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STRENGTHENING OF COASTAL AEOLIAN LANDFORMS WITHIN THE FRONTAL PART OF THE KINBURN PENINSULA

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Introduction. A significant part of the shores of the World Ocean is represented by barrier and abrasion–accumulative coastal systems, which contain accumulative forms of various genesis, composition and morphology (Зенкович, 1962; Шуйський, 2000; Encyclopedia Of Coastal Science, 2005).

Accumulative forms are the largest coastal areas, on the surface of which aeolian processes are actively developing and corresponding relief complexes are formed. Aeolian formations play a very important role in the development of the coastal zone, being the largest natural reservoirs of coastal marine sediments. On some parts of the shores of the World Ocean, coastal complexes of aeolian genesis reach significant sizes and represent natural coastal protection barriers (Морская геоморфология, 1980; Выхованец, 2003; Encyclopedia Of Coastal Science, 2005; Žaromskis, 2018).

Formulation of the problem. Modern climate changes, fluctuations in sea level and anthropogenic activities, in most cases, have a destructive effect on the state of aeolian forms of coastal relief. As a result, these formations are reduced in size or completely destroyed, which leads to a decrease in their coastal protection value. A similar situation within the accumulative areas of the Baltic coasts prompted the population of the coastal territories to take targeted measures to protect and restore aeolian forms (Гуделис, 1954; Болдырев, 1998; Žilinskas and &, 2001; Шуйский, Выхованец, 2001; Выхованец, 2003; Žaromskis, 2018).

Within the Black Sea coast of Ukraine, there are great number of large accumulative forms, on the surface of which specific complexes of the aeolian relief develop, represented by embryodunes, foredunes and kuchugurs (Vykhovanets, 1993; Выхованец, 1998; 1999; 2003).

The formation of aeolian landforms within the frontal part of the Kinburn Peninsula occurs under conditions of active wave processing, frequent manifestation of surge levels and the dominance of multidirectional winds during the year (Davydov, Zinchenko, 2019). The described conditions do not contribute to the formation of large accumulative aeolian forms, and the

existing formations are often washed out or completely washed out during strong storm surges. These processes lead to flooding of the interior parts of the peninsula, with a variety of coastal natural complexes and anthropogenic objects (Fig. 1).



Fig. 1. Wave processing of aeolian landforms of the frontal part of the Kinburn Spit (after a storm surge, December 2012): 1 – Black Sea; 2 – North-western part; 3 – front of the Kinburn Peninsula; a – destruction of the coastal aeolian complex; b – overwash in the aeolian complex lowering; c – washout in the body of the avandune; d – scour.

Sites of the frontal part of the Kinburn Spit that required restoration and strengthening had an average height of 0,3–0,5 m with a width of beaches in front of them of 25–30 m. Medium and fine-grained sands prevailing in the composition of the beach sediments of these areas, without vegetation and not experiencing significant moisture throughout the year. These characteristics of the sand cover determine its significant dynamism even at low wind speeds. The average velocity of aeolian sediment transport is 0,5 m per year.

Strengthening and restoration technologies. Within the frontal part of the Kinburn Peninsula, two technologies were used: the creation of a wind-damping barrier from shields and the landing of a *sand ryegrass* (*Latin Leymusarenarius*) (Fig. 2).

Within the frontal part of the Kinburn Spit, the shield structures were built in several areas where the state of aeolian complexes was the most critical. In some areas where aeolian forms were preserved but required restoration, the rhizome of *Leymusarenarius* was planted.



Fig. 2. Artificial strengthening and restoration of aeolian landforms within the frontal part of the Kinburn Spit: a – creation of a wind-damping shield (2013); b – the condition of the shield after five years; c – planting seedlings (2013); d – condition of the fixed area after five years.

Research results. An experiment on strengthening and restoring individual sections of aeolian complexes was carried out during 2013 and 2014. During this time, sand forms similar to airduns, about 0,5–0,75 m high, formed around the shields. For further growth of the sand forms, it was necessary to raise the shields to a height of about 1,0 m and in some areas to reconstruct them, but these works were not carried out, since the state of the aeolian forms was determined to be satisfactory, and their further increase should be due to natural processes.

The work on fixing aeolian forms with vegetation led to the formation of foci of local accumulation of sand material. However, in some areas that were actively used for recreational purposes, the vegetation was destroyed and, as a result, dispersion processes resumed. Therefore, in the future, it is necessary to provide security zones for such areas.

Conclusions. Within the frontal part of the Kinburn Peninsula, the processes of accumulation and dispersal of aeolian material are reversible. The experiment indicates the possibility of creating a stable aeolian complex, however, under the conditions of systematic work to strengthen and restore it.

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