

Monitoring of Groundwater Recharge Facility and Result Evaluation Method Research in Choushui River

Abstract

By integrating several evaluation methods from domestic and foreign reference, this project has established a performance evaluation conceptual model of groundwater recharge suitable for the artificial recharge facilities. The model contains observed and simulated data to be validated.

Study Area (Choushui River Alluvia Fan)

- The agricultural water usage uses the most percentage, about 87~90%, of total water demand.
- There is severe land subsidence in Changhua and Yunlin counties. In Changhua, the largest subsidence rate is 6.4 cm/yr and the ongoing subsidence area includes 139 km². In Yunlin, the largest subsidence rate is 6.4 cm/yr and the ongoing subsidence area includes 267 km²

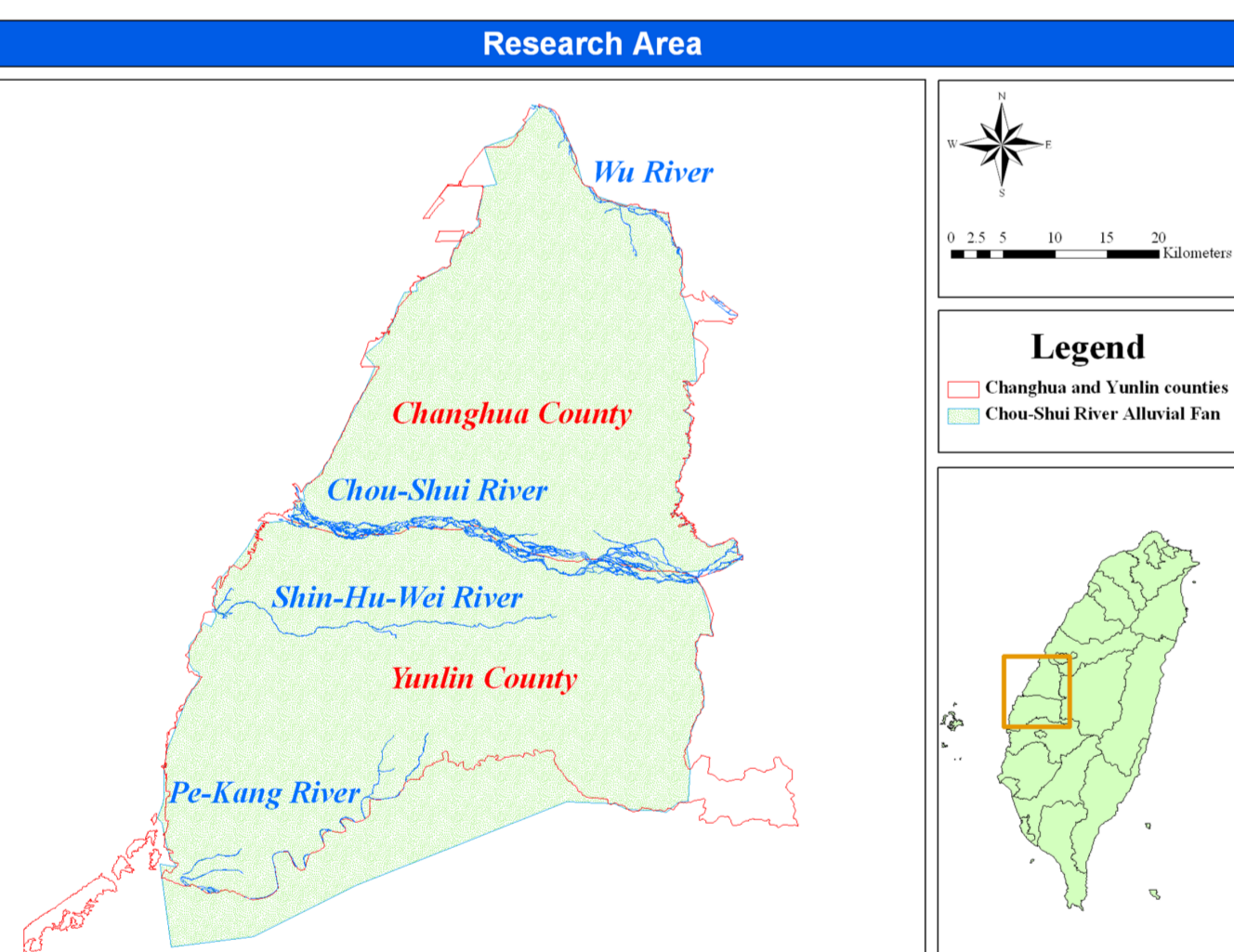


Figure 1. Choushui River Alluvia Fan



Figure 2. agriculture well and the hose with serious land subsidence

Groundwater Recharge Facilities

- Three dams were established to impound water in the dry season. The size of each dams was as follow,
- Dam A: 214m long, 6m wide and 2m-3m high.
 - Dam B: 821m long, 6m wide and 2m-3m high.
 - Dam C: 1200m long, 6m wide and 2m-3m high.
 - Dam D: 1600m long, 10m wide and 2m-3m high.

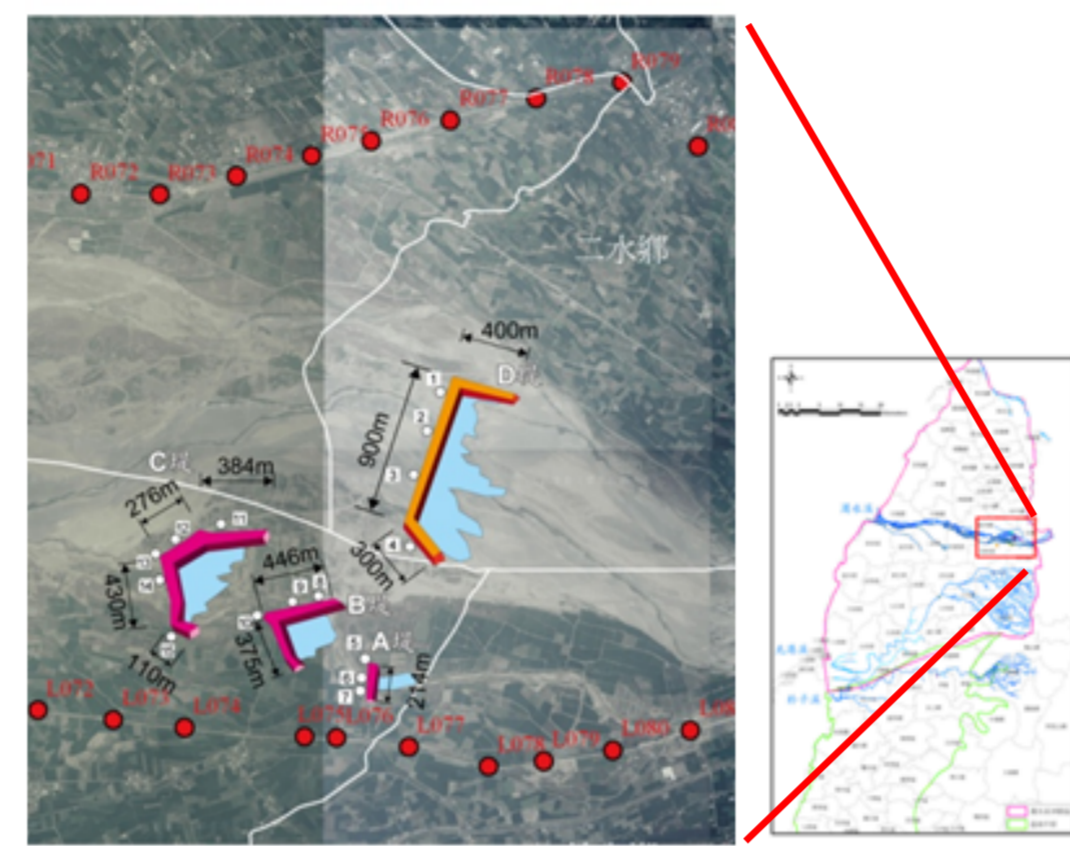


Figure 3. position of the recharge facilities

Operation period

The facility is planned to operate from December 2011 to June 2012. (It is expected to be destroyed by floods when the wet season hits every year.)

