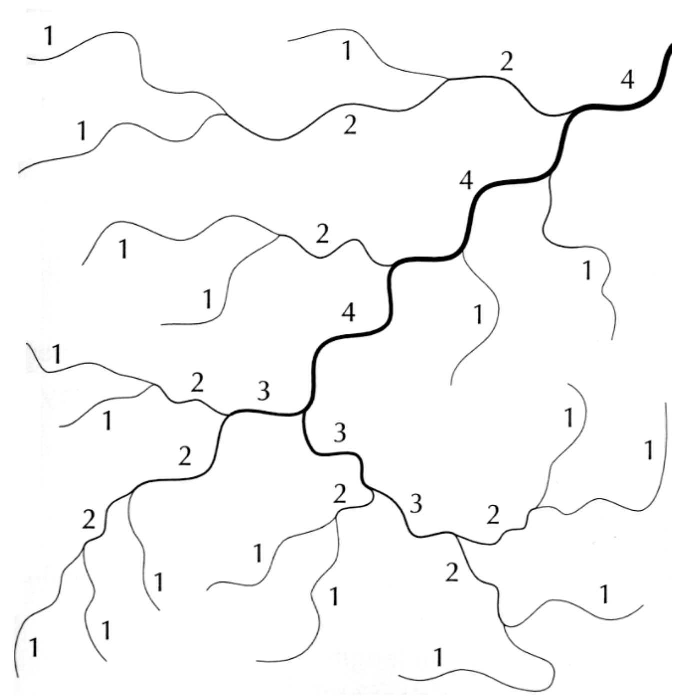
River Processes

Drainage Basin Morphometry

Morphometry - the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimensions of its landforms.

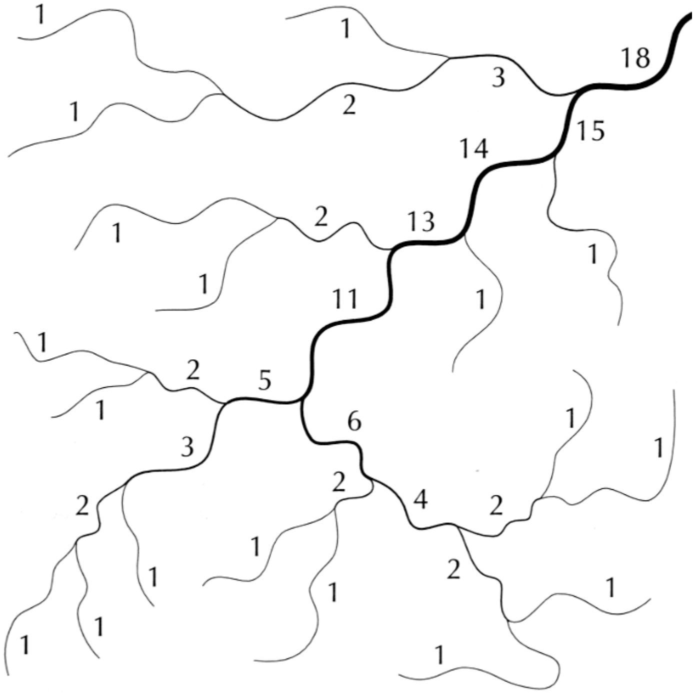
Horton (1945) - ***drainage composition***



River Processes

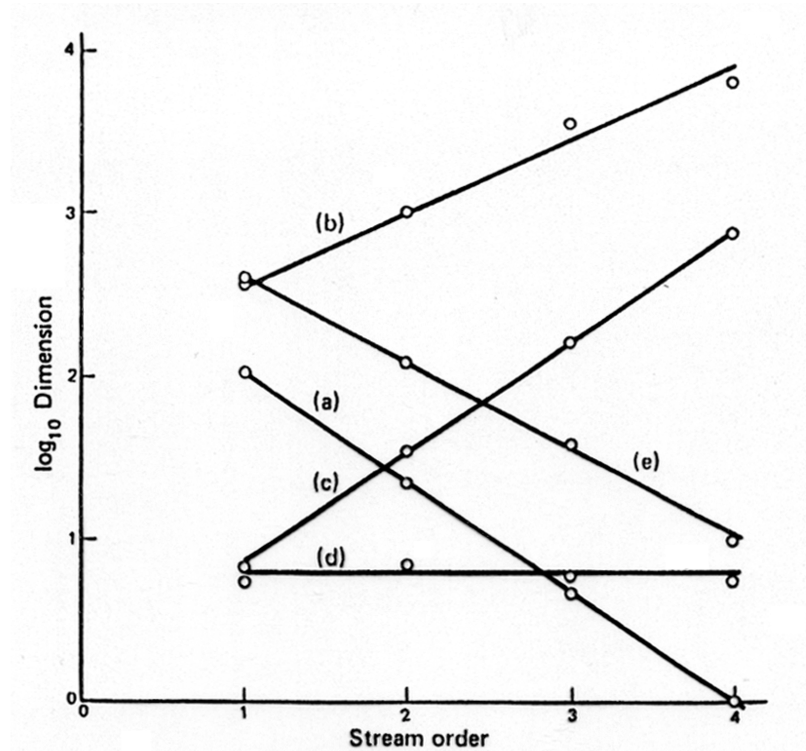
Drainage Basin Morphometry

Shreve (1967)



