8. Recommendations for future subsurface dam projects

The above-described results of the pilot study of the subsurface dam as the “Model Project to Combat Desertification” showed that the "subsurface dam technology" developed in Japan were applicable to West Africa, a region affected by desertification.

However, to construct operational subsurface dams adapted to the physical and social conditions of the region, sufficient attention should be paid to the following.

8-1 Selection of subsurface dam sites

(1) Evaluation of "fossil valley"

In this project, the subsurface dam was built using an existing fossil valley. Although water leakage from reservoir area occurred, it was confirmed that the construction of a subsurface dam using a fossil valley was possible.

It is said that there are many fossil valleys in the Niger River basin, and there may be many possible sites for the construction of subsurface dams.

It should also be noted that the fossil valley is often accompanied by shallow groundwater, and in general, by a wide area of flat lowland. Therefore, fossil valleys seem places with high potential for the development of irrigation or livestock farming. It is desirable to examine the distribution of fossil valleys and their characteristics not only for the construction of subsurface dams, but also from this viewpoint.

(2) Geological structures other than fossil valleys

Although the surveys for the subsurface dam site in this project were carried out targeting “ring-shaped landforms” and “bottleneck-shaped landforms” as well, proper geological structures from these landforms except “fossil valleys” were not found. However, more detailed surveys would make it possible to find proper dam sites from geological structures other than “fossil valleys”, even if these surveys require enormous effort.

(3) Difficulty in estimating exploitable groundwater

In selecting the subsurface dam site, it is necessary to estimate the volume of groundwater to be stored. However, estimating the "water to be stored", which is relatively easy in case of a surface dam, encounters the following difficulties in case of a subsurface dam:

1) Because the water storage layer of a subsurface dam is formed under ground, it is difficult to precisely determine its form and volume.

2) The water storage capacity of a subsurface dam depends on the effective porosity of the geological strata. Determining the effective porosity of all parts of the water storage layer requires a significant survey effort.

3) It is difficult to precisely estimate the recharge of groundwater into the water storage layer.

4) It is difficult to detect water leakage points from the water storage layer, and to forecast the volume of water leakage.

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