

# Changes of coastal dune landscapes in Estonia

Urve Ratas<sup>1\*</sup>, Reimo Rivis<sup>1,2</sup> and Kaija Käärt<sup>2</sup>

Ratas, U., Rivis, R., Käärt, K. 2008. Changes of coastal dune landscapes in Estonia. – Forestry Studies | Metsanduslikud Uurimused 49, 59–70. ISSN 1406-9954.

**Abstract.** Coastal landscapes are strongly affected by their geomorphology, based on the character of deposits and moisture conditions. The main influences on the aeolian ecosystems of coastal areas are heavy winds, salt spray and lack of nutrients. An increase in the frequency of storms in coastal waters may result in the erosion of beaches that were previously stable or prograding. Coastal dune ecosystems are in different stages of vegetation succession and soil development. At present coastal dune landscapes are being rapidly changed by waves and human impact. In the last decade, research on the geomorphologic changes of the coast in Estonia has been quite noteworthy, but the associated changes in ecosystems have been little considered. The main problem for coastal dunes landscape is the decrease of natural habitats due to afforestation, recreation and building. In this paper our attention is focused on changes of Estonian coastal dune landscapes during the last one hundred years.

**Key words:** Estonia, landscape, coastal area, seashore, aeolian sand, beach ridges, dunes, vegetation.

**Authors' addresses:** <sup>1</sup>Institute of Ecology, Tallinn University, Uus-Sadama 5, 10120 Tallinn, Estonia, \*e-mail: urve@tlu.ee

<sup>2</sup>Institute of Mathematics and Natural Sciences, Tallinn University, Narva road 25, 10120 Tallinn, Estonia

## Introduction

Estonia is a small country with a long coastline (3800 km) along the Baltic Sea and thus the coastal landscapes comprise a significant part of the country (Puurmann *et al.*, 2003). The length of sandy beaches along the sea is approximately 340 km. The area of coastal dune landscapes is about 200 km<sup>2</sup>.

Coastal dune landscapes develop in areas of an adequate supply of sand (sediment within the size range 0.2 to 2.0 mm) and prevailing onshore winds. Wind is the dominant factor in shaping a dune system, but sandy beaches are shaped by waves instead of wind. The overall distribution and size of the dunes is a reflection of the key influences of sediment availability, strength and direction of the prevailing and dominant winds, and the physical nature of the coast (Doody, 2001). The coastal dunes of Estonia were formed during the different stages of the Baltic Sea. The Estonian coastal dunes are considerably smaller (by about 5–15 m) than southern Baltic ones. The shallow sea and indented coastline resulting from the land uplift (nowadays up to 2.8 mm per year (Vallner *et al.*, 1988)) did not provide favourable conditions for substantial alongshore drift of sand. The largest dunes, up to 20–25 m in height, formed during the transgressive phases of the Baltic Ice Lake, Ancylus Lake and Litorina Sea (Eltermann & Raukas, 1966; Martin, 1988). Most part of the

coastal landscape emerged from the regressive sea in different phases of the Limnea Sea during the Subboreal and Subatlantic climatic periods (Hyvärinen *et al.*, 1988). These coasts had a deficiency of sediment drift. Therefore the ridge-like dunes are lower and often difficult to distinguish from sandy beach ridges (Keränen, 1986). At present, there is practically no dune sand movement in Estonia (Raukas, 1997).

Coastal dune landscapes can be divided into narrow contemporary beaches and inland zones – the territory with ancient coastal formations (Ratas & Ravis, 2003). The development of sandy beaches depends mainly on openness to prevailing winds and waves. There is no overall soil cover and some pioneer plants and initial primitive plant communities represent the vegetation. An essential source of organic substances on sandy beaches is drift litter, which mainly consists of seaweeds. The coastal vegetation constitutes a specific structure. The plant cover of the lower belt of the shore is comprised of nitrophilous and halophilous species (*Atriplex littoralis*, *A. hastata*, *Matricaria perforata* etc.), which alternate from year to year. The *Honkenyo-Leymetum* association usually occupies the upper belt of sandy beaches and plays a great role in preventing sand movement.

