Physical properties of water:

Within the Earth's atmosphere and surface, the liquid phase is the most common and is the form that is generally denoted by the word "water". Water also forms a supercritical fluid. The critical temperature is 647 K and the critical pressure is 22.064 MPa. In nature this only rarely occurs in extremely hostile conditions. A likely example of naturally occurring supercritical water is in the hottest parts of deep water hydrothermal vents, in which water is heated to the critical temperature by volcanic plumes and the critical pressure is caused by the weight of the ocean at the extreme depths where the vents are located. This pressure is reached at a depth of about 2200 meters: much less than the mean depth of the ocean (3800 meters). Water has a very high specific heat capacity of 4.1814 J/(g·K) at 25 °C – the second highest among all the heteroatomic species (after ammonia), as well as a high heat of vaporization (40.65 kJ/mol or 2257 kJ/kg at the normal boiling point), both of which are a result of the extensive hydrogen bonding between its molecules. These two unusual properties allow water to moderate Earth's climate by buffering large fluctuations in temperature. The density of water is about 1 gram per cubic centimetre. Water is miscible with many liquids, including ethanol in all proportions. Water and most oils are immiscible usually forming layers according to increasing density from the top. The compressibility of water is a function of pressure and temperature.

Sediments are the products of disintegration and decomposition of rocks. Material becomes detached and is transported to a deposition site where it may be affected by solution, cementation, consolidation, or biological action. The physical properties of sediments depend on a number of factors, including composition, texture, and structure of the original formation; topography; type of weathering; and sorting (Lobeck 1939, pp. 63-80). The greatest variety of minerals and textures in sediment comes from the weathering of igneous rocks, especially from this disintegration in semiarid and arid climates. These conditions have produced great volumes of sediment containing much coarse material, including boulders, especially along mountain fronts and in intermontane valleys. These deposits commonly contain a relatively high proportion of unaltered minerals such as feldspars, amphiboles, pyroxenes, and micas. Sediments produced by erosion in more humid and deeply weathered areas generally have a finer texture and a higher proportion of minerals produced by chemical weathering. Small grains of certain minerals resistant to chemical weathering, such as zircon, quartz, rutile, tourmaline, topaz, and ilmenite, remain in sediment relatively unchanged. These detrital mineral suites may reveal the source rock type (Krumbein and Sloss 1963, p. 108). Feldspars, the most common minerals in igneous rock (Pettijohn 1957, p. 122), are much less stable and less common in sediments. In humid climates feldspars are relatively easily decomposed to form products including clay minerals, silica, and oxides of aluminum.

Fluvial geomorphology:

Fluvial geomorphology is the study of interaction of water and the landscape through which it flows. Rivers and streams are dynamic systems that balance water flow and sediment transport. This dynamic condition is referred to as the equilibrium condition, where the discharge and the processes of erosion and sedimentation can maintain a stable river system.

Types of river:

1. Straight

2. Sinuous

3. Braided

4. Meandering

5. Anastomose

Rivers – Discharge:

River discharge is the volume of water flowing through a river channel. This is the total volume of water flowing through a channel at any given point and is measured in cubic metres per second (cumecs). The discharge from a drainage basin depends on precipitation, evapotranspiration and storage factors.

Drainage basin discharge = precipitation – evapotranspiration +/- changes in storage.

River erosion:

To maintain stability in hydrologic process and physical form, a river's energy must be in balance with the volume of water conveyed and the size and volume of sediment it carries. Fluvial erosion is the natural process of the wearing away of soil, vegetation, sediment, and rock from the river channel bed and banks by the action of water. When river channels are altered by humans or nature, the river must readjust to reach its former balance. Such riverine adjustments occur to the channel and to the floodplain or the active river area, including changes in dimension, profile and pattern or course on the landscape. It is important to recognize that erosion is an ongoing natural river process that can be slowed but not stopped. The rate of erosion is affected by local soil type, slope, precipitation, and volume and velocity of river discharge. Other natural or human activities accelerate the natural rate of erosion, such as large storm events, removal or alteration of riparian vegetation, modification of runoff flow patterns, and physical alteration of land within the floodplain and the active river area. People often overlook that rivers are systems in dynamic equilibrium, or a constant state of geomorphic adjustment. Thus buildings and other structures are often built too close to river banks and areas of active river processes, including erosion. The most severe fluvial erosion events in recent years resulted from prolonged heavy rains and repetitive rain events.

