**Redefinition of geomorphic evolution**

*(written sometime during my early graduate studies at Purdue)*

**Law 1:** Rivers flow downhill. Downhill is here not defined as toward the sea but up a gravitational potential gradient nearly identical with a line toward the center of the earth. Thus "downhill" means "up" the gravity gradient toward "more" or higher gravity. (Note in margin: down hereafter refers to the direction from low to high gravitational forces due to the earth's mass; this is interesting because we define "high" as bigger numbers, but high gravity corresponds to low geometric measures of distance from the earth's center or its surrogate, sea level. Sea level is used because "down" for flowing water can't be measured relative to the center of the earth because the mouth of the Mississippi is then higher than the headwaters). Of course, flowing "up" an actual energy gradient, likewise flows "down" the associated potential gradient of that same energy; so where gravity is stronger, its potential is lower

*Note added Nov 1, 2013. Oceans, of course, occupy the gravity "highs", thus rivers flow to the oceans. Rivers flowing along the surface tend to flow perpendicular to the gravity gradient, but always toward a location where the gravitation attraction is higher.*

**Law 2:** A totally adjusted river flows in agreement with the object of its tendency. That is a river flowing perpendicular to the gravity gradient, which flows straight down (geometrically).

**Law 3:** The ultimate "base level" of erosion or material transfer (by endogenic processes) is the center of the earth or the center of the sun, or the center of our galaxy or the center of the universe opposed by motion and hadron temporal/spatial exclusion (Pauli exclusion principle). But I don't think we need to consider ultimate base level to understand the tendency of erosion on the earth's surface, we only need to define it in terms of some isogal gravity surface that would exist were the subsurface irregularities distributed such that the 3 dimensional gravity gradient were perpendicular to the surface of solid matter (which might in time come to approximate the lithospheric surface of a cold earth, assuming exogenic weathering persists, which it would not). This would be a geoid (a somewhat distorted oblate spheroid or whatever they want to call it) best approximated currently somewhat below the surface of the ocean probably about 500 - 1000 feet above the abyssal ocean floors. Erosion is not confined to sub aerial environment, thus the tendency is toward filling in the holes, i.e. the oceans, and the process is observed (turbidity currents destroying undersea power lines).

The directional force exerted on a river by differentials in the existent gravitational surface is augmented by other factors defining the present state of the river. Principal among these are the resistive forces of rocks and friction (i.e. the electromagnetic forces of cohesion and adhesion, respectively). The Coreolis effect (not a real force) is a minor factor. Differentials in the resistance are large compared to differentials in gravity, thus most rivers follow lines of structural weakness where resistance forces are less. The gravitational force may be considered as determined by a time-independent point source that is ta geometrical constant; whereas the source of the forces of resistance is geometrically diffused among all the chemical bonds and their variability in space. Also, directional differentials created by resistive forces are time dependent. Changes occur in the gravitational surface in response to redistribution of mass, but the changes are much slower and smaller in proportion to the total force than changes in resistance.

Rivers are constantly adjusting themselves in response to changes in the forces of resistance from the micro to the mega scales from the movement of a bed-load particle to the monoclinal shifting of a major river, as the Uncompahgre. The relative constancy of the gravitational force tends to cause trends in river adjustments toward perpendicularity with the gravitational surface. This tendency is commonly negated by the forces of resistance, but any deviation from total gravitational adjustment is explicable in terms of resistive forces. A total adjusted river will not tend to migrate, all other will. Migration can be accomplished by monoclinal shifting, joint controlled abstraction, and alluviation.

Rivers focus the work or the gravitational energy, domination the creation of irregularities in the local gravitational surfaces. Thus, hillslope erosion, where gravitational work is diffused, responds overwhelmingly to conditions determined by river erosion. Hillslope erosion also (besides resistance forces caret insert) hinders the adjustment of rivers to the gravitational surface by contribution to the burden of sediment that a river must transport. The more available energy tin the river that is consumed by the work of transportation, the less is available for erosion. River erosion always tends to perpendicularity to the gravity surface (isogal contours).

Since rivers are in low topographic position, their adjustments are primarily controlled by more regional gravitational trends (dependent on subsurface density differences) than hillslope adjustments responding to local (river controlled) gravitational irregularities. Thus one can analyze trend from Bouger maps and other similar representations of the variations of gravity intensity.

