

Natural hazard impacts on transportation system in Russia

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The transportation system of the Russian Federation is one of the most extensive in the world. The safety of the transportation is among of the main goals of the national Transport Strategy of the country. In our study we investigate impacts of natural hazards on road and railway transportation. The road and railway infrastructure is exposed to impacts of various natural hazards and adverse weather conditions. The most dangerous of them are heavy rains, snowfalls, snowdrifts, floods, earthquakes, volcanic eruptions, landslides, snow avalanches, debris flows, rock falls, fog or icing roads, and some other natural factors that can trigger many accidents with victims and injuries. Using the data base of technological accidents that was created at the Faculty of Geography of the Lomonosov Moscow State University as well as statistics of the daily number of road accidents provided by the Russian traffic police and meteorological data, we analyze temporal variations and regional differences of the transport accidents' risk within the Russian federal regions and a contribution of various natural factors to occurrences of transport accidents.

The estimate of the weather impact on the car accidents number in Moscow is presented. Various weather phenomena and meteorological parameters that affect the increase and decrease in the number of car accidents in warm and cold seasons were identified; the extent of this influence was assessed. The weather conditions on the days with serious car accidents for 22 years period were considered. The daily numbers of accidents were compared with the weather conditions on the same days. During the cold season, there are much more weather events influencing the growth in the number of accidents than in the warm season. The snowfall intensity of more than 2 cm per day, the reduction in meteorological visibility, drizzle and snow storms lead to an increase of accident rate by 5–15%. The increase in the number of accidents happens in hot weather (maximum of air temperatures over +30 °C) during the warm season.

The 51% of the serious road accidents occur on the days with weak precipitation (less than 5 mm per day), 33% on the days with snow. The slippery road cover can be the reason of about third part of serious accidents: 30% of them occur on the days with transitions of air temperature through 0 °C, 28% on the days with glaze. The 82% of serious road accidents occur in the presence of complicated weather conditions during the cold season. During the warm period, about 50% of serious road accidents occur in the days with rain (27% of accidents on the days when it's intensity are less than 5 mm per day, and 23% - when more). The other weather factors are not significant. The 62% of serious road accidents occur in the presence of complicated weather conditions during the warm season.

More than 4.5% of all railway accidents recorded in the data base are triggered by different natural hazards or adverse weather conditions. During the study period of 1992-2015, railway accidents or violations of rail traffic under the influence of natural factors were recorded in 19 federal regions of Russia. Among of their triggers should be mentioned as follows: snow drifts, washout of railway lines as a result of heavy rains and flash floods, snow avalanches, rails deformation due to heat wave, landslides, debris flows, rockfalls, floods due to spring snowmelt, and some other natural phenomena.

Keywords: transportation safety, natural hazard impacts , adverse weather conditions, road and railway accidents, data base