Seawater does not have a direct impact on the inland zone. As a rule, farther from the shore the landscape is older and natural processes have stabilised. These areas are the most heavily forested due to sandy soils unsuitable for agricultural crops. The forests were not subject to clear cutting because of their value in the protection of soils from wind erosion, so these areas have remained forested for centuries. The soils of the inland zone are predominantly *Arenosols*, *Podzols* and *Gleyic Podzols*. These sandy soils of dunes are extremely poor in nutrients, are excessively drained and have a high rate of filtration of rainwater to the groundwater. Today fossil soils can be found in the coastal dune landscapes. Vegetation varies from open plant communities to forests. The most characteristic vegetation types are boreal heath and dry boreal forests. Often forests begin immediately landward of the sandy beach and the open area is very narrow. A typical plant species on the foredunes is *Leymus arenarius*, in western Estonia also *Ammophila arenaria*. These plants have long roots that reach down to the lower humid sand layers and their stems can survive bending by the wind; therefore, they hinder deflation (Hellemaa, 1998). In North Estonia *Rosa rugosa* occurs numerously on beach ridges and foredunes, stabilising aeolian sand. On the other hand, *R. rugosa* bushes restrict colonisation by natural dune vegetation (for example, *Lathyrus maritimus*). In a few places on the coastal dune landscape, dry boreal heath grassland (*Galio veri-Thymetum*) occurs. The coastal heath vegetation is distributed as a narrow belt on the dunes and coastal sand plains. In fact, coastal heaths have developed in the course of primary successions: white dunes – grey dunes – *Empetrum* heaths – (*Calluna* heaths) – heath forests on the gradients of age, height and marine influence created by land uplift (Nilson *et al.*, 1997). Forests cover most of the area of the coastal dune landscapes. The characteristic forest types are *Cladina*, *Calluna*, *Vaccinium vitis-idaea* and *Vaccinium myrtillus* pine forest.

Coastal sand dunes are a declining and threatened habitat throughout Europe. Coastal dune landscapes of Estonia are well represented in the EU Habitats Directive with 12 habitats, which are mainly listed under Sea dunes of the Atlantic, North Sea and Baltic coasts. The wooded dunes (2180) are the predominant habitat. The habitats on coastal sandy plains are Western taiga (9010) and Fennoscandian deciduous swamp woods (9080).

Human activity causes changes in the dune topography and vegetation cover (Carter, 1980). The role of human activity (deforestation, grazing, controlled burn-

ing, etc.) has been an important factor in altering coastal dune landscapes. A large part of sand dunes has been lost to housing and other development, causing loss and fragmentation of dune habitats. Afforestation has reduced also the area of natural vegetation of dunes. During the last decades private residences and summerhouses have replaced coastal forests of in the vicinity of towns. Estonian coastal landscapes are under increasing anthropogenic pressure at the present (Ratas *et al.*, 2007).

The aim of this study was to find out relationships between coastline changes and dynamics of coastal ecosystems. Changes related to land use are also dealt with.

## Material and Methods

The current study is based on the results of fieldwork in different parts of the Estonian coastal zone of the mainland and islands (Figure 1). The width of the studied zone was generally 3 km. The coastal dune landscapes differ in the character of natural conditions as well as in land use. In most of the study sites sandy plains dominate, structured by sandy beach ridges or small dunes (Rammu, Kiipsaare, Võsu, Prangli, Tareste), but coastal landscapes with well-developed dune systems (Keibu) also occur.

The Keibu study site is located in Northwest Estonia and borders on Keibu Bay in the north. The bay is highly exposed to the sea. This part of the coast is a typical sandy beach with dunes and depressions between them. The most part of the study site is covered with forest. The Keibu study site belongs to the Nõva Landscape Reserve. The aim of this protected area is to preserve unique coastal landscapes and safeguard local rare plant and animal species as well as natural forest communities.



Figure 1. Location of study sites.

Joonis 1. Uuringualade paiknemine.

The Võsu study site is located on the southern coast of Käsnu Bay (North Estonia) in the settlement of Võsu. Võsu is one of the oldest summer resorts in North Estonia, founded in the 19<sup>th</sup> century. The bay is open to the northern winds. The coastal landscape is represented by a sandy beach, dunes and an aeolian sandy plain. About 60% of the study site is covered with forest. The Võsu River discharges into the bay in the eastern part of the study site.

The Rammu study site is located on Rammu Island (North Estonia). Rammu is a rather low island with a variable topography. Heath vegetation is distributed on an extensive area with the landforms consisting of a series of parallel foredunes or beach ridges. A part of the island was afforested in 1987 by planting pine seedlings. Sandy beaches dominate the southern part of the island. Rammu Island belongs to the Kolga Landscape Reserve.

The Prangli study site is situated on the south-eastern coast of Prangli Island (North Estonia). The sandy beach and aeolian sandy plain are the main landforms. Heath vegetation with *Empetrum nigrum* is characteristic of this area. The Prangli study site belongs to the Prangli Landscape Reserve.

The Kiipsaare study site is situated in the northern part of the Harilaid Peninsula (Saaremaa Island) and belongs to Vilsandi National Park. This area borders on the Baltic Proper in the west and on Uudepanga Bay in the east. Active sandy beaches prevail. In the middle of the study site ancient sandy beach ridges (up to 4.5 m above sea level) with dry grasslands occur.

The Tareste study site is situated on the south-eastern coast of the Tahkuna Peninsula (Hiiumaa Island), 3.5 km south from Lehtma port. Active sandy beaches predominate in the study area. There is a ca 1.5 km long narrow sandy spit in the southern part of the site. An overgrown lagoon is behind the spit. Older coastal formations and areas outside the wave action zone are covered with persistent vegetation.