The purpose of adopting fluvial erosion hazard (FEH) zoning is to limit development in fluvial erosion hazard areas for the purpose of protecting public and private property, and public safety and welfare. Informed by geomorphic channel assessment and management practices endorsed by the New Hampshire Department of Environmental Services (DES) and New Hampshire Geological Survey, this model fluvial erosion hazard ordinance recommends implementation of development requirements and standards that recognize a stream's natural evolution and range of stable conditions. Ultimately, the most effective way to prevent hazards associated with fluvial erosion is avoidance by limiting future human presence and investments in river corridors. The objective of this type of zoning is to guide and encourage measures and improvements that provide increased property and infrastructure protection, and maintain or restore the hydrologic and geomorphic functions and economic values of river systems. The functions and values of healthy river systems include: flood mitigation, water supply, water quality, sediment storage and transport, aquatic habitat, recreation, transportation and aesthetic qualities.

In the broader context, the purposes for adopting fluvial erosion hazard zoning are to achieve the following:

1. Protect public and private property, and public safety and welfare.

2. Address fluvial erosion hazards in the existing built environment.

3. Limit new development within fluvial erosion hazard zones to minimize property loss and damage due to fluvial erosion.

4. Minimize or prevent fluvial erosion hazards in the future.

5. Implement related goals and objectives of local and regional master plans, and supporting river corridor management plans.

6. Protect mapped river and stream corridors that are highly subject to erosion due to naturally occurring stream channel migration and adjustment.

7. Allow rivers and streams to maintain or re-establish their natural equilibrium; thereby avoid the need for costly and environmentally degrading stream channelization and bank stabilization measures.

8. Encourage activities that increase awareness of stream processes and the development of river restoration and mitigation projects.

Types of river erosion:

a) Hydraulic action: It is caused by the shear of water on bed rock. Forces inherent in the flow of running water can perform a good deal in mechanical erosion. It can loosen the fragments of rock from the bed side and remove this along with other materials.

b) Corrosion/abrasion: It means the mechanical abrasion of rocks of bed and sides. The current of the river carries a considerable amount of rock waste as the load. Fragments of the rocks are always striking engulfs the bed and the sides of the valley. The result is that the rocks are getting eroded and the products are carried away by river current. The river waste serves as tools for destruction of the river current. Ex. The formation of pot holes is one of the results of the process. They are round or ellipsoidal holes made on bed by much abrasion by revolving rock fragments, caught up in swirling eddies on river current when the revolving rock fragments are worn down near ones, taking their place and the deepening of pot holes goes on, so long as the river has got sufficient strength.

c) Attrition: If the mechanical process is done on the transported rock fragments during corrosion or abrasion, these fragments often collide among themselves. As a result, these are worned down. Bigger boulders are worn down gradually and pebbles and cobbles are changed to sand and silt.

d) Corrasion/cohesion: It means chemical erosion by river water. The dissolving power of river water is increased by the presence of some aiding sub like alkali matter and some gases in the Co2 etc. The solubility of bedrocks also determines the part of corrosion by river water.

Factors influencing river erosion

i) Surface relief: This determines the gradient upon which the velocity and erosion power of a river depends.

ii) Climate: It determines precipitation finally the volume and velocity of the river. Upon the velocity the erosive power of a river depends. It has been estimated that velocity and shear of the abrasive power i.e if the velocity be doubled, the erosion power will be increased by four times.