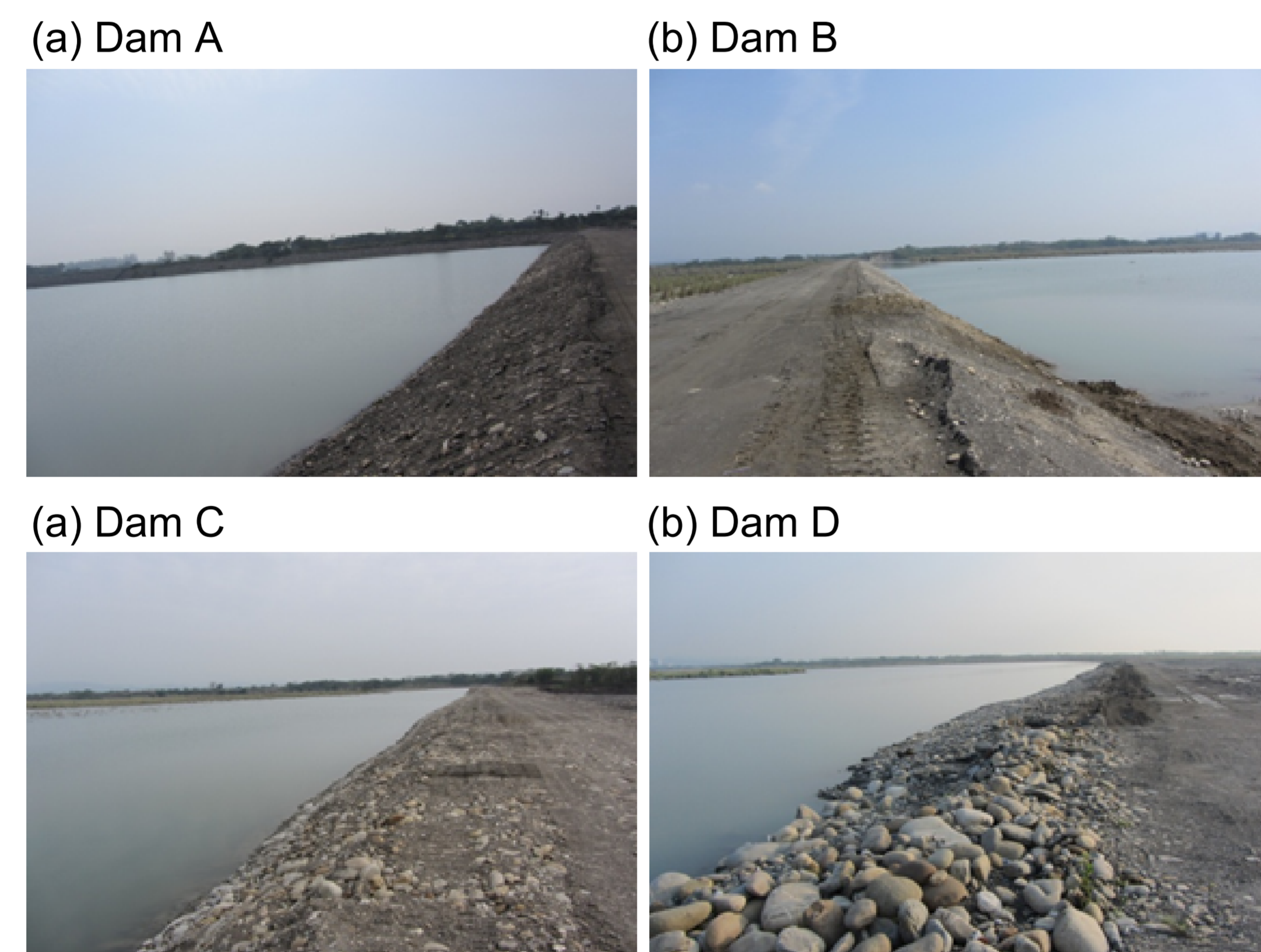


Figure 4. photos of impounding water of recharge facilities

Evaluation of quantity of infiltration (water balance method)

