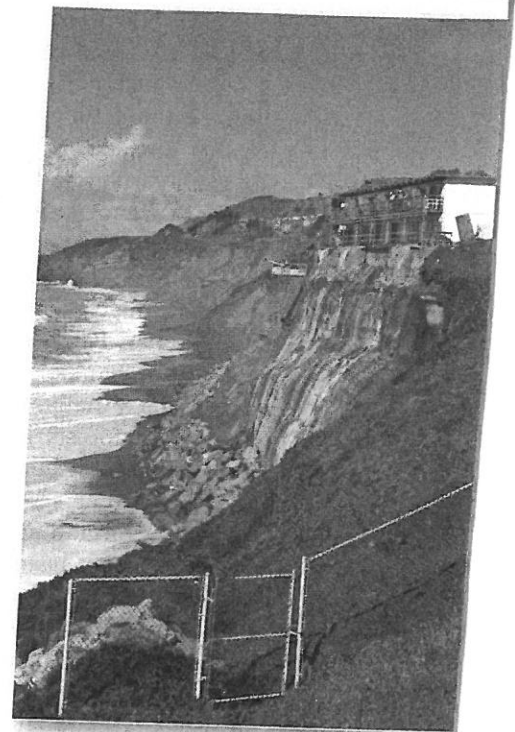
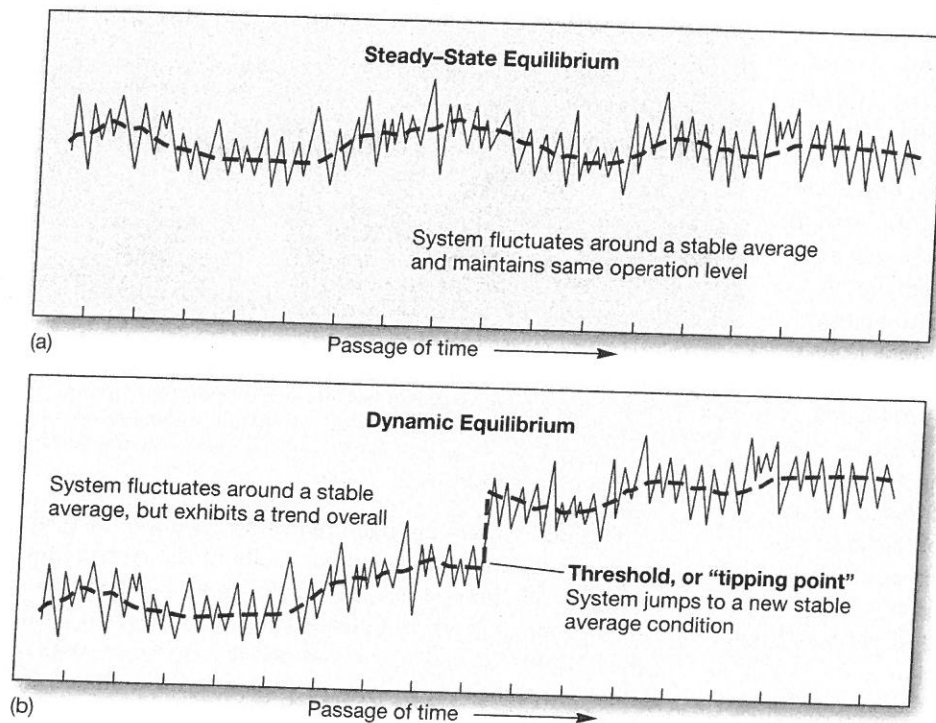


▼**Figure 1.8 System equilibria: steady-state and dynamic.** The vertical axis represents the value of a typical systems variable, such as stream channel width or hillslope angle. [(c) Bobbé Christopherson.]



(c) Wave action and heavy rainfall caused slope instability along the Pacific Coast south of San Francisco in January 2010. When a threshold was reached, the bluffs collapsed, and the cliff face retreated inland some 30.5 m (100 ft).

However, a system may reach a **threshold**, or *tipping point*, where it can no longer maintain its character, so it lurches to a new operational level. A large flood in a river system may push the river channel to a threshold where it abruptly shifts, carving a new channel. Another example of such a condition is a hillside or coastal bluff that adjusts after a sudden landslide. A new equilibrium is eventually achieved among slope, materials, and energy over time. Plant and animal communities can reach thresholds. For example, harlequin frogs in tropical Central and South America are reaching a tipping point, with the extinctions of over 100 known species occurring between 1986 and 2006.

Models of Systems A **model** is a simplified, idealized representation of part of the real world. Scientists design models with varying degrees of specificity. A conceptual model is usually the most generalized and focuses on how processes interact within a system. A numerical model is more specific and is usually based on data collected from field or laboratory work. The simplicity of a model makes a system easier to understand and to simulate in experiments. A good example is a model of the *hydrologic system*, which represents Earth's entire water system; its related energy flows; and the atmosphere, surface, and subsurface environments through which water moves (see Figure 6.4 in Chapter 6). Predictions associated with climate change are often based on computer

models of atmospheric processes, discussed in Chapter 8. We discuss many system models in this text.

Adjusting the variables in a model simulates differing conditions and allows predictions of possible system operations. However, predictions are only as good as the assumptions and accuracy built into the model. A model is best viewed for what it is—a simplification to help us understand complex processes.

Systems Organization in Elemental Geosystems

From general layout to presentation of specific topics, *Elemental Geosystems* follows a systems flow. The part structure is designed around Earth systems pertaining to air, water, land, and living organisms. These are Earth's four "spheres" and represent the broadest level of organization within the book. Within each part, chapters and topics are arranged according to systems thinking, focusing on inputs, actions, and outputs, with an emphasis on human–Earth interactions and on interrelations among the parts and chapters. Specific subjects, such as the eruption of Mount Pinatubo in the Philippines discussed just ahead, recur in many chapters, illustrating systems connections. The illustration in *Geosystems in Action 1*, on the following pages, outlines the part structure and chapter content corresponding to Earth's four spheres.