Collection of the field data on coastal landscapes was started by the authors some decades ago. To reveal landscape changes recurrent investigations and earlier data are used. Our studies are closely connected to the National Environment Monitoring Program. Monitoring of coastal landscapes was included into this program in 1996.

Different study methods have been used for landscape investigation.

1. Compiling landscape (locality) maps and complex profiles as a basis for research.

2. Compiling landscape profiles as vertical cross-sections of the basic landscape units to detail relief changes and vegetation dynamics.

3. Using topographic maps, aerial photographs and ortophotographs from different times to identify changes in shoreline contours, position, vegetation and land cover. By this retrospective method, changes in the land cover can usually be followed back to the beginning of the 20<sup>th</sup> century and in some cases even earlier.

4. Using photos from different times to demonstrate the former situation on study sites.

## Results and Discussion

Changes in the landscapes are caused both by the inner evolution of the landscapes themselves and by human impact on the landscape. Landscape changes are generally based on land cover. The coastal dune landscapes were the most heavily forested areas, where the changes mainly indicate different stages in the management of

forests. For centuries the character of coastal forests has been affected also by heavy storms as well as forest fires. Generally comparative analysis of land cover maps of a coastal dune landscape from different times shows that the proportion of the area used for forestry steadily increased during the last one hundred years. The greatest changes in the land cover took place in the first half of the 20<sup>th</sup> century, when the land use was varied – wooded areas were used also for grazing and haymaking. In the second half of the 20<sup>th</sup> century a large part of coastal forests was designated as protected forest. At the same time the closed border zone of the Soviet Union was the major factor in the low utilisation of the coastal area. These changes are clearly illustrated by the comparative analyses of the land cover of the **Keibu study site** (Figure 2). During the first half of the 20<sup>th</sup> century the proportion of grassland and sandy area without vegetation decreased and that of forested land increased. At the end of the 20<sup>th</sup> century forested land prevailed (ca 65%). During the 21<sup>st</sup> century no major changes have occurred. The forested land is still the dominant form of the land cover. It means that noteworthy changes cannot occur in the protected forest landscape within a relatively short period of time. It is only forest fires and catastrophic wind damage of forests that can change the land cover pattern quickly.

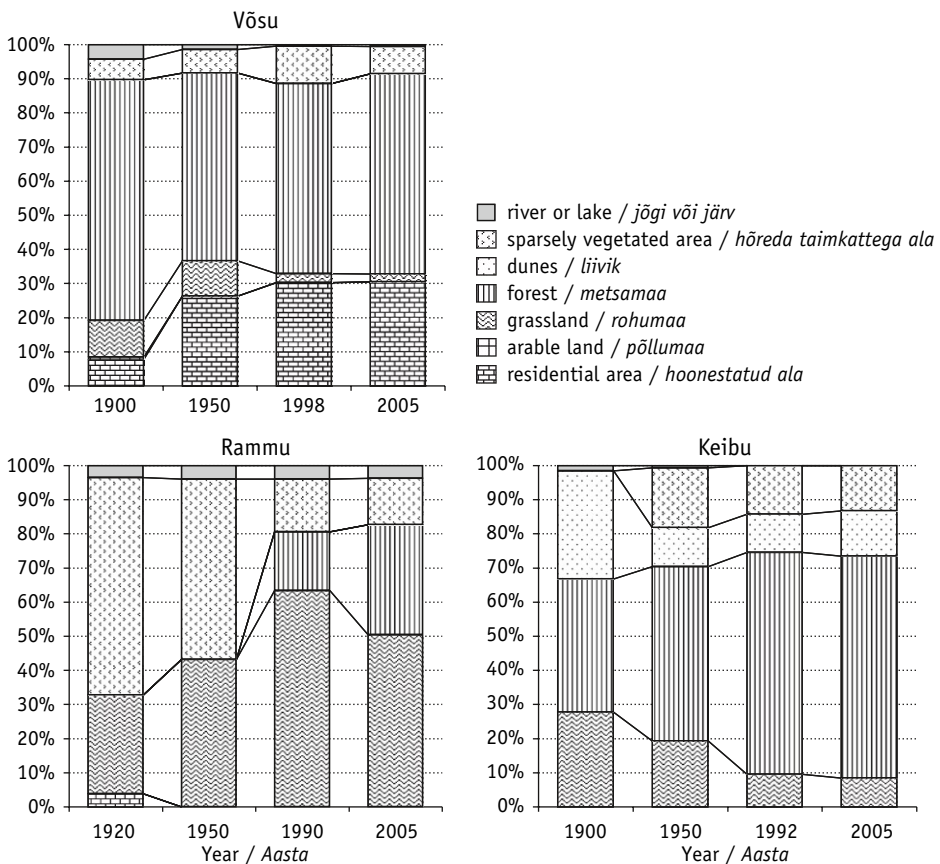


Figure 2. Land cover changes in the Keibu, Võsu and Rammu study sites.

