



Prepared in cooperation with the Office of Surface Water, U. S. Geological Survey,  
Reston, VA

# Annotated Definitions of Selected Geomorphic Terms and Related Terms of Hydrology, Sedimentology, Soil Science and Ecology

**Open File Report 2008–1217**

U.S. Department of the Interior  
U.S. Geological Survey

**Cover Photo:** Snake River in SW Idaho showing channel and related landforms, channel islands, riparian zone, and hillslopes in distant right with rock veneer



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By W. R. Osterkamp

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# Annotated Definitions of Selected Geomorphic Terms and Related Terms of Hydrology, Sedimentology, Soil Science and Ecology

By W. R. Osterkamp

## Preface:

Terminology used in fluvial geomorphology, hydrology, sedimentology, soil science, climatology, and ecology is often inconsistent among the disciplines and within a discipline. The terms defined and described herein were compiled to:

1. recognize the overlapping needs of fluvial geomorphologists and hydrologists and the related perspectives of sedimentologists, soil scientists, climatologists, and ecologists.
2. describe the earth-surface processes that result in landforms or hydrologic events that affect each of the disciplines.
3. extend many of the definitions and provide explanations of how landforms and the landscape change in response to the processes that act upon them.
4. provide different definitions for terms that are used differently by different disciplines, and
5. include specialty terms that are commonly used by practitioners of the several disciplines but are rarely if ever defined in most glossaries or dictionaries, or are inconsistently defined.

As with any list of technical words, many terms have been overlooked, but future revisions to the list may be a start to correcting this deficiency. Many of the annotated definitions given below represent original expressions of the meaning of present-day terms as applied by scientists and technicians of the several disciplines considered. Many others are modifications and elaborations of definitions available in numerous pertinent glossaries. Most of the sources that were used in support of this list, however, emphasize features, such as landforms, and techniques to provide field personnel tools for conducting geomorphic and hydrologic data collection and investigations. A principal intent in developing many of the extended definitions of this list has been to indicate what earth-surface processes were required to result in the landform or feature observed.

Numerous sources, including personal communications, were consulted to generate the definitions listed below. Several, however, were especially helpful and provided foundations from which the extended definitions could be constructed. W. B. Langbein and K. T. Iseri authored U. S. Geological Survey Water-Supply Paper 1541-A (1960), *General introduction and hydrologic definitions*, as part of the Survey's Manual of Hydrology for general surface-water techniques. The list of definitions accentuated hydrologic terms commonly used by Water Resources Division personnel at the time, but also necessarily included numerous fluvial-geomorphic terms. A much more comprehensive list, periodically updated, of definitions related to the earth sciences is the Glossary of Geology, published by the American Geological Institute (Neuendorf and others, 2005, 5<sup>th</sup> edition); this excellent resource of information includes many definitions for geomorphological, hydrological, and ecological terms but, owing to a need for brevity, many of those terms are not thoroughly defined.



**W. B. Langbein**

Other important sources of natural-science definitions with emphases on geomorphology, hydrology, soil science, climatology, and ecology include encyclopedias of geomorphology (Fairbridge, ed., 1968; Goudie, ed., 2003), The Encyclopedic Dictionary of Geography (Goudie, ed., 1994), A Dictionary of the Natural Environment (Monkhouse and Small, 1978), Limited Glossary of Selected Terms (MacArthur and Hall, 2008), Glossary of terms relating to the phreatophyte problem (Phreatophyte Subcommittee PSIAC, 1962), and Bulletin 17B of the Hydrology Subcommittee, Interagency Advisory Committee on Water Data (1982). Appendix 1 lists references for the information sources cited above; others were used less extensively and are not listed.

## Definition and description of selected terms:

### A

**Ablation**, as applied to geomorphology, is the wasting and removal from a rock mass of material by physical processes such as wind erosion or by chemical processes, including dissolution of cementing agents followed by failure of rock material at the chemically altered surface. As applied to glaciology, ablation is the removal of snow and ice from any mass of frozen water through processes of melting, **sublimation** and **evaporation**, wind erosion, and calving (such as failure at the snout of a **glacier**).

**Abrasion**, a form of mechanical weathering, is the reduction of rock fragments or rock surfaces by the wearing, grinding, or rubbing action of other rock particles or of the transport medium, particularly ice in glacial or periglacial environments. Particle-to-particle impact of the sediment load is the principal process of abrasion in streams and the cause of rounding of the sand and coarser stream sediment that comprises bed material. Similar but less dynamic abrasion occurs in **glaciers**.

**Accelerated erosion** is erosion that occurs at a more rapid rate than is typical for a specified site or area. The term generally refers to human-induced land-surface disturbance, especially disruption of soil structure and destruction of natural soil cover by rock fragments and vegetation, that reduces the ability of soil to resist the erosive effects of **raindrop impact**, **overland flow**, concentrated flow in rills and gullies, and wind velocities great enough to detach and entrain soil particles. Most accelerated erosion is the result of human activity (agricultural, grazing, logging, surface mining, urban construction), but it also occurs naturally when a geomorphic threshold is exceeded by processes such as slope failure, avulsion, the effects of high-magnitude floods, fire, avalanche, or plant disease.

**Accretion**, relative to fluvial geomorphology, is a natural process of gradual sedimentation on channel features, especially channel bed and banks, or bottomland surfaces, including the flood plain and low-lying terraces, that extends steep surfaces channelward and slowly increases the elevation of near-horizontal bottomland surfaces through the deposition of fine fluvial sediment.

**Active channel** of an alluvial stream is a short-term geomorphic feature subject to change by prevailing discharges; its upper limit is defined by a break in the relatively steep bank slope of the active channel to a more gently sloping surface beyond the channel edge. The break in slope normally coincides with lower limit of perennial vegetation so that the two features, individually or in combination, define the active-channel reference level.

**Active-channel shelf** is a gently sloping riparian surface of an adjusted alluvial bottomland that normally extends from the break in slope of the channel banks that marks the active-channel edge to the higher bank slope that rises to the edge of the flood plain; the active-channel shelf typically corresponds to a stage approximating mean discharge of perennial streams and is inundated between 5 and 20 of the time.

**Actual evapotranspiration** is the actual loss of water to the atmosphere, as a rate or volume, from a land surface through combined evaporation from the soil and transpiration of plants.



**Adjustment**, as applied to geomorphology in general and to fluvial systems in particular, is the tendency of non-rigid landforms, such as stream channels, to change in size and shape in response to the changing effects (mostly fluxes) of water, sediment, dissolved solids, and organic matter that alter them or pass through them.

**Adventitious** describes a plant part, generally a limb or root of a tree, that grows from the tree following damage or disturbance; adventitious limbs and trunks are common on willow or cottonwood trees that have been damaged during a flood, the date of which often can be determined by applying techniques of **dendrochronology** to the adventitious limb or trunk.

**Aggradation** is the raising or elevating of a bottomland surface through the process of alluvial deposition; conceptually it is the vertical component of **accretion** and is most frequently applied to sediment deposition on a channel bed, bar or other near-channel surfaces, flood plain, or, less often, low-lying alluvial terrace.

**Alkalinity** of a naturally occurring water is a measure of its capacity to neutralize acids and is primarily the result of dissolved salts of weak acids; bicarbonate is a principal form of alkalinity owing to chemical reactions of carbon dioxide dissolved in water with calcium carbonate and other soil components.

**Allometric growth**, a concept applied to landforms and especially stream systems, is derived from the study of **allometry**, the recognition that the proportional sizes of rates of growth of parts of organisms are comparable and often quantifiable; as an example of its application to fluvial geomorphology, it includes the measurement of increases in stream-channel width and depth with increases in discharge of the stream. **Hydraulic-geometry** relations are based on an inference of allometric growth.

**Alluvial aquifer** is a partially saturated deposit of alluvium that yields water to wells; most alluvial aquifers are unconfined and are composed of channel and flood-plain sediment; the water that partially saturates an alluvial aquifer is largely derived from the stream that transported and deposited the sediment.

**Alluvial fan** is a wedge-shaped deposit of recent stream alluvium (erosion products) or poorly consolidated rock debris that radiates outward and downslope as, in plan view, an open fan from a site draining an area of high relief or topography, such as the mouth of a mountain valley, onto a gentler slope, typically a pediment or an alluvial plain; the deposit is thickest at the fan apex, near the valley mouth, and thins to a feather edge at the distal edge of the fan. Active alluvial fans are surfaces of net deposition whereas inactive alluvial fans generally exhibit erosion and stream incision at the apex, the depth of incision decreasing with distance downslope to the distal edges of the fan.

**Alluvium** is a general term for sediment deposited in a streambed, on a flood plain or other bottomland feature, delta, or at the base of a mountain during comparatively recent geologic time.

**Anabranch** of a stream is a separate channel that has diverged from the main channel and rejoins the stream at some downstream site; an anabranch is a discrete, semi-permanent channel that may be of equal or smaller size as the main channel, thereby distinguishing it from channel braids that are not discrete and may be highly ephemeral.

**Angle of repose** is the maximum departure from horizontal, expressed as an angle, at which a slope formed of loose, cohesionless sediment retains stability. The angle of repose is a function of the frictional properties of the sediment and the angularity of the sediment grains; it varies from about 30 degrees for coarse, rounded particles to about 39 degrees for angular particles of sand, and is typically 32 to 34 degrees for dry sand of dunes.

**Annual flood** is the maximum instantaneous discharge, typically expressed in cubic meters per second ( $\text{m}^3 \text{s}^{-1}$ ), that occurs at a stream site in a water year (October 1 through September 30).

**Annual flood series** is a list of annual floods measured at a streamflow gage site for the period of record or a selected part of the period of record.

**Antidune**, in a fluvial setting or on a stream bed, is a transient sand wave or dune that moves upstream by processes in which erosion of sand particles occurs on the downstream slope of the bedform followed by deposition of the sand particles on the next upstream slope.

**Aquiclude** is a nearly impermeable rock body that can absorb water very slowly and hence can only release the absorbed water to springs or seeps very slowly; where an aquiclude is at or near a lowland surface, swampy conditions may occur owing to the inability of surface water to infiltrate readily.

**Aquifer** is any rock body or geologic deposit of alluvium or similar rock debris that is partially or fully saturated with ground water and has properties of permeability (transmissivity) and porosity that enable it to yield the ground water to a well or spring at a rate significantly high to fulfill a specified purpose; aquifers are grouped as **unconfined**, those controlled by near-surface gravitational and atmospheric-pressure conditions, and **artesian**, those that are poorly connected to the land surface due to an impermeable layer separating it from the land surface.

**Aquifuge** is an impermeable rock body that cannot absorb water and hence cannot release water to springs or seeps very slowly; where an aquifuge is at or near a lowland surface, swampy conditions may occur owing to the inability of surface water to infiltrate.

**Archaeology** is a **composite science** involving the study and understanding of both recent-past and ancient peoples and cultures through the excavation of sites of habitation and the recovery of artifacts; the practice of archaeology typically requires the application of disciplines including soil science, paleontology, hydrology, geomorphology, chemistry, and sedimentology, and the use of analytical techniques such as the identification of clays and rock fragments, particle-size analysis, and dating by radiocarbon analysis.

**Arête** (from the French term for fishbone) is a sharp-edged, serrated ridgeline feature of a high alpine area sculpted by progressive back erosion of steep bedrock walls above two or more cirques formed by the glaciers occupying the cirques. A specific type of arête is **col**, which is a pass or saddle generally separating two glaciated peaks and bounded on both sides by cirques.

**Arid** refers to a climatic zone that receives average precipitation of less than 250 mm annually.

**Armoring**, as a fluvial-geomorphic process, is the **winnowing** of fine particles from the uppermost bed sediment of a stream channel, resulting in a bed-surface layer of generally gravel to boulder sizes that are resistant to scour; because armoring occurs at specific flow rates, the **armor layer** may be susceptible to removal by higher flow and sedimentation during lower flow. Armoring occurs on hillslopes by similar winnowing processes of **eolian** removal of fine sediment, or by a variety of related processes, such as **gully gravure**, that result in the concentration of coarse sediment or rock particles as a surface veneer.

**Arroyo** is a **gully** or small **channel**, generally in arid and semiarid areas of northern Mexico or the southwestern United States, in which streamflow occurs inconsistently or infrequently and, except during periods of streamflow, is directly underlain by unsaturated alluvium; arroyos typically have a rectangular to steeply sided trapezoidal cross section, banks a meter or more in height formed of fine-grained, poorly consolidated over-bank sediment, and a nearly flat, sandy bed. Synonyms are ephemeral-stream channel, dry wash, and wadi (southwestern Asia, Arabian Peninsula, and northern Africa)

**Aspect**, when used in a geomorphic context, refers to orientation or the compass direction in which a landform or surface faces (the north-facing slope of a mountain has a northerly aspect).

**Association**, as applied to ecology, is a plant community, or an assemblage, the plants of which exhibit similar environmental requirements; an association generally includes one or more dominant species. As applied to soils and soil science in the United States, an association of an area refers to two or more soils that are closely related, and are mapped as contiguous features, owing to similar conditions of climate, topography, and vegetation; if the soils have similar characteristics owing to common parent material from which they have developed, they represent a **catena**.

**Avalanche** is a volume of snow, ice, soil, or rock fragments, or more commonly a mixture of them, that moves very rapidly down a slope by gravity; the term is most typically applied to the sudden movement of snow and ice in mountainous areas, but very poorly sorted deposits resulting from similar slope failures of de-stabilized soil and near-surface rock material, as a **debris avalanche**, are widespread in high-relief areas.

**Avulsion**, as applied to fluvial processes, is a rapid change in the course or position of a stream channel, especially by incision (erosion) of lowland **alluvium**, to bypass a **meander** and thereby shorten channel length and increase channel gradient; avulsion commonly occurs during floods but also can occur by normal processes of lateral migration of a stream channel during non-flood discharges. For legal purposes, bottomland areas, including **channel islands**, repositioned relative to the prior channel by avulsion belong to the previous owner and remain in the political jurisdiction (state or county) to which they had formerly belonged.

## B

**Backwater**, referring generally to natural hydrologic systems, is any volume of water that is backed up or prevented from moving downslope or downstream by any barrier obstructing movement; in hydrology, backwater often is the slowing or reversal of flow in a stream or tributary upstream from its confluence with another stream that is at flood stage.

**Badlands** is a semi-technical term referring to a very rugged topography of badly eroded, soft, relatively flat-lying sedimentary rocks that are deeply incised by rills and gullies; badlands, such as the prototype example of western South Dakota, generally occur in areas of arid or semiarid climate that sustain short-duration but high-intensity thundershowers, have steep side slopes that support little or no vegetation, exhibit virtually no soil development, and yield copious amounts of sediment to runoff and streamflow following rainfall.

**Bajada** is a group of coalesced alluvial fans, generally deposits of numerous streams draining and eroding parts of the same mountain range, that form a broad band along and downslope from a mountain front; because bajadas are composites of many alluvial fans, their surfaces are of irregular shape. Bajadas are most common in arid and semiarid areas and were named for landforms adjacent to mountain ranges of the southwestern United States and northern Mexico.