River Processes

Drainage Basin Morphometry



Linear morphometric relationships

Analysis of Some Characteristics of the Mill Creek Drainage Network*

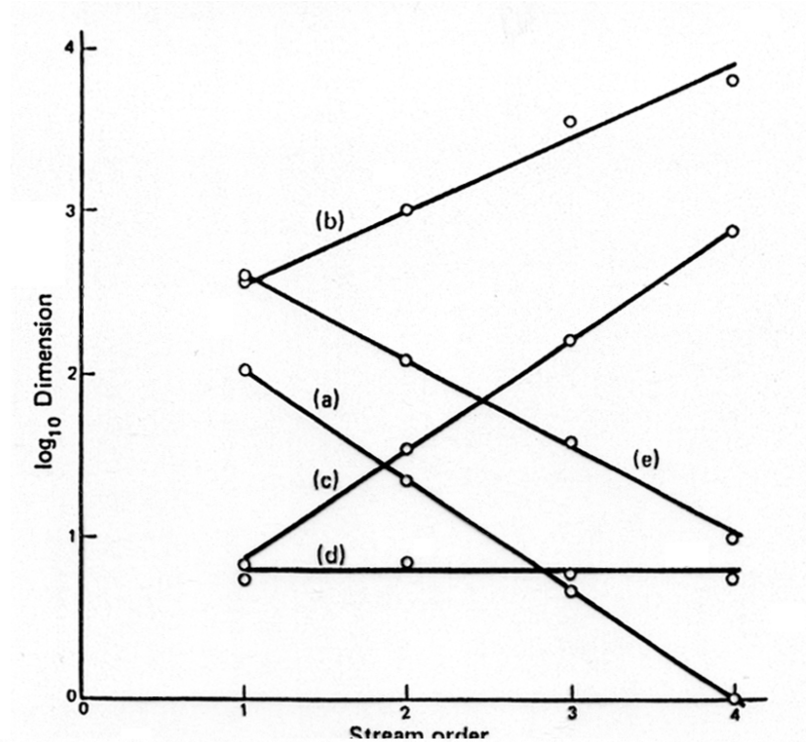
Dimension / *Stream Order*	*(a)* *Number of Streams*	*(b)* *Average Length (ft)*	*(c)* *Average Basin Area (10^5 ft^2)*	*(d)* *Stream Density (mi/mi^2)*	*(e)* *Average Channel Slope (tan < x 10^3)*
1	104	364	6.97	5.45	396
2	22	993	33.73	7.02	123
3	5	3432	161.97	6.06	39
4	1	6283	747.14	5.66	10

Source: Morisawa (1962), Table 1.

River Processes

Drainage Basin Morphometry

Length ratio



Analysis of Some Characteristics of the Mill Creek Drainage Network*

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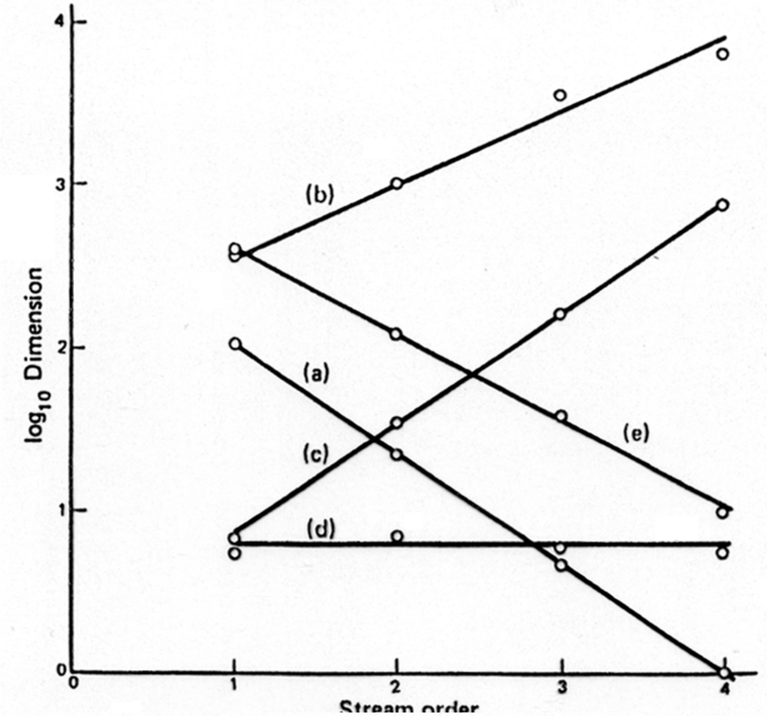
River Processes

Drainage Basin Morphometry

Areal morphometric relationships



Analysis of Some Characteristics of the Mill Creek Drainage Network*

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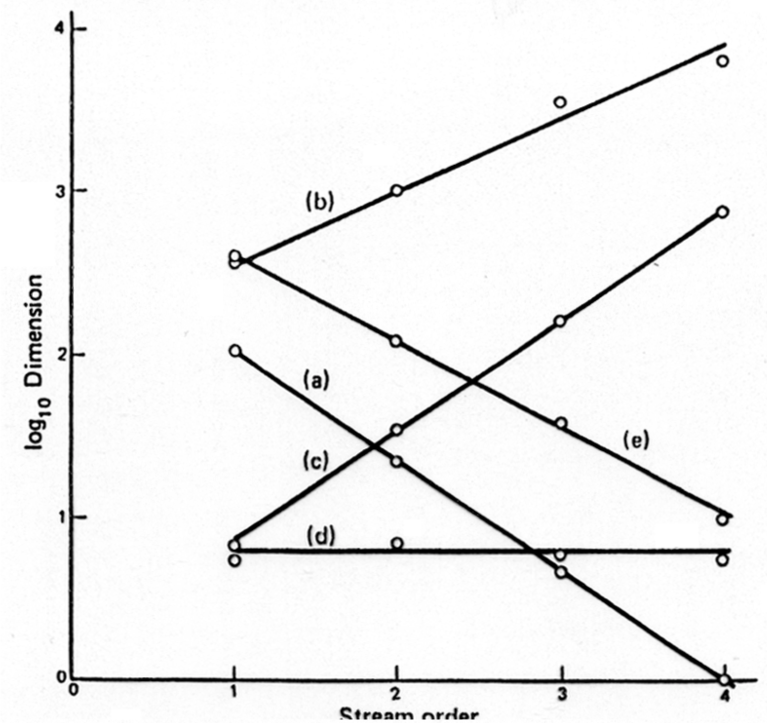
Source: Morisawa (1962), Table 1.

