

Natural and artificial factors controlling 275-day flow in the Japanese Alps region

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City dwellers living at low-lying flat lands depend heavily on water resources supply from mountainous areas. At the same time, they are put at risk of flood due to heavy rains. For assuring river flow at drought periods and reducing a sudden increase in flood runoff, it is fundamentally important to maintain or improve water storage function, especially groundwater storage function, in watersheds. However, it has not yet been established to diagnose/evaluate quantitatively such a function. The objectives of the present study are to identify natural/artificial factors controlling groundwater storage function and to quantify their impacts, through a multivariate analysis based on flow regime and geographical information. We used river flow and dam-inflow data at 170 stations across the Japanese Alps region. As data sets of natural/artificial factors, we used mesh (i.e., raster) data of climatic normal, surface geology, terrain classification, and land use pattern, all of which are provided by Ministry of Land, Infrastructure, Transport and Tourism. Multiple regression analysis for the 95-day flow (i.e., high flow condition) with stepwise variable screening revealed statistically significant factors including annual total precipitation amount, annual mean temperature, annual maximum snow depth, upland area, volcano area, and quaternary rock area. On the other hand, for an analysis of the 275-day flow (i.e., low flow condition), impact of precipitation and temperature were not significant. This indicates that the 275-day flow is a good index reflecting water storage as snow or groundwater. Partial regression coefficients of a multiple regression equation clarify large negative impact of golf course, ski slope, and wilderness (above the timberline); 275-day flow decreases with increasing areas of these types of land use. In contrast, uplands (mainly alluvial fans) and paddy fields had a positive impact. Also, forest have a slight positive impact. Consequently, construction of golf courses and ski slopes with forest cutting and land reclamation have likely reduced water storage function of watersheds. It is particularly important to properly manage alluvial fans and paddy fields for maintaining the function. Such a function should be revisited as geo-ecological service and considered for watershed management and national land policy.

Keywords: Flow regime, Japanese Alps region, geo-ecosystem service