**Bank**, as a geomorphic concept, typically refers to a sloping margin of a natural, stream-formed, alluvial channel that confines discharge during non-flood flow; within the earth sciences, designation of a right or left bank is done when looking in the downstream direction.

**Bankfull discharge**, a hydrologic term, is the flow rate ( $\text{m}^3 \text{s}^{-1}$ ) when the stage (height) of a stream is coincident with the uppermost level of the banks -- the water level at channel capacity, or bankfull stage. Thus, the concept of bankfull discharge, which often approximates the mean annual flood for perennial streams, includes the flood plain as a unique, identifiable geomorphic surface, all higher surfaces of alluvial bottomlands being terraces, and acknowledgement that bankfull discharge occurs only when stream stage is at flood-plain level.

**Bankful stage**, a fluvial-geomorphic term, is the water-surface level at the tops of alluvial-stream banks that corresponds to the level of adjacent flood-plain surfaces, if present. Thus, bankfull stage is the level at which bankfull discharge occurs, the upper limit of channel capacity. As such, the concept of bankfull stage requires an interpretation of site-specific landforms, especially bank. Although bankfull stage can refer to various channel-bank levels, it generally applies to alluvial-stream channels (1) having sizes and shapes adjusted to recent fluxes of water and sediment, (2) that are principal conduits for discharges moving through a length of alluvial bottomland, and (3) that are bounded by flood plains upon which water and sediment spill when the flow rate exceeds that of bankfull discharge.

**Bank material** is the sediment of which the mostly sloping sides, or banks, of a stream channel are formed; like bed material, it is generally reflective of the size range of the total sediment load of the stream, may be partly residual, but for regime channels is mostly indicative of the suspended-load transported by streams during non-flood periods.

**Bank storage** is the process by which water, during periods of above-normal streamflow, infiltrates into and saturates typically aerated bank sediment (alluvium) higher than the normal stream surface; as the flow event recedes and stream stage declines, bank-storage water seeps from the alluvium and reenters the stream.

**Bar** is in-channel sediment of relatively coarse bed material, typically coarse sand through cobbles in size, that is generally deposited during the recession of a high flow and is mostly exposed during periods of low flow; the upper surface of bars of perennial streams is typically equivalent to a stage of about 40-percent flow duration.

**Barranco**, a Spanish term applied to incised channels of the water-deficient southwestern United States, refers to a deep, rectangular to steep-sided trapezoid shaped ravine or arroyo in partially consolidated bottomland alluvium; barrancos are indicative of an erosive drainage network and are maintained by channel-bed erosion and the collapse of the arroyo walls during brief periods of ephemeral streamflow..

**Base flow** is sustained, low, or fair-weather flow of a stream; base flow ( $\text{m}^3 \text{s}^{-1}$ ) generally is derived from ground-water inputs to the stream channel.

**Base level** is the lowest level or elevation for which a stream of flowing water hypothetically can effect erosion. The ultimate base level is the sea surface or slightly lower, but as a geomorphic concept, base level refers to more transient conditions such as an erosion-resistant dike over which a stream flows and is unable to alter during a short interval of geologic time.

**Bed**, or **stream bed**, is the bottom surface of a water course, generally of a stream channel, upon which water and sediment move during periods of discharge .

**Bed load**, or **sediment discharged as bed load**, is the sediment that is moved by **saltation**, rolling, or sliding on or near the stream bed, essentially in continuous contact with it.

**Bed material** is the sediment of which the mostly horizontal bed of a stream channel is formed; it is generally reflective of the size range of the total sediment load of the stream, in many cases may be partly residual, but is mostly indicative of the bed-load sizes transported by the stream.

**Bias**, as used in scientific investigations in general, but particularly in **hydrology** and plant **ecology**, is systematic error introduced to the investigation by inappropriate sampling, inadequate sampling or testing of hypotheses, or by the purposeful favoring of one hypothesis over one or more others; an example of unintentional bias is the sampling for suspended-sediment concentration at one site of a stream channel without accounting for other concentrations at other sites of the channel section.

**Billabong** is an Australian term, derived from the aboriginal word for “dead river”, describing blind or discontinuous anabranches of complex channel systems; billabongs are typically dry but seasonally may be filled with water.

**Biomass** is the amount, expressed generally as mass (or weight) per unit area or the volume of the environment, of near-surface living organisms in a specified area at a specified time.

**Biome** is a mature ecosystem that characterizes a particular natural environment.

**Biophysical continuum** is a complex, dynamic gradient of habitat types from headwaters to oceanic confluence. Riverine flora, fauna, and physical features are usually distributed rather predictably along the gradient according to the requirements specified by each stage in a species life cycle, and by downstream change in fluvial-geomorphic process.

**Bioturbation** of soil and subsoil is the physical rearrangement of sediment particles forming the soil and subsoil fabric by churning, stirring, or disruption through organic or biophysical processes of resident lifeforms; included types of bioturbation, or faunal and floral soil disturbance, are the effects of worms, rodents, and ungulates, as well as root expansion and, in forested areas, sediment movement due to treefall.

**Block field** is a continuous surface cover of large angular to subangular rocks derived from a source of well jointed bedrock either beneath or upslope from the block covering. The blocks are generally dislodged by frost action and form a layer greater than one or two clast thicknesses (as opposed to a rock veneer, which has a thickness no greater than two clast thicknesses). A block field can occur on a steep slope if the source rock is exposed along a high ridge or similar topographic feature, whereas the term felsenmeer refers to a block field that occurs on a flat or gently sloping surface that is derived from an underlying source

**Bole**, derived from an English term for a shade of brown, refers to the trunk, or stem, of a tree; as applied by plant ecologists, the bole of a tree is often the wood of the trunk and does not necessarily include the bark.

**Bolson**, or **playa basin**, is a drainage basin of an arid to semiarid area with interior drainage toward the playa; it is the surface area that contributes excess precipitation, as runoff, to the playa.

**Bottomland** is that part of an alluvial valley formed of and underlain by alluvium that has been transported by and deposited by the stream flowing through the valley reach; bottomlands may include the channel bed and one or more terraces.

**Boulder**, as bed sediment or bed material, is sediment defined to be of particle diameter greater than 256 mm in diameter (b-axis).

**Brackish water** is water on or beneath a land (or water) surface that accumulates as a result of natural processes of precipitation and which contains dissolved solids (mostly salts) of concentration intermediate between that of fresh water and salt water; the concentration of dissolved solids in brackish water is sufficient to cause deleterious effects by ingestion of living organisms adapted to a dependency on fresh water.

**Braided stream** is one with a wide, relatively horizontal channel bed over which water during low flows forms an interlacing pattern of splitting into numerous small conveyances that again coalesce a short distance downstream; the conveyances, or sub-channels, lack channel characteristics, are highly ephemeral, and thereby are distinguishable from anabranches. A synonym is **anastomosing** stream, a biological term referring to the vein patterns of some plant leaves.



## C

**Caespitose** trees are those with trunks growing in clusters or tufts. As applied to plant ecology and hydrology, caespitose trees are generally willows and cottonwoods that have been sheared at the surface by a destructive flood; if the root system survives the event, multiple trunks are likely to spout from the below-surface root mass.

**Calcrete**, a calcium-rich type of **duricrust**, is a near-surface pedogenic accumulation, usually less than a meter in thickness, of secondary precipitates of calcium carbonate and other calcium or silica salts. Calcrete is typical of a semiarid climate and forms a poorly permeable to nearly impermeable layer or crust binding silt, sand, and gravel of poorly developed mineral soils. Because calcrete formation reduces soil permeability and porosity, infiltrating rainfall may be temporarily perched on its top, providing soil moisture to vegetation.

**Canopy** is the cover or crown of leaves, needles, and branches of trees forming a forest; the canopy affects erosion by intercepting rainfall and causing evaporation of a portion of it, thereby preventing that portion from reaching the surface and becoming runoff, and by protecting soil particles at the surface from erosion by rainsplash impact.

**Capillary fringe** is a zone of the subsurface that is continuous with the overlying zone of saturation, contains capillary interstices (some or all of which are filled with water), and in which the pressure is less than atmospheric.

**Carrying capacity** of a watershed, landscape, drainage network, lake, or ground-water system is the production, through natural biophysical processes, of ecosystem services that each can yield without sustaining loss in function; for a grassland the carrying capacity might be the annual growth of grass that can support grazing by herbivores without environmental damage, whereas the carrying capacity of a ground-water system is the rate at which water can be extracted from wells, and replaced by natural recharge, without a reduction in volume of the ground-water reservoir.

**Capacity** of a stream, which is synonymous with **competence**, or stream competence, refers to the ability of a current of water (or wind) to transport specified particle sizes of sediment.

**Catchment** is a synonym for **drainage basin**, but the term often has the connotation of a smaller area than that of a drainage basin (a sub-basin).

**Catena**, from the Latin word for chain, is a series or linkage of concepts or objects, especially writings such as essays or short stories; as applied to **soil science**, a catena is a **soil association** of a limited area derived from common parent material or source rocks that provide it with characteristics distinguishing it from other soil associations of the larger area or drainage basin.

**Cation exchange capacity** (of a colloidal material) is the excess of oppositely charged ions in proximity to a charged clay or mineral surface (or layer) that can be exchanged for other cations; it is usually expressed in milliequivalents of cations that can be exchanged in a soil or sediment sample with a dry weight of 100 grams.

**Cave** is any natural subsurface macro opening, or chamber, or series of openings or chambers; caves form through a variety of processes in most rock types but most commonly are the result of solution of carbonate rocks, particularly limestone, by the movement of **ground water**.

**Channel** is a natural, or constructed, passageway or depression of perceptible linear extent containing continuously or periodically flowing water and sediment, or a connecting link between two bodies of water.

**Channel erosion** is the detachment and transport, possibly followed quickly by re-deposition, of soil particles or channel-bed material by concentrated flow in areas of open-channel flow.

**Channel-geometry method**, based on hydraulic geometry, is a technique of indirectly estimating streamflow characteristics by recognizing that the size of an alluvial channel is indicative of the water conveyed through it, and that the shape of the channel is largely the result of the sediment transported by the stream.

**Channel, or fluvial, island** is a landform that rises above and is surrounded by stream passageways and which persists a sufficient time so that persistent vegetation can develop if adequate moisture is available.

**Chézy equation** is an empirical formula relating stream velocity,  $V$ , to controlling variables  $R$ , hydraulic radius and energy slope,  $S$ :  $V = C[RS]^{1/2}$ , in which  $C$  (which is analogous to the Manning coefficient,  $n$ ) is a constant of proportionality.

**Chinook** is a regional name in alpine areas of North America for vertical, cyclonic-induced, **foehn** winds; chinook winds typically occur in the winter, result from the downslope movement of relatively warm, dry air, and often are especially strong in valleys of east-flowing mountain streams. Because chinook winds may be quite strong, they can be very damaging and erosive, causing snapping and uprooting of trees and **eoian** entrainment of soil and sediment particles as coarse as fine gravel.

**Cirque** is typically a deep, steep-walled, bowl-shaped (or partial bowl-shaped) depression formed by glacial erosion of bedrock in the uppermost snow-accumulation high alpine areas; cirques of lower-relief alpine areas may have walls of moderate steepness and relatively shallow bowl-like depressions. The term cirque is sometimes applied to similar bowl-like geomorphic features formed by other than glacial processes.

**Clay**, as used in sedimentology as opposed to mineralogy, is fluvial sediment defined to be of particle diameter no greater than 0.002 mm; some systems define the upper size limit to be 0.004 mm.

**Climate** describes the characteristics and variability of weather at a site or specified area; included are precipitation, temperature, humidity, and derivative elements such as barometric pressure, wind velocity, dew point, and measures of cloud cover. Climate is one of the basic controls of soil and landscape development, the movement of water, erosion, and vegetation.

**Climatology** is the science or study of climate, including its effects on the physical and biological resources of the area of interest; it is a quantitative description of the spatial and temporal variability of climate characteristics over areas of land and water.

**Cluster**, as applied to issues of bed load and the formation of small-scale bed forms in the surface layer of gravel-bed alluvial channels, can be either a discrete or individually organized grouping or interconnected structures comprised of a network of bed-material or bed-load particles that rises above the level of areas of adjacent channel bed; clusters occur in any part of a channel, including near the edge, near the thalweg, and on bars. The dynamics of clusters (which are loosely subdivided and named by shape, such as pebble, line, comet, ring, and heap), that is processes of their formation, are not well understood.

**Coastal dune**, including coastal dune field, is an accumulation, or concentration, of beach sand primarily by wave-action sorting processes as a low, small-scale mound, ridge, or, more commonly, a complex (field, or zone) of mounds and ridges along coastlines of oceans, seas, and other large water bodies; if active they may be bare, or, if inactive, they may be partially to fully vegetated. Coastal dunes are subject to translocation, without a basic loss of scale or structure, by wave action or wind.

**Cobble**, as fluvial sediment, is sediment defined to be of particle diameter between 64 and 256 mm in diameter (b-axis).

**Coefficient of skewness**, or **skew coefficient**, is a numerical measure or index of the lack of symmetry in a frequency distribution; it is a function of the third moment of magnitudes about their mean, a measure of asymmetry. As applied to hydrologic records such as annual floods or a measure of maximum precipitation events, is a quantitative index of the skewness, or asymmetry, of the frequency distribution of a list of measured values; a skewed distribution occurs when computed values of the mode, mean, and arithmetic mean of the list vary, resulting in a bunching of plotted values on one side of the mean as opposed to a tailing away from the mean of plotted values on the opposite side.

**Cohesiveness** is a strength-imparting property of fine-grained sediment, generally clay, by which individual particles cohere or bond together by electrochemical forces of the particle surfaces.

**Colluvium** is a layer, generally less than 3 meters in thickness, of unconsolidated and heterogeneous weathering products (soil material and sediment) and rock fragments deposited following sheet erosion by unconcentrated surface runoff and by gravitational processes, especially soil creep, other types of mass wasting, physical weathering, and bioturbation; colluvium generally occurs as a blanket of poorly sorted sediment and rock fragments on the lower parts of hillslopes underlain by bedrock.

**Comminution** is the process of reducing a mass to small, fine particles by impact, abrasion, or soil dynamics; as a geomorphic or hydrologic process, comminution occurs through particle interaction in flowing water or glacial ice, and in **archaeology** the term is applied to taphonomic (fossilization) processes in which charcoal, bone, or shell becomes pulverized and disseminated following deposition and burial by physical weathering, **mass movement** such as **creep**, **bioturbation**, and **pedogenesis**.

**Commodity water** is that portion of the accessible water resource that is viewed by humans, and economists in particular, to be an article of commerce and thus to have a monetary value as an economic good; in contrast, ecosystem-services water is that portion of the total water resource that is essential for ecosystem function and as such has intrinsic value for physical and biotic processes.

**Competence** refers to the ability of a current of water or wind to transport sediment, emphasizing the particle size rather than the amount, measured as the diameter of the largest particle transported; it depends, therefore, on the critical shear stress, which is a function of the hydraulic radius of the stream channel and the energy slope.

