(3) Observation of rate of streamflow

To estimate the rate of streamflow of the Kolongo River that probably recharges the groundwater stored by the subsurface dam, the rate of streamflow and the level of the river water were observed at the points where the geometry of the cross-section of the river could be measured easily. The observations were conducted at two points: where the old main road crosses the Kolongo River, and where the current main road crosses the river.

The observation was carried out for 5 years from 1998 to 2002, but reliable results were obtained only in 2000 and 2001. The rate of streamflow where the old main road crosses the river, calculated from the results of the observation, was as follows:

in 2000 (exceptional drought year): about 6,000,000 $m^3$/year
in 2001: about 11,000,000 $m^3$/year

## 6-3 Fluctuation in the groundwater level in the reservoir area

(1) Assessment of the effectiveness of the subsurface dam for water storage

Figure 6.3 shows the water storage state by the subsurface dam at two periods after the construction of the dam, i.e., on 2 October 1998 (at the beginning of the dry season) and from 19 to 24 February 1999 (in the middle of the dry season).

In these two periods, the reserved water level was higher by 4.5 to 6.5 m compared with the groundwater level downstream of the dam. It was also higher by 2.5 to 5 m compared with the groundwater level in the corresponding seasons before the construction of the dam. All these results proved the effectiveness of the subsurface dam for water storage.

(2) Seasonal fluctuation in the reserved water level

However, the reserved water level fell in the dry season, as the comparison of the results of the observation in the two periods in Fig. 6.3 shows. Indeed, some of the reserved water was pumped out, but the amount of such water was tiny compared with the whole reserved water (the amount of pumped out water was 3,000 $m^3$/year (see Section 7.(1)), whereas the estimated reserved water volume was about 400,000 $m^3$ at the end of the dry season of 2002 (see Section 6-5)), and could not have caused the fall in the reserved water level.

Such "seasonal fluctuation" in the reserved water level occurred every year. As a proof of this, Fig. 6.4 shows the results of the continuous observation of the groundwater level from June 1998 to February 2003 at the well P-4 (a “well of the all-strainer type”) located about 200 m upstream of the subsurface dam. This figure also shows the groundwater level observed from November 1996 to November 1997 in the well B-2-4 located at the dam site, for comparison with the groundwater level before the construction of the dam.

(3) Interannual fluctuation in the reserved water level

The results of the observation of the reserved water level shown in Fig. 6.4 show the following characteristics of interannual fluctuation in the reserved water level.

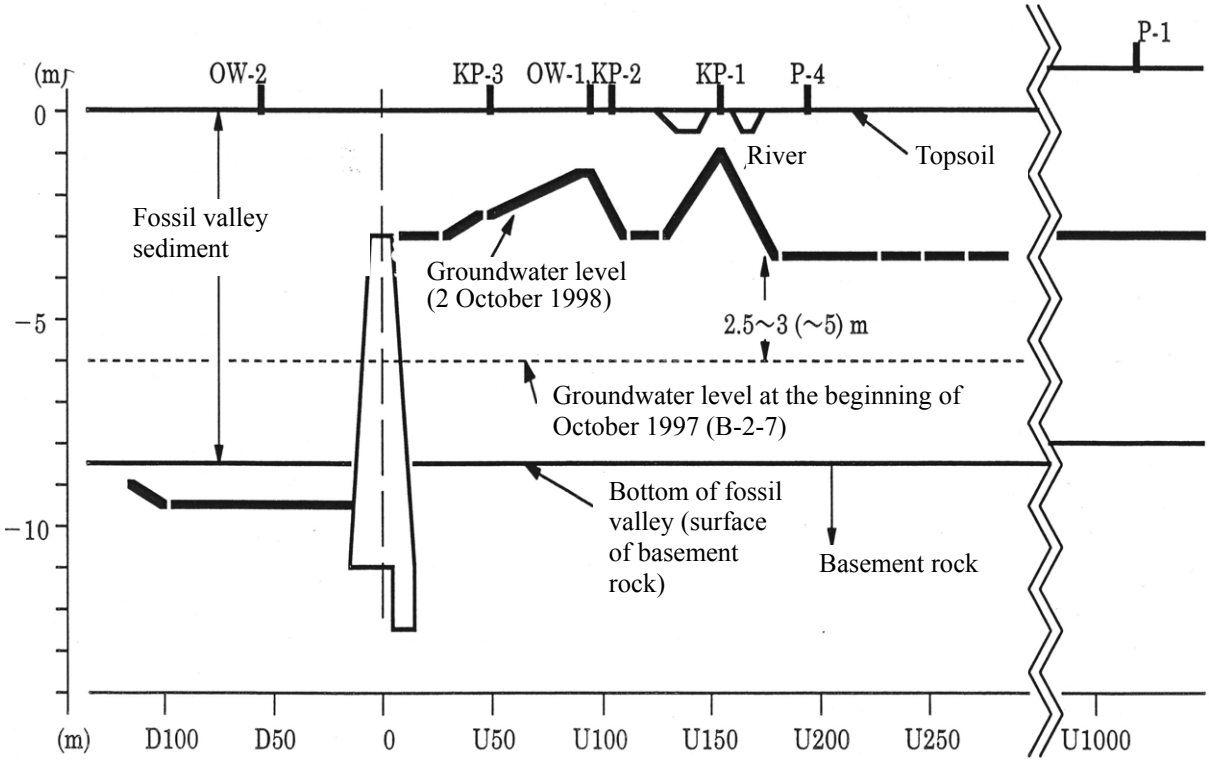
1) Every year, the reserved water level rose in the rainy season and fell by 2.5 to 4.5m by May and June, i.e., between the end of the dry season and the beginning of the rainy season.

