War of Independence (1918 – 1920), the population density in rural areas rose considerably during the first half of the 1920s. Although, during the Soviet occupation (1944

– 1991), large building complexes for collective farms were erected, the traditional village landscape in Vooremaa largely remained intact during this period and is somewhat different from the rest of the country. One of the explanations for this might be landscape elevation and overall natural conditions, which already had set the frames for most suitable settlement pattern. The position and distribution of arable land has not changed significantly during the 20th century, though some of it remains uncultivated at present. However, significant changes did take place in the usage of semi-natural grasslands during the second half of the 20th century. Large tracts of open meadows in the depressions between drumlins that were open and still in use before the Second World War, are now transforming back into swamps or are overgrown with forest. It has been estimated that only about 1/3 of the meadows has remained open, and in turn the proportion of forested land has risen (Keskkonnaamet 2012, 7).

Today, the largest settled areas in the study region are the town of Jõgeva (5305 inhabitants[4]), and the rural towns/villages of Siimusti (650), Kuremaa (367), Palamuse (472), Laiuse (371), Torma (396), Voore (281), Kaarepere (263), Vaimastvere (254), Luua (298), Tabivere (971), Äksi (437), Lähte (492), Vasula (273), and Kõrveküla (744). Most of the other settlements have under 250 inhabitants.

Figure 8. Typical boreo-nemoral hepatica type forest in the northern part of Vooremaa. Photo: Martti Veldi

[4] Numbers according to the Estonian Population Register – https://www.siseministeerium.ee/en/population-register

The forested areas of Vooremaa are mostly the damp and swampy depressions between the drumlins or around lakesides. A number of drumlins is also covered with forest vegetation. Swamp covers around 20% of the are of Vooremaa. The largest wetland of Vooremaa, Endla bog, is situated in the north-western part of the area, stretching over a length of 15 km between the drumlins. Common forest vegetation types in these sections of the landscape are wetlands with white birch (*Betula pubescens*), grey alder (*Alnus incana*), and mixed forest. Depending on different soil types, fresh boreo-nemoral forest (*Hepatica* and *Aegopodium* types) in the central and northern parts (Figure 8), and fresh boreal forest (*Oxalis-Vaccinium myrtillus* type) in the southern part of Vooremaa, are most common (Arold 2005; Paal 1997).

2.5 Water

The lower depressions between the drumlins are situated in proceeding belts parallel to the drumlins. At the beginning of the Holocene, the landscape in Vooremaa was full of lakes, which in the process of natural succession has mostly turned into areas with denser wetland vegetation. Open lakes have survived in the southern part of the region, where “comet drumlins” with steeper slopes are more common. Today there are only 12 large lakes remaining in Vooremaa. The northernmost lake is Lake Endla, which is situated in the middle of the largest wetland area and is a remnant of a once much larger paleolake. The southernmost lake is Lake Vasula. Due to the use of mineral fertilizers by famers in the area, at present the eutrophication level in lakes is very high. The deepest lake (25m) is Saadjärv in the southern part of the region (Arold 2005).

Vooremaa is crossed by one main river, the river Amme (55 km; Figure 9), which originates from the Lake Kuremaa, follows the main depressions between drumlins, before flowing into the larger River Emajõgi.

Figure 9. Amme River near the Iron Age hillfort in Ehavere. Photo: Martti Veldi.