**Complex response**, as applied to geomorphology, connotes the tendency of natural drainage systems that receive water and sediment from a complex assortment of landforms (such as hillslopes, terraces, and flood plain) to respond accordingly in complex, often difficult to anticipate, manners following disturbance such as rejuvenation. The concept is based on the recognition that any change modifying a system, whether natural or imposed, induces change elsewhere that may progress sequentially from a landform or process to others.

**Composite science** refers to complex disciplines, including geomorphology, ecology, soil science, hydrology, and archaeology, that are composed of distinct parts of other types of study but which have specific and generally agreed-upon goals requiring various scientific and technological approaches of investigation to meet those objectives. A goal of geomorphology, for example, is a genetic interpretation of landforms, and techniques of physics, chemistry, biology, and engineering are employed to develop interpretations.

**Control**, as applied to a **gaging station (streamgage)** is the physical feature(s), either sectional, channel, or flood plain, that directly defines the slope of the stage-discharge relation at the streamgage. The control defines the relative hydraulic stability of a stream bed, channel, or flood plain. At low flows the sectional control is usually at or immediately downstream from the measurement section of the gage; a typical stable natural control is bedrock or consolidated alluvium that is not subject to scour or deposition. Typical unstable natural controls are sand and gravel riffles and point bars, which are subject to shifting both by scour and deposition. Examples of an artificial control are a weir, flume, or low cement dam. At channel and flood-plain flows, the control is defined by the shape and roughness of the channel and flood-plain cross-sections.

**Convergence**, when used in a geomorphic context, is a term to acknowledge that some landforms with outwardly similar characteristics developed from a narrow range of similar process sets causing the landforms and thus may have quite different internal or structural characteristics. When used in a hydrologic context, convergence, or **convergent flow**, refers to a contraction of flow paths as surface runoff traverses a concave slope or as ground water moves from a relatively unrestricted flow path to one of greater restriction.

**Conveyance**, as applied to hydrology and fluvial geomorphology, is a measure of the amount of water that can pass through a stream-channel section without spilling onto higher surfaces as flood flow.

**Corrosion** refers to the water-related chemical erosion of rocks and inorganic soil material by dissolution and similar weathering processes including oxidation, hydrolysis, carbonation, and hydration; the older, less specific term, **corrasion**, is loosely synonymous.

**Creep**, as applied to geomorphology, is a process of mass movement by which soil and rock gradually and slowly move by deformation caused by gravitational stress; the process is continuous, or nearly so, and irreversible, resulting in the movement of sediment and rock fragments to lower sites on the landscape and the availability of the sediment and rock fragments for addition to fluvial-sediment loads. Creep also includes glacial processes of deformation of snow and ice.

**Creosote-bush** (*Larrea tridentate*), an **indicator species**, is a shrub of southwestern North America extending northward into Oregon, Idaho, and Wyoming; creosote-bush is indicative of **bajadas** and related low-relief landforms of semiarid deserts, well drained conditions, and calcareous soil that commonly has near-surface pedogenic **calcrete**.

**Critical flow** in open channels occurs when, for a specified flow rate, that flow rate is at a maximum for the energy ( $d + v^2/2g$ , in which  $d$  is water depth,  $v$  is water velocity, and  $g$  is the acceleration due to gravity) of the water; critical flow occurs only when the Froude number is 1.0.

**Critical shear stress**, relative to fluvial geomorphology and hydraulics, is the lowest required value of **shear stress** applied by flowing water to initiate motion of individual particles of specified size (diameter) along the bed of a stream.

**Curve number** is an index of the runoff potential on a land surface in response to rainfall; as applied to the USDA-NRCS Curve Number Method, it is  $1000/(10+S)$ , in which  $S$  (in inches), is the maximum possible difference between the effective rainfall and the direct storm runoff depths. Curve numbers range from 0 (no runoff under any condition) to 100 (all rainfall of any event results in runoff).

**Current meter** is a device to measure velocity at a point within the flow field of a stream of water; the device, typically a Price AA or pigmy meter, consists of a vertical rod with attached cups that are free to rotate at a rate corresponding to the water velocity.

## D

**Darcy-Weisbach formula** is a widely used equation of hydraulic engineering to compute head loss or pressure loss due to frictional losses by water flowing through a pipe or similar conduit. For use in open-channel flow of natural stream channels, it states that head loss varies with the surface roughness times channel length divided by hydraulic radius times the velocity head.

**Datum** is any point or surface to which other landscape points can be related, both horizontally and vertically, to locate the points on the earth's surface, typically for purposes of topographic mapping. The official vertical datum of the United States government is the North American Vertical Datum of 1988, and the horizontal datum is the North American Datum of 1983 (NAD 83).

**Debris flow** is the downslope mass movement, by either inertial or viscous processes at velocities greater than those of **creep** or solifluction, of a non-Newtonian slurry of a plastic mixture of water and generally coarse, poorly sorted sediment; debris-flow slurries, depending on the particle-size distribution of the sediment, typically vary from 50 to 80 percent sediment by volume.

**Deflation**, a form of erosion, is the entrainment and transport of fine (mostly clay, silt, fine sand), dry, generally unconsolidated, sediment from a source deposit by the action of wind turbulence; the re-deposited sediment may be concentrated as eolian dunes (sand) or loess (clay, silt, and very fine sand).

**Degradation** is the lowering of a bottomland surface through the process of erosion; conceptually it is the opposite of the vertical component of **aggradation** and is most frequently applied to sediment removed from a channel bed or other low-lying parts of a stream channel.

**Delta** is a fan-shaped landform of fluvial sediment deposited at and beyond the mouth of a stream, usually a river, as it debouches into a body of standing or low-velocity water, generally an ocean or lake, or some other water body of reduced or stagnant flow. As a delta continues to form and grow outward from the mouth of the stream into the standing water, channel gradient is minimized and the stream typically separates into a complex of relatively straight channel **distributaries** that are poorly capable of carrying the coarser fractions of their **total sediment loads** to the distal edge of the delta.

**Dendrochronology**, from the Greek words for tree, time, and study, is the dating of past events, including climate fluctuations, through the counting of annual tree rings and analysis of the sizes and structure of the rings; the application of dendrochronology to geomorphology, sometimes termed dendrogeomorphology, is the use of dendrochronological techniques to interpret and date earth-surface processes and resulting landforms.

**Denudation** is the sum of the processes that result in the wearing away or the progressive lowering of the earth's surface by various natural agencies that include weathering, erosion, mass wasting, and transportation.

**Deposition** is the constructive process of accumulation into beds or irregular masses of loose sediment or other rock material by any natural agent; it is especially the mechanical settling of sediment from suspension or tractive movement in water.



**Depth-integrated sample** is a sample of sediment that is accumulated continuously in a sampler that moves vertically at a constant rate and that admits water and sediment mixture at a velocity about equal to the stream velocity at every point of the sampler's travel. Depth-integrating samplers normally collect water and sediment mixture only from the stream surface to about 0.1 meter above the stream bed. The part of the stream traversed by depth-integrating samplers is the "sampling zone" or the "sampled zone".

**Desert** is a generic term describing an area of low precipitation relative to evaporation; typically, the term desert applies to areas receiving less than 250 mm mean annual precipitation, but areas of higher precipitation are also considered deserts if evaporation rates are high. Owing to low precipitation, very cold areas, such as Antarctica, may be classed as deserts. Where subtle differences in climatic variables result in different vegetation communities, deserts are given specific names such as the Mojave, Sonoran, and Chihuahuan Deserts of southwestern North America.

**Detachment** is the process of separation of transportable particles from a soil or soft-rock layer, usually by running water, raindrop impact, or wind.

**Discharge**, as a hydrologic term of streamflow, is expressed as the movement downstream per unit length of channel of a volume of water; water discharge is given in volume per unit time, typically cubic meters per second ( $\text{m}^3 \text{s}^{-1}$ ). As a sedimentology term, discharge is the movement of a mass of sediment per unit length of channel in a specified time interval; technically it is expressed in watts per meter ( $\text{W m}^{-1}$ ), but informally it is viewed as mass per unit time. Owing to theoretical considerations, the term **sediment-transport rate** is preferred to that of sediment discharge.

**Dissolved load** is the part of the total stream load that is carried in solution, such as chemical ions yielded by erosion of the landmass during the return of precipitation to the oceans; also called **dissolved solids** and *solution load*.

**Dissolved solids** refers to the sum of all mineral material in solution in surface or ground waters; the amount of dissolved solids is a measure of the quality of the water and is generally expressed as milligrams per liter. The regulatory acronym for dissolved solids is **TDS** (total dissolved solids).

**Distributary**, as a fluvial-geomorphic term, typically refers to the spitting of a stream channel into two or more segments that leave the main channel and do rejoin it, as generally occurs on **deltas**; less commonly the term is used to characterize the individual channels of an **alluvial fan** that split from a main, up-slope, channel and again coalesce downslope.

**Distribution (or partition) coefficient**,  $K_d$ , is the extent to which a solute is sorbed to a given sediment particle at equilibrium, and is quantified as  $C_s/C_e$ , where  $C_s$  is the concentration of a contaminant sorbed to a specific weight of sediment, and  $C_e$  is the concentration of the same solute dissolved in an equal amount of water. This definition, for use in sediment studies, differs from that used by chemists, which is the ratio of concentrations of a solute in two immiscible solvents (for geologic situations, generally oil and water).

**Disturbance** is any short-term alteration, natural or imposed, of the land surface that results in a change of geomorphic, hydrologic, or biological processes from a state of approximate equilibrium to one of relative instability; time scales of disturbance generally vary from years to centuries.

**Divergence**, when used in a geomorphic context, is a term to acknowledge that some landforms with characteristics measurably different among each other are the end, or final, results of a narrow range of similar process sets causing the landforms. When used in a hydrologic context, divergence, or **divergent flow**, refers to a broadening or expansion of flow paths as surface runoff traverses a convex slope or as ground water moves from a restricted flow path to one of less restriction.

**Dominant discharge** is described as the discharge of a stream that is associated with the maximum **sediment-transport rate** for specified magnitude and frequency of flow; as such it is a theoretical discharge representing the single flow rate of a stream that accomplishes the most geomorphic work during an extended period of time. The term is an extension of the **bankfull-discharge** concept and is commonly inferred to be the maximum flow that the channel of an adjusted perennial stream can convey without causing spillage onto the flood plain. When applied to the adjusted perennial streams for which it was defined, dominant discharge may have geomorphic significance, but when applied to **intermittent-** and **ephemeral-stream channels** formed by reduced rates of precipitation, runoff, and streamflow, the concept is of questionable value and may be inappropriate.

**Drainage basin** is an area of land surface, upslope from a specified channel site to topographic divides separating the basin from adjacent drainage basins, over which water that results from precipitation moves and converges through a system of channels to (and past) the specified channel site.

**Drainage density** is the ratio of the combined stream lengths of a drainage basin to the basin area ( $\text{km km}^{-2}$ ); drainage density is indicative of the facility by which excess rainfall moves from an upland surface. High values of drainage density are indicative of high transfer efficiency and therefore of high peak discharge.

**Drainage network** is the system of channels and other paths of conveyance for water and sediment moving downslope through a drainage basin.

**Drift** is a term with different meanings depending on whether the topic is caves, coastal studies, geophysics, hydraulics, or surface-water hydrology; as applied to glacial geology and geomorphology, drift is rock debris of any size deposited by ice of a glacier or sediment-laden meltwater flowing from a glacier. Related terms are **outwash** and **till**.

**Dry wash** is a channel in which streamflow occurs inconsistently or infrequently and, except during periods of streamflow, is directly underlain by unsaturated alluvium; dry washes are most common in arid and semiarid regions and typically have a rectangular to steeply sided trapezoidal cross section, banks a meter or more in height formed of fine-grained, poorly consolidated over-bank sediment, and a nearly flat, sandy bed. Synonyms are ephemeral-stream channel, arroyo (northern Mexico and southwestern United States), and wadi (southwestern Asia, Arabian peninsula, and northern Africa)

**Duff** is fresh to moderately decomposed organic matter that veneers the surface in forested areas; duff is derived from fallen trees, failed shrubs and saplings of the understory, remains of herbaceous vegetation, seeds, especially of conifers, and, to a minor degree, scat and remains of animals. Duff absorbs and stores moisture and thereby increases evaporation at the expense of runoff and ground-water recharge; because runoff mostly flows through duff, it slows the runoff rate and minimizes the potential of runoff to entrain and transport sediment downslope and to rills and gullies.

**Dune**, including dune field, is an accumulation, or concentration, by depositional processes of water or wind as a low, small-scale mound, ridge, or, more commonly, a complex (field, or zone) of mounds and ridges, of loose, well sorted granular material (generally sand) that, if active, may be bare or, if inactive, partially to fully vegetated; dunes are subject to translocation, without a basic loss of scale or structure, by the action of streamflow, waves, or wind.

**Duricrust** is an accumulation of mineral precipitates at or near the land surface of generally semiarid areas; a calcium-rich duricrust is a **calcrete** and a silica-rich duricrust is termed a **duripan**.

## E

**Ecohydrology** is that branch of natural science that describes interactions between ecosystems and hydrologic processes by considering how those processes affect the distributions, functions, and dynamics of biota, and by identifying feedbacks from biota to the hydrologic cycle.

**Ecology**, a **composite science**, is the study of organisms relative to the environment in which they live.

**Ecosystem** describes the complex of biotic populations, the biophysical (environmental) constraints on the biotic populations, and the ability of the complex to function as an ecological unit within a specified area or part of a watershed.

**Ecosystem services** are the production of renewable natural resources through processes yielding clean water, soil, vegetation, and wildlife.

**Ecosystem-services water** is that portion of the total water resource that is essential for ecosystem function and as such has intrinsic value for physical and biotic processes; in contrast, commodity water is that portion of the accessible water resource that is viewed by humans, and economists in particular, to be an article of commerce and thus to have a monetary value as an economic good.

**Edaphology**, a **composite science**, when viewed as a division or sub-discipline of **soil science**, is the study of interactions of soils with those organisms dependent on the soils, and thus has a long history of application to agriculture; if viewed as a division of **ecology**, edaphology is the study of the controls that soil characteristics place on plant ecology and plant growth.

**Effective precipitation** is that portion of rainfall, generally measured in millimeters (mm), resulting in runoff and sustaining soil moisture available for plant growth; owing to elevated rates of **evapotranspiration**, effective precipitation in arid and semiarid regions is generally lower than it is in high-latitude areas with the same measured precipitation but lower evapotranspiration.

**El Niño-Southern Oscillation (ENSO)** refers to the global coupling, or **teleconnection**, of oceanic-atmospheric phenomena with weather in other areas. Specifically, the term is applied to a warming trend during a small number of years of sea-surface water of the tropical eastern Pacific Ocean, causing atmospheric-pressure differences in the southern hemisphere and elsewhere (Southern Oscillation, SO) and short-term alteration of precipitation patterns; in arid and semiarid areas of southwestern North America, for example, winter rainfall during El Niño years is typically greater than normal, as are streamflow and sediment movement.

