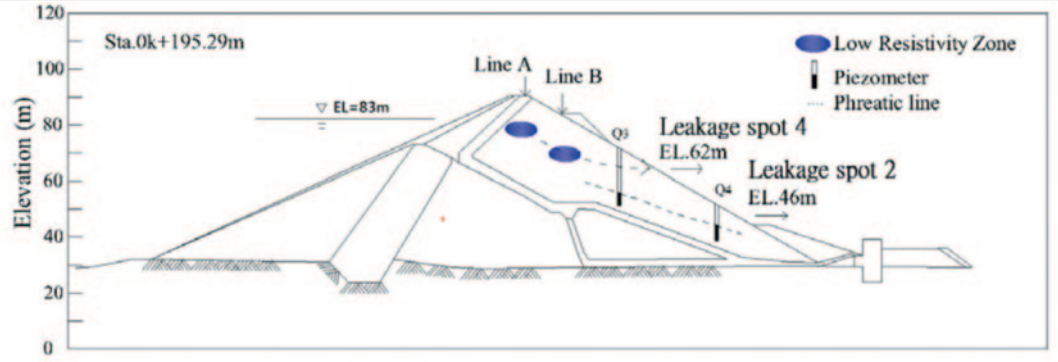
Investigation of seepage in earth dam – 2D ERT and time-lapse

CASE STUDY

Resistivimeter SYSCAL PRO SWITCH 48

As in many other places all over the world, more than 75% of reservoirs in Taiwan are earth dams. Seepage in an earth dam have to be well monitored to insure the dam's stability.

Storage is diverted from the Keelung River during rainy periods in typical wet winters and during typhoon storms in the summer, a relative low precipitation season. The dam was first constructed in 1980 but to meet the increasing demand for water supply, the dam crest was raised in 1998 from EL. 75 m to EL. 90 m. Several abnormal leaks appeared on the downstream face of Hsin-Shan reservoir in Taiwan no longer after the dam was reconstructed to raise the maximum reservoir water level. The dam's administrators preferred non-intrusive geophysical methods for examining the issues.



Low resistivity zones from ERT and hydraulic heads from piezometers on the dam cross-section near the abnormal leakages spots 2 (EL. 46 m) and (EL. 62m).

Three 2D ERT profiles were deployed on the abutments, dam crest, and downstream shell of the dam, respectively. Periodic measurements were additionally collected on the downstream shell for time-lapse measurements (line B) for investigating relationships between electrical properties variations and other environmental factors. Combining ERT results with geotechnical monitoring data clearly indicates the likely mechanism of abnormal seepage. Time-lapse measurements further support the inducted mechanism as it monitor water infiltration of unsaturated zone.

Single investigations were used mainly to perceive anomalous seepage in the dam.

The time-lapse measurements on line B (closest to the leakage) repeated every months provided additional information by studying the time-variation pattern.

The low resistivity zones and the possible pathways of the anomalous leakage at the downstream face are well above the phreatic line. This indicates that the abnormal leakage is not directly related to the steady-state seepage of the reservoir.

According to the leakage monitoring, the amount of the abnormal leakage depend greatly on the precipitation. A possible explanation is that the perched low resistivity (wet) zones are due to rainfall infiltration trapped by some impermeable layers in the shell. The perched water finds its way out at the spot 4 and further downstream to the spot 2 with significantly less amount.

Relation between resistivity and hydrological factor was quantitatively analyzed helping the administrator to reveal the abnormal leakage and to better understand its mechanism.

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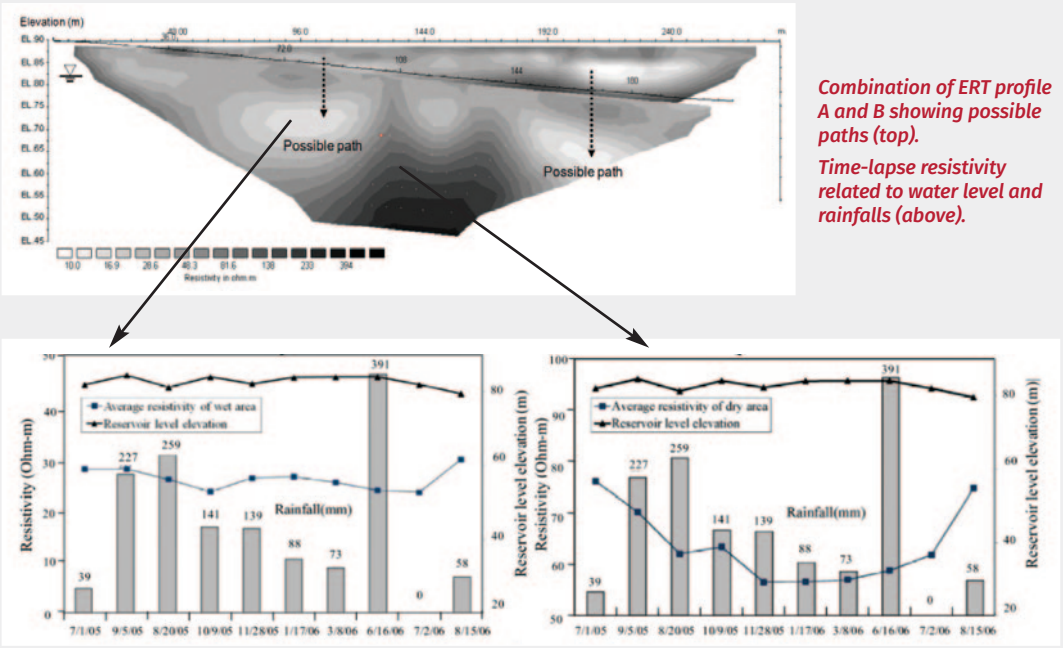

Combination of ERT profile A and B showing possible paths (top).

Time-lapse resistivity related to water level and rainfalls (above).

SYSCAL PRO SWITCH 48

SYSCAL PRO Switch 48 is a versatile electrical resistivity-meter which combines a transmitter, a receiver and a switching unit in one single casing. **It allows to simultaneously control 48 electrodes.** The output specifications are 800V (1 600V peak-to-peak) in switch mode, 2.5A, and 250W (12V battery).

The SYSCAL Pro Switch uses multi-core cables for controlling a set of electrodes connected in a line or in several lines. The 48 electrodes can be increased through a Switch Pro 48 unit.

Based on a ten channels configuration, SYSCAL PRO Switch allows to carry out up to 10 readings at the same time for a high efficiency.

Chih-Ping Lin et al., 2013, Journal of GeoEngineering, Vol, 8, N°2, pp, 61-70.