Grading by a river is its response to its tendency to perpendicularity to the gravitational surface. A river is graded when the three-dimensional gravity vector acting on a point in the river is inclined slightly downstream and exactly balanced by the same upstream inclination of the river of the forces of resistance (friction, internal and external) If we do not exclude resistance of viscosity (also rocks to erosion) from the forces or resistance in the definition of grade - no (all) rivers may be said to be graded. If we do then resistance reduces to friction of the channel perimeter (wet and dry) and sediment transport. By this definition, a grades river cannot erode or deposit. It will probably, but not necessarily be flowing on its own unconsolidated deposits. The final adjustments just before attainment of grade will probably be more efficiently accomplished by alluviation rather than erosion. This follows because eustatic seal levels have risen in the most immediate past, and alluviation provides an environment of unconsolidated materials in which increasingly smaller final adjustments may be rapidly made (the Snohomish and feeder valleys on the west slope of the cascades are good examples).

The surface of the floodwaters should be considered as the surface of the river in a definition of a grades stream, because great irregularities exist in a meandering rivers course, and it is doubtful if these correspond to meanders in the gravity gradient. In essence as before, a graded stream is unmeasurable. Is it a balance of forces, with certain (and variable) exceptions? But rather than trying to dull our perceptions by arguing over what grade it, and conceiving of grade as a condition toward which rivers tend (teleology), let us analyze the tendency of rivers in terms of their adherence to the first law of geomorphology -- Rivers run downhill.

If we must, let us say a graded river is one that flows perpendicular (in the horizontal plane) to the gravity gradient (isogal contours, I think I was confusing gradient with surface at the time, see above). Then there is no tendency for the river to migrate.

This raises the possibility of a serendipitously graded river in the high mountains following a joint set perpendicular to the gravity gradient (nota bene). But any definition of grade will have its difficulties. Adjustments of a river contrary to the gravitational trends are controlled by structural irregularities. Given enough time, however, the tendency of gravitational adjustment will prevail. This is true not only for major rivers and extended denudation of the land, but also for minor tributaries and local erosional networks.

The forces of resistance have received much more attention than the forces of gravity in determining river behavior. But even these forces are poorly understood. Perhaps a consideration of the gravitational forces will help clarify some of the problems encountered in determining a river's behavior. A few examples follow (find) gravity maps for:

America - Mississippi Rive

County maps - its major streams Mesa County - Uncompahgre, Gunnison, Colorado River

Need to convert maps to actual gravity - not Bouger

**Summary**

This paper is to present a new perspective on the study of river behavior by consideration of the most fundamental determinants of river flow. A few remarks have been made concerning the possibility of redefining river tendencies in terms of gravity rather than grade. Base-level and grade were suggested to be products of gravity rather than ends in themselves (marginal insert: as determined products of a higher-order reference system (gravity) they are more amenable to definition in terms of that system than a system in which they are conceived as final causes). Historical geomorphology can benefit greatly by definition of the tendency of river work, as can more time-restricted study of processes. Hillslope forms may yield more readily to deterministic explanation if local gravity surfaces are considered as a determinant. This essay is a suggestion for an approach and not a conclusive statement on results or definition. It is my that that the suggestion is fruitful.

*Added later in a different pencil:*

*The relative effects of the forces acting on a river can be derived by vector analysis. It should be remembered that vectors are not real forces, but represent abstract directional effects of a single force. In the case of gravity the force is perpendicular to the equal-intensity gravitational field (isogals). The vectors to be considered are the gravitational vectors. These are determined by:*

1. *The topographic slope and*
2. *The gravitational gradient*

*The topographic slope (marginal insert: only vertical components) determines the downhill component (caret insert: parallel to the present slopes) of the total field as g(cosf) and for high slope angles is overwhelmingly dominant. The gravitational gradient has both vertical and horizontal component vectors. The vertical component augments the total field vectors determined by slope. The horizontal component creates a tendency for lateral migration. For very low slopes, this component matches the vertical components in strength, but on low slopes little residual energy is available for erosion (as all is consumed in transportation or both sediment, but mainly of water). All potential energy of a stream is consumed as kinetic energy. Erosion, internal and external friction and transportation account for the expenditure of all available energy. Deposition does not directly consume energy, but "gives" energy to a stream by decreasing energy consumed in transportation and its friction Total energy available to a stream can be computed by integrating the potential energy created by the difference in elevation of all points on the surface of the stream and sea level as for any point on the surface because all points are on a "stream" line toward a lower point.*