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Hidrogeological balance of Cerro Prieto dam (NE Mexico) and sub-bottom infiltration: geophysical study

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The geographical location of the State of Nuevo Leon, due to its physiographic features, has temperate and arid climate; undeveloped drainage, low precipitations, and high evapotranspiration rates, as well as rapid demographic growth. Hydrological balance for the Cerro Prieto water reservoir has been analyzed for last two decades. The procedure comprises standard hydrological modeling as implemented in Arc/Info as well as a cell-based modeling of water depth and storage volumes. Analysis of hydrological data showed sufficient misbalance between water recharge (by rain, river flow) and loss due to evaporation, filtration, extraction, discharge, etc. Fluctuations in Dam's water level result from several natural factor and human influences. Analysis of this data shows nonlinearity of hydrological cycle and, as a result, uncertainty in the water balance, which may range from 2.5 up to 30-35%. Also strong seepage losses at the outlet structure were mentioned by De León Gómez (1993). These seepages and non-linearity of the water balance are a risky factor for the stability of the dam.
Geophysical study was carried out during 2002-2010 years including gravity, magnetic, very high resolution seismic and electrical data. Water infiltration (seepage flow in dam and reservoir floor) was received by self-potential investigation. A north-east trending deep fault zone, related with gravity and magnetic anomalies, was recognized. As a result, an echelon series of northwest-trending normal faults deform basin fill. Besides, the recent (late Pleistocene) north-east trending fracture zone is characterized by up to 30 meters of total displacement as defined by geomorphology and gravity gradient. Self-potential anomalies and natural electrical horizontal gradient are associated with north-east direction of the seepage flow. The strong negative SP anomaly (-90 millivolts) is associated with water infiltration through the fractures of the reservoir bottom. Preliminary estimation shows water loose by infiltration up to 30 billion of cubic meters per year.