Extreme phenomena in nature manifest themselves in the form of: floods, droughts, hurricanes, storms, earthquakes; and unfortunately they are often associated with natural disasters. In addition to these types of natural crises, economic and financial crises, such as a significant economic recession or a stock market slump, are very important. In order to understand natural or economic processes, certain characteristic quantities are recorded, e.g., temperature, rainfall, wind speed, water levels in rivers, and stock and economic indicators. Such recordings create time series, i.e. series of numbers indexed by the time of measurement. Extreme values (shorter - extremes) in time series are visible as events exceeding a certain level of magnitude. The study of the behavior of extremes in time series is carried out by statistics and related sciences.

Current knowledge about the behavior of extremes in time series is large, but still insufficient to apply to real registrations. The mathematical Theory of Extreme Values is built on the assumption that time series are composed of uncorrelated values. Later works, based mainly on numerical analysis, extended this knowledge to cases of linear series with correlations (memory) of infinite range. On the other hand, many natural series are characterized by non-linearity and long memory, but with a finite range.

The aim of this project is the advancement of the knowledge on the behavior of extremes in time series with characteristics similar to that in natural registrations. This is in accordance with the basic tasks of theoretical geophysics, the role of which is to build new mathematical and physical models and numerical procedures dedicated to geophysical processes.

To achieve this goal, an appropriate mathematical model will be constructed, which will be used to generate the series with the required properties. The study of the relationship between the nonlinearity of the model and its memory and the behavior of extremes will be conducted using numerical simulations. Due to the fact that the procedure for the reconstruction of this model from the data will be derived, the results obtained from synthetic data will be able to be confronted with the results from natural data. This will enable the application of the obtained theoretical knowledge to analysis of environmental, economic and social extreme phenomena. Another advantage of having an appropriate mathematical model of time series is the possibility of forecasting extreme phenomena using the probabilistic transition function, which can then be determined by the parameters of the model.

The result of the project will be the creation of the stochastic non-linear time series model with long finite-range memory, which will be able to describe properly the behavior of extreme values in natural data, as well as their forecasting. The developed numerical procedures will be used for the analysis and modeling of selected geophysical (meteorological, hydrological and seismological) time series. Proper risk assessment of crisis situations will help to reduce possible social and economic losses.