River Processes

Drainage Basin Morphometry

Drainage density



Analysis of Some Characteristics of the Mill Creek Drainage Network*

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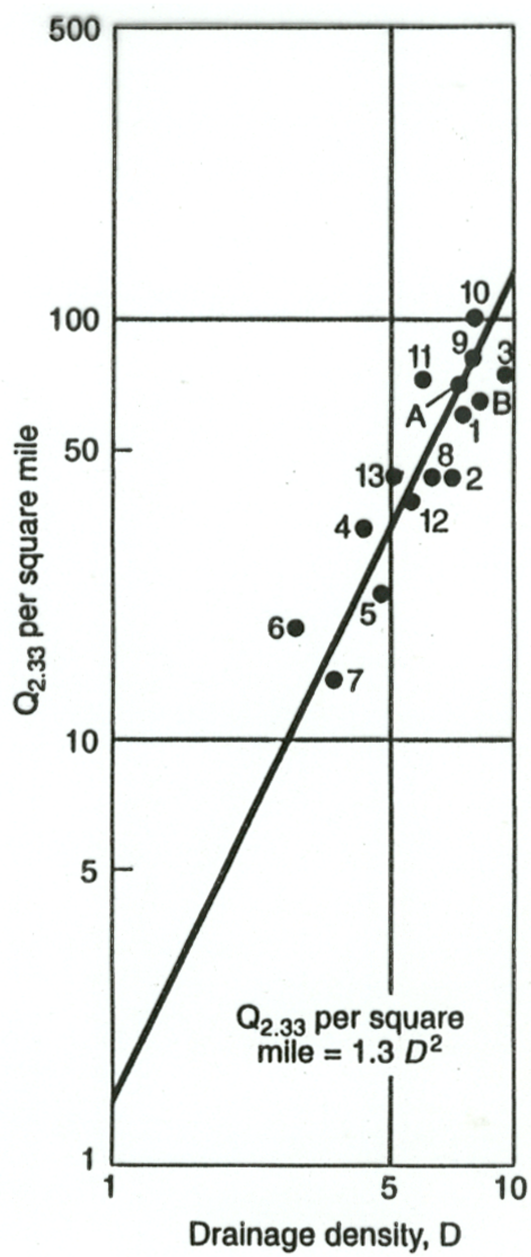
River Processes