iii) Nature of bed rock: If the rock is soft, erosion will be high and if it is hard, it will be checked with great extent. The solubility of the material composing the bedrocks also determines the rate of erosion. If the bed rock be composed of soluble materials, the river can perform a good deal of erosion on the other hand, if they are composed of hard rocks and are insoluble then the erosion will be maximum, other factors remaining equal. Horizontal layers of sedimentary layers are more easily eroded than vertical one. In case of inclined bed, if the inclination is in the same direction as the river flows, then erosion will be greater otherwise lesser.

iv) Presence of joints and fissures: Presence of joints and fissures in the bed rocks facilitate erosion. Bacause water can then easily penetrate to a great depth and consequently a great area will be exposed to erosion by river water.

v) Hardness of the transportation: As already pointed out, the fragments serve as tools in the case of river erosion. If these fragments be of hard material, mechanical erosion will be high. It is obvious because soft material can do little erosion.

vi) Dissolving power of river water: These necessitate the presence of some dissolved gases in river water. Though ordinary water is a good solvent its dissolving power is enhanced by the presence of some suitable material in solution with it.

vii) Nature of river: The velocity of river in deep narrow channel is greater than in a broad channel of shallow depth because of greater friction from greater area in later case. The velocity is also dependent on gradient. The volume of river also determines to a large extent the velocity of river. It has been estimated that a river with eight time's larger volume will flow doubly swifter. This explains why a river is more destructive during flood.

River drainage pattern:

Table: Significance of basic and modified basic drainage pattern

Basic	**Significance**	**Modified basic**	**Added significance or locale**
Dendritic	Horizontal sediments or beveled, uniformly resistant crystalline rocks. Gentle regional slope at present or at time of drainage inception. Type pattern resembles spreading oak or chestnut tree.	Subdendritic	Minor secondary control,generally structural.
		Pinnate	Fine textured,easily erodible materials
		Anastomotic	Flood plains, deltas and tidal marshes
		Distributary (dichotomic)	Alluvial fans and deltas
parallel	Generally integrates moderate to steep skopes but also found in areas of parallel,elongate landforms. All transitions possible between this pattern and type endritic and trellise	Sub parallel	Intermediate slopes or controlled by subparallel landforms
		collinear	Between linear loess and sand ridges
Trellise	Deeping or folded sedimentary,volcanic, or low grade metasedimentary rocks; areas of parallel fractures; exposed lake or sea floors ribbed by beach ridges. All transitions to parallel patterns. Type pattern is regarded here as one in which small tributaries are essentially same size on opposite sides of long parallel subsequent streams	Sub trellise	Parallel elongate landforms
		Directional trellise	Gentle homoclines. Genyle slopes with beach ridges.
		Recurved trellise	Plunging folds
		Fault trellise	Branching, converging, diverging, roughly parallel faults
		Joint trellise	Straight parallel faults&/or joints

<table>
<tr><td>Rectangular</td><td>Joints&/or faults at right angles. Lacks orderly repetitive quality of trellise pattern; streams and divides lack regional continuity</td><td>Angulate.</td><td>Joints &/or faults at other than right angles. A compound rectangular-angulate pattern is common</td></tr>
<tr><td>Radial</td><td>Volcanoes, domes, and erosion residuals. A complex of radial patterns in a volcanic field might be called multiradial.</td><td>Centripetal</td><td>Craters, calderas and other depressions. A complex of centripetal patterns in area of multiple depressions might be called multi centripetal.</td></tr>
<tr><td>Annular</td><td>Structural domes and basins, diatremes and possibility stocks.</td><td></td><td>Longer trivutaries to annular subsequent streams generally indicate direction of dip and permit distinction between dome and basin.</td></tr>
<tr><td rowspan="4">Multibasinal</td><td rowspan="4">Hummocky surfacial deposits; differentially scoured or deflated bed rock; areas of recent volcanism, limestone solution, permafrost. This descriptive term is suggested for all multiple-depression patterns whose exact origins are unknown</td><td>Glacially disturbed</td><td>Glacial erosion and/or deposition</td></tr>
<tr><td>Karst</td><td>limestone</td></tr>
<tr><td>Thermokarst</td><td>Permafrost</td></tr>
<tr><td>Elongate bay</td><td>Coastal plains and deltas</td></tr>
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