Joonis 2. Maakatte muutus Keibu, Võsu ja Rammu uuringualadel.

The impacts of human activities depend upon the distance to large settlements. For example, at the beginning of the 20<sup>th</sup> century forested land, covering ca 70% of the area, was the main land cover type on the **Võsu study site**. The residential area occupied only 8% of the study site (Figure 3). During the 20<sup>th</sup> century the share of forested land decreased considerably (to 55%) and that of residential district increased (30%). The unvegetated sandy areas constituted ca 10% of the whole site. Up to now the structure of the land cover has not changed significantly. The available natural potential has been used and several regulations for land use (protection, building restrictions) have been imposed to preserve the natural ecosystems.

During the last decades private residences and summerhouses have replaced coastal forests in the vicinity of towns (mainly in the surroundings of Tallinn). The forests in the coastal zone have many extremely important environmental functions, among them prevention of erosion. Tourism and recreation are also users of forest resources. Most coastal forests are fragile ecosystems that can be easily destroyed by trampling. In very dry periods plant communities with a high proportion of lichens and mosses may seriously suffer. In coastal recreational landscapes of Estonia up to three quarters of recreational damage occur in old (100–200 years) pine forests of *Vaccinium vitis-idaea* and *Cladina* site type of III–IV quality classes. The production of these forest is generally low. The seedlings are destroyed by holidaymakers and those remaining in a few groups do not secure regeneration of forest (Örd & Kalda 1994; Örd, 2000). The main function of the forests is probably environment protection.

The decrease of open landscapes and diminishing of landscape diversity are also caused by forestation. In coastal dune landscapes of North Estonia a significant decrease of heaths can be

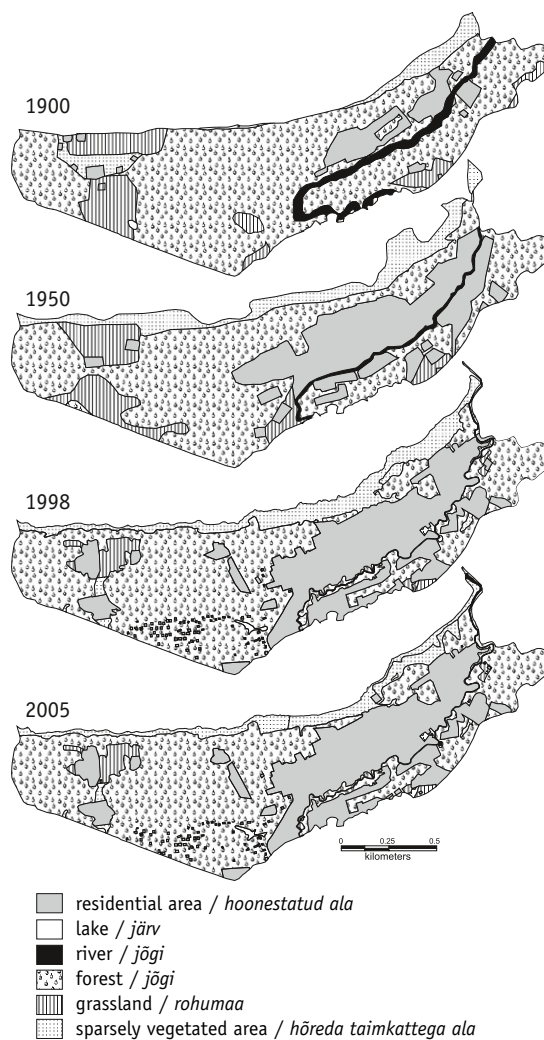


Figure 3. Land cover maps of the Võsu study site.  
Joonis 3. Võsu uuringuala maakatte kaardid.

observed. The coastal (*Empetrum*) heath vegetation is distributed as a narrow belt on dunes and coastal sand plains of the mainland part and the islands of North Estonia. *Empetrum* heath is on the southern margin of its distribution area in Estonia and belongs to a priority natural habitat type (2180) of Natura 2000. The main changes in this plant community were caused by forestation, but natural processes were also of importance. One of the largest areas of *Empetrum* heaths is on Rammu Island. Noticeable changes occurred during the 20<sup>th</sup> century, when the area of fields, grasslands and sparsely vegetated areas decreased and that of forests increased (Figure 2). The decrease of open areas began in the second half of the 20<sup>th</sup> century, when the local inhabitants were forced to leave the island, and it intensified in the middle of the 1980s, when pine seedlings were planted. By now the forested area has essentially increased and that of coastal heath decreased. In the south-western part of the island (near the site of a former village) an erosional scarp in the soft Quaternary deposits is shifting towards the centre of the island, cutting the area of coastal heath. At the same time *Empetrum* is expanding in the north-western part of the island against dry boreal heath grassland.