2) The lowest level in a year, which was recorded between the end of the dry season and the beginning of the rainy season, rose year by year except in 2001.

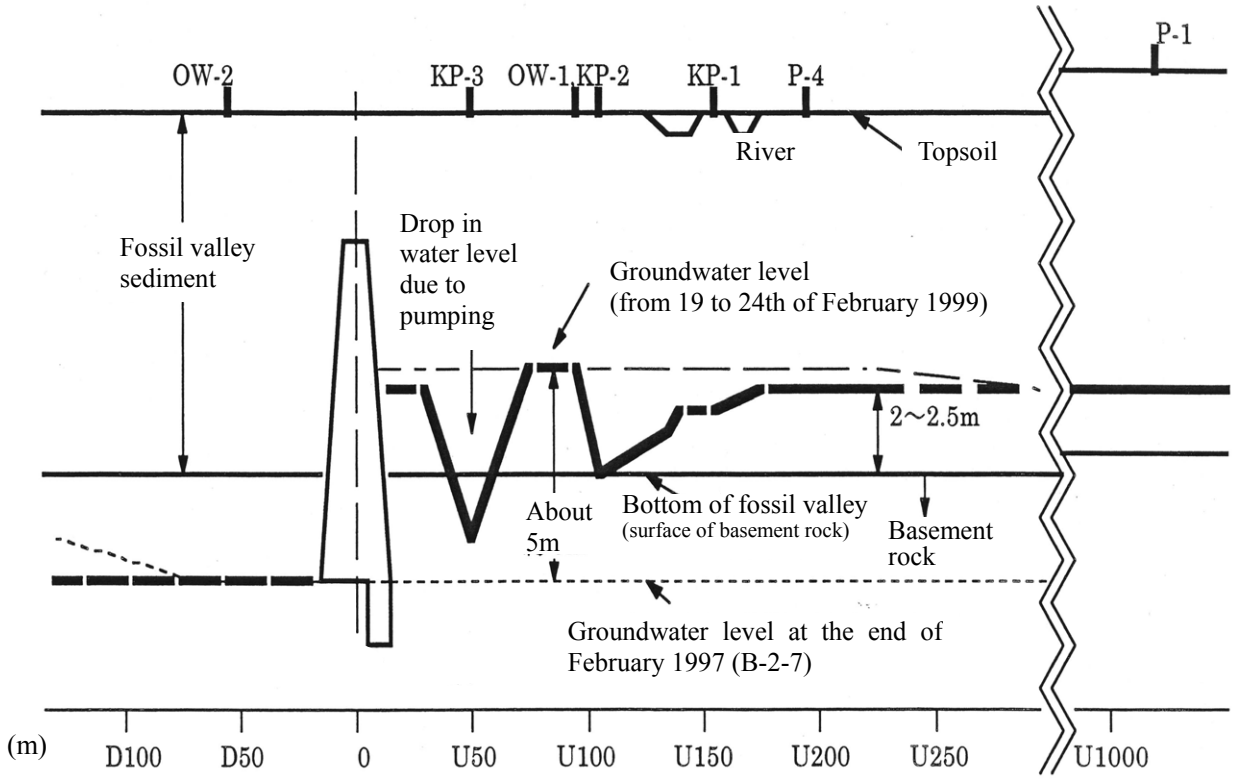
3) The reserved water level during the rainy season of 2000 was very low compared with that of the previous years, and the lowest level between the end of the dry season and the beginning of the rainy season fell in 2001. This can be attributed to the exceptional drought in 2000 around Nare Village. The reserved water level was also low during the rainy season of 2001. It may reflect the fact that the annual rainfall in the upstream area of the Kolongo River basin was lower in 2001 than in 2000 (see Table 6.3). The reserved water level is thus closely related to rainfall within the drainage basin of the river.

