

# Landslides as a Risk Factor in the Operation of Pipeline Systems

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## ABSTRACT

Pipeline infrastructure on the territory of Russia is construct and operate in various natural conditions. In regions where hazardous geological processes are active (seismicity, landslides, karst, etc.), they have a diverse impact on pipeline systems. At the same time, the activity of hazardous geological processes is an objective factor that affects pipelines. When risk analysis of natural factors affecting the integrity of pipeline systems, natural factors can be considered in two aspects:

- 1) as direct sources of accidents (one-time hazard) that cause "instantaneous" destruction;
- 2) as sources of long-term impacts (permanent hazards) that provoke the appearance of hidden pipeline defects.

Landslides, depending on their mechanism, can be attributed to both direct hazard sources and permanent hazards. According to P. M. Davis and co-authors (2011), the share of accidents caused by landslides on main oil pipelines in Europe is up to 3% of all accidents. However, according to J. Zambrano and co-authors (2018) the share of the natural component of the risk of accidents on main oil pipelines laid in mountain-folded regions can reach 15%, surpassing the total impact of corrosion and structural-technological factors. The frequency of dangerous situations on pipelines due to various factors in Russia is 60-80 events per year.

### Methodology of landslide risk analysis at pipeline systems.

Methodologically, in landslide risk analysis three approaches can be distinguished:

- 1) method based on the analysis of pipeline systems accidents caused by landslide activity at similar facilities;
- 2) method based on the assessment of the actual damage to the pipeline system by landslides, taking into account their repeatability;
- 3) method based on calculating the probability of landslide activity along the pipeline system.

The first approach is the most common, however, having the least objectivity, it is justifiably applicable only at the stage of investment justification. When choosing the route of a pipeline system, it is most appropriate to use the second approach. The third approach, based on probabilistic analysis, can be effectively applied in order to minimize risks. However, it is currently not widely used in Russia.

The presentation provides examples of risk analysis of pipeline systems accidents caused by landslide activity.

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The basic idea of probabilistic analysis for quantitative assessment of slope stability is to obtain a probability distribution function of the safety factor depending on the probability distribution functions of the physical and mechanical characteristics of the soils and rocks composing the slope. Additional factors affecting landslide activity are also taken into account (Zerkal & Fomenko, 2016).



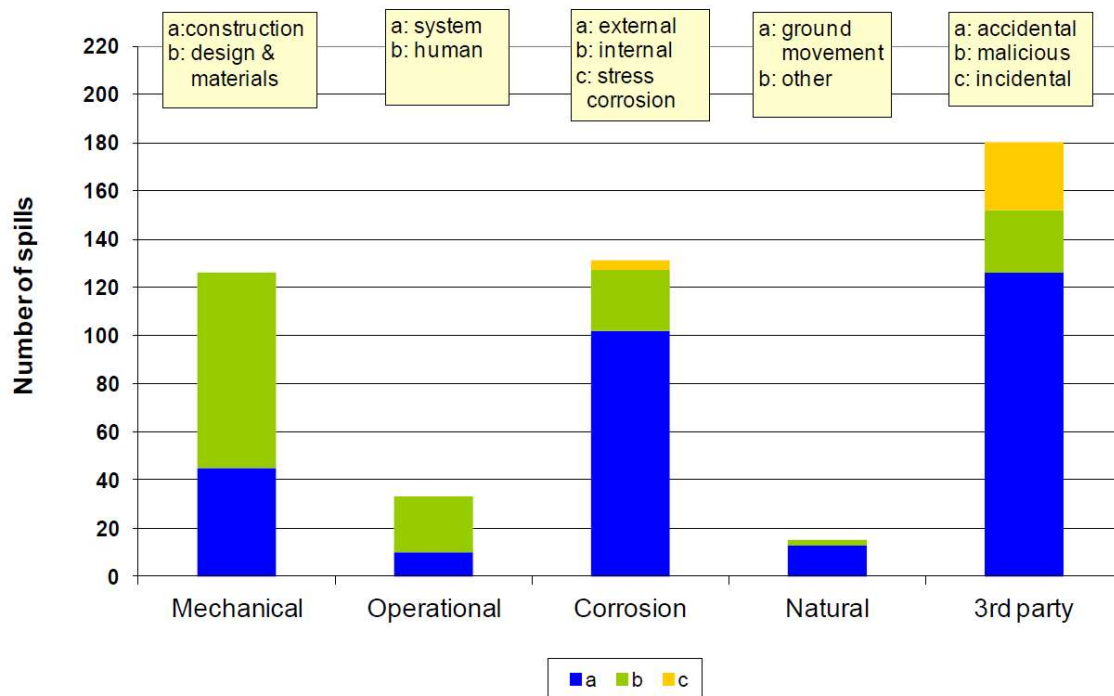


Fig.1. Distribution of major and secondary spillage causes – All pipelines  
(by P.M.Davis (Davis et al., 2011)).

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