Climatic effects on Central Valley hydrology
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The success of CALFED plans to restore ecological health and improve water management of the Bay-Delta System will depend on the extent to which the natural and human-induced variations of the System are anticipated and accomodated. These plans will be executed under conditions determined by both slow and rapid changes in freshwater flows through the System. The streamflow signals generated in the mountain catchments of the Sierra Nevada and northern California mountain ranges propagate down the Sacramento and San Joaquin River Valleys to the Bay-Delta, where they are the dominant causes of changes in water quality. Much of what management plans can and cannot guarantee for future ecological health and water quality in the Bay-Delta System will depend on the spectrum of throughflow variations that will confront them on time scales of days to years. This spectrum of flow variations is dominated by climate-driven natural-runoff variations in the watersheds of the Sierra Nevada and other Northern California mountain ranges. A second-order influence is by human interventions, which are themselves often closely related to climatic events. Historically, reservoir effects on Delta outflows share 30% of their variance with natural flows and In-Delta effects share 17% with the natural-flow variations. A comprehensive understanding of how these signals are generated, including responses to weather and climate variations and how they propagate through the watershed systems, incorporating both natural and human factors, is essential to a full understanding of water quality variability in the Bay-Delta. Thus, observation, interpretation, and modeling of the variability of runoff processes in the mountains of the Bay-Delta catchment are critical to the development of sustainable CALFED management plans.

Recent studies by the U.S. Geological Survey and collaborations of University of California campuses and National Laboratories have suggested how at least two broad watershed-analysis efforts in the distant parts of the Bay-Delta catchment can contribute to CALFED planning. First, analyses of natural streamflow variations and human changes to those flows, together with their impacts on Bay salinities, are delineating important climatic thresholds of high and low flows beyond which virtually no historical levels of flow management could control effects on the Bay-Delta System. That is, some historical, natural streamflow levels have been so extreme that management of Bay-Delta effects would have been impossible! The frequency and severity of such events needs to be determined and incorporated into CALFED planning. Those frequencies and severities also are subject to change with land-use, water-use, and climatic conditions and can only be assessed through the use of watershed models of various scales and levels of sophistication. Second, recent modeling efforts have demonstrated that streamflow variations--and, potentially, water-management variations--can be forecast with useful levels of skill at lead times ranging from days to seasons. Modern weather and climate predictions are

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improving in skill, and snowmelt and rainfall-runoff models are being modified to capitalize upon those improvements. Forecasts of Bay-Delta throughflows on various time scales will soon be possible and will provide further options and mechanisms for planning and management of the Bay-Delta system.