Temporal variation of filling processes of valley-head hollows in the Ohmatsuzawa Hills, Sendai, northeastern Japan

*Takahisa Furuichi[1,2,3], Kiyoshi Saijo[4], Toshikazu Tamura[5]

1. Graduate School of Agriculture, Hokkaido University, 2. Sustainability Research Centre, University of the Sunshine Coast, 3. Environmental Education Center, Miyagi University of Education, 4. Faculty of Education, Miyagi University of Education, 5. Emeritus Professor, Graduate School of Science, Tohoku University

A valley-head area is structured by several micro-landforms, each of which expresses hydro-geomorphic processes in evolution of hillslopes (Tamura 1974, 2008). Head hollows form from landslides, while subhollows develop from shallow landslides that have shorter recurrent intervals and smaller magnitudes than those for head hollow formation (Furuichi 1995, 2015). Filling or modifying of the scours or depressions constitutes another half of the evolution cycle, but its processes and timing appear to be not fully explored. Geomorphological knowledge on filling of the scours involves implications in geomorphic environment especially in terms of the climate change history. This paper presents field-based observation and analysis on filling processes of valley-head areas in relatively gentle, Neogene sedimentary-rock hills in northeastern Japan.

The Ohmatsuzawa Hills extend between the Naruse and Yoshida River lowlands, about 25 km north of Sendai. The hilltops align along the skyline below the level of 140 m a.s.l. and represent erosional surfaces with gravel beds (Akojima, 1971). The study area of the Showa Man-yo Forest Park is located in western part of the Ohmatsuzawa Hills. The highest and lowest elevations occur on the crest slope at 70 m a.s.l. and in the stream floodplain at 20 m a.s.l., respectively. The local basement is the Pliocene Miyatoko Tuff. Fluvial boulders of volcanic origin are found on some of the hilltops and less often on middle to lower parts of slopes. Eight valley-head areas form in the study area and micro-landforms of channel, subhollow, head hollow, upper sideslope and crest slope are identified and aligned in this order upstream.

Profiles of regolith in test pits and by the cone penetration test show layered structure. At channel heads, for instance, a gravel layer of 40-50 cm thick overlies the weathered (in-situ) Miyatoko Tuff at c.a. 80 cm deep and is occasionally covered by a buried humus layer of 10-20 cm thick. The gravels must have been transported (colluvium) given that patches of buried humus are found within the gravel layer. Spatial extent of the colluvial gravel layer is narrower than the area of head hollow but wider than subhollow. ^{14}C dating of a patch of buried humus within the colluvial gravel layer indicates an age of the middle of the Holocene and ages of a buried humus layer overlying the colluvial gravel layer are younger than the patch of buried humus.

It has been reported that shallow landslides can occur in (relatively steep) upper sideslopes once intensive rain and/or strong ground shake (earthquake) affect the slope stability and therefore evolution in valley-head areas is driven not only by continuous diffusional processes such as soil creep but also occasional mass-wasting (Tamura et al. 2002, 2011). In the preset study area, the colluvial gravels are sourced to the hilltop gravel deposits and were likely transported through shallow landslides occurred across the crest slope and (relatively gentle) upper sideslope. The time of the mass-wasting falls in the warmer (and probably wetter) period in the Holocene, suggesting forest fire and/or intensive rainfall may have caused the mass-wasting although earthquakes are known to induce landslides on convex slopes. The period of the mass-wasting was followed by a static period indicated by development of the buried humus.

References
Akojima I, 1971. J. Gakugei, Tokushima Univ. (Nat. Sci.) 21, 7-22.
Furuichi T, 1995. Trans. Jpn. Geomorphol. Union 16(3), 300.
Furuichi T, 2015. Trans. Jpn. Geomorphol. Union 36(4), 231-251.
Tamura T, 1974. Ann. Tohoku Geogr. Assoc. 26, 189-199.
Tamura T, Li Y, Chatterjee D, Yoshiki T, Matsubayashi T, 2002. Catena 48, 89-105.
Tamura T, 2008. In: Sakio H, Tamura T (eds.): Ecology of Riparian Forests in Japan. 15-30.
Tamura T, Sato Y, Furuichi T, 2011. 8th Int. Workshop on Present Earth Surf. Process. and Long-term Environ. Changes in East Asia (Chendu), 12-13.

Keywords: head hollow, subhollow, mass-wasting, Holocene, climate change