**The Prangli study site** is also characterised by expansion of *Empetrum* heath. Loose (aeolian) sand is becoming covered with young *Empetrum* patches. During the last years essential changes have occurred on the shore (Figure 4). Cape Liivsääre has noticeably shortened and lowered due to a heavy storm in 2005, and a fresh erosional scarp has developed on the backshore of the cape. On the part of the beach east of

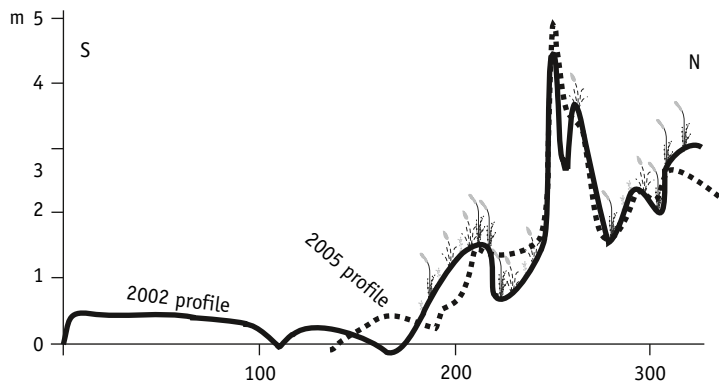
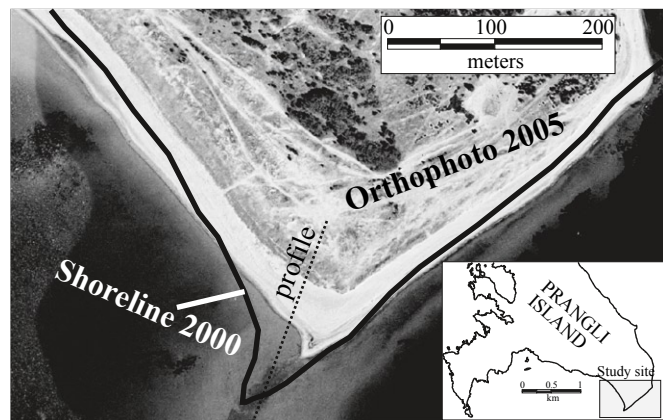


Figure 4. Landscape changes at the Prangli study site.

Joonis 4. Maastiku muutused Prangli uuringsaalal.

the cape sediments have drifted away and a wide (up to 50 m) sloping sandy beach with a few boulders has developed. Sand has accumulated on the western coast of the study site. Vegetation is very sensitive to annual variation of the moisture and nutrient conditions in soil. The material has been redeposited by wave action, with the fine-grain fractions washed away. Therefore, the surface is unsuitable for the rooting and growth of plants. Here only annual plant species are met, mainly growing on *Fucus* drift litter.

The most extensive changes caused by shore processes were observed in the **Kiipsaare study site**, where due to intensive erosion the area of aeolian sand plains and thus that of dry heath grasslands had decreased. The dynamics of the coastline and coastal scarp in this area has been observed in detail since 1970 (Orviku, 1974; Orviku *et al.*, 2003; Rivis, 2005). Shore processes during the 20<sup>th</sup> century caused the north-westernmost point of the peninsula to migrate to the north-east and to change its shape (Figure 5). During the first half of the 20<sup>th</sup> century, Cape Kiipsaare migrated 30–35 m and during the second half of the 20<sup>th</sup> century about 75–90 m in the north-eastern direction. The north-western coast has receded due to erosion but accumulation has been prevailing on the eastern coast of the cape. Similar changes have taken place also in the development of the scarp, which retreated up to 50 m from the 1950s until the 1980s, and 50–70 m during the last 20 years (Rivis, 2005). The changes in the coastline and coastal scarp have caused changes also in the vegetation and soil of the area. The January 2005 storm induced clearly visible changes in the development of coasts and the dynamics of beach sediments. Some of the sand from the beach was cast at the centre of the cape on its formerly vegetated ridges (Tõnisson *et al.*, 2008). The greatest decrease in heath grasslands is due to the heavy storms in 2005

