Foredunes are coastal dunes that develop under prevailing onshore winds, when sand is transported landwards off the beach and is trapped by vegetation. In the first stage of their development small nebkha often with shadow dunes form on the uppermost backshore. Nebkhas are formed by wind blown (called 'aeolian sand transport' after Aeolus, the God of Wind) sand deposition within a discrete plant, and sometimes shadow dunes (pyramidal shaped dunes) formed in the downwind shadow (behind) the nebkha. Over time these dunes may laterally coalesce and grow in height, and eventually evolve into a continuous dune ridge forming a new foredune (*incipient foredune*). Its further growth results in the trapping of most of the sand supplied from the beach, and this cuts off the supply of sand to the older dune landward which becomes stabilized by vegetation (termed the *established foredune*). On coasts where beaches are broad and the sand source is abundant, successive foredune ridges develop. They are a desirable element of every coast, because they provide a natural coast protection against the destructive action of storm waves. Therefore, improving and expanding our knowledge about the mechanisms and factors controlling the processes leading to the formation of nebkha and foredunes is very important.

There are various aspects of foredune initiation, evolution and geomorphology. However, if we wish to comprehend the detailed morphodynamics (the interactions between the airflow [dynamics] and the form [morphology]) of a foredune, and understand exactly how a foredune builds over time, we need to examine both medium term (~1–30 years), and very short term (day by day) to instantaneous processes. Medium term studies of foredune evolution usually comprise topographic surveys carried out repetitively over time. The surveys provide data on topographic change which indicate where sediment is being deposited or eroded on a foredune, but such surveys and research provides little indication of the actual flow dynamics and sediment transport that occur at different times and which, in total, creates the layer or deposit that one observes between two topographic survey periods. Therefore, the research primarily planned within this project focuses on evolution of foredunes in the short term scale.

Research on the development of foredunes in the short term has so far focused on: 1) airflow forcing and steering in beach-foredune systems in relation to the direction of incident wind, 2) impact of the various factors on overall aeolian saltation process on *unvegetated* surfaces, 3) sand transport mode and intensity between and around individual plants. Despite all these works, there have been very few studies conducted on sand transport **in, and over fully** *vegetated* surfaces and none have examined exactly how sand moves into and across a discrete plant or across a laterally extensive vegetation canopy second by second in the field to build individual grain layers, and eventually build the entire dune. We do not know if the assumption regarding aeolian sand grains bouncing off flattened leaves (skimming flow mode) during high energy events is, in fact, possible or true. We do not know if sand grains can be transported *under* fairly moderate to dense vegetation canopies, and if true, how does it occur and over what distances.

One of the principal reasons for the lack of development of understanding how aeolian processes and wind flow operate on dunes (particularly with a vegetation cover) is that there has been, until recently, an absence of robust technologies to measure turbulence and especially sediment flux at high frequencies. The adoption of ultra-sonic anemometry some years ago, the recent use of Wenglor® laser particle counters, and the invention of an efficient self-orienting vertical-array sand trap has allowed measurement of fluxes at rates of 1 kHz or faster, and the capture of suspended sand grains.

Therefore, the main scope of the research is to investigate mechanisms of short term to instantaneous sediment transport in and above various plant covers across both nebkhas of varying sizes, and across foredune ridges during different wind events. The objectives of the project is to conduct a series of sophisticated experiments to (i) gather high-frequency data on sediment transport flux, wind flow, and turbulent boundary layer processes near the surface in vegetated (nebkha and foredune) environments; (ii) measure the sediment transport and changes in the sediment concentration profile downwind on different foredune and nabkha morphologies; and, (iii) measure and contrast the sediment transport, sediment concentration profile, wind velocity and direction within, and on vegetated surfaces with differing vegetation height and/or density across foredunes during varying incident wind velocity conditions.

In addition, we as yet still do not understand fully how sand is delivered to the beach to then be blown by the wind inland. This project will also utilise a sophisticated model called Delft3d to model wave energy gradients along the Łeba barrier and determine how much sediment can be delivered under various mild to storm wave conditions to the surfzone and beach. In this way we will gain a better understanding of surfzone-beach-dune interactions over time.