**Eluviation** is the hydrologic process by which water percolates downward and out of a **soil zone**, moving dissolved solids, colloids, and organic material from the surface through the A horizon into the B horizon; precipitation of dissolved solids, especially as carbonate minerals, in the B horizon may be an important process of **calcrete** formation.

**Entrainment** is the process by flowing water or air, or by the mixing of water or air between opposing currents, of mobilizing sediment by picking up particles and transporting them in suspension, as suspended load, and along the channel or other surface of transfer, as bed (or traction) load; rates of hydrologic entrainment depend on stream power (the product of discharge and water-surface slope) and the sizes of the sediment particles.

**Eolian** (or **aeolian**, from Aeolus, the Roman god of the winds) pertains to **entrainment** processes of erosion and sediment transport, deposition, and translocation (mainly sorting) by wind; eolian features include wind-blown sand forming dune fields, atmospherically deposited silt and fine sand (loess) and volcanic ash (tuff), and erosional landforms such as **yardangs**.

**Eolian dune**, including **eolian dune field**, is an accumulation, or concentration, by depositional processes of wind as a low, small-scale mound, ridge, or, more commonly, a complex (field, or zone) of mounds and ridges, of loose, well sorted granular material (generally sand) that, if active, may be bare or, if inactive, partially to fully vegetated; eolian dunes are subject to translocation, without a basic loss of scale or structure, by the action of wind.

**Ephemeral gully** is a gully, typically in an agricultural field, that develops due to water erosion during a growing season but which is subject to removal by any primary tillage operation.

**Ephemeral stream** describes streamflow within a normally dry channel; the streamflow occurs inconsistently or infrequently and, except during periods when the ephemeral streamflows occur, the channel bed is directly underlain by unsaturated alluvium.

**Ephemeral-stream channel** is a channel in which streamflow occurs inconsistently or infrequently and, except during periods of streamflow, is directly underlain by unsaturated alluvium or rock; ephemeral-stream channels are most common in arid and semiarid regions and typically have a rectangular to steeply sided trapezoidal cross section, banks a meter or more in height formed of fine-grained, poorly consolidated over-bank sediment, and a nearly flat, sandy bed. Synonyms are **dry wash**, **arroyo** (northern Mexico and southwestern United States), and **wadi** (southwestern Asia, Arabian Peninsula, and northern Africa)

**Equifinality**, when used in a geomorphic context, is a term to recognize that some landforms, such as braided stream channels, are the end, or final, results of a wide range of possible process sets yielding the observed landform; the concept of geomorphic equifinality is roughly analogous to the biological concept of convergent evolution, which is an acknowledgement that initially dissimilar species, if subjected to similar environmental conditions over long time periods, may develop closely similar physical and behavioral characteristics. As applied to watersheds, a range of different disturbances, both intrinsic and extrinsic, may ultimately yield similar down-basin landforms; a braided stream channel is one of many examples.

**Equilibrium**, as a means of characterizing a geomorphic feature (such as a specified hillslope or stream-channel reach), refers to the balance between inputs and outputs, mostly water, dissolved solids, and sediment (including specific particle sizes), that must be attained to achieve stability. Because fluxes of matter and energy are never constant in natural landscapes, the term equilibrium, when applied to geomorphic systems, is generally modified by “dynamic” or “quasi”, implying that the feature or process is time-integrated and adjusted to the range of inflows and outflows typical of the system. The term is often used synonymously with geomorphic stability.

**Erodibility** is an expression of the susceptibility of a surface to the erosion process; thus, it is the ease by which sediment, rock, or especially soil is detached and entrained, generally by rainsplash, surface flow, or wind. Erodibility, in quantitative terms, is the loss in mass per unit area of a sediment, rock, or soil surface that results from application of a known external energy or shear.

**Erosion** is the process of detachment and transport of soil particles by the erosive agents of raindrop impact and surface runoff from rainfall.

**Erosivity** is an expression of the capacity of rainfall to detach particles from a soil surface and initiate the erosion process; it should not be confused with **erodibility**, which expresses the susceptibility of soil, sediment, or rock to erosion processes. Research has demonstrated that the erosivity (of rainfall) for an individual storm approximates the product of the energy of the storm and its maximum 30-minute intensity.

**Estuary**, as a geomorphic feature, is the funnel-shaped river-valley reach where the river debouches into a marine environment. Most estuaries are continental-margin stream valleys that were formed by typical fluvial processes at a time, generally glacial, of lowered sea level. Owing to glacial retreat and rise in sea level, the valley of the formerly free-flowing near-coast river became flooded as an estuary of a mixture of fresh river water and saline marine water.

**Eutrophication** is the process by which water, generally ponded or stagnant, becomes enriched in dissolved nutrients and deficient in dissolved oxygen; typically, the process occurs when runoff from fertilized fields transports phosphates into the water body, thereby causing algal blooms and a consequent depletion of dissolved oxygen.

**Evaporation**, as applied to hydrology, is the conversion of water to a gaseous or vapor state.

**Evapotranspiration** is the loss of water from any surface by the combined processes of evaporation and transpiration; **actual evapotranspiration**, the actual rate of water loss to the atmosphere is a concept often used by hydrologists for **water-balance** studies, whereas **potential evapotranspiration**, a theoretical water loss under conditions of continuous saturation, is used especially by climatologists.

**Exceedance probability** is the probability, or likelihood, that the peak discharge of a designated flood event will exceed a specified discharge within some standard period of time, generally a water year.

**Exchangeable sodium percentage** is the percent of the cation exchange capacity of soil or sediment that is due to sodium.

**Expansion reach** of a stream or channel is a length of the stream or channel in which the width increases to the degree that flow spreads over the widened section of channel bed, causing a corresponding increase in cross-sectional area of the flow and reductions in flow depth and velocity. Owing to lowered velocity as a stream enters an expansion reach, the ability of flow to transport coarse sediment is diminished and deposition as bars or other in-channel features occurs. For this reason, **channel islands** commonly form in expansion reaches.

## F

**Felsenmeer** is a type of block field, a continuous surface cover of large angular to subangular rocks derived from an underlying source of well jointed bedrock; the blocks are generally dislodged by frost action and form a layer greater than one or two clast thicknesses (as opposed to a **rock veneer**, which has a thickness no greater than two clast thicknesses).

**Flood** is any climatically controlled, relatively high streamflow that overtops the natural or artificial banks in any reach of a stream, thereby being of geomorphic significance; where a flood plain exists, a flood is any flow that spreads over or inundates the flood plain.

**Flood-frequency curve** is a graph showing recurrence intervals of floods plotted as the abscissa and the magnitudes of the floods plotted as the ordinate.

**Flood plain** is a strip of relatively smooth land bordering a stream incision, built of sediment carried by the stream and dropped in slackwater beyond the influence of the swift current of the channel; the level of the flood plain is generally about the stage of the mean annual flood, and therefore one and only one flood-plain level can occur in a limited reach of bottomland.

**Flow duration** refers to the percentage of time that a specified discharge is equaled or exceeded.



**Flow-duration curve** is a cumulative-frequency curve that shows the percentage of time that specified discharges are equaled or exceeded.

**Fluvial**, from the Latin word, *fluvius*, for river, refers to or pertains to streams; included are stream processes (fluvial processes), fluvial landforms, such as fluvial islands and bars, and biota living in and near stream channels. Common usage is often extended by geomorphologists to hydrologic processes on hillslopes.

**Fluvial**, or **channel, island** is a landform that rises above and is surrounded by stream passageways and which persists a sufficient time so that persistent vegetation can develop if adequate moisture is available.

**Fluvial system**, after Schumm (1973), is an idealized representation of a watershed into zones of (1) erosion and sediment entrainment, (2) transfer of sediment, and (3) deposition of sediment.

**Freeze-thaw cycle**, as applied to rock and soil weathering, is the process by which capillary water occupies the pores, fractures, joints, or crevices of near-surface rocks or rock fragments and freezes upon lowered air temperature; owing to expansion as water turns to ice, pressure is exerted on the pore, fracture, joint, or crevice sides, pushing them apart and causing a form of physical weathering.

**Fresh water**, in contrast to brackish water or salt water, is water (or ice) on or beneath a land (or water) surface that accumulates as a result of natural processes of precipitation; fresh water contains dissolved solids (mostly salts) of insufficient concentration to cause deleterious effects by ingestion of living organisms other than those adapted to sea water or similar supplies of water with high concentrations of dissolved solids.

**Froude number** is a dimensionless index to characterize the type of flow, or tranquility of flow, in a channel or similar hydraulic structure; it is defined mathematically as:

$v/\sqrt{gd}$ , in which, in consistent units,  $v$  is water velocity,  $g$  is the acceleration due to gravity, and  $d$  is depth of flow.

## G

**Gage height**, as determined for a gaging station, is the water-surface elevation, or **stage**, relative to an arbitrary datum.

**Gaging station**, also referred to as a **streamgage**, is a specified site on a stream, channel, canal, lake, or reservoir where systematic observations of streamflow or related hydrologic data are collected.

**Generalized skew coefficient** is a skew coefficient, determined by the integration of many values of skew coefficient within a specified area, that is assumed applicable to all streams of the area.

**Geomorphic threshold** is a critical characteristic or condition of a landscape or geomorphic system that, if rendered unstable by some measure of disturbance exceeding the critical level of stability, change within the system, often as a sequence of responses, is induced; geomorphic responses to an external stress exceeding a threshold are termed extrinsic, whereas those occurring because on-going change within a system has caused a threshold to be exceeded are termed intrinsic.

**Geomorphology**, a **composite science**, is the study of landforms including, in recent times especially, investigations into the processes that cause and alter the landforms.

**Glacial** refers to the conditions, processes, features, and landforms of those areas with adequate precipitation and sufficiently low temperatures that snow and ice accumulates, or formerly accumulated, to a thickness that deformation and the flow, or movement, of glacial ice occurs.

**Glacier** is a large mass of ice formed wholly or mostly on land by the compaction and recrystallization of snow, possibly with ice additions from the freezing of meltwater or rainfall, that creeps slowly downslope by gravity-induced deformational processes; glaciers have permanence measured in periods exceeding decades or centuries and range in size and environment from small alpine glaciers of high-elevation or high-relief areas to flowing ice sheets that are sub-continental in areal scale and that can move on very low slopes.

**Gleying** is a process of soil genesis, commonly of well weathered clay horizons, in which the soil becomes mottled, generally in a tightly layered manner, caused by partial oxidation and reduction of ferric-iron compounds due to fluctuating ground-water levels (intermittent episodes of saturation and aeration). The amount of time indicated by gleying is indefinite but often it is interpreted to suggest that the gleyed zone dates from sediment deposited in a slough or similar depression of a flood-plain surface of a paleo-landscape.

**Gradient**, as applied to stream channels, is the rate of elevation change between two specified sites of horizontal distance measured along the **thalweg** of the channel; it is generally expressed as a non-dimensional number ( $m\ m^{-1}$ ).

**Gravel**, as fluvial sediment, is sediment defined to be of particle diameter between 2 and 64 mm in diameter (b-axis).

**Ground water** refers to water in the subsurface that saturates the rocks and sediment in which it occurs; the upper surface of ground-water saturation is commonly termed the water table.

**Ground-water reservoir** is a saturated body of ground water having loosely definable spatial limits; among the goals of ground-water hydrology is the objective of determining the volumes of water in ground-water reservoirs.

**Gully** is a small hollow or **channel** worn in earth or unconsolidated material, as on a hillside, by running water and through which water runs only after a rain or the melting of ice or snow; it is larger than a **rill** and smaller than a stream channel.

**Gully erosion** is the displacement of soil or soft rock particles by running water that forms distinct, narrow incisions that are larger and deeper than rills and that usually carry water only during and immediately after heavy rain or the melting of ice or snow.

**Gully gravure**, a French term meaning to dig or engrave, refers to a sequence of slope-retreat processes in which a hilltop capping of coarse, erosion-resistant rock debris concentrates in channels or depressions formed by erosion on a hillslope below of less resistant geologic materials. The coarse rock debris gradually entraps interstitial finer-grained erosion products, either derived from the surrounding material or weathered from the deposited debris. The permeability and porosity of the channel filling are thus reduced, and runoff is diverted to the periphery of the channel fill, where new gullies occur only to be filled by more debris. In this manner, an entire hillslope can become veneered with coarse rock debris.

## H

**Habitat** is the living space for one or more organisms; it is described by the combined environmental parameters of biotic and abiotic factors.

**Halophytes** are plants that have the ability to survive despite the presence of large amounts of salt or alkali in the soil water on which they depend.

**Hard-water effect** is the tendency of the dissolved inorganic carbon in many “hard-water” lakes to be in disequilibrium with atmospheric CO<sub>2</sub> owing to a short residence time. A result is that radiocarbon in the water, carbonate minerals formed in the water, and organisms living in the water, is deficient relative to that of the atmosphere, thereby yielding computed ages older than the true ages. Similarly, streams that receive significant amounts of ground water with substantial subsurface residence times contain dissolved carbon that also is deficient relative to atmospheric radiocarbon, and radiocarbon dates derived from the water and its biota are greater than the true ages.

**Headcut**, a type of knickpoint, is a vertical or near-vertical face, or drop, on the bed of a stream channel that interrupts the channel gradient and, through processes of channel erosion, progressively moves up-channel.

**Herbs** are plants whose stems develop very little wood but consist mostly of soft tissue, and which generally die each year. Perennial herbs are those plants whose tops generally die each year but whose roots survive for two or more years.

**Histogram** (history gram) is a bar graph, without open intervals separating bars along the horizontal axis, for which the area or vertical height of each bar is proportional to the frequency or relative frequency of the variable represented. Histograms typically are used by hydrologists to illustrate particle-size distributions of sediment samples by representing the proportional amount of sediment in a specified size class as the bar height; the summation of the areas or heights of the bars must equal the total (100 percent) sample volume or weight.

**Humus** is a complex mixture of brown to dark brown components of soil organic matter, mostly amorphous and colloidal substances, that are decomposed to the extent that the sources of the material cannot be identified.

**Hydraulic conductivity** is a measure of the ease by which a fluid, generally water, will pass through a porous medium, often soil or rock.

**Hydraulic geometry** describes, for a given cross section of a stream channel, the graphical relations among plots of hydraulic characteristics (width, depth, velocity, gradient, roughness coefficient, particle sizes) as simple power functions of river discharge; hydraulic-geometry pertains to the water in a channel as opposed to the geometry of the channel. Hydraulic-geometry relations can be developed both for the at-a-station condition and the downstream-direction condition.

**Hydraulic gradient** is the gradient (often termed slope) of the energy grade line – the line representing the sum of kinetic and potential energy along the flow path; for uniform flow, the hydraulic gradient and the slope of the water surface are equal. An analogous term of ground-water hydrology is **potentiometric surface**.

**Hydraulic radius**,  $R$ , of a stream channel is the ratio of its cross-sectional area,  $A$ , to its wetted perimeter,  $WP$ :  $R = A/WP$ .