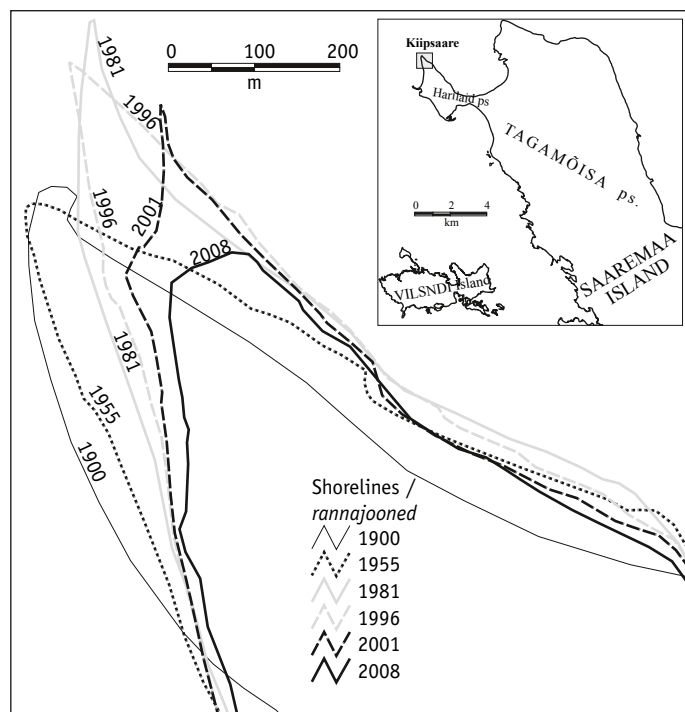


Figure 5. Shoreline changes at the Kiipsaare study area.

Joonis 5. Rannajoone muutused Kiipsaare uuringualal.

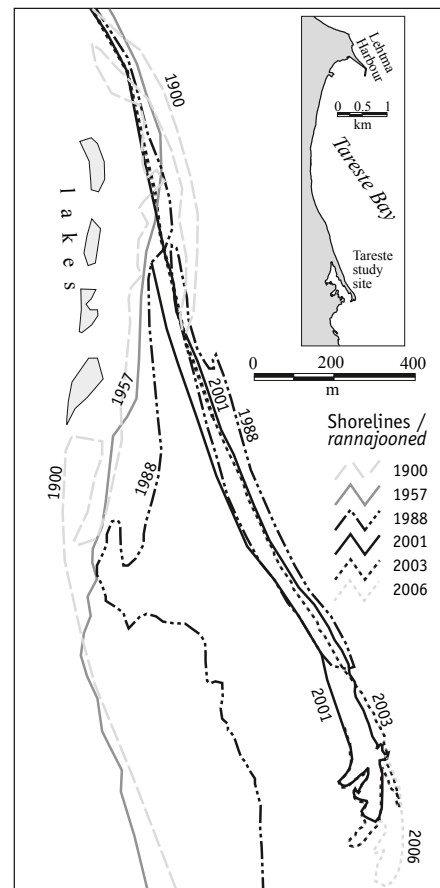
Figure 6. Cape Kiipsaare before (July 2004) and after (April 2005) the heavy storm on January 2005. Photos by H. Tõnisson.

Joonis 6. Kiipsaare nukk enne (juuli 2004) ja pärast (aprill 2005) 2005. aasta jaanuaritormi (H. Tõnissoni fotod).

and 2007 (Figure 6). In comparison with the situation in 1996, the continuous change of the coastline and the prevailing process of erosion have brought along a decrease in the habitats of *Honkenya peploides* and *Ammophila arenaria*. Also the formation of new sand heaps under the influence of the heavy winds in 2007 in the south-eastern part of the study site is noteworthy.

**The Tareste study site** in the eastern part of the Tahkuna Peninsula is dominated by coastal dune landscapes. The Tareste Spit with its complex system of erosion and accumulation processes and strong human impact is the most thoroughly investigated site of the study area (Fig. 7). In natural conditions deposits eroding into the sea were partly transported to the south. The development of the Tareste Spit has been very quick: the changes in the shoreline and the position of the coastal scarp over a hundred years can be clearly seen. The spit was very small at the end of the 1880s (Tiismann, 1924). The shores north of the study area have been eroded for many decades after a harbour was constructed at Lehtma (the NE corner of the Tahkuna Peninsula) in 1914. The eroded deposits were partly transported to the south before the groins were erected. After the erection of harbour facilities at Lehtma, the main routes of sediment transport were cut off and the sand was trapped between the groins and the shoreline. At the same time, a noticeable deficit of sand became evident and active erosion started south of the harbour (Raukas *et al.*, 1994).

Figure 7. Shoreline changes at the Tareste study site.  
Joonis 7. Rannajoone muutused Tareste uuringualal.



This is also proved by the results of the repeated topographic survey at Tõrvanina, showing a disappearance of a 40 m wide strip of land during 1976–1998, formerly consisting of beach ridges covered with vegetation (grey dunes). There is a scarp now eroded into the old shore deposits at the landward edge of the former shore. A forest stand is right at the top of the scarp (Ratas & Rivis, 2003; Rivis 2005). In the lower-lying parts of the spit the predominant plant associations are those with nitrophilous annuals; in higher places *Leymus arenarius* is found.

## Conclusions

Most changes along the Estonian coast result from a combination of strong storms, high sea levels induced by storm surge, ice-free sea and unfrozen sediments. In recent decades the main shore process has been erosion. In many places the shores have been severely damaged by frequent storm surges. The accumulation of sand is observed in a few places. Growth trends of land have been observed for the accumulative sandy spits. The condition of sandy beach ecosystems generally depends on shoreline stability, which in turn depends on the balance of shore processes and shoreline dynamics. In the sites well exposed to the prevailing winds and waves, the landscape structure of the shores may change very quickly. Most vegetation communities of the active coast have been destroyed or their development has changed essentially in relatively short time.

