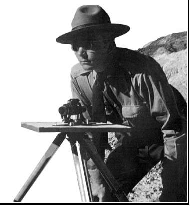
GEOLOGIC RESOURCE MONITORING PARAMETERS

Stream Channel Morphology



Brief Description: Alluvial streams (rivers) are dynamic landforms subject to rapid change in channel shape and flow pattern. Water and sediment discharges determine the dimensions of a stream channel (width, depth, and meander wavelength and gradient). Dimensionless characteristics of stream channels and types of pattern (braided, meandering, straight) and sinuosity are significantly affected by changes in flow rate and sediment discharge, and by the type of sediment load in terms of the ratio of suspended to bed load [see stream sediment storage and load]. Dramatic changes in stream bank erosion within a short time period indicate changes in sediment discharge. Because changes in alluvial channel cross-section, especially width, may indicate change in the discharge characteristics of the stream, known discharges can be expressed as a simple power relation with channel width ($Q = aWb$, where Q = discharge, a = a coefficient, W = channel width, and b is an exponent). At ungauged stream sites, therefore, measurements of channel morphology can lead to indirect estimates of discharge, which, if varying with time, may indicate changes in mean discharge or in the occurrence of floods at specific recurrence intervals.

Significance: Channel dimensions reflect magnitude of water and sediment discharges. In the absence of hydrologic and streamflow records, an understanding of stream morphology can help delineate environmental changes of many kinds. Changes in stream pattern, which can be very rapid in arid and semi-arid areas, place significant limits on land use, such as on islands in braided streams and meander plains, or along banks undergoing erosion.

Environment where Applicable: Alluvial streams occupying bottomlands comprised of terraces and flood plains.

Types of Monitoring Sites: Characteristic stream reaches

Method of Measurement: Repeated ground and/or aerial surveys of channel patterns and cross-sections, using streamflow gauges, channel cross-section monuments, and other automated and manual loggers.

Frequency of Measurement: Depends on observed rate of change, but no less than once every 5 years.

Limitations of Data and Monitoring: It is difficult to gauge stream change without historical records. Floods may destroy observation sites.

Possible Thresholds: Meander amplitude can increase until cutoff is inevitable. Stream variability involving changes between straight, meandering, and braided forms can reflect changes on valley gradients as a result of active tectonics and tributary influences.

Key References:

Chang, H.H. 1988. Fluvial processes in river engineering. New York: John Wiley & Sons.

Osterkamp, W.R. & E.R.Hedman 1982. Perennial-streamflow characteristics related to channel geometry and sediment in Missouri River basin. U.S. Geological Survey Professional Paper 1241.

Osterkamp, W.R. & S.A.Schumm 1996. Geoindicators for river and river-valley monitoring. In Berger, A.R. & W.J.Iams (eds). Geoindicators: Assessing rapid environmental changes in earth systems:83-100. Rotterdam: A.A. Balkema.

Schumm, S.A. & B.R.Winkley (eds) 1994. The variability of large alluvial rivers. New York: American Society of Civil Engineers Press.

Related Environmental and Geological Issues: Condition of riverine ecosystems; stability of islands and channels, and jurisdictional boundaries defined by rivers.

Overall Assessment: Monitoring stream channel morphology can be useful when no data are available on sediment load, flow rates and other hydrologic parameters.

Source: This summary of monitoring parameters has been adapted from the Geoindicator Checklist developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning. Geoindicators include 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators were developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. Some general references useful for many geoindicators are listed here:

Berger, A.R. & W.J.Iams (eds.) 1996. Geoindicators: assessing rapid environmental change in earth systems. Rotterdam: Balkema. The scientific and policy background to geoindicators, including the first formal publication of the geoindicator checklist.

Goudie, A. 1990. Geomorphological techniques. Second Edition. London: Allen & Unwin. A comprehensive review of techniques that have been employed in studies of drainage basins, rivers, hillslopes, glaciers and other landforms.

Gregory, K.J. & D.E.Walling (eds) 1987. Human activity and environmental processes. New York: John Wiley. Precipitation; hydrological, coastal and ocean processes; lacustrine systems; slopes and weathering; river channels; permafrost; land subsidence; soil profiles, erosion and conservation; impacts on vegetation and animals; desertification.

Nuhfer, E.B., R.J.Proctor & P.H.Moser 1993. The citizens' guide to geologic hazards. American Institute for Professional Geologists (7828 Vance Drive, Ste 103, Arvada CO 80003, USA). A very useful summary of a wide range of natural hazards.