Nonstationarity in the Dam Engineering Profession

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Abstract

Modern concrete was invented in the late 1800’s, but it bears little resemblance to concrete produced today. Throughout the early 20th century, concrete was refined and re-engineered as more was learned about how it behaved under years of tensile, temperature, and abrasive loading. The advancement of concrete dam technology proceeded at a similar pace, roughly following the advancement of its main constituent. Dam design changed after the failure of Malpasset Dam in 1959 and following the failure of Vaiont Dam in 1960 when the importance of site geology and regional geology became apparent. Dam design changed significantly after the near failures of Koyna Dam in 1967 and Lower San Fernando Dam in 1972 when understanding the importance of the performance of dams in earthquakes became apparent. Embankment dam design changed even further following the failure of Teton Dam in 1976 where the importance of filters was tragically highlighted. The history of seismology was written mainly following some of the major seismic events and accompanying disasters from the 1906 San Francisco Earthquake through the 1995 Kobe Earthquake. After each event, the analysis tools, the understanding of the nature of the events, and the methods used to evaluate seismic risk underwent major updates. Each of these disciplines has been forced to consider nonstationarity as a consequence of the limits of human knowledge of natural systems. Although not an exact comparison, what the hydrometeorology profession is experiencing related to climate change is similar to the experience in seismology over the last 100 years and what every profession has experienced as our understanding of the world around us has advanced. The climate changes, crustal plates move, and human understanding changes and adapts. As the science surrounding climate change advances, it will be absorbed and assimilated into standard engineering practice. This paper briefly summarizes how dam safety considers or plans to consider the changing climate into its evaluation of the safety of its structures.