**Hydric** refers to an environment (habitat) that is characterized by abundant moisture.

**Hydrograph** is the graphical representation of a hydrologic variable, such as the stage of a stream or the water level in a well, as a function of time; a hydrograph for runoff (streamflow) is a graph of the time-rate distribution of flowing water passing a site on the landscape, generally at a stream channel and often for a specific flow or runoff event.

**Hydrologic budget** is a quantitative accounting of the various components of water or stored in drainage basins or watersheds; when the amount of water entering a system equals that leaving or stored in the system, the hydrologic budget is assumed, over reasonably long time periods, to be in balance (see **water balance**).

**Hydrologic cycle** is the cycle of water movement (in the liquid, solid, and vapor phases) from the atmosphere to land, surface-water, and ground-water bodies, including movement among land and water bodies, before returning to the atmosphere.

**Hydrology**, a **composite science**, is that part of the earth sciences that is concerned with the origin, circulation, distribution, and properties of water; important elements of hydrology include the measurement of fluxes of water (as streamflow, ground-water discharge, etc.) and the manners by which the fluxes affect the landscape (erosion, plant growth, etc.).

**Hydrometer** is a bulb that indicates the specific gravity of a water-sediment mixture by the height at which it floats above the mixture surface; the hydrometer is commonly used to compute concentrations of fluvial sediment too fine to fall from suspension, and to determine particle sizes of fine sediment in soils.

**Hydroperiod** is the annual or otherwise repeatable period of time, typically expressed in days or weeks, during which either alluvium underlying a bottomland area is persistently saturated or the bottomland area is covered by water.

**Hydrophyte** is a plant that is adapted to a habitat of water or very wet conditions (including wetlands).

**Hyperarid** refers to a climatic zone that receives average precipitation of less than 100 mm annually.

**Hyporheic zone** is the ill-defined volume of sediment, adjacent to and beneath an alluvial stream channel, through which ground water moves roughly parallel to streamflow. Water of the hyporheic zone generally is readily exchangeable with stream water, receiving water as **bank storage** through influent reaches of channel and yielding water as seepage through effluent reaches. Processes of the hyporheic zone help control water temperature, dissolved-solids and sediment transport, and near-channel ecology. Along **intermittent-stream channels**, flow in the hyporheic zone at and slightly below channel level is commonly referred to as underflow or perennial underflow that generally supports cottonwood trees or other **phreatophytes**.

**Hypoxia** literally is the condition by which a deficiency of oxygen reaches tissues of the body; as applied to hydrologic systems, it is a deficiency of dissolved oxygen in water and thus an inadequate concentration of oxygen to maintain a healthy aquatic ecosystem.

I

**Illuviation** is the movement of soluble and fine-grained material downward with descending soil water into sites of the B horizon, where deposition or re-precipitation of the dissolved minerals occur; illuviation is a specific form of **eluviation**.

**Indicator species**, as applied to plant ecology, refers to a plant whose natural presence on a particular surface, soil, or landform is indicative of that surface, soil, or landform; as examples, in moist parts of North America black walnut (*Juglans nigra*) is indicative of the **flood plain**, whereas sacaton (*Sporobolus airoides*) is a bunchgrass of arid and semiarid parts of western North America that is typically indicative of alkali soils of alluvial bottomlands.

**Infiltration** refers to the movement of water, from rain, snowmelt, runoff, and storage, from the land surface through the air-soil interface and into the soil zone.

**Infiltration rate** of porous rock or a soil signifies the rate, often expressed in  $\text{mm sec}^{-1}$ , at which the rock or soil can absorb water provided to it from the surface by rainfall or snowmelt; infiltration rate replaces the previous term, **infiltration capacity**, which was the maximum rate at which infiltration could occur.

**Inselberg** (German, meaning island hill or island mountain), as applied to the American Southwest, is a rock prominence surrounded and partially submerged by unconsolidated to loosely consolidated sediment mostly of fluvial origin; inselbergs are common in the Basin and Range Physiographic Province, where bedrock segments of mountain blocks, relative to the land surface, have become separated or detached from the main mountain block through alluvial-fan deposition around the bedrock segment.

**Instability**, as a descriptor of geomorphic processes and landforms, refers to a condition of imbalance between inflows and outflows of matter through or over a landscape feature. As a geomorphic concept, instability is often expressed as some state of dynamic- or quasi-equilibrium, signifying that geomorphic processes and landforms are almost always in a condition of dis-equilibrium and are almost always adjusting to regain relative stability; an objective if applying the term is to determine the degree to which a process or landform deviates from stability or equilibrium.

**Interception** is that portion of precipitation that wets vegetation or other surface cover and returns to the atmosphere by evaporation during and following the precipitation event.

**Interfluvium** is the area between sites of concentrated flow, particularly stream channels but including gullies and, at a smaller scale, even rills, for which interrill area may be a preferred term.

**Intermittent stream**, as a hydrologic term, is intermittently or seasonally flowing water in a natural, **intermittent-stream channel**; the flow of an intermittent stream typically is derived from wet-season runoff or snowmelt, and the surface of an intermittent stream, or the bed of the channel upon which flow occurs, typically is higher than the level of the zone of saturation in the adjacent water-bearing alluvium or rocks. This characteristic is fundamentally different from that of an **ephemeral-stream channel**, which at most times is separated from the zone of saturation by a variable thickness of unsaturated alluvium or rock.

**Irrigation** is the application of water, by means of canals, pipes, sprinklers, or controlled flooding, onto a land surface to augment the water that otherwise would be inadequate to promote growth of crops or other vegetation.

**Isohyet** is a line, or contour on an **isohyetal** map, that connects points of equal precipitation; isohyets and isohyetal maps generally refer to amounts of mean annual precipitation (as examples, 50 mm or 100 mm), but also can be generated for other periods of time such as months, seasons, or the duration of a single storm.

J

K

**Karst** is a type of topography or large-scale landform characterized by numerous collapse structures visible at the surface as spring or **cave** openings and **sinkholes**, and in the subsurface as caves and smaller solution openings that provide underground drainage; the closed depressions and collapse structures that dot a karst landscape are the result of chemical weathering by dissolution of carbonate rocks, principally limestone and dolomite, and less commonly of evaporate rocks, especially gypsum and anhydrite, in areas of arid and semiarid climate. Noteworthy limestone areas of karst topography in the United States are the karst plains and landscapes of Kentucky, the Ozark Plateau of southern Missouri and northern Arkansas, and the karst plain of northwestern Florida.

**Kinematic viscosity**, the ratio of the viscosity coefficient to density of a liquid, is a measure of the ability of streamflow to entrain and transport sediment.

**Knickpoint** is any interruption or break of a channel gradient, especially a headcut site of abrupt change or inflection in the longitudinal profile of a stream channel or its valley.

**Krotovina**, a soils term of Russian origin, is a once-open irregular tubular structure or chamber made by a burrowing animal, such as a pocket gopher, that subsequently has filled with sediment from above.

## L

**Lacustrine** refers to any feature formed or caused by the processes of a lake; thus, a body of **lacustrine sediment** (lake beds) is typically one of mostly fine fluvial sediment that dropped from suspension as and while the silt-laden streamflow was ponded as lake water.

**Laminar flow**, as a hydrologic term, is water movement (flow) in which the lines of flow are essentially constant and in which flow direction at all sites remains nearly unchanged through time; laminar flow is typical of most ground-water movement whereas most concentrated flows of stream channels are turbulent. .

**Lentic** refers to or relates to still or sluggish water such as lakes, ponds, and swamps; lentic species are organisms that live in still or sluggish water.

**Levee** (natural) of a stream channel is a broad, low ridge or embankment of coarse silt and sand that is deposited by a stream on its flood plain and along either bank of its channel; natural levees are formed by reduced velocity of flood flows as they spill onto flood-plain surfaces and can no longer transport the coarse fraction of the suspended-sediment load. Especially along meandering streams, natural levees may be of mappable areal extent; they tend to be relatively thin bands of silt and sand sloping gently down-valley from the down-valley bank of the channel from that portion of a meander crossing the valley floor.

**Loam** is a porous, permeable soil comprised of similar proportions of clay, silt, and sand; loams generally contain **humus** (decomposed organic matter) and may have a minor amount of gravel.

**Loess** is a wind-deposited accumulation of terrestrial clastic sediment generally of coarse-clay to fine-sand sizes but mostly silt; loess bodies tend to be highly erodible, unstratified, and are mostly derived by deflation and re-deposition of fine, quartzitic sediment from poorly protected surfaces of till, glacial outwash, fluvial-overbank and lake-bed deposits, and deserts.

**Lotic** refers to or relates to moving water, especially streamflow; **lotic species** are organisms that live in moving water.

## M

**Manning equation** is an empirical formula relating stream velocity to controlling variables; when channel width and depth are included, the simplified formula (in metric units) is expressed in terms of discharge, Q:  $Q = [1/n] G^{1/2} W D^{5/3}$ , in which n is the roughness coefficient, G is channel gradient, W is channel width, and D is mean channel depth. For hydraulic computations, the formula is usually expressed as

$Q = [1/n] A R^{2/3} S^{1/2}$ , in which n is the **roughness coefficient**, A is cross-sectional area, R is hydraulic radius, and S is the energy slope of the reach.

**Mass movement** is any downslope transfer, through gravitational (inertial) and generally water-facilitated (viscous) processes, of near-surface soil and rock material; rates of mass movement range from very slow creep to nearly instantaneous slope failure.

**Mass wasting** is the failure and movement by gravity of a volume of soil, alluvium, rock, or ice to a downslope site storage; it the result of the process of **mass movement**.

**Mean annual flood** is the average flood discharge ( $\text{m}^3 \text{s}^{-1}$ ) for a specified period or number of years.

**Meander** of a stream is one of a series of regular, sharp, freely developing, and sinuous curves, bends, loops, turns, or windings in the course of a stream; the process of stream meandering is a means of channel-gradient adjustment through sorting of stored sediment by erosion at the outside of a bend and deposition, as a point bar, at the inside of the bend.

**Meander belt** is that area of an alluvial bottomland defined by lines, on both sides of the zone of activity, drawn tangentially along the points of maximum horizontal extent of the various meanders in a sequence of meanders.

**Measured suspended-sediment load** is the suspended-sediment load that can be computed from water discharge and the concentration of depth-integrated samples.

**Mechanical (or physical) weathering** is the reduction of rock fragments and rock surfaces by physical processes including abrasion, shattering by particle impact, expansion of crevices by roots, frost action, or salt-crystal growth, and gravitational effects such as slope failure and other forms of mass movement. Mechanical weathering affects the physical condition of the rock or rock fragment; the chemistry of the rock is unaltered.

**Mesic** refers to an environment (habitat) that is characterized by moist conditions, neither markedly wet (**hydric**) or dry (**xeric**).

**Mesophyte** is a plant that is adapted to a habitat of moderately moist conditions.

**Monsoon** is a seasonal wind or shift in wind direction resulting from greater variation in air temperatures over land areas than over oceans. Commonly monsoonal shifts in air flow are accompanied by changes in precipitation patterns owing to changed moisture sources; in southwestern North America, for example, influxes of moist marine air from the south in July, August, and September often cause high-intensity convectional **monsoonal thunderstorms**.

## N

**Normal distribution**, a statistical concept, is a probability distribution of (hydrologic) data that exhibits symmetry relative to the mean, median, and modal values of the data. A normal distribution assumes a “bell-shaped” curve when the data are plotted as magnitude relative to frequency and is known also as a Guassian or Laplacean distribution. A principal application of probability distributions to hydrology is flood-frequency analysis; flood records of some stream exhibit a normal distribution but most do not, necessitating the use of a **skew coefficient** as a means of describing the distribution.



## O

**Ordinary High Water Mark** is a legal term with numerous definitions generated by court decisions. According to Title 33 Code of Federal Regulations 329.11(a)(1), the “ordinary high water mark” on non-tidal rivers is the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. Though open to other interpretations, this definition implies a level similar to that of the stage of mean discharge and thus a **flow duration** of generally 5 to 20 percent.

**Outlier**, relative to a list or group of credible hydrologic data, is a value within the data set that departs from the trend defined by the rest of the data; an example could be a flood discharge five-fold greater than that of any other flood in a lengthy record of annual flood discharges.

**Outwash** in a general sense is soil particles or sediment that moves down an upland surface with overland flow to a rill or gully and is re-deposited on areas of lesser slope; more commonly outwash is used as a geomorphic term referring to rock debris that is removed from a glacier by meltwater and is re-deposited in the stream channel as glaciofluvial sediment.

**Overland flow** is that part of precipitation or snowmelt that moves over the land surface, often in small rivulets owing to micro-topography, toward a rill, gully, or channel before becoming runoff as concentrated flow within the rill, gully, or channel.

**Oxbow**, as a hydrologic feature, is a horseshoe-shaped length of stream channel, a nearly closed **meander** loop. As a fluvial-geomorphic feature, an oxbow is an abandoned meander loop of an alluvial channel on a **flood plain** or **alluvial terrace**; evidence of an oxbow that has largely filled with sediment may remain as a **meander scar** on the flood plain or alluvial terrace. An **oxbow lake** is a horseshoe-shaped body of water, sometimes ephemeral, that occupies a geomorphic oxbow.

## P

**Partial-duration flood series** is a list of all flood peaks that exceed a chosen base stage or discharge, regardless of the number of peaks occurring in a year.

**Particle size** is the diameter (mm), as measured along the intermediate axis of a sediment particle (thus, the maximum particle size that can pass through a screen or sieve of that mesh size); sediment types are typically specified using a phi scale, by which particle sizes of less than 0.002 mm are clay, those ranging from 0.002 to 0.062 mm are silt, those of 0.062 to 2.0 mm are sand, and particles of 2.0 to 64 mm, 64 to 256 mm, and more than 264 mm, respectively, are designated gravel, cobbles, and boulders. Sediment of **wash-load** size, less than 0.062 mm, is determined by hydrometer analysis.

**Particle-size distribution curve** is a graph, or curve, of specified particle sizes of a fluvial-sediment sample plotted against values of percent weight of incremental portions of the sediment sample finer than the total dry weight of the sediment sample. The resulting curve shows which particle sizes may be enriched or deficient, and allows comparison with other particle-size distribution curves.

**Pebble** is a general term for a small rock fragment, typically from 4 to 64 mm in diameter, that has been rounded through the process of stream transport.

**Pebble count** is a systematic method of sampling and measuring the diameters (b-axis) of a sufficient number of pebbles (and possibly other rounded rock fragments of smaller and larger size) to attain a significant representation of the range of sizes and median size of a deposit of coarse sediment.

