Characterization of contemporary fire regimes in Russian boreal forest under impact of climate change and anthropogenic alterations: Thematic study of the Sakha Republic (Yakutia)

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Characterization of contemporary fire regimes is still a challenging scientific task, especially in the light of climate warming and increasing human alteration to forests. This research is the first study to characterize the contemporary fire regimes in the Sakha Republic of Russia. Due to dry climate, high regional lightning activity along with increasing anthropogenic pressure on forests and forested lands, the Republic is characterized by one of the highest forests burning in the country. At the same time, since 1960s, there was detected strong warming trend, especially in the transition spring season, which affected the duration of the fire season and overall fire intensity. The problem of forest fires in the region is escalated by the fact that in the Sakha Republic still does not exist digital, spatially explicit fire database, so our first task was to develop own fire database using combination of the regional fire statistics and satellite fire estimates based on NOAA AVHRR and MODIS products in order to construct the reliable data for fire regime characterization and further use by scientists and other stakeholders.

We carried out fire activity analysis for two institutional levels. First was the regional level (the Sakha Republic) and the second forestry district level. Analysis on forestry district level was performed with the aim to capture the regional changes in the fire regime and establish whether existing significant increasing trends in the main fire variables such as fire frequency and burned area. The main focus was on the burned area as more critical one in the terms of losses.

We developed a new approach for fire regime characterization based on common statistical analysis techniques, which can be applied to any region. The study period, 1996-2018, had not been chosen at random, since 1996 the Sakha Republic underwent rapid industrialization, which we are proposing impacted the fire activity and exist satellite fire estimates.

Changes in the fire regime of the Republic were analyzed with the aim to examine the historical and recent dynamics of main fire features such as number of fires and burned area. During the study period both number of fires and burned area showed increasing trends. The same increasing trends were found at local (forestry district) level. The spatial distribution of fires across the Republic shows that the highest fire activity was observed in Central and Western forestry districts affected by both climate warming and economic industrialization accompanied by involvement of more forested lands into industrial activities and large agroindustry.

The main original part of our research was the investigation of changes in the temporal evolution of fire regimes. This analysis was performed using the Rodionov regime shift detection method. We could identify not only the character of fire trends, but also the exact time when they were occurred. It helped us to identify the causes of the increase of fire activity. The other original part of our research was the fire seasonality analysis. Using combination of regional fire statistics and satellite fire estimates we found that the fire season in the recent decades (from 2009) was started from April and continues through October. As result, were increased both duration of the fire season and total burned area extent. In the most recent

fire seasons (2017 and 2018), the total burned area was increased more than twice. To capture the impact of climate warming on fires was done the comprehensive analysis of the fire weather during extreme fire seasons.

As a final result, were prepared projections of future fire weather based on the ensemble of climate models. They are showing a high possibility of the temperature increase and intensification of drought conditions on the whole territory of the Republic which can make future fire seasons even more severe. The results of projections of fire weather were used to estimate future burned area extent based on regression modeling.

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