

CHAPTER 9 - MASS WASTING

Overview

When material on a hillside has weathered (the process described in chapter 5), it is likely to move downslope because of the pull of gravity. Soil or rock moving in bulk at Earth's surface is called mass wasting. Mass wasting is one of several surficial processes. Other processes of erosion, transportation, deposition - involving streams, glaciers, wind, and ocean waves - are discussed in following chapters.

Landsliding is the best-known type of mass wasting. Landslides destroy towns and kill people. While these disasters involve relatively rapid movement of debris and rock, most mass wasting is very slow. Creep is a type of mass wasting too slow to be called a landslide.

In this chapter, we describe how different types of mass wasting shape the land and alter the environment and what factors control the rapidity or slowness of the process. Understanding mass wasting and its possible hazards is particularly important in hilly or mountainous regions.

Learning Objectives

1. Mass wasting is movement of bedrock, rock debris or soil downslope as a mass in response to gravity. The material moves under the influence of gravity alone, without the aid of erosional agents (wind, water, ice).
2. Mass wasting is classified on the basis of rate of movement, type of material, and nature of the movement. Rates vary from slow (< 1 cm/year) to rapid (> 50 km/hour). Types of material include bedrock, unconsolidated debris, and soil. Movements include flow (movement as viscous fluid), slide (movement as coherent mass along defined surface), and fall (free-fall).
3. Slides may be either translational (plane parallel to slope) or rotational (also called slump; movement along a curved surface).
4. Factors promoting mass wasting include: steep slopes, high local relief, thick debris above bedrock, planes of weakness parallel to hillside, freeze and thaw, saturation of debris with water, long periods of drought with episodes of heavy precipitation, and sparse vegetation (Table 9.2).
5. Gravity is the driving force for mass wasting. Shear (gravitational) force is parallel to slope. Shear strength is resistance to movement or deformation. If shear force is greater than shear strength, mass wasting occurs.
6. Water is a critical factor in mass wasting. Small amounts of water actually inhibit mass wasting because surface tension increases shear strength. On the other hand, water mixed with clay will significantly reduce surface friction, which acts against the force of gravity. As the water content increases, the rate of movement increases, for example a change from creep to mudflow.
7. Creep is very slow, continuous downslope movement of soil or unconsolidated debris promoted by water in the soil and cycles of freeze and thaw where shear forces are slightly greater than shear strength.
8. Debris flows are mass wasting taking place as a moving mass, including earthflows, mudflows and debris avalanches. Earthflow is slow or rapid downslope movement of water saturated debris as a viscous fluid. Rotational sliding (movement along a curved surface; previously called slumping) is commonly associated with earthflow. Solifluction is a variety of earthflow that occurs above permafrost in colder climates. Mudflow is a flowing mixture of debris and water usually moving in a channel. Debris avalanche is a very rapidly moving mass of debris, air and water.

9. Rockfalls are blocks of bedrock that fall freely or bounce down a cliff. A rockslide is a mass of bedrock moving along an inclined surface; a rock avalanche is a larger version of the same process. Debris slides and debris falls are the same process involving movement of a coherent mass of debris rather than bedrock.

10. Landslides can be prevented by recognizing potential problems during planning and proper engineering during construction of buildings and roads. Avoiding oversteepening of slopes and undercutting slopes as well as providing adequate drainage for excess water are useful measures.