**Pediment** is a low-angle sloping surface that is typically developed on bedrock or older, partially consolidated alluvial deposits in an arid or semiarid region; pediments encroach largely by headward fluvial erosion into the bases of hills, mountains, or plateaus, forming and maintaining abrupt and slowly receding fronts or escarpments. Thus, processes of pedimentation yield low-relief surfaces of uniformly gentle slope, or ones that are slightly concave upward, on which erosion is minimal and the erosion products from the high-relief bedrock exposures move downslope with little or no permanent storage of sediment. Channel incision of a pediment may occur following renewed uplift of the bedrock area or incision of the principal stream at the downslope end of the pediment

**Pedogenesis**, or soil genesis, refers to the mode of origin of a soil, with emphasis on the processes of soil-forming factors responsible for the development of the solum (true soil) from unconsolidated parent material. Among the processes that contribute to pedogenesis are additions from above of precipitation and contaminants; changes of organic matter to **humus** and of rock-forming minerals to hydrous oxides, clays, ions, and  $H_4SiO_4$ ; downward transfer of humus compounds, clays, ions, and  $H_4SiO_4$ ; upward transfer of ions and  $H_4SiO_4$ ; and removal (normally by ground-water movement beneath the soil profile) of ions and  $H_4SiO_4$ .

**Pedology**, a **composite science** and a synonym of **soil science**, includes the study of soil processes and treats or considers the formation, properties, classification, and mapping of soils; some soil scientists regard pedology to be one of two main sub-disciplines of soil science, the being **edaphology**.

**Pendant bar** is a narrow, sharp-crested accumulation of relatively coarse bed sediment deposited at the downstream (lee) side of a resistant protrusion during a large flood; pendant bars, which typically are separated from the protrusion (typically bedrock) by a depression caused by heightened flow velocity and scour around the protrusion, parallel the flow direction and thus aid in the reconstruction of flood dynamics. The term pendant bar generally is applied to large-scale landforms of high-magnitude floods, whereas the term sand splay often refers to flood-plain or terrace features of smaller scale caused by similar processes during floods of high frequency.

**Perennial stream**, as a hydrologic term, is continuously flowing water in a natural stream channel; the surface of a perennial stream fluctuates at or near the upper level of the zone of saturation in the adjacent water-bearing alluvium or rocks.

**Periglacial** refers to the conditions, processes, features, and landforms of those areas at and near the margins of present or former glaciers or glacial conditions; snow and other forms of precipitation in periglacial areas generally are insufficient to result in the occurrence of glacial processes, but frost action and related types of physical weathering may be important as determinants of surface processes and landforms.

**Phenology**, as a general concept, is the branch of science that treats of relations between short-term climatic variations and periodic biological phenomena; as a part of **ecology**, phenology concerns principally short-term changes in biological processes, such as bird migration, plant flowering and seed dispersal, and tree growth, that vary with season and seasonal variations such as air and water temperatures and water availability.

**Phreatophyte** is a plant dependent on water in the zone of saturation (ground water of the saturated zone), either directly or through the capillary fringe.

**Phytogeomorphology**, the blending of the Greek word for plant with the study of landforms, refers to the study of interactions among processes of geomorphology and plants and to how landforms and plant occurrences are mutually affected.

**Phytolith**, from the Greek words for plant and stone, is a mineral body of microscopic size that precipitates in or around cell walls of plants; the size, shape, and composition of phytoliths often are diagnostic of the plant species from which they precipitated. Most phytoliths are opaline silica but many are formed of calcium oxalate. Because phytoliths are inorganic products of plant growth, they do not decay readily after death of the plant or plant cell and if extracted from the soil in which they were deposited can be used to recognize previous vegetation patterns and climate.

**Piedmont** is a gently sloping surface extending from the base of a mountain or mountain range toward the valley center area; an extensive piedmont of the eastern United States lies along the eastern flank of the Appalachian Mountains and in the western United States numerous discontinuous piedmont areas are at the bases of block-fault mountains of the Basin and Range Province.

**Pinyon-juniper** refers to an open-woodland **plant community, ecosystem, or habitat**, of semiarid parts of North America (especially **piedmont** areas of New Mexico, Arizona, and Utah) that are dominated by pinyon pine (*Pinus edulis* and/or *P. cembroides*) and various species of juniper (especially oneseed juniper, *Juniperus monosperma*, and Rocky Mountain juniper, *J. scopulorum*); a pinyon-juniper community is comprised of one or more **indicator species** of pinyon and juniper genera, and generally occurs on well drained sandy to gravelly soils of moderately to steeply sloping **pediments** and **alluvial fans** that have mean-annual precipitation range of 250 to 400 mm,

**Piping** is an erosional process, by water percolating through unsaturated soil or subsoil, that results in removal of generally fine-grained sediment particles by downward and lateral migration and the formation of small conduits, tunnels, or pipes through which the water and entrained sediment moves; the conduits created by the piping process may cause collapse of overlying sediment and surface expression as small depressions and **gullies**.

**Plant community** is a dynamic group or association of complementary plant species that compete for the same water, nutrient, and mineral resources of a limited area with specific ranges of physical characteristics.

**Plant density**, a measure of plant abundance, is the number of individual plants, or stems, of a species, a group of species, or of all species, per unit area; the concept of plant density is often extended to express how the plants are distributed, such as random, clumped, or organized according to land-surface gradients. The concept of plant density is complicated by the difficulty in defining area; for example, what is the area of a steep slope?

**Plant cover**, a measure of plant abundance, is the amount, generally as a percent, of a unit area that is visually covered when viewed from above; plant cover can be applied to all species, to tree canopy for forests, or to ground cover when limited to smaller species; if observations suggest a plant cover of 50 percent, 50 percent of the area is also bare and subject to erosion by raindrop impact. The concept of plant cover is complicated by issues of area (what is the area of a steep slope?), amount of cover (are there multiple leaf layers within a plant, between plants, or between groups of vegetation?), and completeness of cover (are there holes between the leaves or branches of a plant through which light can penetrate?). Because plant cover reduces the potential erosive effect of **raindrop impact**, it is a critical consideration in the studies of **erosion**, **geomorphology**, and **sedimentology**.

**Playa** is an ephemeral lake of an arid or semiarid area, the floor of which supports sparse to seasonal vegetation and is underlain by fine-grained deposits washed to the lake bed by infrequent precipitation events. Sediment of the playa floor typically is mostly silt and clay with abundant organic material and salts that precipitate as water evaporates following runoff to the basin interior. Sediment underlying many playas of the Basin and Range Province is saturated at shallow depth; playa floors of the Southern High Plains in northern Texas and western New Mexico generally lie well above the zone of saturation. A **playa basin**, or **bolson**, has interior drainage toward the playa and is the surface area that contributes excess precipitation, as runoff, to the playa.

**Pluvial**, from the Latin word for rain, connotes rain or rainy. As used in the earth sciences, the word signifies a period of abundant rainfall and runoff and the hydrologic and earth-surface processes effects of that rainfall and runoff; a principal geomorphic use of the term pluvial is to distinguish parts of Pleistocene time when rainfall rates, that were greater than present rates in much of the warmer-climate areas of North America, and runoff resulting from abundant snowfall in mountainous areas generated high water levels in **pluvial lakes**, such as Lake Bonneville and Searles Lake of the Basin and Range Province.

**Point (or meander) bar** is bed sediment, generally sand and gravel, that is deposited on the inside part of a meander curve as part of the normal process of fluvial sorting of sediment.

**Pool**, as applied to alluvial stream channels, is a relatively deep, low velocity reach of quiescent flow between upstream and downstream **riffles**, or rapids, at which the flows are ordinarily more rapid and turbulent.

**Pool-riffle sequence** in alluvial stream channel refers to a succession of one or more combinations of **pools** and **riffles** along the channel in the downstream direction; during flood the normally low water velocities in pools and higher water velocities at riffles are reversed, causing scour and removal of accumulated sediment from pooled reaches and deposition of bed sediment on riffles.

**Potential evapotranspiration** is the loss of water, as a rate or volume, that *would* occur from a continuously saturated land surface through combined evaporation from the soil and transpiration of plants; potential evapotranspiration is a theoretical loss that assumes an unlimited, constant supply of water.

**Potentiometric surface** is a hypothetical concept of ground-water **hydrology** representing the height or surface to which water in a well rises or maintains if pumping does not occur; for confined ground water under artesian pressure the potentiometric surface is higher than the top of the ground-water body, whereas the potentiometric surface of an unconfined ground-water body is similar to the **water table**.

**Precipitation** is the discharge (mm) of water in liquid or solid form from the atmosphere onto the land, water, and ice surfaces of the earth; precipitation includes condensation as dew or frost, although this component is typically minor in terms of quantity.

## Q

**Quadrat** is a small area, possibly a square with 1-m sides, within which samples or observations of plants, rock fragments, soil conditions, or other land-surface characteristics are taken; most commonly quadrats are used in **ecological** studies to document the species occurring in the area. Often quadrats are positioned along a **transect** to obtain detailed knowledge or develop a statistical analysis of vegetation or other characteristics on a landform or plant community.

## R

**Raindrop impact, or rainsplash**, are terms expressing the effect that individual raindrops have on erosion processes; the energy expended, per unit area, by raindrops when they strike a soil or rock surface can be very high, resulting in the dislodging of soil particles that then are susceptible to entrainment by water moving downslope as overland flow to rills, gullies, and stream channels.

**Rating curve** is a graph relating water discharge to water-surface elevation (gage height, or stage) at a specified site or cross section of a stream channel.

**Reach (of a stream)** refers to an uninterrupted part of a stream channel between two points; generally the two points are where readily recognizable tributary inflows occur, but can also include features such as meander bends, gorges, or a significant change in geology (which in turn could be the cause of a gorge or a waterfall).

**Recurrence interval** of hydrologic events is the *average* interval of time, generally expressed in years, within which, for example, the magnitude, or discharge, of a given flood will be equaled or exceeded.

**Regime (or regime theory)** is the concept that alluvial stream channels are self-forming and self-adjusting; the term applies only to channels that make at least part of their boundaries from their transported load, carrying out the process at different places and times in any one stream channel in a balanced or alternating manner that prevents unlimited growth or removal of boundaries. Thus, a stream channel is said to be “in regime” when it has achieved an approximate equilibrium between matter and energy entering a stream reach and matter and energy leaving the reach.

**Regulation** of a stream is an imposed alteration of the discharge and discharge fluctuation of flows; most commonly regulation is caused by the construction of a dam and the control of water releases to the channel downstream from the dam. Stream regulation by a dam and reservoir has the effect of storing much of the fluvial sediment that enters the reservoir from upstream; consequently, the water released from the dam generally has a highly deficient sediment load and tends to cause downstream bed and bank erosion and related changes in fluvial landforms.

**Rehabilitation**, as applied to stream corridors (bottomlands) that have been altered through human activity, is the establishment or re-establishment of a condition of health and constructive activity. A goal of rehabilitation, therefore, is to minimize, not eliminate, the effects of human-induced alterations, thus promoting stable landforms, bioproductivity, and species diversity. Within industry, **reclamation** is often used synonymously with rehabilitation or **restoration**.

**Restoration**, as applied to stream corridors (bottomlands) that have been altered through human activity, is the attempt to recreate the adjusted physical and biological conditions that were present prior to the alteration; a goal of restoration, therefore, is to minimize and eliminate the effects of human-induced alterations, thus promoting stable landforms, bioproductivity, and species diversity.

**Reynolds number**, as applied to hydrologic processes, is a numerical quantity to describe the character of flow (typically laminar or turbulent) in a geologic or landscape setting; it is the ratio of inertial forces to viscous forces, equal to the product of velocity (often mean velocity) and a linear measure such as diameter or depth divided by the kinematic viscosity of the liquid (water/sediment mixture).

**Riffle**, as applied to alluvial stream channels, is a short, relatively shallow and coarse-bedded length over which the stream flows at ordinarily higher velocity and greater turbulence than it does through upstream and downstream pooled reaches where cross-sectional areas of the channel are greater, bed material is smaller, and velocities and turbulence are less.

**Rill** is a very small incision eroded into soil or soft rock as a direct-runoff response to precipitation; it is one of the first and smallest incisions to be formed as a result of erosion by concentrated flow from upland surfaces and therefore is subject to removal by standard tillage operations of agriculture.

**Rill erosion** is the development of numerous, minute to small, closely spaced incisions resulting from the uneven removal of surface soil or soft rock by flowing water that is concentrated in streamlets of sufficient volume and velocity to generate erosive power; it is an intermediate process between **erosion by overland flow** and **gully erosion** and is the most identifiable indicator of serious erosion resulting from watershed disturbance. The depth of flow that causes erosion in rills is typically less than about 30 mm. Rill erosion on lands that have been treated for **rehabilitation** or **reclamation** is considered to be accelerated erosion.

**Riparian** pertains to the banks of a stream; within **ecology** the term has been broadened to refer to biota and other characteristics of alluvial bottomlands.

**Riparian zone**, as applied to the study of fluvial systems, is an ecological term referring to that part of the fluvial landscape inundated or saturated by flood flows; it consists of all surfaces of active fluvial landforms up through the flood plain including channel, bars, shelves, and related **riverine** features such as **oxbow lakes**, oxbow depressions, and natural **levees**. Particularly in arid and semiarid (water-deficient) environments, the riparian zone may support plants and other biota not present on adjacent, drier uplands.

**River continuum** refers to a biotic gradient, resulting from variations in physical characteristics along an adjusted stream (in dynamic equilibrium and thus time-independent), that is defined by a series of biological responses and consistent patterns of loading, transport, use, and storage of organic matter along the stream length. Because the river-continuum concept addresses biology, it is more specific than that of the **biophysical continuum**, which considers habitat gradients.

**Riverine** is that characteristic by which a feature or process pertains to or is formed by a river.

**Root flair** refers to that part of a plant, generally a tree, at which roots extend laterally from the base of the trunk, or **bole**. Where only the uppermost part of the root flair is observable, it is inferred that normal processes of **sedimentation** or **erosion** have occurred; if large roots near the bole are fully visible it is assumed that erosion has occurred since establishment of the tree, and if none of the root flair is visible, particularly in a **riparian zone**, it can be inferred that sedimentation has occurred since tree establishment.

**Rock glacier** is a mass of poorly sorted, coarse rock debris that typically occurs in periglacial, high-relief areas of mountains and that contains interstitial ice subject to deformational processes of glaciers and therefore downslope movement of the ice and rock as a plastic mass; a landform that previously was deposited as a rock glacier, but, owing to subsequent melting or insufficient additions of snow, ice, and water to maintain a matrix of interstitial ice subject to glacial deformation, is an inactive rock glacier.

**Rock veneer**, or rock-fragment veneer, is a thin accumulation of rock clasts that partially or fully cover a surface or hillslope. The concentrations of generally gravel- or cobble-sized rock fragments develop by a variety of processes, all of which increase slope stability by protecting underlying fine sediment from erosion. Rock veneers typically extend no deeper than one or two clast thicknesses, thereby distinguishing them from thicker rock accumulations such as talus, **felsenmeers**, or coarse channel sediment.

**Roughness coefficient** is a factor in formulas for computing the average velocity of flow of water in a conduit or channel that represents the effect of roughness of the confining material on the energy losses in the flowing water. The most widely used roughness coefficient is “n” of the **Manning equation**; other roughness coefficients are the Chézy resistance factor and the Darcy-Weisbach friction factor.

