Most of the landforms on the Earth are shaped by various sedimentary processes (erosion, transport and deposition of sediment). Transport mechanisms are obvious in rivers and oceans where the particles that composed the bed may be entrained by the flow of sufficient strength and moved for a long distance. This is also the case on lands, where aeolian transport systematically occurs as soon as there are loose sediment and strong winds. Under extreme conditions, these aeolian processes are responsible for dramatic short-term events such as dust storms. Nevertheless given the basic range of wind speed on Earth, their impact on landform evolution can be usually observed over longer timescales when they generate erosional (yardangs) or deposional features (sand seas). Overall, aeolian processes are responsible for shaping dunes in various natural environments in desert and coastal areas.

Dunes are not only fascinating objects displaying various shape and orientation. They are also primary landscape features which have a critical importance for the stability of various natural environments. In coastal areas, dunes protect land from the destructive power of the sea storm waves. In desert areas, dunes are sediment traps that store sand along the sediment pathways for a long time. In addition, the migration of dunes can strongly affect human activities and damage lines of communication, roads and railroad tracks. To understand the formation and the evolution of these dynamical landforms, it is critical to relate the sediment flux to wind speed. These relations, the so-called transport models, have been studied since a long time by physicists and geomorphologists using both laboratory experiments and analytical modeling. Nevertheless, all these transport models are still subject to intense debates, not only because they may significantly differ from one another, but also because they can only be applied to the specific and simple conditions in which they have been elaborated. In the light of the variability of the natural systems and a large number of factors impacting the sand transport rate, the main objective of this project is to quantify aeolian sediment transport with respect to moisture content and sand bulk density, as two variables that significantly influence this transport.

The originality of our research is to concentrate on intensity of aeolian transport in different natural environments, under arid and temperate conditions, using both field data analysis and numerical modeling. In the field, a major objective is to determine (1) spatial variability of surface sand properties including textural properties, moisture content and sand bulk density and (2) temporal variation (in the daily scale) of moisture content and sand bulk density, and (3) influence of this variables on sand transport rate. It will be coupled with monitoring of meteorological factors such as wind speed and direction, air temperature and humidity, atmospheric pressure, precipitation and insolation. These different variables may then be related to one another in order to evaluate better the physical ingredients that participate to transport in natural environments.

Given the apparent complexity of processes acting within dune fields, it is often necessary to rely on numerical methods to estimate the overall sediment flux and the migration history of individual grains. As for the establishment of transport models, the modelling of bed forms has always considered uniform sand surface properties. A challenging aspect of this project is to integrate in a dune morphodynamic model the variability of sand surface properties that may affect the sand transport rate. Then, we hope to numerically reproduced dune patterns inaccessible to models before and to provide better predictions of their evolution and dune field development in time.