

## Rock control, denuded hillslope and discharge system in warm humid regions

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Under humid and warm regions as Japan, a stable discharge system of seepage water in hillslope is maintained by not only geophysical structures( soil and weathered layer ) but also biological system such as forest. From long term point of view, topography, soil, ecosystem and water discharge system play hydro-geomorphological interactions directly or indirectly to one another. In the discharge system, both macro and micro pores of soil layer or weathered bedrock play especially important roll, which controls the permeability and storage capacity under the ground. Among them, natural pipes consisting of continuous macro pores play a roll in the water discharge during a heavy rainfall event. The capillary water stored in micro pore can be used by trees in dry season. These macro pores and micro pores are made by physical and chemical weathering processes. However, biological weathering is the most important for the development of these pores in soil. Forest ecosystems can evolve a matured soil system from soil particles in order to adjust a suitable environment for their own lives. Because the tree root system needs not only water but also enough air, an efficient discharge system may be created as one of the most important environment. This discharge system changes as follows according to the rainfall conditions.

1) In the case of usual storms: The discharge system is stable and it can discharge successfully the seepage water.

2) In the case of unusual heavy storms: The slope failure may occurs due to increasing of water pressure when the water table of throughflow, rises or the pipe-discharge system becomes plugged and partially destroyed. However, this system is recovered with the recovery of forest and soil. This can be called a healthy feedback. The humid and warm climate suitable for forest contributes much to these recovery. Therefore, this feedback can control the expansion of a denuded area made by a slope failure and a wide denuded area may not be naturally developed.

3) In the case of unusual heavy storms in bare lands created by severe human activities: In this case, especially in granite area or the Tertiary area, an unhealthy feedback acts because the critical threshold of healthy feedback is exceeded. Then, the bare land expands rapidly throughout a mountain area. It is almost impossible for forest and soil to be recovered naturally. Human afforestation work is necessary. Such hillslopes were founded in the wide area of Japan till the second half of 20th century. There is no stable discharge system in such bare hillslopes. Consequently, frequent occurrence of overland flow surface flows caused severe floods and soil hazard.

The discharge system seems to be made as a part of hillslope development. The geological character of the bedrock and the climate (rainfall and temperature) play an important roll in making of the discharge system. This system can be considered as one of the effects of rock control.

Keywords: hillslope hydrogy, discharge system, rock control, bare land, ground structure, hydro-geomorphological interaction