

Chapter II Study area

II-1: Topography and geology

The investigated area is located in Awano Town, Kamitsuga County, Tochigi Prefecture, Japan (Figure 2). The surrounding area of the investigated area belongs to the eastern side of the Ashio Mountains, which consist of Triassic to Jurassic sandstone, shale, chert, and limestone (Aono, 1985; Sudo *et al.*, 1991; Kamata, 1997). The investigated area is underlain only by Triassic bedded chert (Figure 2). The bedrock of bedded chert has a strike of N-S direction and an almost vertical dip. The thickness of each bedded chert layer is 30 – 50 mm, and the boundary between layers partially includes a thin (several mm) layer of siliceous shale (Aono, 1985; Kamata, 1997). The pumice deposits 'Kanuma Pumice', fallen in 31,000 to 32,000 yBP (Machida and Arai, 1992), are partially intercalated within flat valley-floor sediments.

Figure 3 shows the topographic map of the investigated area. Altitude of the area ranges from 160 m to 480 m. The area has a dissected landscape with rugged ridge, and consists mostly of steep slopes with the angle of 30 – 50° (Photo 1).

Vegetation in the investigated area mainly consists of planted forest of Japanese cedar (Sugi: *Cryptomeria japonica*) and Japanese cypresses (Hinoki: *Chamaecyparis obtusa*). Deciduous broad-leaved forest including oaks (e.g. Konara: *Quercus serrata*; Mizunara: *Quercus. mongolica var. grosseserrata*; Kunugi: *Quercus acutissima*) locally remains on ridges or steep slopes. Understory vegetation seasonally grows in both of the planted and natural forests from spring to fall.

II-2: Climate

Figure 4 shows an average monthly air temperature and rainfall over 22 years (1979 – 2000) at the AMeDAS station 'Kanuma', Japan Meteorological Agency (JMA). The AMeDAS station is located 11 km northeast of the investigated area (Figure 2). Mean monthly temperature ranges from 1.2 °C (January) to 24.2 °C (August), and annual mean temperature is 12.5 °C. Mean annual number of freeze-thaw days ranges from 50 to 100 days (Suzuki, 1966). The average annual rainfall is 1476 mm, 76 % of which occurs during the rainy season from May to October as following three types. Rainfall events from June to July are attributed to the Monsoon front (Baiu front). Thunderstorms bring intensive rainfall events from July to August. The larger rainfall is brought from August to October by Typhoons, which approach the investigated area 2 – 3 times a year.

Figure 5 indicates the fluctuation in monthly average temperature and rainfall at the 'Kanuma' in the observed three years (from 2000 to 2002). As described in detail later, most of hydro-geomorphic observations were started on 11 June 2000. The annual rainfall was 1,523 mm in 2000, 1,753 mm in 2001, and 1,591 mm in 2002, which exceeded the average of 1,476 mm over 22 years. In particular, the largest monthly rainfall of 460 mm in August 2001 was almost twice the monthly average of August over 22 years (1979 – 2000; 243 mm).

Return periods of daily and hourly rainfall were statistically analyzed with extreme statistics of daily rainfall for 112 years (1891 – 2002) and hourly rainfall for 72 years (1931 – 2002) at the meteorological observatory 'Utsunomiya', JMA. These extreme statistics consist of the annual maxima of daily and hourly rainfall. The meteorological observatory 'Utsunomiya' is located 20 km northeast of the investigated area. Although the AMeDAS station 'Kanuma' is closer to the present

study area, the period of record at 'Kanuma' is only 22 years. Data at 'Utsunomiya' observatory with the longer period were used accordingly. The return periods were calculated in two different methods, i.e., Chow's method (Chow, 1964) and Iwai's method (Iwai and Ishiguro, 1970). The results are shown in Table 1. The return period of daily rainfall with 110 mm is 3 years, and that with 200 mm is 50 to 75 years. The return period of hourly rainfall with 100 mm is 100 to 200 years.