A Study on Changes in Landuse and Stream Course in Siwalik Region, Nepal
ネパールシワリク山地における河道変化と流域土地被覆の変遷

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1. Introduction

Floods are very common natural disasters in the Nepal Himalaya. In Siwalik hill region which is the southernmost hill range of Nepal Himalaya, floods of small streams become the panic for local residents in the monsoonal rainy season every year. There could be two principle implications of floods from Siwalik stream systems. First, agricultural land in the terraces and flood plain area are damaged by bank erosion and inundation. Second, these streams inflict loss of lives and properties, and frequent havoc to infrastructures like roads. In this context, two types of geomorphic processes are important: bank cutting in the terraces, and course widening and sometimes course shifting in the floodplains. This study is based on the use of multi-temporal aerial photographs and field monitoring works undertaken in a selected stream. Main objectives of the study are to (i) document historical change pattern of land use and stream planform over the last four decades and (ii) to identify type and process of geomorphic hazards induced by the streams.

2. Study area and stream characteristics

The research site called Khajuri stream is located in Trijuga river basin in Udayapur district in eastern Nepal (Figure 1). Elevation from mean sea level varies from 165m on the floodplain to 300m on hilltop. The study area covers an area of 26.5 sq km. It consists three small watersheds and stream systems, which drain into Trijuga river. The area can be divided into four geomorphic units: hillslope, upper terrace, lower terrace (stream terraces) and flood plain. The hillslope is dissected with many instabilities such as landslides, gullies and slope failures, which are the principle sources of sediment to which the stream systems transport downstream. Most part of the headwaters is covered by natural vegetation i.e. forest and shrubs (Figure 2), while terraces and flood plain are used for cultivation.

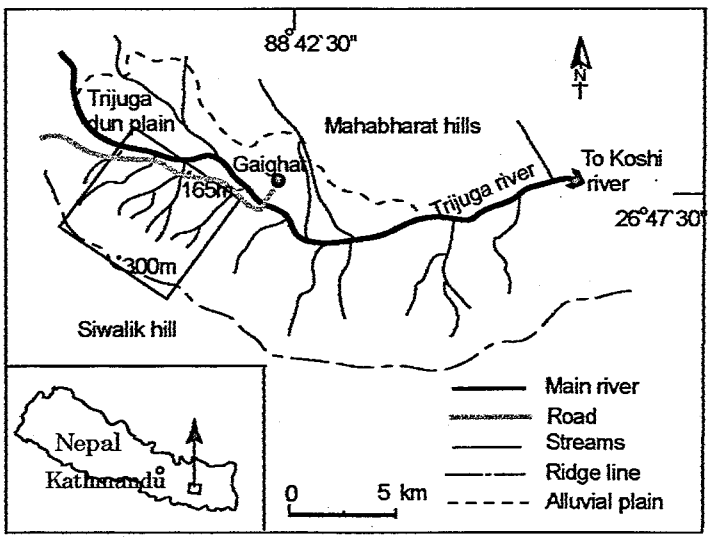

Figure 1. Location map of study area

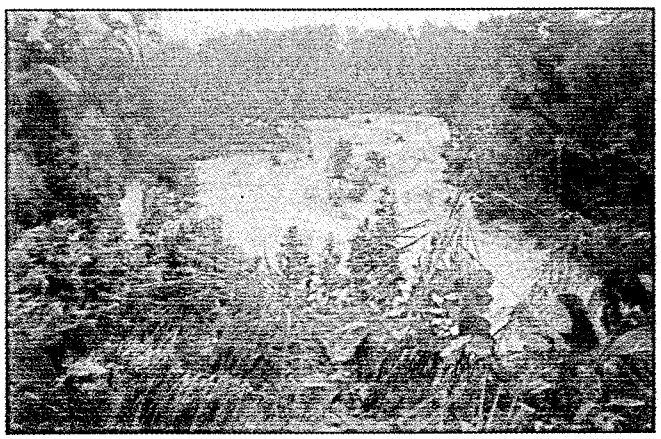

Figure 2. Widening of Khajuri stream in the forested hillslope

3. Methodology

The study is mainly based on the use of computer-assisted interpretation of multi-temporal aerial photographs and satellite image. Aerial photographs of 1964 (scale 1:12,500), 1978 and 1992 (scale

1:50,000) and satellite image (ASTER) of 2003 were rectified using a software called ERDAS Imagine and overlay technique was adopted using another software called Adobe Illustrator.

