Natural Hazards and Environmental Decision Making

Landslide Hazardous Slope Arrays and their Hydrogeological Features

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ABSTRACT

Participants in the construction industry (surveyors, designers, builders) are usually unanimous in understanding the significant role of groundwater (GW) in the construction conditions of the site, in the stability of the slopes. However, on the issue of quantifying this role, opinions are far from unambiguous, which often leads to its underestimation or revaluation. Numerous examples of irrational design of drainages as a part of anti-landslide measures (POM) are available, for example, in the works of E. P. Emelyanova (1959), I. M. Tsypina (1974), V. A. Vsevolozhsky (2007) and others.

The experience of studying dangerous geological processes (DGP) since 1970 in the conditions of the dismembered territory of Moldova, known for its widespread occurrence landslides, swamp and pits on slopes, and since 1990 in Chuvashia, convinced us that differences in opinions on the role of GW in these processes are more often are associated with an inaccurate determination of the types of GWs that are common within arrays. Below is a scheme of the typification of GW developed by us in 1971-75 in connection with the intensification of work on the design of irrigation of farmland, perennial plantings (drip irrigation, etc.) on the slopes, and forecasting its consequences. The scheme provided a common conceptual language and terminology of reclamation engineering geology to a large circle of specialists (geologists, soil scientists, land surveyors, agronomists, hydraulic technicians, land reclamators) of many organizations (survey, design, research) involved in solving the problem. The scheme helped to understand the types of feeding of wells and landslides, the causes of waterlogging, landslide deformations of farmland on the slopes, to understand, especially the types of groundwater, their modes and role in slope processes in Moldova.

But later, since 1990, these developments turned out to be useful for the territory of the Middle Volga Region (Volga Upland), especially during geotechnical surveys for the design of anti-landslide measures (ALM) on the slopes of the valleys of the Volga and Sura rivers. The possibility of using Moldavian developments in the territory, in particular in Chuvashia, is not accidental. These territories, in addition to belonging to the Russian platform with subhorizontal occurrence of sedimentary cover rocks of the Phanerozoic age, belong to the common extraglacial (periglacial) zone with similar climatic conditions both in the ice ages (Arctic deserts) and in the interglacial with corresponding cover formations. Hence there is the widespread development of loess plains, aeolian sands even beyond the alluvial terraces of large rivers. These territories are also close geomorphologically: they are raised in the Quaternary and erosion dissected. Territories with similar types of slopes (from deluvial to landslide and even, rarely, to landslide-scree) are similar, but they significantly differ in the dominance of shallow solifluction-deluvial slopes in Chuvashia and steeper erosion-denudation and landslide - in Moldova. Hydrogeologically, these territories have much in common, if we ignore the age of the water-bearing sedimentary cover of the interfluves and consider it as a complex of interlocking water-resistant and water-containing layers.

Typification of GW for engineering and geological purposes is carried out taking into account their role in the development of certain hazardous processes (karst, suffusion, leaching, subsidence, flooding, and land sliding). The emphasis is placed on the spatial position of the aquifer in the system "water-bearing stratum

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- water repellent". So, in the geological section of well №1 in the Victory Park (Cheboksary), within one "aquiferous complex of the Tatar Paleozoic sediments," there were up to 4-5 independent stratal and interstratal aquifers, which play their own role in the stability of the Volga slope.

Based on the foregoing, for the design of reclamation of waterlogged and landslide slopes, we use the following series of types of GW or aquifer: 1 - soil water; 2 – top water; 3 – ground water; 4 – interstratal water; 5 - low pressure stratal GW; 6 - high-pressure interstratal water (artesian); 7 – micro-interstratal water. Of the seven listed GWs, the content of the first three and the 6th GW is interpreted in the literature more or less unambiguously. The other three are defined below. Interstratal GW 4 - groundwater is between water-resistant strata, non-pressure - the GW power is less than the capacity of the water-containing stratum. Aquifer GW 5 - differs from GW 4 in that the water completely fills the water-containing stratum (layer) and may have a low pressure. Micro-interstratal GW 7 - confined to the strata of thin alternation (intercalation) of clays, siltstones and fine sands, bounded by water-resistant rocks below and above. The horizon is poorly developed; in the unloading zones on the slopes it feeds the swamp (frontal feeding).

Horizons 3, 4 and 5 can be unloaded on slopes, in ravines, within the walls of landslide disruptions in the form of descending (horizons 3, 4) and ascending (horizons 5, 6) springs. The above types of GW are simultaneously considered as types of underground water supply of the swamp, wells and landslides. In addition to them, surface water due to precipitation can also participate in the swamping of land. As factors of waterlogging and by their role in slope processes, atmospheric waters are subdivided into internal, falling directly onto the object, and external (alluvial), falling onto the object (waterlogging site, landslide, and ravine) from the side.

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