**Runoff (or rainfall excess)**, that part of precipitation that appears in surface streams ( $\text{m}^3 \text{s}^{-1}$ ), is the amount of rainfall input minus hydrologic abstractions, or losses, of **interception**, depression storage, **infiltration**, and **evapotranspiration**; it is more restricted than **streamflow** as it does not include stream channels affected by artificial diversions, storage, or other works of man.

**Runon** is water on the land surface that moves from upslope sites as **overland flow** or within small **rills** into a specified area of observation; where appropriate, runon should be included in the I (inflow) factor of a **water-balance** computation, but frequently it is ignored.

## S

**Salinity** is a quantitative expression of the concentration of dissolved solids in water or soil and is generally measured and represented by the electrical conductivity of a sample of the water or soil; salinity is an important measure of the tolerance of a plant species to subsist with the available water.

**Saltation** is the process by which sediment, generally of sand size and coarser, bounces along the stream bed by the impact of the flow of water or of other moving particles; saltation can also occur by the movement of wind .

**Salt water** is water on or beneath a land (or water) surface that accumulates as a result of natural processes of precipitation and which contains concentrations of dissolved solids (mostly salts) typical of normal sea water or of other small water bodies such as the Dead Sea or the Great Salt Lake; the concentration of dissolved solids in salt water is sufficient to cause deleterious effects by ingestion of living organisms adapted to a dependency on fresh water or brackish water.

**Sample**, relative to the needs and activities of the *natural sciences*, is a small part or quantity that is randomly obtained to represent the whole of a larger mass, volume, group, or population; it is limited in size to be easily analyzed, studied, characterized, and stored, large enough to be typical of the larger feature, element, or landscape process, and has a degree of permanence. In general, a sample (such as a small volume of sand from a selected part of a dune field) has properties that allow it or a derivative (such as a known volume of water, snow, or ice that is evaporated but all solid residue is retained) to be preserved without employing measures that are destructive to the properties that characterize the sample as representative. Relative to *statistical measures of hydrology*, a sample is a value or element within a larger population of values; as an example, an annual flood discharge from a gage site is a sample of the entire list of floods for an annual series.

**Sand**, as fluvial sediment, is sediment defined to be of particle diameter between 0.062 and 2.0 mm in diameter (b-axis).



**Sand splay** is a low ridge or rounded length of deposits of sand to fine gravel on a flood plain or low terrace; sand splays typically are flood sediment extending from the lee, or downstream, side of an obstacle (most typically large trees) to the flood flow.

**Sapping**, or **ground-water sapping**, is a process of steady sediment removal by the laminar flow to and release of ground water as seepage at the saturated base of an escarpment, arroyo, or similar erosional feature, above which the soil, subsoil, alluvium, or bedrock is unsaturated. Sapping results in the separation at the seepage site of sand and silt particles from the rock or sediment through which the ground-water movement occurs; coupled with sediment-particle separation due to evaporation and precipitation of salts, the process causes erosion, undercutting, over-steepening of slope at the base of the landform, and eventually slope failure and cliff retreat.

**Sawyer**, a channel snag, is a tree extending from the bed of a stream and having branches that project above the water surface; the term may be the source of the name for the Mark Twain novel, Tom Sawyer.

**Schmutzdecke** is a German term meaning dirty cover, or filth cover; as applied to stream beds, it is a gelatinous complex, formed in the uppermost few centimeters of the channel alluvium, of variable proportions of bacteria, fungi, protozoa, rotifera, and aquatic insect larvae. For influent (loosing) streams, schmutzdecke reduces the potential for **transmission loss** of discharge by acting as an interstitial seal in the sand and gravel of the bed material, thereby minimizing the ability of water to flow through the schmutzdecke layer to underlying horizons of the unsaturated zone.

**Sediment** is detached fragmental material that originates from either chemical or physical weathering of rocks and minerals and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural agencies.

**Sedimentation** is the process by which sediment is mechanically deposited from suspension within a fluid, generally water, or ice, thereby accumulating as layers of sediment that are segregated owing to differences in size, shape, and composition of the sediment particles.

**Sediment budget** is an accounting, or inventory, of **sediment-transport rate**, generally as components based on **particle-size** ranges entering and leaving a specified area or stream reach; when the fluxes of sediment that enter and leave are unequal, the assumption follows that the differences signify the net amounts of sediment that are stored or taken from storage within the area or reach.

**Sediment concentration** of streamflow is the amount of sediment, generally as a dry weight, that is entrained in a specified volume of water; sediment concentration is typically expressed in milligrams of sediment per liter of the water/sediment mixture.

**Sediment delivery** is the sum of hydrologic and geomorphic processes resulting in the availability of sediment for transport in a stream network; sediment-delivery processes range from entrainment in overland flow to rapid mobilization by bank failure to much slower movement as soil creep.

**Sediment-delivery ratio** is the ratio, expressed as a percent, of sediment yield of a drainage basin to the total amount of sediment moved downslope by denudational processes during a specified period of time; over long time periods, mass balance must be maintained and the mean sediment-delivery ratio must approach 1.0.

**Sediment duration** is the percentage of time that a specified concentration of fluvial sediment is equaled or exceeded; a range of sediment durations from the same stream permits the construction of a sediment-duration curve.

**Sediment-duration curve** is a cumulative-frequency curve, derived from a flow-duration curve and sediment concentrations in water samples collected at known discharge rates (a sediment-rating curve), that shows the percentage of time that specified discharges of suspended sediment are equaled or exceeded.

**Sedimentology**, a **composite science**, as applied to geology is the study of the characteristics of sediment forming sedimentary rocks, unconsolidated fluvial, mass-movement, and eolian deposits, and soils; as part of the disciplines of geomorphology and hydrology, sedimentology is the study of (1) mineral composition, particle size or particle-size distributions and sorting, physical metrics such as orientation and angularity, chemistry, porosity and permeability, organic and fossil content, age, and history or evolution of sediment particles or of a sediment body, and (2) the rates of movement of sediment on hillslopes, with water as fluvial sediment, and in glacial ice.

**Sediment-rating curve** is a line (curve) averaging concentrations of fluvial sediment in transport, generally as measured from suspended-sediment samples, collected through the range of discharges typical of a stream; it shows mean variation in sediment concentration with variation in discharge for the period of data collection.

**Sediment station** is an installation with a sampling device, generally for collecting samples of suspended sediment, at a stream site at or near a gaging station; the purpose of a sediment station is the collection of sediment-concentration values for the prevailing water discharge, thereby permitting the computation of an instantaneous value for sediment discharge.

**Sediment-transport rate**, commonly termed **sediment discharge**, is the rate at which a dry weight of sediment passes a section of a stream in a given time; **total sediment-transport rate**, or **total sediment load**, is the sum of the suspended-sediment and the bed-load transport rates or loads. It is the total quantity of sediment, as measured by dry weight, or by volume, that is transported during a given time and is reported in watts per meter ( $W m^{-1}$ ) or in mass per unit time.

**Sediment yield** is sediment-transport rate per unit area, generally from watersheds or drainage basins larger than the field scale; erosion studies, however, may consider sediment yield from smaller areas of the hillslope or plot scale..

**Semiarid** refers to a climatic zone that receives an average 250 to 500 mm of **precipitation** annually; in semiarid areas **potential evapotranspiration** typically exceeds precipitation.

**Shear** is a strain, or change in shape or volume of a body resulting from stress; as applied to fluvial processes and sediment transport, it typically refers to the stress that is exerted on sediment particles by a moving fluid – air, water, and ice.

**Shear stress** is that portion of stress acting tangentially as a tearing action (as opposed to that portion that acts as a normal stress) to a plane or surface; thus, a sediment particle resting on a channel bed is affected by the shear stress created by water moving on the bed.

**Sheet erosion** is the process by which thin layers of surface material are gradually removed more or less evenly from an extensive area of gently sloping land by broad, continuous sheets of running water rather than by streams flowing in well-defined rills, gullies, or channels. Because **overland flow** typically occurs in small rivulets owing to micro-topography, sheet erosion is more of a theoretical concept than an actual process.

**Sheet flow** is an **overland flow** or downslope movement of water taking the form of a relatively thin, continuous film or veneer moving over relatively smooth soil or rock surfaces and not concentrated into **rills** or **channels**. Like **sheet erosion**, sheet flow is a theoretical concept that can be observed under controlled laboratory conditions but may never occur as a natural process.

**Shoal** is a relatively shallow area of a stream channel or other water body that is caused by the deposition of sediment, generally sand or gravel, or by bedrock that is more resistant to erosion than are adjacent areas of the stream or water body.

**Shrub** is a woody plant, smaller and more freely branched than are trees, that lacks a main stem, even at the base.

**Silt**, as fluvial sediment, is sediment defined to be of particle diameter between 0.002 and 0.062 mm; some systems define the lower size limit to be 0.004 mm.

**Sinkhole** is a generally shallow circular- to oval-shaped depression of a **karst** landscape; sinkholes typically form by surface collapse following solution and often **cave** formation in underlying carbonate rocks.

**Sinuosity**, as applied to stream-channel pattern, is a non-dimensional ratio, generally expressed in meters per meter or kilometers per kilometer, of the length of the channel **thalweg** to the length of the stream valley, measured between the same points.

**Skew coefficient (or coefficient of skewness)** is a numerical measure or index of the lack of symmetry in a frequency distribution; it is a function of the third moment of magnitudes about their mean, a measure of asymmetry. As applied to hydrologic records such as annual floods or a measure of maximum precipitation events, is a quantitative index of the skewness, or asymmetry, of the frequency distribution of a list of measured values; a skewed distribution occurs when computed values of the mode, mean, and arithmetic mean of the list vary, resulting in a bunching of plotted values on one side of the mean as opposed to a tailing away from the mean of plotted values on the opposite side.

**Slack water**, as applied to fluvial systems, is runoff or streamflow that is prevented in some manner from maintaining a normal velocity and thereby becomes ponded or nearly so.

**Slack-water deposit** is fine-textured sediment that falls from suspension in a body of slack water owing to little or no stream velocity; slack-water deposits resemble and in many cases are nearly the same as deposits of lacustrine sediment.

**Slope** is any inclined surface of the earth. As a geomorphic measurement, slope is the inclination, generally measured in degrees departure from horizontal or expressed as a non-dimensional number (meters per meter), of any surface of the earth's landscape (including sub-aqueous surfaces); for application to models of hillslope soil loss, steepness is often used synonymously with slope.

**Soil**, as a product of natural hydrologic and geomorphic processes, is a layered mass of minerals and, generally, organic matter and rock fragments that differs from the parent material (rocks) from which it is derived in terms of morphology, physical and chemical characteristics, and organisms and organic content; the layers, or horizons, that comprise a soil are of variable thickness (as also are soil bodies), are typically but not always unconsolidated, and differ from each other in terms of degree of alteration that has occurred during the weathering process of the underlying parent material. A fundamental classification of soil types includes clay, silt, sand, gravel, peat, chalk, and loam (having significant amounts of clay, silt, sand, and possibly gravel) soils.

**Soil association**, or **soil complex**, of an area refers to two or more soils that are closely related, and are mapped as contiguous features, owing to similar conditions of climate, topography, and vegetation; if the soils have similar characteristics owing to common parent material from which they have developed, they represent a **catena**.

**Soil horizon**, or **soil zone**, is a thickness of soil that differs from adjacent strata in terms of physical properties such as structure, color, or particle-size distribution, or by chemical composition, especially the amount and alteration of organic matter or the content of clays and related weathering products; standard designations of the three mostly commonly recognized mineral horizons of soils are the uppermost, dark-colored **A horizon**, which is a zone of humic-material accumulation, reducing conditions, and leaching, the underlying **B horizon**, which is generally lighter or reddish in color owing to oxidizing conditions and is the zone or horizon at which **humus**, silicates, and clays typically accumulate, and the lowest **C horizon**, which contains little organic material and is formed of partially weathered, unconsolidated rock material and fragments that are transitional between the developing soil above and bedrock below.

**Soil loss** is generalized as that portion of eroded sediment that moves from agricultural fields, small catchments, or other sites of disturbance or interest; the remainder of eroded sediment is stored at various sites of microtopography, behind vegetation, or in other small depressions on the hillslope surface. More precisely, soil loss is the rate of soil eroded from that portion of the land surface experiencing a net loss of soil mass or volume.

**Soil moisture** is water held by capillary forces, including adhesion, between soil particles and organic material and as a film on soil particles in an aerated (unsaturated) soil zone; soil moisture is lost to the atmosphere by processes of evapotranspiration and is replenished by precipitation.

**Soil profile** is an assemblage of all **soil horizons** at a site that in vertical section extends from the surface to the parent material from which the soil was derived.

**Soil science**, a **composite science**, includes the study of soil processes and treats or considers the formation, properties, classification, and mapping of soils; a synonymous term is **pedology** although some soil scientists regard soil science to have two principal sub-disciplines, pedology and **edaphology**.

**Solifluction** is a slow (normally at a velocity less than  $5 \times 10^{-2} \text{ m yr}^{-1}$ ) type of mass movement by viscous processes of a non-Newtonian, generally saturated, mixture of poorly sorted sediment and related soil material; the term applies in particular to the plastic flow of surficial material, in areas of high relief and high elevation, that is underlain by frozen ground, thereby preventing the downward movement of meltwater during episodes of near-surface thawing.

**Solute** is any dissolved substance; in natural environments it is generally rock, mineral, soil, or organic matter dissolved in water.

**Sorting** is the process by which sediment particles of similar characteristics, mostly size but shape and specific gravity as well, are selectively separated from other particles, concentrated, and deposited as a sedimentary mass by an entraining fluid, generally water and wind but to a lesser degree by ice and slurries (mass movement).

**Sorting index** is a numerical measure of the extent to which the process of sorting has caused the concentration certain particle sizes within a sediment deposit; prominent is a sorting index,  $S$ , based on a standard deviation, of  $0.5 (d_{50}/d_{16} + d_{84}/d_{50})$ , in which  $d_{16}$ ,  $d_{50}$ , and  $d_{84}$ , respectively, are the particle diameters, as determined from a size-distribution analysis, in which 16, 50, and 84 percent of a sediment sample by weight is finer than the total sample weight.

**Source area** is, as related to the process of channel initiation, the area of a watershed supplying water and sediment to the area of stored sediment above the highest point of an identifiable channel; thus, a source area supplies sediment to a drainage network, and some or most of that sediment may be temporarily stored before entrainment as fluvial sediment.

**Specimen**, relative to the needs and activities of the natural sciences, is an individual item, part, or quantity typical of a larger mass, volume, group, or population, which has apparent or obvious characteristics that categorize it as representative of part of a larger feature, element, or landscape process, and which, owing to susceptibility to deterioration, lacks permanence. In general, a specimen (such as a bacteria culture) has properties that prevent it, without undergoing some form of preservation or reduction, from being suitable for long-term storage.

**Stability**, as a descriptor of geomorphic processes and landforms, refers to a condition of approximate balance between inflows and outflows of matter through or over a landscape feature. As a geomorphic concept, stability generally is regarded as being an integration of processes affecting a system and thus has time-independence; the term often is used synonymously with (dynamic or quasi) equilibrium.

