S E S 2 0 2 0
Sixteenth International Scientific Conference
SPACE, ECOLOGY, SAFETY
4 – 6 November 2020, Sofia, Bulgaria

ESTIMATION OF A NATURAL HAZARD RISK INDEX FOR THE EXTREME WEATHER EVENTS: TORNADOES, HURRICANES, DROUGHTS AND WILDFIRES. A METHOD AND A SOFTWARE PROPOSAL

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Keywords: *Natural hazards, climate change, extreme weather*

Abstract: *Risk indexing is a useful and powerful tool that can provide valuable information on the risks associated with natural hazards.*
Such methods were widely used during the last few decades for the purposes of natural hazards risks estimation, particularly in development, oil and gas, nuclear power and air transport industries.
Here the lack of the statistically sufficient historical data is the first obvious obstacle, while on-going climate change scenario requires more up-to-date methodologies as frequencies and magnitudes of the extreme weather events, among other factors, generally depend on the rising sea surface temperature.
Following mixed statistical-modeling approach where we use existing NOAA historical extreme events data, remote sensing imagery and atmospheric model outputs we present a method and a software product concept for calculation of the Natural Hazard Risk Index for extreme weather events - Tornadoes, Storms, Droughts and Wildfires.

Risk indexing is a powerful tool that can provide valuable information on the risks associated with natural hazards. Such methods were widely used during the last few decades, particularly indevelopment, oil and gas, nuclear power and air transportation industries. Greenhouse-gas induced climate change sets demands for more up-to-date methodologies since frequencies and magnitudes of extreme weather events depend on the global land and ocean surface temperatures.

Following mixed, statistical-modeling approach where we use existing NOAA historical extreme weather events data, atmospheric modeling , forecast reanalysis data and remote sensing imagery we present a method and a software product concept for calculation of the Natural Hazard Risk Index for extreme weather events — Tornadoes, Storms, Droughts, Floods and Wildfires within present and future climate scenarios.

The index is a product of the event probability and impact factor values. Parameters of probabilities distributions of the studied events are fitted with NTA (Neuman Type A) distribution [2] as it can provide better accuracy by taking into account closely happening rare events.

For the statistical analysis within present climate scenario for precipitation-related extreme events (Droughts, Inland Floods and, implicitly, Wildfires) we use ECMWF ERA-Interim [1] forecast reanalysis data. Low elevation, forestation and power grid locations are obtained from analysis of Landsat-7 and ASTER satellite images and together with historical data on events in a certain region they determine a group of weight coefficients in the index calculation scheme. Losses and economic damage are included depending on the final goal of the analysis.

For windspeed-related extreme weather events impact rate for a single event happening in a certain location is set to be proportional to the kinetic energy. Impact rates are put in accordance with a discrete scale similar to Fujita [3]. Event tracks are obtained by processing time series data on windspeeds and relative vorticities. Here, for the each time step the initial grid is transformed into the series of resolution scales by iterative convolution with a wavelet operator kernel. The feature recognition and tracking algorithm is applied to the scales with certain parameters which characterize the event type and strength which gives information about approximate tracks of the corresponding events. Initial set of events for fitting of the parameters of the pattern recognition algorithm are obtained from NOAA historical data on Natural Hazards.

Since calculation setup on a global domain could require significant computational costs, rapid estimations are performed with coordinates and historical events chosen stochastically with Monte-Carlo algorithm [4], provided the amount of considered events is large enough in statistical sense.

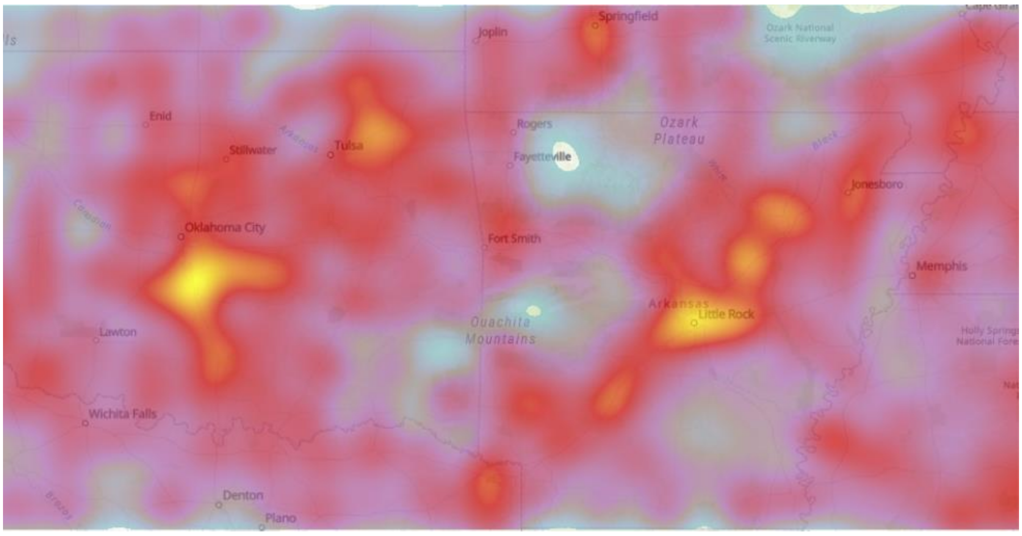

Fig. 1. Estimated tornado Risk Index for the State of Oklahoma

Within ongoing climate change scenario [5] one trying to do a long term risk forecasts faces a number of challenges, where concern about relevance of the historical data is one of the obvious ones, as frequencies and magnitudes of the extreme weather events, among other factors, generally depend on the rising sea surface temperature [6]

The ongoing greenhouse-gas induced climate change is generally expected to increase the intensity of heavy precipitation, with implications for flooding.Previously [9] the relative importance of different physical factors affecting vertical motions in different seasons and latitude zones was shown within a statistical study of one year simulation with an atmospheric model and generalized omega equation. Numerous studies have shown a relationship between precipitation and atmospheric vertical motions for both midlatitudes [7] and tropical regions [8].

Improving atmospheric gas parametrizations and increasing sea surface temperature by 1, 2, and 4 degrees in the initial modeling setup we perform statistical analysis of the atmospheric model output for 5, 10 and 15 simulation years which allows to estimate indexes of precipitation-related natural hazard risks for different seasons and regions within changing climate scenario.

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