4. Changes in land use and stream planform

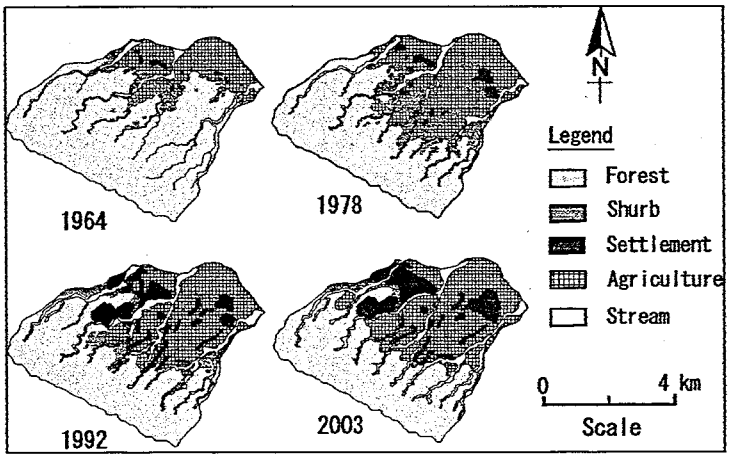

Figure 3 Delineation of land use change from 1964 to 2003 overlaying aerial photographs

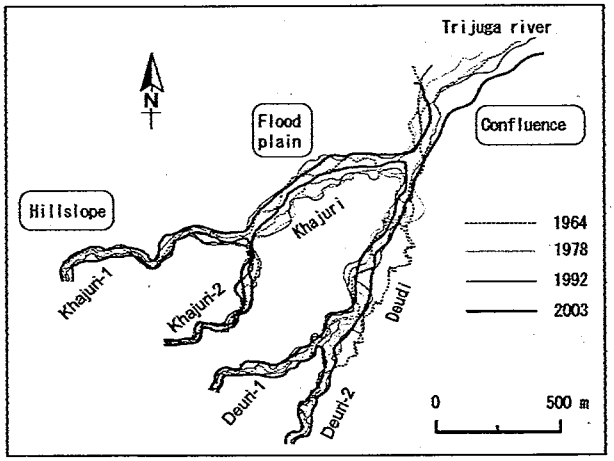

Figure 4 Delineation of stream plan form changes from 1964 to 2003 by aerial photo overlay.

Overlay of rectified photographs indicates that in the period between 1964 and 1972, massive deforestation occurred to expand agricultural land, mainly in the floodplain and terraces (Figure 3). However, rate of deforestation decreased since then probably due to unsuitability of Siwalik soil in the hillslopes for agriculture. There could also be a positive effect of forest management policy such as community forestry started in 1995.

It was also revealed that Siwalik streams have undergone significant changes in cross-section, mostly they are broadening and the extent of change is more pronounced in flood plain and confluence areas (Figure 4). As a result, they induce geomorphic disasters such as bank cutting in the terraces, floodplain inundation and stream course change. Main cause of the geomorphic changes was the occurrence of intensive rainstorms while changes in landuse had no noticeable effects.

There are two processes of change in stream planform. (1) In the hillslope zone, stream widens by bank erosion, which occurs in the principle of selective scouring. More erodible layers of loosely bounded gravel and boulder are washed away first, following the less erodible layers of sand and silt. (2) In the flood plains, lateral inundation is the main process, which occurs mainly during torrential downpours. In such condition, quick and transient peak flow discharge is generated which is often higher than bank full discharge. Generation of such a quick runoff is attributed to the high network of steep drainage channels in the headwaters

5. Conclusion

In view of the weak and degrading landscape of the Siwalik hills, it is extremely important to conserve it in order to mitigate geomorphic hazards in the local scale and to minimize sedimentation problems in the low-land plains of Terai. Hence it is necessary to identify and prioritize the most vulnerable streams and stream locations for planning of protection structures. Bank erosion and flood hazard maps could be the useful tools for such planning. The findings of this study could be important for making such hazard maps of Siwalik streams.

本研究の一部は平成 15 年度（財）砂防・地すべり技術センター研究開発助成を受けて実施した。