**Stage**, or **gage height**, is the height of a water surface above an established datum plane, generally at a gaging station.

**Stage-discharge curve**, or **rating curve** is a graph showing the relation between the **gage height**, usually plotted as the ordinate, and the amount of water flowing in a channel, expressed as volume per unit time, plotted as abscissa.

**Stage-discharge relation** is the relation between stage and discharge expressed by the stage-discharge curve.

**Standard deviation**, as applied to sediment studies, technically is the square root of the average of the squares of the deviations of specified particle sizes, typically  $d_{16}$ , and  $d_{84}$ , about the mean,  $d_{50}$ , of a particle-size analysis. Practically, the standard deviation, as applied to sediment studies, is a measure of data scatter, and thus provides also measures of the range of particle sizes from the mean and sediment sorting; the computation causes about 68 percent of data populating a set to be within one standard deviation of the mean, which is the reason for selecting values of  $d_{16}$ , and  $d_{84}$ .

**Stemflow**, a hydrologic term that also pertains to sedimentology (erosion) and plant ecology, is an effect of **interception** that results in the gravitational movement of water down the limbs, stems, or trunk of plants, especially trees. Particularly for trees, stemflow concentrates intercepted rainfall by the crown of the tree at the surfaces of stems or trunks, causing enhanced wetting and **soil moisture** in the ground areas beside the trunks. This process set minimizes the erosive impact of **raindrop impact** beneath the tree, but especially during intense storms may cause **overland flow** and **rill erosion** at the base of the plant owing to the concentration of water.

**Stream** is a general term for a body of flowing water; in hydrology the term is generally applied to the water flowing in a natural channel as opposed to a canal or a drainage ditch.

**Streamflow** is the discharge ( $\text{m}^3 \text{s}^{-1}$ ) that occurs in (and, during floods, adjacent to) a natural channel. The term streamflow is more general than **runoff** and can be applied to discharge regardless of whether it is affected by diversion or regulation; streamflow is the water remaining after losses of precipitation or snowmelt to evaporation or sublimation and after available water has satisfied the needs of vegetation and replenishment of soil moisture.

**Ground water**, as inputs from springs and seeps, may be a significant component of streamflow in some channels.

**Stream order** is a designation indicating the position that a stream-channel segment has within the hierarchy of channels of a drainage network; the uppermost, headwater channels of a drainage network are typically assigned a stream order of 1 and the most downstream channel segment has the highest stream-order designation, perhaps 6 or 8. Owing to subjectivity in how a channel hierarchy is interpreted (where, for example, a 1<sup>st</sup>-order headwater channel begins), and confusion caused by a variety of stream-ordering systems, the use of stream order, which was extensive in the 1950s and 1960s, is now limited.

**Stream power**, the ability of flowing water to accomplish work (sediment transport, erosion), is the product of discharge and water-surface slope; stream power, per unit length of channel, is typically expressed in watts per meter ( $\text{W m}^{-1}$ ).

**Subcritical flow**, or tranquil flow, in open channels occurs when the water velocity is lower than that of critical flow and the Froude number is less than 1.0; in subcritical flow, ripples caused by a water-surface disturbance move both upstream and downstream.

**Sublimation**, as applied to hydrology, is the direct conversion of ice or snow to a gaseous or vapor state.

**Subsidence**, as an earth-surface process, is the gradual lowering or sinking of a land area, with little or no horizontal component, owing to steady compaction of subsurface rock or sediment. Natural subsidence can result from a variety of causes including solution of carbonate or evaporate rocks, erosion and weathering processes of soil and subsoil materials, and processes related to tectonism, volcanic activity, and **freeze-thaw cycles**. Induced subsidence may occur beneath areas underlain by soft, easily sheared rocks, especially poorly consolidated alluvium of the Basin and Range Province, where water (or gas or oil) have been extracted, thereby reducing the buoyancy effect provided by the subsurface fluid; similarly, if a large volume of water is introduced to porous, unsaturated alluvial beds, the added weight and reduction of shear strength may cause steady compaction of the underlying alluvial beds.

**Supercritical flow**, or rapid flow, in open channels occurs when the water velocity is greater than that of critical flow and the Froude number is more than 1.0; in supercritical flow, ripples caused by a water-surface disturbance all move downstream.

**Supply-limited** is a term to describe the short-term ability of a stream to transport a specified type of fluvial sediment or a specified range of particle sizes of sediment; when a supply-limited condition occurs, the sediment load, or flux, is limited by the amount of sediment that is available for entrainment and transport, not by the ability (or competence) of the stream to move the sediment.

**Surface water** is water evident above the land surface either flowing in a **channel** or collected in a lake, pond, or reservoir.

**Suspended sediment**, or **suspended load** is sediment moved in suspension in water and is maintained in suspension by the upward component of turbulent currents or by colloidal suspension. The regulatory acronym for suspended load is **Total Suspended Solids (TSS)**.

## T

**Teleconnection** refers to cause-and-effect empirical relations among weather patterns and characteristics in various parts of the world resulting from variation in sea-surface temperature; for example, there is likely teleconnection between summer precipitation in southwestern North America and **El Niño** events of the Pacific Ocean.

**Terrace** is a valley-contained surface that typically is expressed as a long, narrow, nearly level or gently inclined landform bounded along the lower edge by a steeper descending slope and along the higher edge by a steeper ascending slope; a terrace is always topographically higher than the flood plain, and is inundated by floods of greater magnitude than the mean annual flood. An **alluvial terrace** is an aggradational feature, is composed of unconsolidated to poorly consolidated alluvium and its weathering products, and generally reflects an abandoned flood-plain surface; a **strath** (from the Gaelic word for wide river valley) **terrace** is an erosional

feature formed by stream incision into a bedrock surface, and may have little or no relation to a former flood plain.

**Thalweg** is the line within a stream channel connecting the lowest points at all sites of the channel.

**The First Law of Hydrology:** Everything leaks.

**The Second Law of Hydrology:** There are never enough data.

**Till** is that portion of **drift** deposited directly by glacial ice; till generally lacks stratification, is poorly sorted or unsorted, and is formed of all sediment sizes, the largest of which may be poorly rounded.

**Tinaja** refers to an ephemeral water pocket or scour pool in the American Southwest that develops below a waterfall, generally in bedrock, or by minor spring flow or seepage inadequate to sustain streamflow.

**Total load** refers to the total amount of any physical or chemical constituent or contaminant that is transported by a moving fluid, generally water as streamflow. The term most typically is used to characterize sediment discharge in streams, for which it is the combined fluxes of suspended sediment and bed load, expressed often in (metric) tons per day.

**Total Maximum Daily Load (TMDL)**, a term from Section 303(d) of the Clean Water Act, is the maximum amount of a pollutant, including sediment, that a water body can receive and still meet water-quality standards for its designated use.

**Total sediment-transport rate**, or **total sediment load** is the sum of the suspended-sediment and bed-load transport rates; it is the total quantity of sediment, as measured by dry weight or volume, that moves past a site during a given time. Often the suspended-sediment transport rate is measured, but the bed-load transport rate must be estimated.

**Total suspended solids (TSS)**, when used as a regulatory concept in the hydrologic sub-discipline of sedimentology, is a measure of the suspended-solids, or solid-phase, content of a water sample. According to Standard Methods for the Analysis of Water and Wastewater (1995), TSS is determined from a sub-sample of an original water sample, whereas the American Society for Testing and Materials (ASTM) advocates that the determination be made from an entire sample of the water-sediment mixture; the two approaches are not compatible.

**Transect** is a line or path along which measurements or observations are taken, generally at equal intervals, as a means of compiling data for an investigation. As applied to **geomorphology** or **sedimentology**, for example, it could be the measurement of the diameter of each sediment particle or rock fragment occurring at 1-m intervals along a 100-m length of channel bed or hillslope; as applied to plant **ecology**, a transect is a line along which observations of vegetation are made, often within **quadrats**, that might include presence or absence of species, height or trunk diameter of trees, or surface area covered by individual plants, as a means to study characteristics of a particular assemblage of species. The use of transects in geomorphic or ecological investigations is a means to minimize the potential for introducing **bias** into the study.



**Transmission loss** is the abstraction, or reduction, of flow in ephemeral or intermittent stream channels as discharge migrates downstream; the loss occurs by infiltration of streamflow into normally dry (unsaturated) sediment forming the channel bed and banks and therefore much of the flow abstraction becomes recharge to the ground-water reservoir.

**Transpiration** is the process by which water in living organisms, primarily plants, passes into the atmosphere.

**Transport** is the movement, shifting, or carrying away by natural agents of sediment (and dissolved load) from one place to another on or near the earth's surface.

**Transport-limited** is a term to describe the short-term ability of a specified flow rate to transport a specified type of fluvial sediment or a specified range of particle sizes of sediment; when a transport-limited condition occurs, the sediment load, or flux, is limited by the flow rate of the stream, not by the availability of sediment. Less commonly, transport-limited is applied to hillslope-erosion studies, for which it recognizes a condition of insufficient overland flow to move all eroded sediment down the slope.

**Tree** is a woody plant having a single main stem or trunk at least to some measurable height above the surface; exceptions are **caespitose** trees, generally willows and cottonwoods, with trunks growing in clusters or tufts because the main trunk was sheared at the surface by a destructive flood.

**Turbidity** is the *optical* property (state, condition, or quality) of opaqueness or reduced clarity of a fluid, due to suspended, colloidal, and organic matter and dissolved solids that provide color, that causes light to be scattered, absorbed, and diffracted rather than being transmitted directly through the water.

**Turbulent flow**, as a hydrologic term, is water movement (flow) in which the lines of flow are erratic and mixed and in which flow direction at all sites changes frequently and nearly instantaneously; turbulent flow is typical of stream and other surface-water bodies whereas laminar flow is typical of slowly moving ground water.

## U

**Underflow** is the down-valley movement of water in a near-surface alluvial aquifer that is hydraulically connected and directly related to the stream channel; underflow is most descriptive of near-surface ground-water movement beneath stream channels of arid and semiarid areas where it typically provides water adequate to sustain phreatophytic trees such as cottonwoods despite unreliable amounts of streamflow.

**Understory** is the undergrowth, or underlying layer of plants (shrubs, herbs, etc.) of forest vegetation; the understory plants of a forest generally are adapted to conditions of limited light owing to shade caused by trees that form the canopy. The understory affects erosion by intercepting that rainfall penetrating the canopy, by causing evaporation of a portion of it and preventing that portion from reaching the surface to become runoff, and by protecting soil particles at the surface from erosion by rainsplash impact..

**Unmeasured sediment-transport rate, or unmeasured sediment load**, is the difference between the **total-sediment rate** and measured suspended-sediment discharge.

## V

**Variable source area** is a geomorphic concept acknowledging that within a drainage basin the amounts of water, sediment, and organic matter entering the drainage network from sub-basins (or source areas) vary depending on local characteristics such as climate, geology and soils, topography, and history (especially floods, fires, and land use).

**Viscosity**, or internal friction, is the property of a substance, a water/sediment mixture when applied to fluvial systems, to resist flow; viscosity is measured as the coefficient of viscosity, the ratio of shear-stress rate to the shear-strain rate.

## W

**Wadi** is a channel, generally in arid or semiarid areas of southwestern Asia, the Arabian Peninsula, and northern Africa, in which streamflow occurs inconsistently or infrequently and, except during periods of streamflow, is directly underlain by unsaturated alluvium; wadis typically have a rectangular to steeply sided trapezoidal cross section, banks a meter or more in height formed of fine-grained, poorly consolidated over-bank sediment, and a nearly flat, sandy bed. Synonyms are ephemeral-stream channel, dry wash, and arroyo (northern Mexico and southwestern United States).

**Wash load** is the part of the total sediment load of a stream that is usually supplied from bank erosion or from upland sources by overland flow. It is the finest part of the load (that part which typically can be held in suspension at even very low stream velocity) that can be easily carried in large quantities (it is “supply-limited”, not “transport-limited”); it is generally determined by assuming that suspended sediment in transport that is finer than 0.062 mm is the wash load.

**Water balance** is an accounting of the volumes of water entering, leaving, and stored in a hydrologic area or unit, typically a drainage basin or aquifer, during a specified time period in which the amount of water entering the area or unit equals the amount leaving; in equation form, the water balance, or **hydrologic budget**, for a drainage basin is expressed as  $P = O + ET - I + \Delta S$ , in which P is precipitation, O is outflow, as streamflow, ET is water lost through evapotranspiration and sublimation (including loss of intercepted precipitation), I is inflow, as streamflow and runoff, and  $\Delta S$  is change in stored water, including ground water, soil moisture, and imposed additions or extractions.

**Watershed** is a drainage divide or a “water parting”, but commonly usage of the term has been altered to signify a drainage-basin area contributing water to a network of stream channels, a lake, or other topographic lows where water can collect.

**Watershed management** is, through the application of scientific principles and knowledge of drainage-basin characteristics, the administration and regulation of water and related natural resources of land, soil, and biota of the watershed for the beneficial use and conservation of those resources; included are the management of water and plant resources and the control of fluvial processes (especially erosion and sediment deposition).

**Water table** is a lay term to describe the surface defined by the top of the zone of saturation in a non-confined, often alluvial, aquifer.

**Water year** is the period October 1 through September 30; in most mid-latitude areas of the northern hemisphere, the general time of October 1 is one of low flow, hence the selection of October 1 as break date.

**Weathering** is the destruction or alteration, through chemical and biochemical processes, of near-surface rock and sediment; weathering leads to the removal of waste products as dissolved loads in water but results in little or no transport of solids (erosion) that are released or modified by the weathering process.

**Wetland** is a bottomland or low-lying area, including ephemeral-lake floors, at which water either is shallowly ponded on the surface or has a persistent (weeks or longer) near-surface condition of ground-water saturation adequate to support hydrophytic vegetation.

**Wetted perimeter** of a channel section is the length of which water is in contact with the channel bed and banks; wetted perimeter is a hydraulic parameter in the computation of streamflow from physical properties of the channel.

**Winnowing** is the preferential entrainment and transport of fine particles from those of the coarse fraction of a sediment deposit by fluid motion; the term is applied especially to the transport of fine sediment sizes from a poorly sorted reservoir of sediment by wind, but the winnowing process occurs also by the action of water moving on hillslopes, in rills and gullies, in stream channels, and along beaches and other parts of lakes or oceanic tidal zones.

X

**Xeric** refers to an environment (habitat) that is characterized by deficient moisture.

**Xerophyte** is a plant that is adapted to a habitat of low moisture availability.

Y

**Yardang** is a sharp-crested landform, of relatively soft, generally fine-grained sedimentary or volcanic rocks, that is typically oriented parallel to the dominant wind direction in an arid region or desert and has surfaces sculpted by processes of abrasion by wind-entrained sediment (mostly sand and silt).

## Z

**Zone of aeration**, or **zone of vadose water**, is the typically moist but unsaturated subsurface zone between the land surface and the top of the **zone of saturation** (water table).

**Zone of saturation** is that part of the subsurface in which the interstices of porous and permeable rocks are saturated with water under pressure equal to or greater than atmospheric pressure.

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