Today the coastal landscapes are under increasing human pressure. Greatest changes in the inland zones are connected with the establishment of forest plantations. Forestation is one of the most serious threats for open landscapes in the coastal area. Nowadays coastal dunes are a popular area for recreation. The recreational activity on sandy shores occurs mostly during the summer months with peak activity in July and August. The more intensively used forest areas were located in the immediate proximity of the popular sandy beaches. Another major problem is the decrease in coastal dune habitat due to real estate development as well as inappropriate land use.

Nowadays coastal dune landscapes have chiefly recreational value and their intensive exploitation may have unfavourable consequences. However, the use of the dune area primarily as a recreational site would mean that the needs of tourism infrastructure would have a great impact on the naturalness of the site. Landscape diversity is the basis for the development of ecotourism on the coastal areas. Integrated management and planning should be developed for coastal areas, taking into consideration the impact of fishing, shipping and construction of infrastructure on the coasts in addition to inland impacts from agriculture and forestry. The beach and inland area of coastal dune landscapes should be treated as one unit for overall management planning.

**Acknowledgements.** This paper was supported by the target-financed project No. SF0280009s07, funded by the Estonian Ministry of Education and Research. The authors are thankful to the Estonian Ministry of Environment. We would like to thank Are Kont, Eva Nilson, Kaarel Orviku and Hannes Tõnisson, who gave us help and advice during our research work. We are grateful to Tiia Kaare for improving the English version the manuscript.

## References

- Carter, R.W.G. 1998. Coastal Environments. An Introduction to the Physical, Ecological and Cultural Systems of Coastlines. Academic Press, London. 619 pp.
- Doody, J.P. 2001. Coastal Conservation and Management: An Ecological Perspective. Kluwer Academic Publishers, Boston. Conservation Biology Series, 13. 306 pp.
- Eltermann, G., Raukas, A. 1966. Estonian sand dunes. – *Eesti Loodus*, 1, 12–18. (In Estonian with English and Russian summaries).
- Hellemaa, P. 1998. The development of coastal dunes and their vegetation in Finland. – *Fennia*, 176(1), 111–221.
- Hyvärinen, H., Donner, J., Kessel, H., Raukas, A. 1988. The Litorina Sea and Limnea Sea in the Northern and Central Baltic. – Donner, J., Raukas, A. (eds.) *Annales Academiae Scientiarum Fennicae*, Series. A. III. Geologica – Geographica, 148, 25–35.
- Keränen, R. 1986. Which is coast dune? (Mikä on rantavalli?). – *Terra*, 98, 1, 79–83. (In Finnish).
- Martin, E. 1988. Relationship between dune formation and Baltic Sea transgressions in Estonia. – Winterhalter, B. (ed.). *The Baltic Sea*. Espoo, Geological Survey of Finland, 79–85.
- Nilson, E., Kannukene, L., Truus, L., Ratas, U., Puurmann, E., Tobias, M. 1997. Biological diversity. – Ratas, U., Nilson, E. (eds.). *Small Islands of Estonia*. Landscape Ecological Studies. Publication 5, Institute of Ecology, Tallinn, 131–179.
- Orviku, K. 1974. Estonian seacoasts. Tallinn, Estonian Academy Publishers. 111 pp. (In Russian, with English and Estonian summaries).
- Orviku, K., Jaagus, J., Kont, A., Ratas, U., Ravis, R. 2003. Increasing activity of coastal processes associated with climate change in Estonia. – *Journal of Coastal Research*, 19(2), 364–375.
- Puurmann, E., Ratas, U., Ravis, R. 2004. Diversity of Estonian coastal landscapes: Past and future. – Palang, H., Sooväli, H., Antrop, M., Setten, G. (eds.). *European Rural Landscapes. Persistence and Change in a Globalising Environment*. Kluwer Academic Publishers, Dordrecht/Boston, London, 411–424.
- Ratas, U., Ravis, R. 2003. Coastal dune landscape of Estonia. – Mandre, M. (ed.). *Forestry Studies / Metsanduslikud Uurimused*, 39, 9–19.
- Ratas, U., Puurmann, E., Ravis, R. 2007. Estonian aeolian coastal landscapes and problems of land use. – Koff, T., Raukas, A. (eds.). *Year-book of Estonian Geographical Society*, 36. Tallinn, Tallinn University Press, 74–95.
- Raukas, A. 1997. Aeolian activity. – Raukas, A., Teedumäe, A. (eds.). *Geology and Mineral Resources of Estonia*. Tallinn, Estonian Academy Publishers, 290–293.
- Raukas, A., Bird, E.D., Orviku, K. 1994. The provenance of beaches on the Estonia islands of Hiiumaa and Saaremaa. – *Proceedings of the Estonian Academy of Sciences. Geology*, 43(2), 81–92.
- Ravis, R. 2005. Shoreline dynamics in Estonia associated with climate changes. *Dissertations on Natural Sciences (Tallinn Pedagogical University)*. Tallinn, TPÜ kirjastus. 119 pp.
- Tiismann, B. 1924. Coastal dunes of Hiiusaare, their stabilisation and forestation. *Tartu Ülikooli Metsaosakonna Toimetised*, 1, 1–95. (In Estonian).
- Tõnisson, H., Orviku, K., Jaagus, J., Suursaar, Ü., Kont, A., Ravis, R. 2008. Coastal damages Saaremaa Island, Estonia, caused by extreme storm and flooding on January 9, 2005. – *Journal Coastal Research*, 24(3), 602–614.
- Vallner, L., Sildvee, H., Torim, A. 1988. Recent crustal movements in Estonia. – *Journal of Geodynamamics*, 9, 215–223.
- Örd, A. 2000. Protection forests and their management in Estonia. *Tartu, Keskkonnaministeerium & DANCEE*. (In Estonian).
- Örd, A., Kalda, A. 1994. Damage to Estonian coastal forests caused by recreation. – *Eesti Mets*, 4(25), 21–22. (In Estonian).