Altogether, the reserved water level is rising year by year in spite of the obvious seasonal fluctuation and a fall in the exceptional drought year.

Figure 6.5 shows the interannual fluctuation in the groundwater level observed in the well NP-1 located 5 km upstream of the subsurface dam, which followed a similar pattern of rising with seasonal fluctuation. This interannual rising trend of the groundwater level was also observed in the other wells located upstream of the dam. It was thus concluded that the reserved water level of the subsurface dam is consequently rising with the upstream expansion of the reservoir area. The reservoir area was estimated to reach 5 to 6 km upstream of the subsurface dam in 2002.




A: Groundwater level upstream and downstream of subsurface dam (2 October 1998)




B: Groundwater level upstream and downstream of subsurface dam (from 19 to 24 February 1999)

Fig. 6.3: Change in reserved groundwater storage state

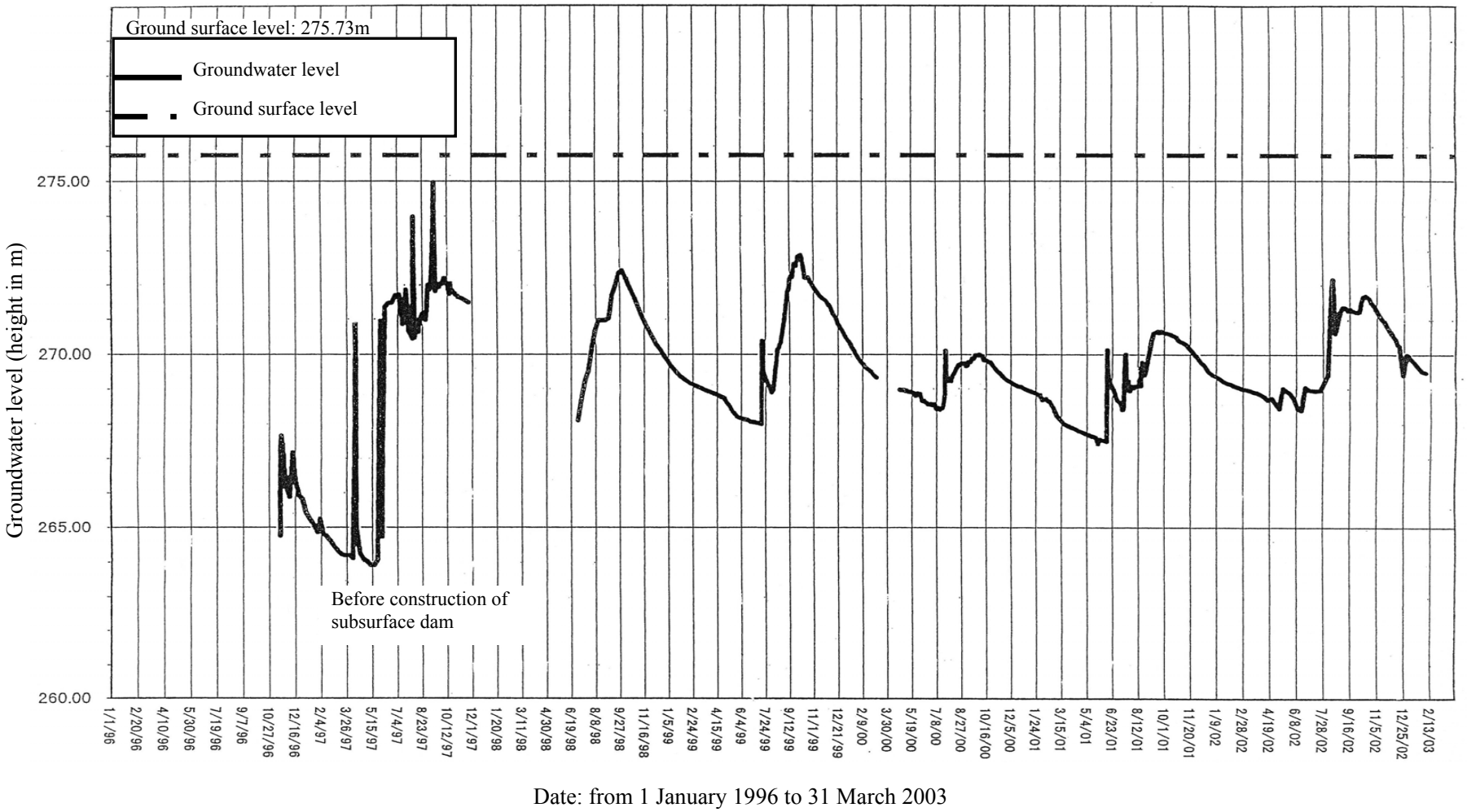
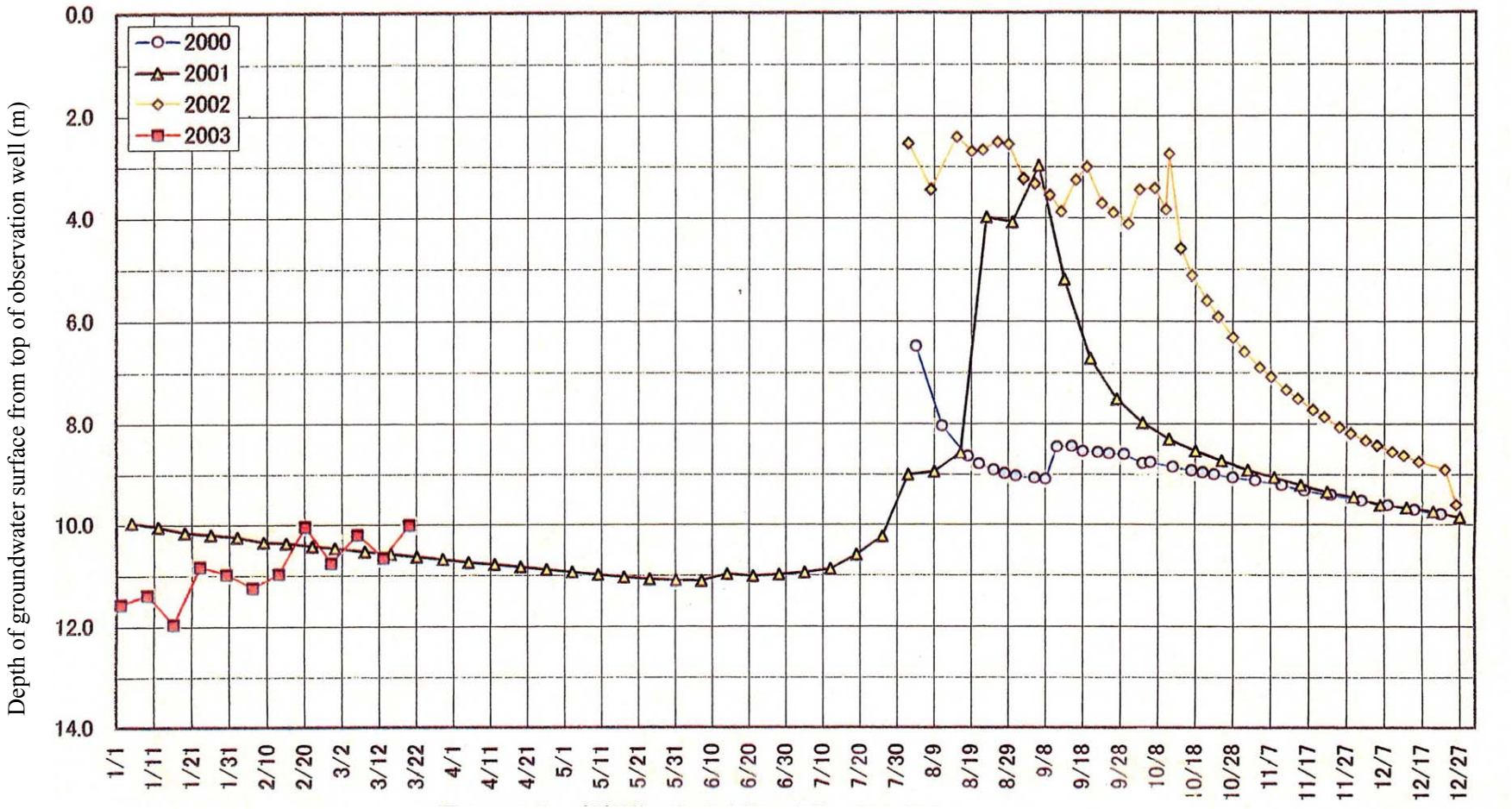



Fig. 6.4: Results of continuous observation of reserved groundwater level by the subsurface dam (at observation well P-4)




The results showed that, in general, the groundwater level increased annually together with the "seasonal fluctuation".

Fig.6.5: Interannual fluctuation in reserved groundwater level (at observation well NP-1)