# ABSTRACT

This thesis is an account of my research activities in the last 10 years (2004 – 2014), conducted mainly in the field of Geomorphology (Coastal geomorphology, Climate variability and landform dynamics, Periglacial processes).

The section of the thesis dedicated to the scientific achievements contains 4 chapters, out of which the first 3 show the evolution of the coastal environment at different space and time scales, from the short and medium term dynamics – from hours to years – of different shoreline units (ch. 2) to the multidecadal coevolution of the shoreline (ch. 3) or the century to millennia evolution of deltaic systems (ch. 4), the last chapter treats periglacial processes associated with permafrost in the Southern Carpathians (ch. 5).

Stretching roughly 150 km, the Romanian Danube Delta coast displays an elaborate morphology, a result of a rich fluvial sedimentary input (20 mil t/year, 1985 - 2013), that is still 3 times smaller than the one reached in the 1980's (56.5 mil t/year, 1849 -1984), and of a considerable marine energy ($H_{s\ wave}$ = 1.43 m) and a strong sedimentary transport exerted by the longshore drift (500 – 1000 x $10^3$ $m^3$/year). The unique conjunction of these factors exhibits a strong individuality, morphologically rendered through a complex puzzle of beach ridge plains (Sărăturile, Periteaşca, Chituc), rapidly growing secondary deltas (Chilia, Sfântu Gheorghe: 12 - 14 m/year), barrier islnds (Sacalin, Musura), extremely fast eroding shores ( deltaic barriers: Împuţita – Ivancea, Zătoane, reaching rates of -12…-20 m/year, accreting sectors (5 – 14 m/year, 4.5 m/year for the Sulina and Periteaşca sectors respectively), and shores with stable shorelines that display the most evolved and intricate morphologies (Sfântu Gheorghe).

In chapter 2, every major unit of the shore (dunes, beaches, longitudinal bars) has been thoroughly analysed in terms of its morphology, dynamics and morphometry. Regarding the interannual foredune dynamics on the Sf. Gheorghe shore, we found a medium term increase in volume (1 – 5 $m^3$/m/year, 1998-2013), with high rates in the south according to the wider stretch of the beach. Foredune aggradation can be limited by onshore oriented extreme storms, but the last of this magnitude dates back to winter 1997 – 1998; the last 10 years being defined by a dramatic decrease in the frequency of severe storms that favoured the volumetric increase of foredunes. Experimental eolian topographic measurements revealed that the seasonal wind regime and vegetation density contribute to an increase in dune volume in the interval of April – November and an erosive or stable trend in December – March. Aeolian sedimentary flux in the foredunes is about 25 – 50 % smaller than that of the beach but remains elevated in comparison with the majority of dune systems formed in a temperate climate, especially because of the low rainfall and sparse vegetation, so that an aerodynamic morphology on the maritime slope is developed. This is affected by sand accumulations during weak and medium onshore winds (6 –

15 m/s) and is eroded during strong winds (> 15 m/s) that can transport sand to the interior slope of the dunes.

Bathymetric surveys reveal a harmoniously developed multi-barred system (most often 3 bars) on stable shores, and a reduced number of 0 – 2 bars on erosional sectors. Multiannual evolution trends of longshore bars are characterized by offshore migration with rates of 20 – 50 m/year, directly correlated with the shoreline dynamics: bars are slowly drifting on stable and accumulative sectors and rapidly drifting on erosive ones. The relationship between the behavior of longshore bars and foredunes is moderate on stable and accumulative shores and low on erosive ones. In the first case, beaches are wider than the critical aeolian fetch at medium and low wind speeds (< 15 m/s) allowing for similar behavior of dunes and bars, whereas on erosive sectors of coast, foredunes display a significantly lower variability.

