In future subsurface dam projects, it is advisable to carry out more detailed surveys to estimate more precisely the volume of water to be stored. Nevertheless, even with such an estimate, it is impossible to completely avoid fairly large error. This should be taken into account in selecting subsurface dam sites and in making plans for using the reserved water.

(4) Selection of dam site from a socio-economic viewpoint

In this project, taking into account its experimental character, priority was given to the hydrogeological conditions in selecting the subsurface dam site. In future subsurface dam projects for practical purposes, socio-economic factors should be taken into account as well.

In general, using the reserved water by the subsurface dam requires "water-pumping facilities". If the subsurface dam is located far from where the reserved water is used, large "water-supply facilities" are also required. In some cases, the cost of the installation of these facilities may be higher than that of the construction of the subsurface dam.

Therefore, in selecting the subsurface dam site, the following factors should be taken into account for better cost-effectiveness:

- Population that will use the reserved water
- Possibility of developing irrigation or livestock farming using the reserved water

In addition, note that if polluted water enters the reservoir area of a subsurface dam, it takes an enormous amount of time to restore the water quality due to slow water circulation. Therefore, precautions against water pollution by agricultural chemicals, for example, should be taken when using the land within the reservoir area.

8-2 Survey methods

(1) Use of aero-photographs

Most of the study area for this project was very flat, so the use of aero-photographs was essential for the field exploration. The use of aero-photographs is effective in general in field exploration in areas with huge peneplains such as in Africa. It is thus desirable to disseminate the technique of using aero-photographs to African engineers engaged in geomorphological and geological studies.

(2) Points to be noted in observing groundwater

It was revealed that there were some perched water bodies in the fossil valley sediment at the subsurface dam site in this project, and the existence of this perched water strongly affected the results of the observation of groundwater level. It is thus necessary to note that it is possible to overestimate seasonal fluctuation in the groundwater level due to the presence of perched water.

In general, perched water may not only be in fossil valley sediment, but also in basement rock.

(3) Importance of hydrological observation (rainfall, rate of streamflow, groundwater level, etc.)

The surveys and the evaluations in this project encountered difficulties due to a lack of existing hydrological data on rainfall, rate of streamflow, groundwater level, etc.

As rainfall sometimes shows an extreme difference even between relatively close points, it is

advisable to arrange rainfall stations more densely in areas where there is a shortage of water resources as in the Sahel. In addition, as variation in river water is closely related to the exploitation of river water and groundwater, it is preferable to measure the rate of streamflow as at many points as possible, even in the same river system. As for the groundwater level, although the observation data collected during the excavation of deep wells were relatively well preserved, the data of the groundwater level in shallow wells and the data of seasonal and interannual fluctuation in the groundwater level were limited. These data are necessary for any exploitation of groundwater resources. The establishment of systems for such observation and data-keeping is thus desirable.

(4) Surveys in the reservoir area

As described in Section 8-1-(3), form, volume, hydraulic characteristics and possibility of water leakage of the reservoir layer of the subsurface dams are not easy to determine. Surveys to determine these parameters for the construction of a subsurface dam are thus important.

8-3 Methods of construction of a subsurface dam

(1) Disadvantages of a "subsurface earth dam"

The method of construction adopted for this project was to install an "earth dam" (earth dike) under ground. This method poses the problem of "water springing" during construction. In this project, there was little “water springing” from the excavation face of the fossil valley sediment and special measures were not necessary. However, when there is a lot of shallow groundwater and stopping “water springing” is difficult, it sometimes becomes impossible to continue construction.

It should be noted that a subsurface dam to be constructed very deep under ground requires a great quantity of excavation and backfilling, with corresponding costs. The risk of water springing also increases.

(2) Material of the dam body

In this project, the dam body was built with materials extracted from a place away from the dam site. However, surplus soil produced by excavation at the dam site proved usable as the dam material later on.

The reuse of the surplus soil produced by the construction of a “subsurface earth dam” eliminates the need to use material from other places, and thus can reduce the negative impact on the environment. This process should be considered in planning “subsurface earth dam” projects.

(3) Introduction of a "cut-off wall by an underground diaphragm wall”

In this project, the method of constructing the "subsurface earth dam" was selected to use materials available in Burkina Faso. However, the principle of the subsurface dam is the same as that of the "cut-off wall" that is generally used for construction work, and the “cut-off wall” is applicable to the subsurface dam. Especially when, as described above, there is a risk of a large amount of “water springing” during excavation work, or when the dam is to be built very deep under ground, or when shortening the construction period is necessary because work can only be carried out in the dry season, the “cut-off wall method” is better than the “underground earth dam”.