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Terrain-Based Groundwater Potential and Groundwater Level Monitoring in Mountainous Regions of Central Taiwan

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The scarcity of freshwater has become a global issue in recent years, particularly in the plain regions of Taiwan. To address this challenge and enhance groundwater management for sustainable use, it is crucial to assess the groundwater resource potential in mountainous regions, as they serve as major recharge sources for the plains in Taiwan. To understand the relationship between groundwater potential and the geological settings of mountainous regions, various field investigation techniques were employed, including geological drilling, core logging, down-hole geophysical well logging, packer tests, and constant-rate pumping tests. This study focused on the main watershed in Central Taiwan, integrating all field investigation results to assess and analyze groundwater potential. Long-term groundwater monitoring wells were established to observe seasonal fluctuations.

Given the geological complexity of the mountainous region, a total of 75 boreholes with a depth of 100 meters were drilled in different geological units. Among the 48 selected sites with higher groundwater potential, groundwater monitoring stations were established, and constant-rate pumping tests were conducted to determine well yields and estimate the hydraulic properties of the rock aquifer. Integration of core and well logging revealed a composition of regolith and fractured bedrock. Geomorphological assessments, including slope analysis and the index of topographic position and wetness, categorized seven terrains: areas near the roof, at ridges, steep slopes, flat slopes, valleys or creek bottoms, alluvial fans downstream from valleys, and main riverbed deposits.

The results showed that the thickness of regolith ranged from 0.5 to 80.8 meters, with a geometric average of 14.7 meters, depending on different terrain types. Well yields ranged from 0.5 to 900 L/min, with an average of 134.4 L/min. Groundwater-level fluctuations ranged from 2.04 to 39.71 meters in shallow aquifers and 1.64 to 29.62 meters in deep aquifers, with outliers reaching 60.53 meters. Notably, higher average well yields and groundwater fluctuations were observed in main riverbed deposits and flat slopes. These findings highlight the observed terrain-based groundwater potential, emphasizing the pivotal role of groundwater-level fluctuation in recharge dynamics.