## Muutused Eesti luitelistes rannikumaastikes

Urve Ratas, Reimo Rivis ja Kaija Käärt

### *Kokkuvõte*

Maa ja mere piiril kujunenud luitelised rannikumaastikud on noored ja kiiresti muutuvad nii looduslike protsesside kui ka inimtegevuse mõjul. Enamus neist on kujunenud Limneamere staadiumi jooksul. Maastikuliselt enamlevinud on madalatest luitestunud rannavallidest liigestatud mereliivatasandikud (Võsu, Rammu, Prangli jt.), kuid esineb ka hästi väljakujunenud luidetega alasid (Keibu). Nende piires saab eraldada aktiivse liivaranna ja sellest sisemaa sunnas jääva vanema rannamoodustistega ala. Aktiivsetes liivarandades muld puudub, taimkattes esinevad ranna alumises osas üheaastased nitrofiilsed taimekooslused, ranna ülaossa jääb merihumura ja liiv-vareskaera kooslus, mille juurestik tungib sügavale ning mis aitavad kinnistada liivasid. Rannikumaastike siseosa on enamasti metsastunud, väikesel pindalal kohtab taimestumata liivikuid. Siin esineb ka kuivi nõmmerohumaid ning Eesti põhjarannikul isegi kukemarjanõmmesid. Metsa ja nüüdisranna vahele jäävad alad, kus luitelistel rannavallidel kasvab liiv-vareskaer, Eesti saartel ja ka mandri äärmises lääneosas aga luidekaer.

Luitelised rannikumaastikud on kergesti haavatavad, kus intensiivne kasutus toob kaasa liivade liikumise. Sisemaal toimunud muutustest annab ettekujutuse maakatte muutus. Eelmise sajandi jooksul toimus uuringualadel metsamaa suurenemine rohumaa ja lahtiste liivikute arvelt. Muutused viimastel aastakümnetel on aga palju väiksemad, mis suuresti seotud siinsete metsade võtmisega kaitse alla (Keibu). Huvitav on märkida, et sama tendents esineb ka Võsu uuringualal, kuhu jääb ka osa Võsu alevikust. Suuri ja kiireid muutusi võivad põhjustada siinsetes metsamaastikes metsatulekahjud, tugevate tuultega kaasnev tormimurd ja lagedate alade metsastamine (Rammu), mis toob kaasa avakoosluste kiirendatud kadumise.

Viimastel aastakümnetel toimunud tormisuse suurenemine ning sellega kaasnenud ajutine merevee tõus on kutsunud esile liivarandades suuri muutusi. Rannajoone muutused toovad kaasa ka muutused taimkattes. Enamasti iseloomustavad meie liivarandasid kulutusprotsessid, mille tulemusena rannajoon nihkub sisemaa suunas ning koos sellega kaovad mitmete taimede elupaigad. Uusi kuhjepiirkondi kohtab rannas aga harva, sageli väljendub see liivaste maasäärte tekkimises, mis toob kaasa uute elupaikade kujunemise.

Luitelisi rannikumaastikke kasutatakse praegu intensiivselt puhkekohtadena, samuti ohustab neid suuremate keskuste juures ehitustegevus. Kõik see toob kaasa mitmete elupaikade hävimise või nende seisundi halvenemise. Luiteliste rannikumaastike kaitseks ja säilimiseks on vajalikud integreeritud planeeringud, kus aktiivset liivaranda ja sellega piirnevat sisemaapoolset ala tuleb käsitleda ühtse tervikuna.

*Received April 25, 2008, revised May 29, 2008, accepted July 4, 2008*