Drainage Basin Morphometry

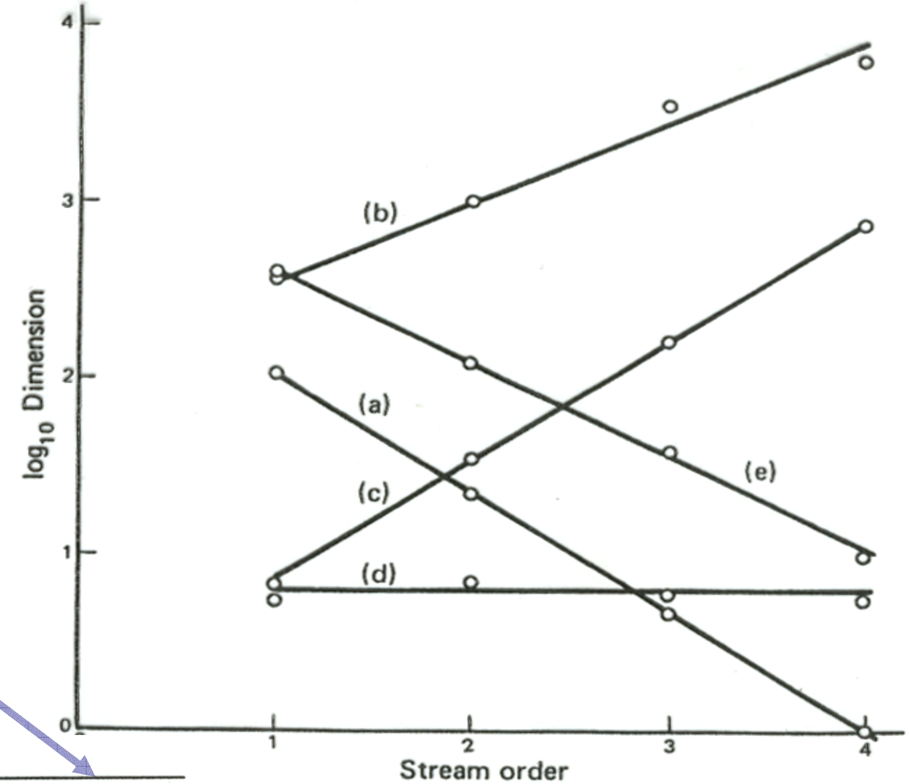
Drainage density



DRAINAGE BASINS

Basin Morphometry **relief morphometric relationships**

Relief ratio



Analysis of Some Characteristics of the Mill Creek Drainage Network*

Dimension	*(a)*	*(b)*	*(c)*	*(d)*	*(e)*
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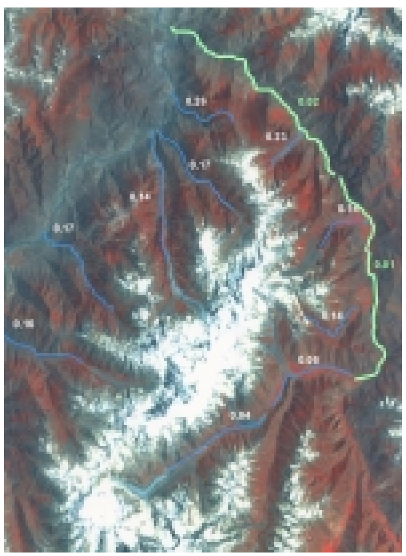
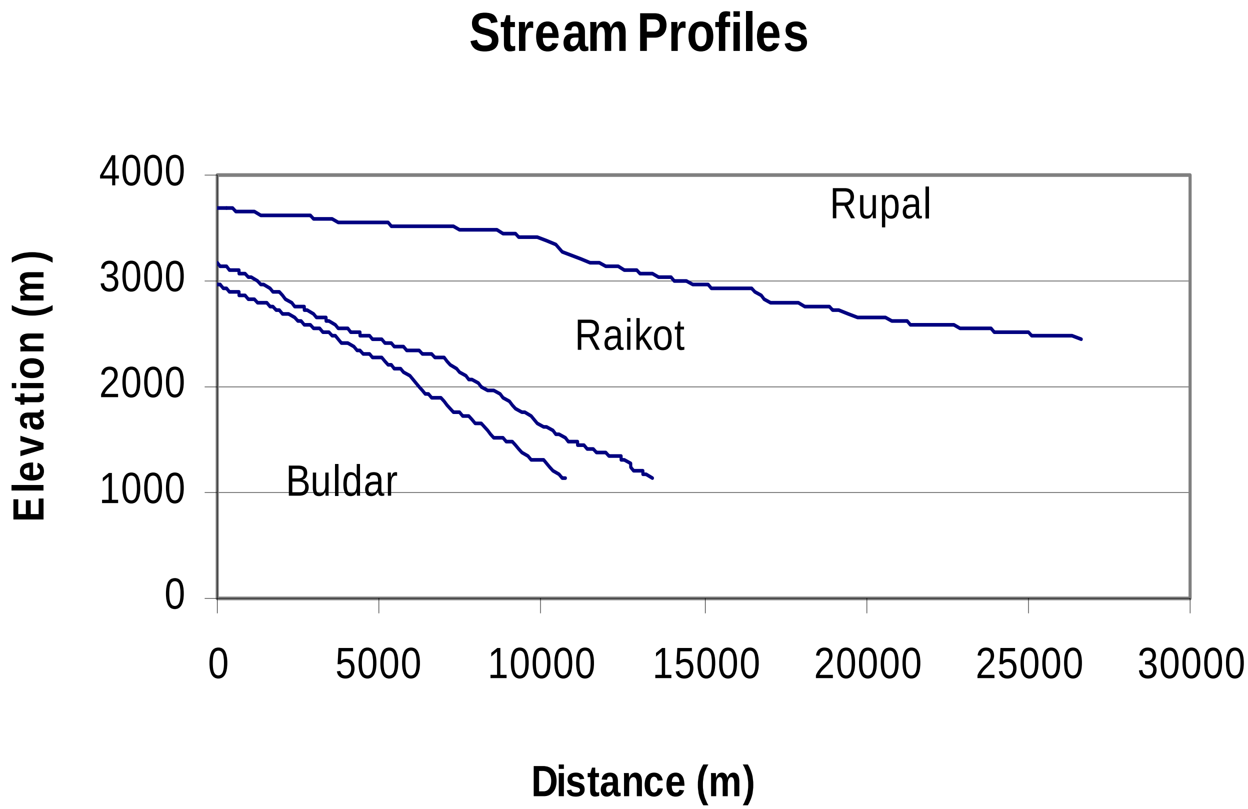
Source: Morisawa (1962), Table 1.