In chapter 3, the first classification of coastal storms in Romania is put forward, in 5 categories depending on the storm energy (intensity) and the shore morphology (storm impact potential, determined by storm intensity and the angle of the waves with the shoreline). The active season (October - March) records 70 % of the total number of storms in a year and 84 % of severe storms (cat. III – V). The strongest storms occur mainly in December – February, with a maximum of probability in December and January (1.35 days/month with severe storms). Multiannual storminess trends in the last 50 years reveal a variable storm climate activity, with 4 major intervals: 2 intervals of increased storminess (1962 – 1977; 1994 – 2004), separated by a period of moderate storminess (1978 – 1993) and continuing to present with a more calm, quiescent interval with a reduced frequency in extreme storm occurrence (2005 – 2014).

A comprehensive analysis of data collected over the last five decades on the Danube delta coast (topographic maps, satellite imagery, GPS surveys and beach profiles) revealed two different shoreline dynamics patterns: high mobility during 1960-1979 interval with big retreating and advancing rates and low mobility afterwards (1979-2006). The divergence zones in the longshore sediment transport system experienced the highest rates of retreat (~20 m/yr and ~10 m/yr in the first/second time interval), whereas the shoreline advanced fastest along the coast of active lobes (i.e., Chilia and Sf. Gheorghe lobes). The decrease of coastal processes intensity from the second interval was similar for the erosive beaches (with 55-66%) and non-uniform for the accretionary coasts (20-61% for open beaches and 80% for the sheltered secondary deltas). Wind data analysis points out a good connection between multi-decadal winter storm frequency along the Danube delta coast and negative NAO phases (r = -0.76). The results of the present study clearly show that shoreline changes at decadal time scales are also ultimately driven by the NAO which controls the storminess on the Danube delta coast.

Studies regarding the evolution of the southern delta (ch. 4) bring solid evidence regarding the way in which coastal changes have influenced the destiny of the ancient city of Histria. Dated paleoshorelines together with archeological evidence document the ancient city’s foundation on a peninsular littoral complex consisting of a rocky island, a N-S aligned beach ridge plain and a connecting tombolo, 100 to 200 m long developed to the lee of the rocky promontory. 10 – 20 km north of Histria, the southernmost distributary of the Danube (Dunavăţ) has developed a deltaic lobe in the interval 2000 – 1300 BP. Most probably, in the early and medium stages of Dunavăţ lobe development, sea depths near the coast have fallen, thus hindering navigation on the northern and eastern routes from the city. The lobe reaches it's maximum expansion in the 7th century CE, when Histria becomes completely detached from the coast. At the same time, the distributary is abandoned, with a shift in water flow favouring the Sf. Gheorghe distributary, and longshore currents reshuffle the eroded sediments from the Dunavăţ lobe to the newly formed Saele – Chituc beach ridge plain, that moves the shoreline 8 km away from the city thanks to its fast progradation rates (10 – 15 m/year in 1300-700 BP). In the last 700 years, lakes Sinoe and Istria begin to take shape due to very localized neotectonic processes dependent on active fault distribution. The southern delta paleoenvironmental study also includes a local sea level reconstruction, that indicates a relatively stable level for the last 4 millennia between -2 m and the present 0 m. These findings do not support the Phanagorian regression hypothesis in the 1st millennium BC.

In chapter 5 I have briefly outlined the results of our investigations on permafrost in the Southern Carpathians. In this case, we could confirm the existence of continuous and discontinuous permafrost in rock glaciers, screes and rock walls. Also, it was found that a very important control factor in permafrost extension such as the inferior altitudinal limit of it in different lithological settings is the debris deposit porosity. The greater the porosity, the lower the altitudinal limit. In Retezat and Parâng granitic massifs where the deposits display high porosity, the permafrost is to some degree widespread in rock glaciers over 1950 – 2000 m, whereas the massifs made up of schists (reduced porosity) displayed a higher altitude inferior limit of permafrost at 2150 m. Rock walls containing permafrost have northern exposure and altitudes higher than 2350 m. Active rock glaciers can be found only in granitic massifs at over 2100 m altitude. Analysis of the two climatic control factors of permafrost, the cold snow-free interval (October – December) that shrunk in duration and the annual average of air temperature that displays a rising trend, brought us to the conclusion that the majority of surfaces with permafrost in Southern Carpathians are in disequilibrium with the current climate