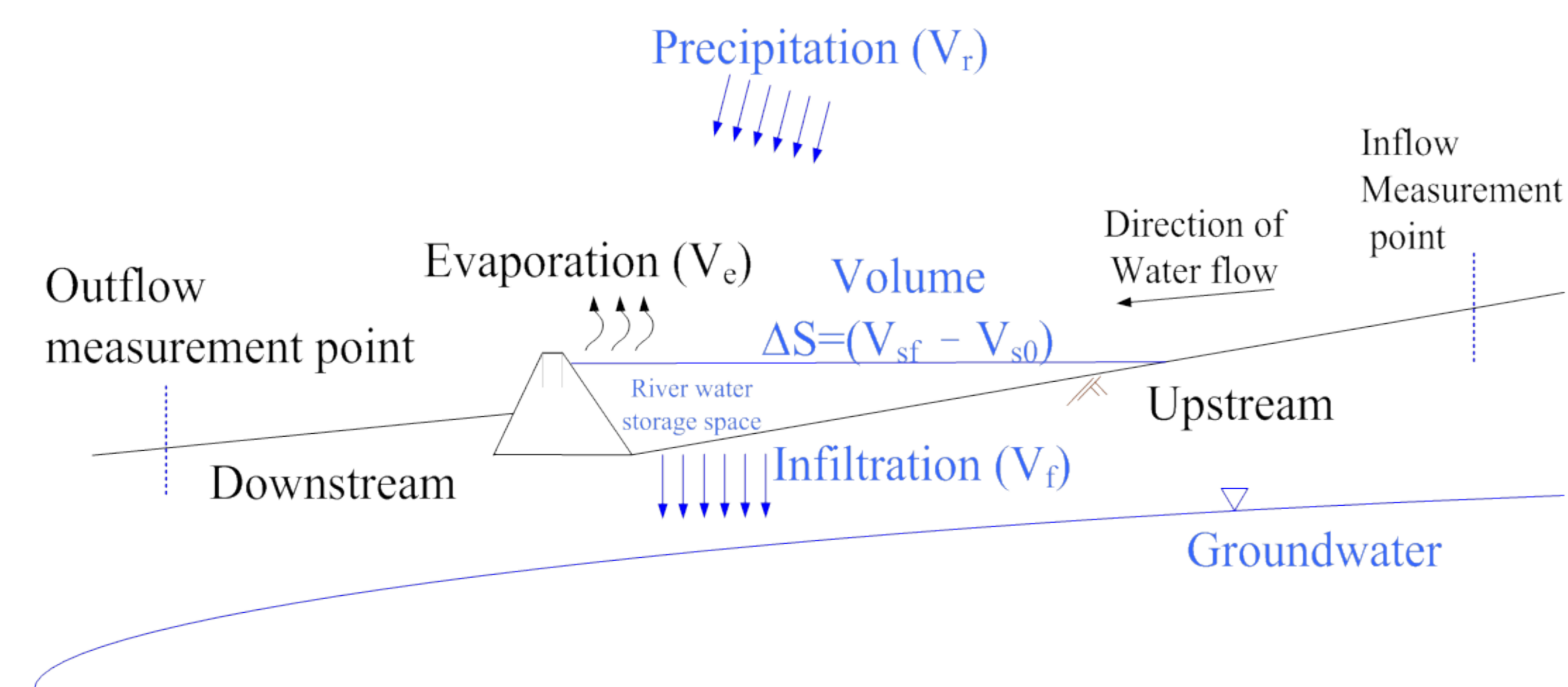


Figure 5. conceptual model of water balance method

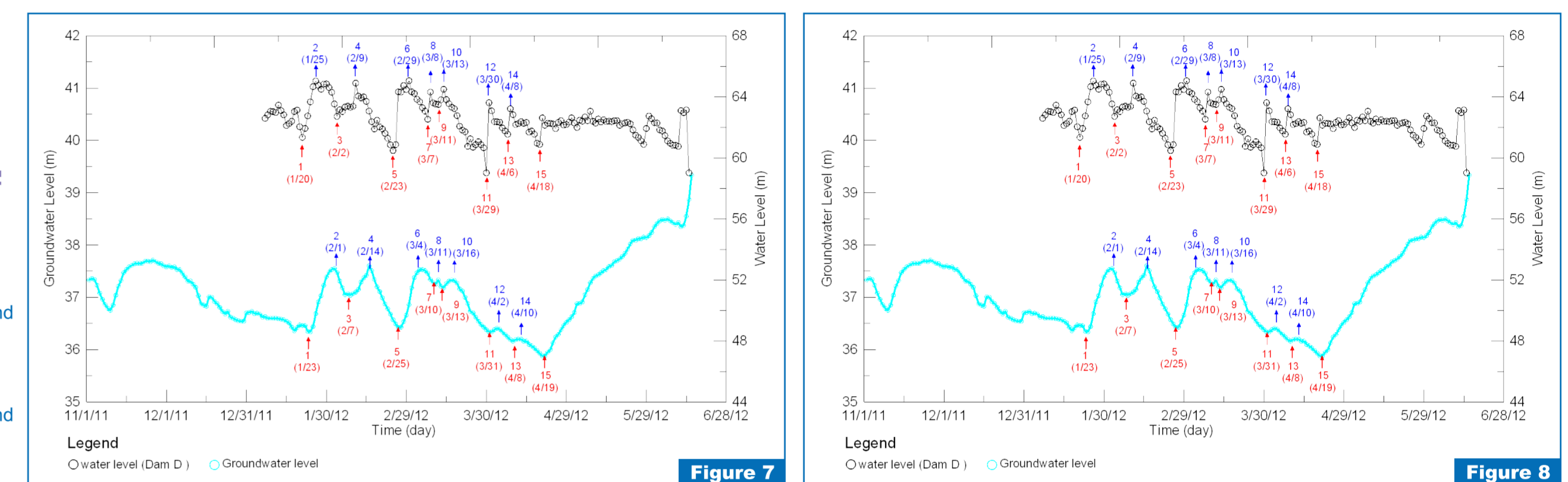
- After recharging surface water to the facilities, it should be able to recharge Changhua and Yunlin along with the direction of groundwater flow.
- According to the results of oxygen stable isotope analysis, groundwater recharge ratio from the river at the northern highland beach near the facilities is about 0.69~0.93, and the ratio at the southern beach is 0.65, the results show that the major source of groundwater recharge in Changhua and Yunlin along the coast of Choushui River is river water.
- In order to analyze the affects of 174-days long river impoundment, we utilized groundwater numerical model (MODFLOW) to simulate groundwater environment. The computation results show that the recharge caused by the embankment have strong impact on neighbor regional groundwater environment during operation. Additionally, 5 years cycle of the recharge form this facility has been simulated to evaluate the long term impact on the groundwater environment in Ershuei, Sijhou Township of Changhua County and in Citong Township of Yunlin County.

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Groundwater level fluctuation

Figure 7. Hydrograph of groundwater level and impounding water level of Dam A, B, C

Figure 8. Hydrograph of groundwater level and impounding water level of Dam D



Groundwater flow model (Modflow)