River Processes

Drainage Basin Morphometry

Relief ratio

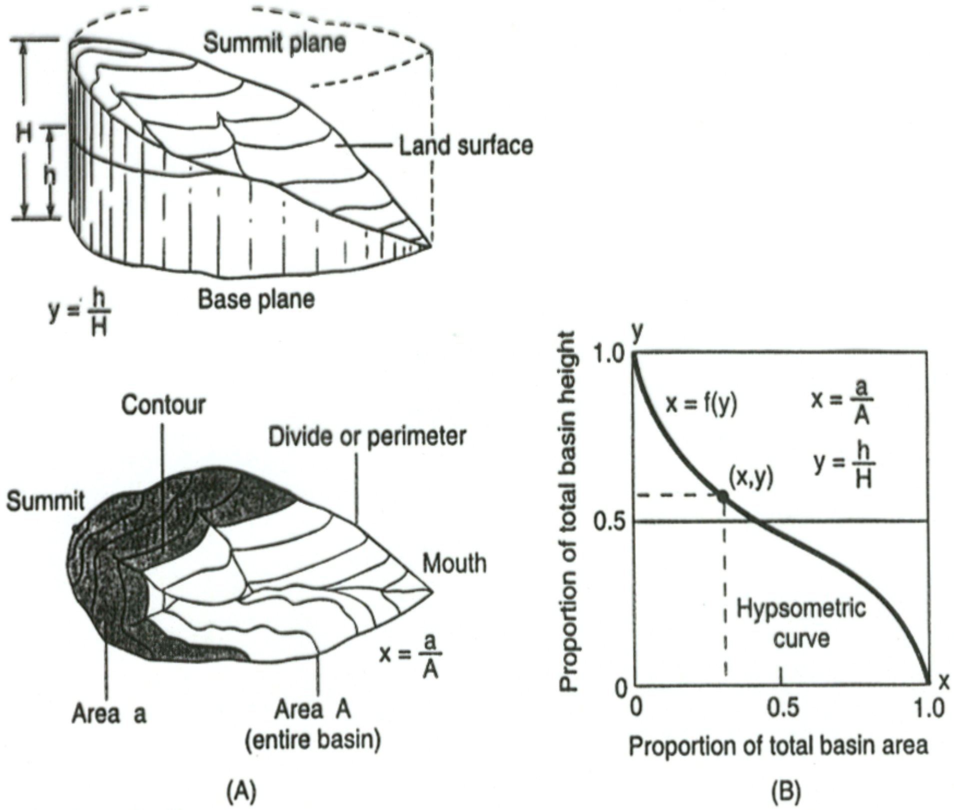




River Processes

Drainage Basin Morphometry

Hypsometric analysis



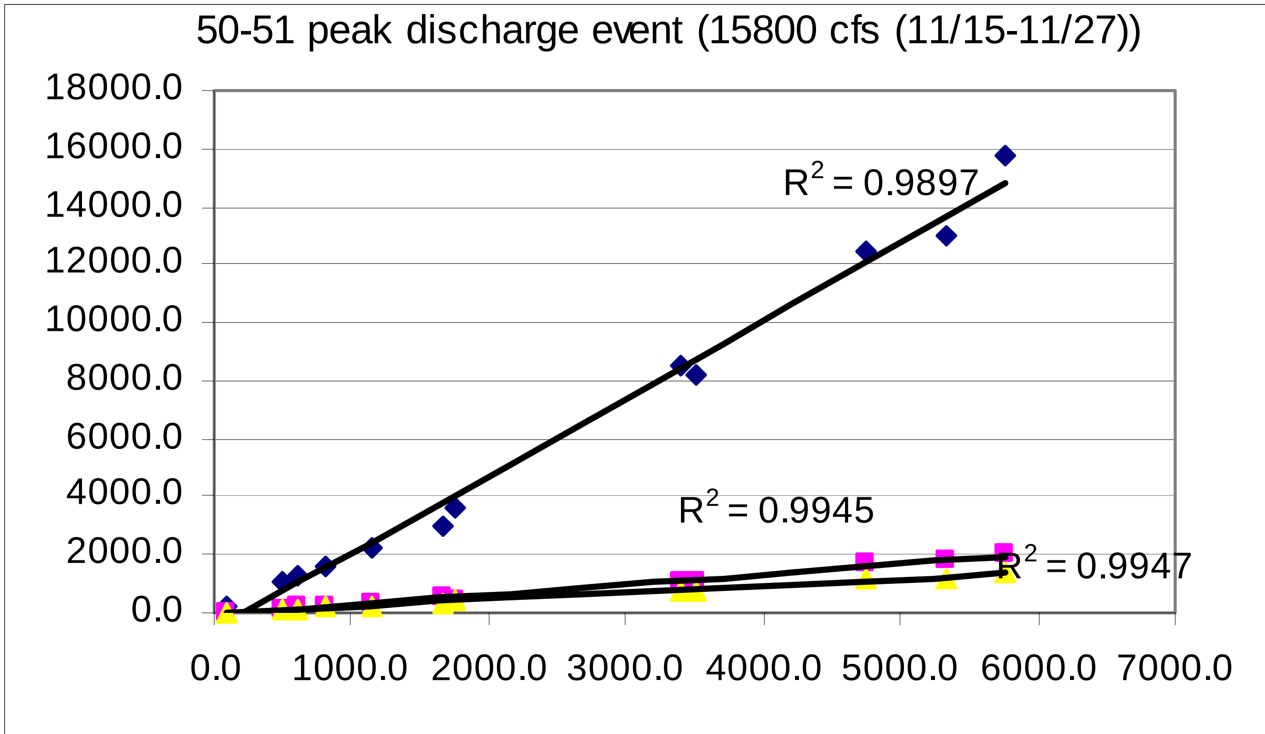
Ingredients of a hyposometric analysis. (A) Diagram showing how dimensionless parameters used in analysis are derived. (B) Plot of the parameters to produce the hyposometric curve.

(Strahler 1952b)

