Since the mid-twentieth century increased cyclonal activity has been observed in winter periods in the North Atlantic due to global climate change. In effect, the number of extreme storm surges in the Baltic Sea is increasing steadily, which in turn - together with milder winters and limited ice cover - exacerbate coastal erosion. The morphology of cliff coasts is shaped not only by storm surges, but also by precipitation and insolation.

The observed rates of changes in the coastlines, particularly those due to erosion, are now a serious concern for the communities inhabiting the littoral zones. Appropriate management, closely linked to balanced development of the littoral areas, is becoming a major challenge for the research community, which is involved in knowledge-based shaping of environmental policies.

The primary scientific objective of the proposed CLIFFREAT project (Coastal CLIFFs under retREAT imposed by different forcing processes in multiple timescales) is to investigate the hypothesis that faster cliff coast erosion can be directly linked to the occurrence of series of subsequent storm surges of different parameters and is only indirectly connected to increasing severity of storms. The storms weaken the cliff's structure and may cause erosion that would happen not during the extreme events, but between them, triggered by intensive rainfall or other causes. This objective will be achieved by obtaining, for the first time in the country, quantitative material describing precisely the scale of erosion on three test areas localized on the southern coast of the Baltic Sea.

While planning the development of coastal areas, it is necessary to prepare the description of the complex interaction between natural forces and socioeconomic activities. For this purpose, obtaining very precise data that would enable us to determinate erosion speed and its relationship with selected variables is paramount. This way, it will be possible to create a description of the reason-result relation between the elements influencing the geosystem of the coastal cliff areas.

In the detailed approach, several additional goals could be distinguished. The most important ones are: (1) long-term geomorphological monitoring of selected sections of the coast in order to determine the real, instead of estimated or modelled, values of erosion of unconsolidated coastal cliffs; (2) recognizing the starting conditions that introduce significant changes to coastal geomorphology by means of finding the relationship between the erosion rate on coastal cliffs of different exposition and selected variables: amount of precipitation, the increase of the sea level, wave height, lithology and geological setting; (3) recognizing the impact of a series of storms to coastal morphology; (4) recognizing if distribution of eroded material influences progress of cliff recession.

Economic limitations simply make it impossible to design and build schemes to protect vulnerable coastal areas from all anticipated events. Indeed, scenarios of climate change impacts calculated using present models are diverse and they do not provide accurate data for cliff coasts since they are based mostly on datasets gained from low-lying coasts. Therefore there is an urgent need to provide datasets describing erosion rates along high coasts affected by extreme events and other forcing processes. Reliably analyzed datasets will enable the possibility to evaluate commonly used protection methods and to organize different ones when needed.

Detailed, quantitative monitoring of the effects of erosion will be carried out at three selected test sites in the south Baltic Sea. Two sites in Poland and one in Germany shall be researched using mobile laser scanning (MSL) and terrestrial laser scanning (TSL) technology already field-tested on the southern coast of Portugal. The research described in this project is pioneer in terms of empirical data. Detailed measurements of erosion have never been conducted in Poland in a two-way manner: occasional in connection with defined hydro-meteorological conditions and systematic as an element of constant monitoring aimed at recording the impact of rainfall.

The project will provide such datasets using state-of-the-art technology such as mobile LIDAR (Light Detection and Ranging), required to develop accurate vulnerability mapping based on reliable data. This work is considered to be crucial in the process of development of protection policies for future coastal hazards.

The proposed project will reconsider achieved knowledge and perform research activities in the Southern Baltic in order to properly analyse the overlapping of several forcing processes such as effects of storminess associated with lithological vulnerability and the geological setting of the shores as well as rising sea levels and the precipitation values. This will have a pioneering nature especially due to the possibility of analysing short-term effects of a single storm or a series of storms (effects of storms of various parameters occurring one after another).

The final scientific outcome of the project will be a series of at least three research papers in respected international journals. Their themes will consider the general characteristics of coastal erosion in the studied sections, analysis of the impact caused by a series of subsequent storm surges of different parameters, and finally quantitative comparison of applied modern and traditional techniques used for coastal monitoring.
An unquestioned added value for the proposed analysis is also the possibility of comparing acquired results with recently conducted research such as long-term hydro-meteorological effects that have been investigated in this area recently. Existence of such regional analysis enables enormous comparison possibilities, and an interaction with different scientists working in the same region will definitely raise the value of the project's outcomes and could have a significant impact not only on the scientific discipline, but also in the field of coastal economy and social awareness of cliff erosion. Unquestionable advantage of the proposed Project is the use of classical approach to the methodology of data acquisition process. Following good practices form other studies such as measuring cliff retreat regularly and event based, seems reasonable and allows to compare results with other studies realized on different European coasts not only build of soft cliffs but also rocky ones.

The Project work-plan is divided into five work packages, as follows:

“Initial historical analysis” is related to establishing the reference state of the investigation area. Severe storms have historically affected the coastline and their impact has been evaluated often by using as criteria both physical and socio-economic impact (e.g. estimated erosion rate or loss of lives and damage to properties). A historical review of storms is necessary in order to collect all data and relate them to the forcing signals, and to quantify and evaluate morphological responses, which are very often described more qualitatively than numerically. The initial analysis will be undertaken using databases available at national levels (for both the Polish and German investigation areas) for what concerns the forcing factors, to identify a number of critical events, which can be traced across the coastline. The review will consider the presence of trends in meteorological data (e.g. changes in storminess) and examine how these may provide guidance to understanding changes in erosion rates at the coastal cliffs.

“Geomorphology database” will create new geodatabase standards for archiving the quantitative and qualitative historical data and new data to be collected during the Project. The new standards will ensure that the perspective end-users of the project (e.g. Maritime Offices or any other institutions interested) are provided with a comprehensive standardized database.

“Cliff monitoring” is related to intensive monitoring of a critical stretch of coastline at three chosen sites in the region of the south Baltic. Field investigations are planned to be carried out on three coast sections, each of about 0.5 to 1 kilometre in length. The first two are located along the Polish coast: one on Wolin Island and the other on the central coast. Both have a NW exposition to dominant waving conditions. The third test area, located in Germany, covers a section of cliffs on the Usedom Island coast with a NE exposition. The field sites will have the role of a “real-scale” laboratory, where high quality and high-resolution datasets will be collected. These studies will focus on risk priorities connected with a real erosion rate as identified in earlier analysis.

“Cliff dynamics analysis” aims to conduct an analysis that will find interrelations between the changes of the coastline (cliff retreat) determined on the basis of information measured in earlier stages. For the purpose of the project, these forces are identified as: precipitation values and their intensity, meteorological-hydrological effects including the ones of the extreme events as well as the change of the sea level caused by climatic and anthropogenic factors. Existing relations between the cause and the effects will be described by the models of various types, from the statistical to mechanistic to models using GIS.

“Dissemination & exploitation” aims to promote, publicize, and disseminate results from the CLIFFREAT Project. It is planned to disseminate the results both nationally and worldwide at different subject conferences. A minimum of three articles from JCR-listed journals will be submitted. A promotional campaign about coastal erosion will be realized during the monitoring activities.