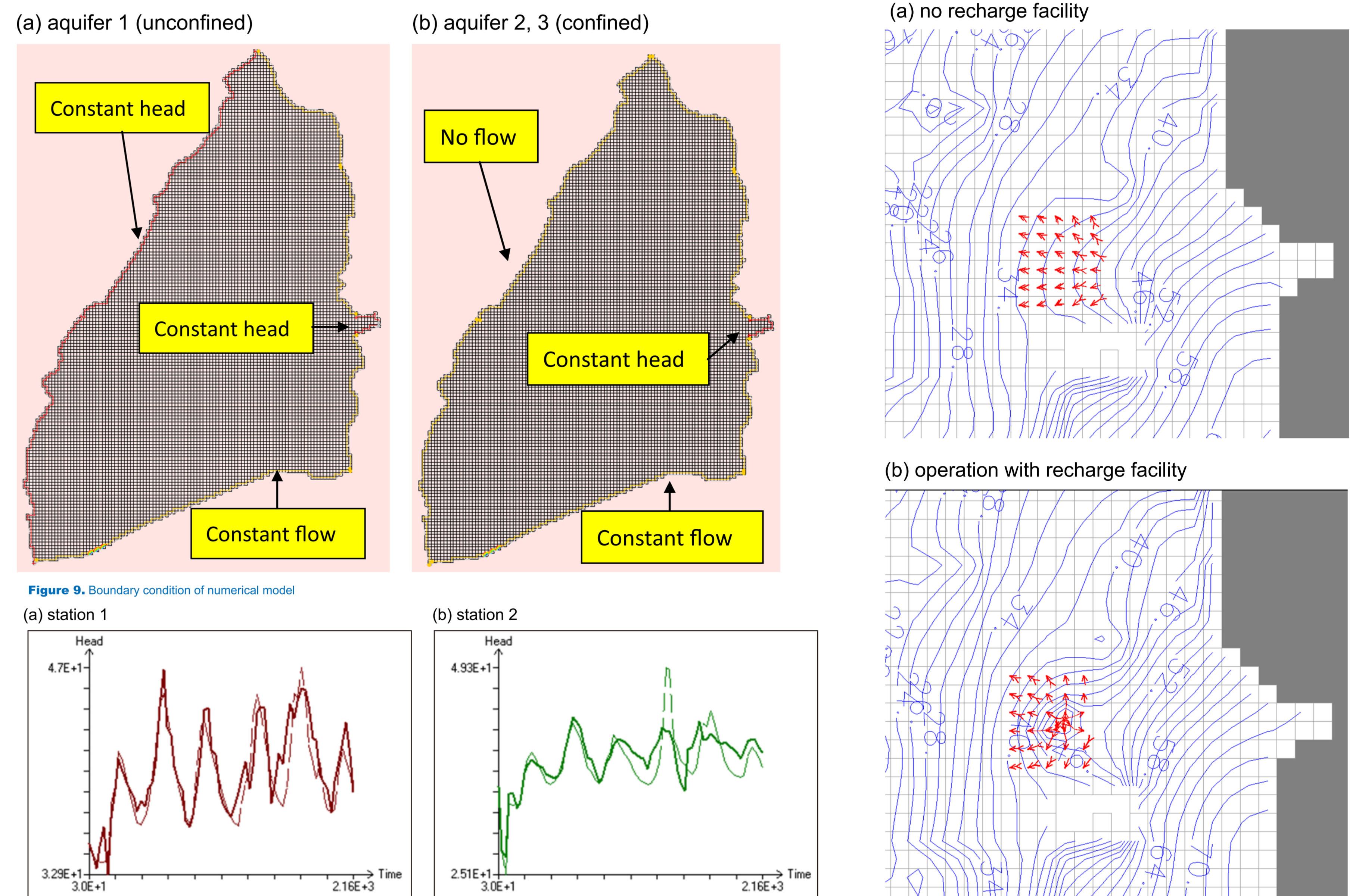


Figure 9. Boundary condition of numerical model

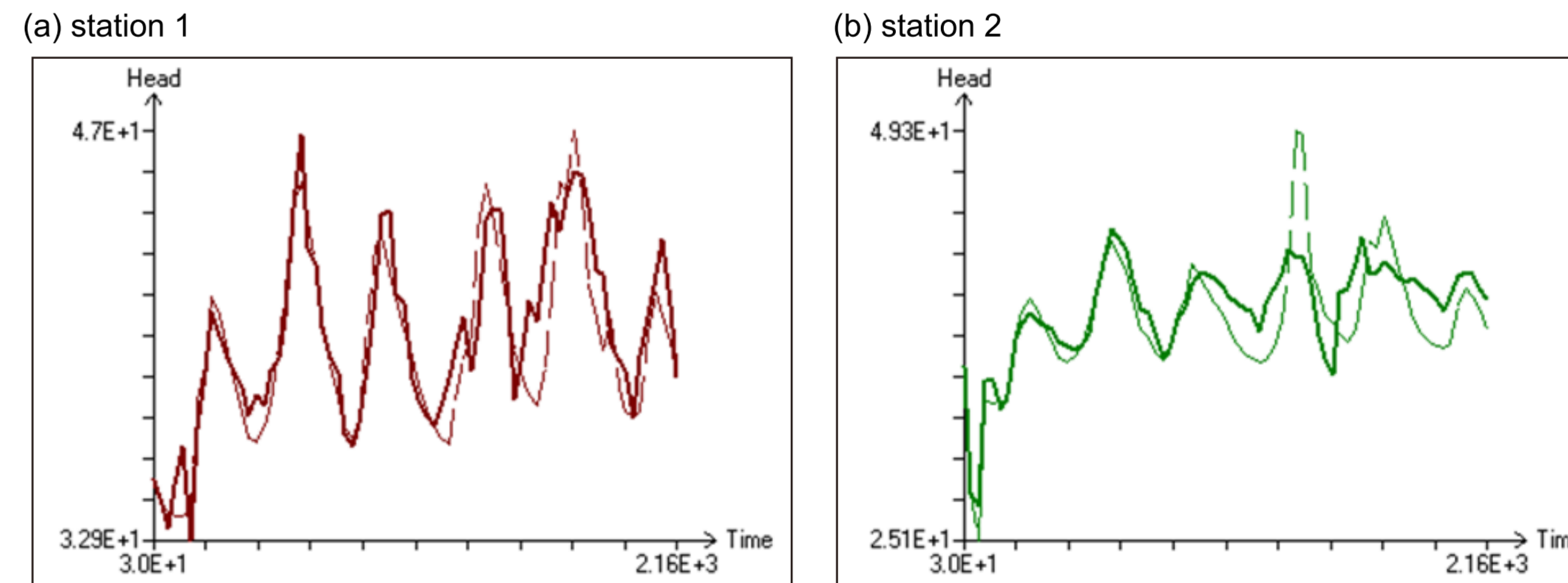


Figure 10. Results of calibration

Figure 10. Simulation result

Table 1. The result of quantity evaluation of infiltration

Facility	Quantity of infiltration (10 ⁴ tons)
Dam A, B, C	2157
Dam D	1931

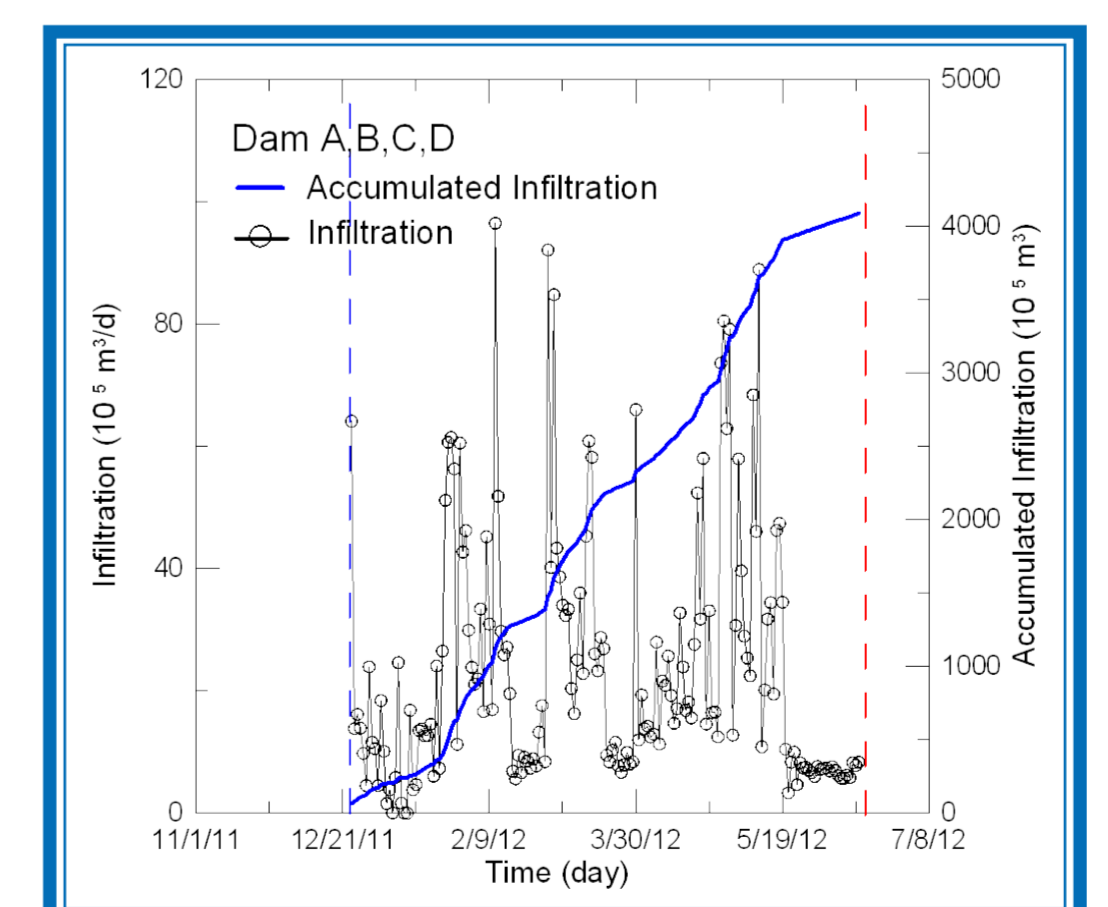


Figure 6. Daily infiltration and accumulated infiltration

Conclusion

Results from the performance evaluation concept models including:

- Total recharge amount from the facilities is 40.88 million tons, Benefit/Cost Ratio of direct recharge efficiency is about 5.35, the ratio is higher than that of 2010(4.18)
- According to the water level data from nearby observed wells, we found the direction of surface water infiltration includes horizontal also vertical component, the horizontal component flowed to downstream then infiltrated to aquifer.
- Maximum infiltration distance from each embankment was between 850m and 1,150m after impounding river water.