River Processes

Drainage Basin Morphometry

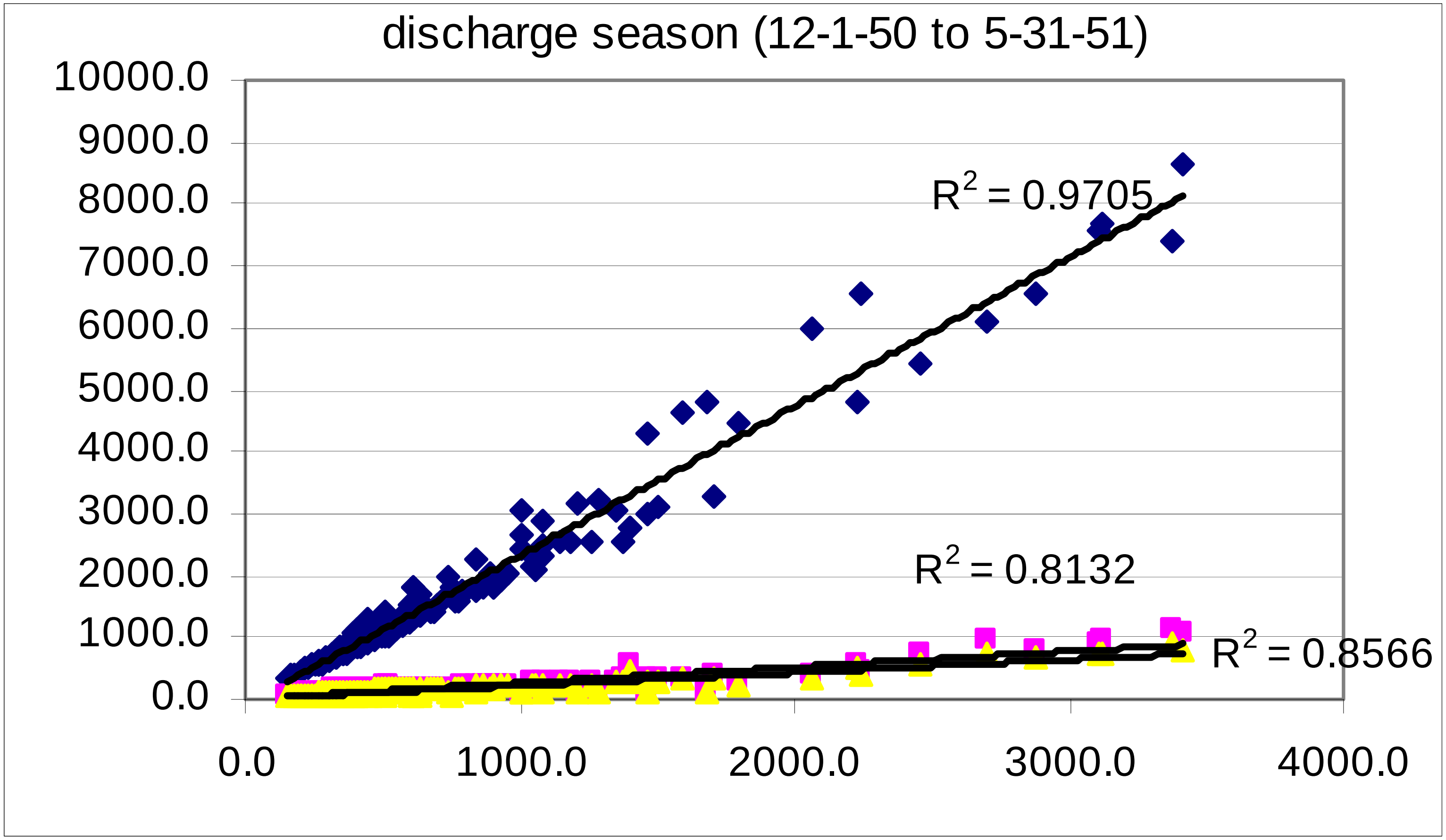
River flow (discharge) conditions also exhibit (under appropriate conditions) some degree of morphometry.



YEAR										CC
1950										33.0
1950										52.0
1950										35.7
1950										213.3
1950										360.0
1950										171.3
1950										94.3
1950										97.3
1950										57.3
1950	11	25	762.0	1590.0	218.0	184.0	810.0	1643.3	226.3	190.0
1950	11	26	588.0	1260.0	175.0	147.0	610.3	1293.3	178.7	150.3
1950	11	27	481.0	1030.0	143.0	120.0	492.7	1053.3	148.0	123.3
1950	11	28	409.0	870.0	126.0	103.0	445.0	950.0	134.5	111.5

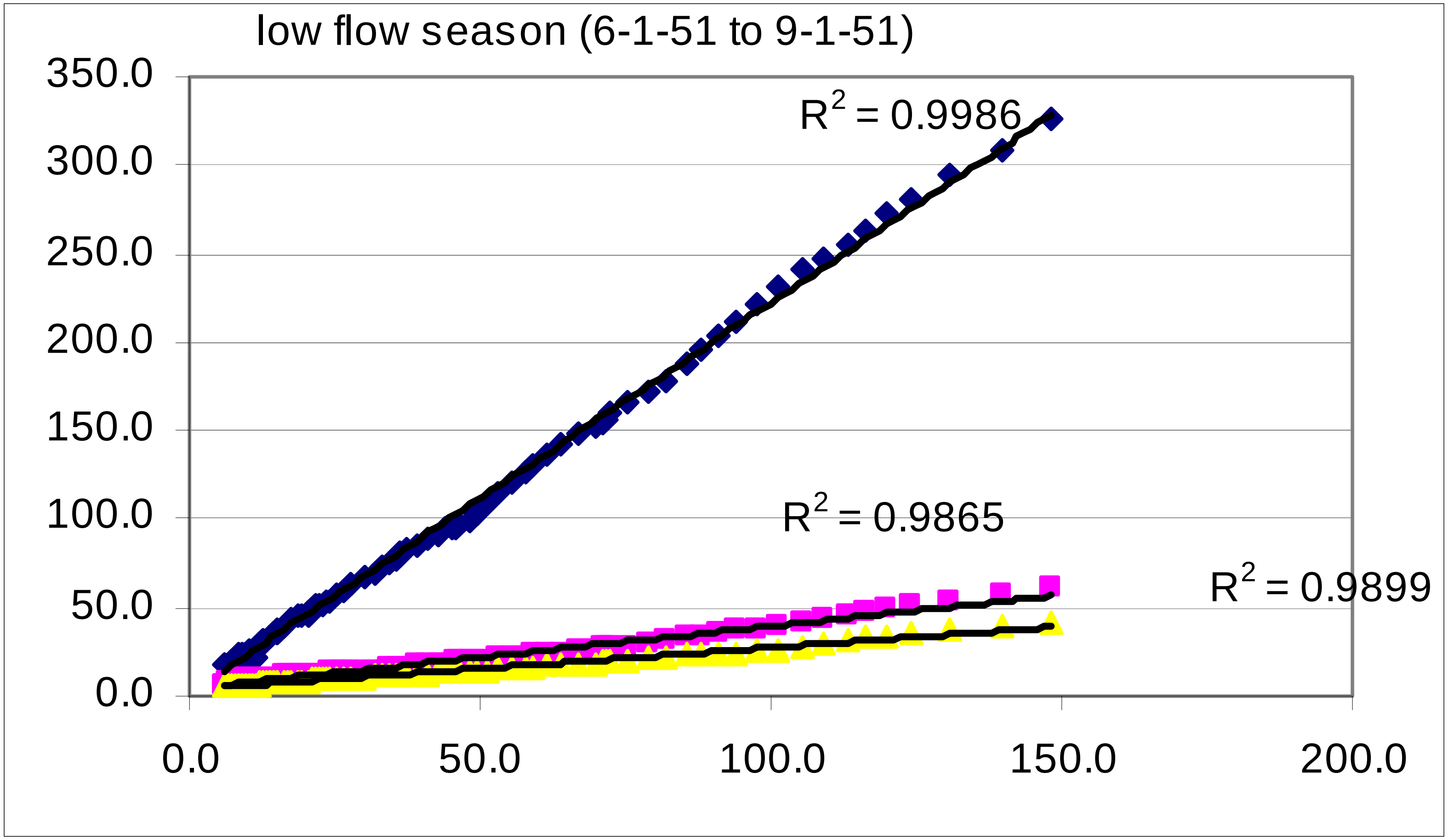
River Processes

Drainage Basin Morphometry



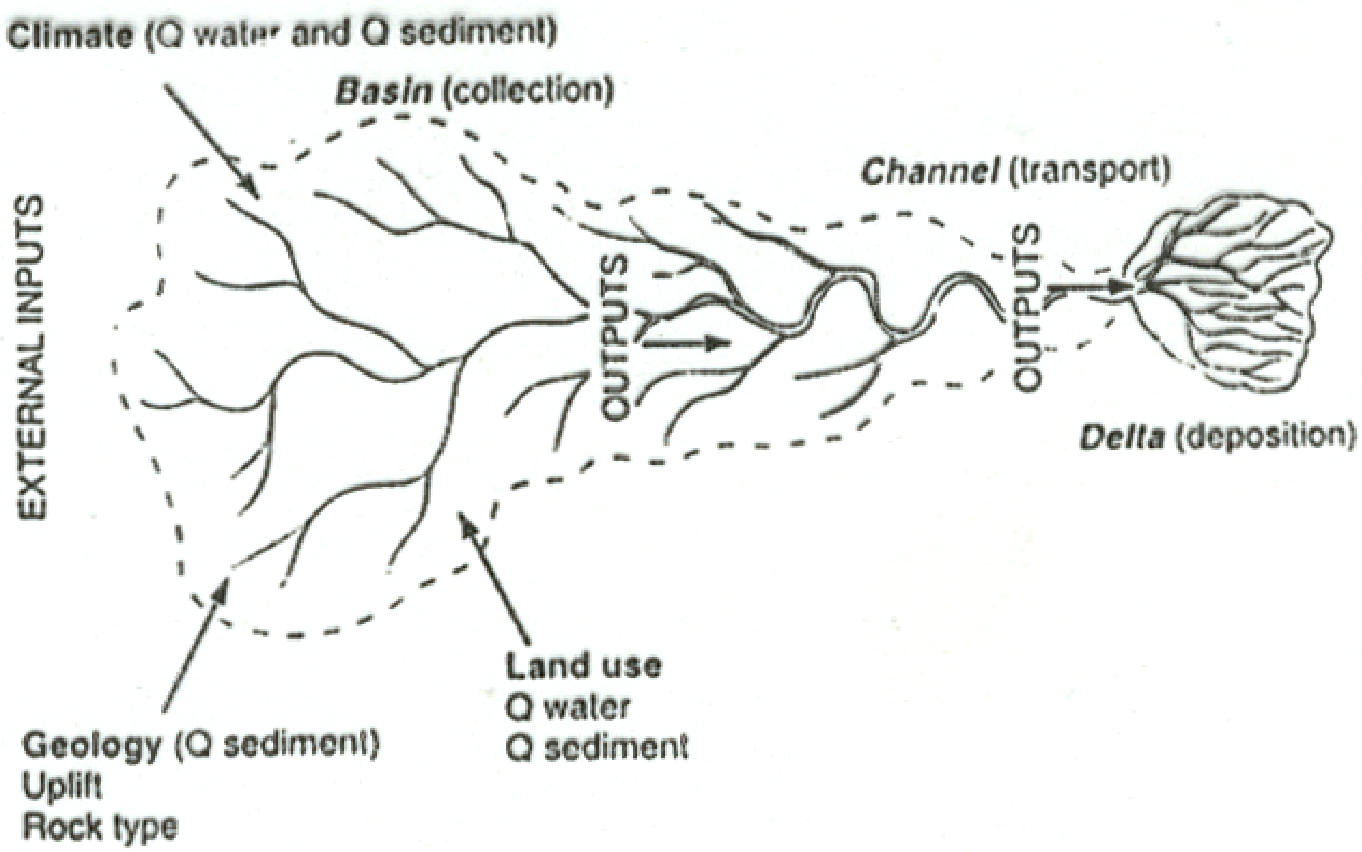
River Processes

Drainage Basin Morphometry



River Processes

Drainage Basin Evolution - denudation



River Processes

Drainage Basin Evolution - denudation

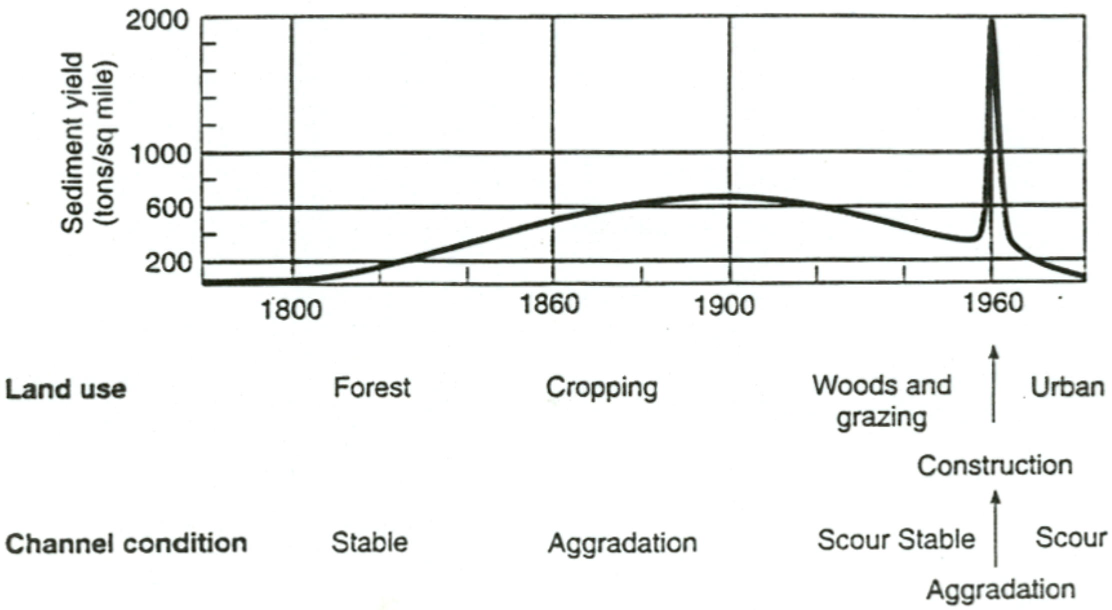
A number of interrelated geologic, hydrologic, and topographic factors cause the magnitude of sediment yield to vary widely from region to region. The most important of these are

- precipitation and vegetation,
- basin size,
- elevation and relief,
- rock type, and
- human activity.

River Processes

Drainage Basin Evolution - denudation

Precipitation and vegetation

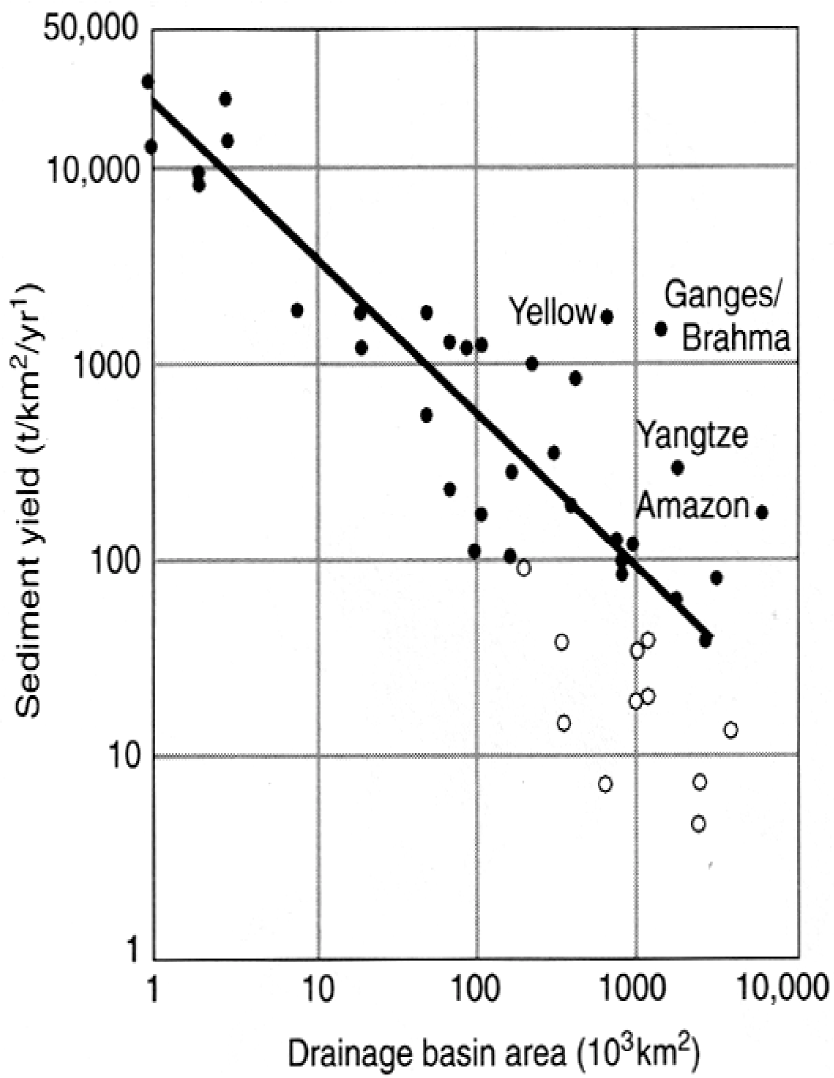


Changes in sediment yield and channel behavior in one area under various types of land use.
(Wolman 1967)

River Processes

Drainage Basin Evolution - denudation

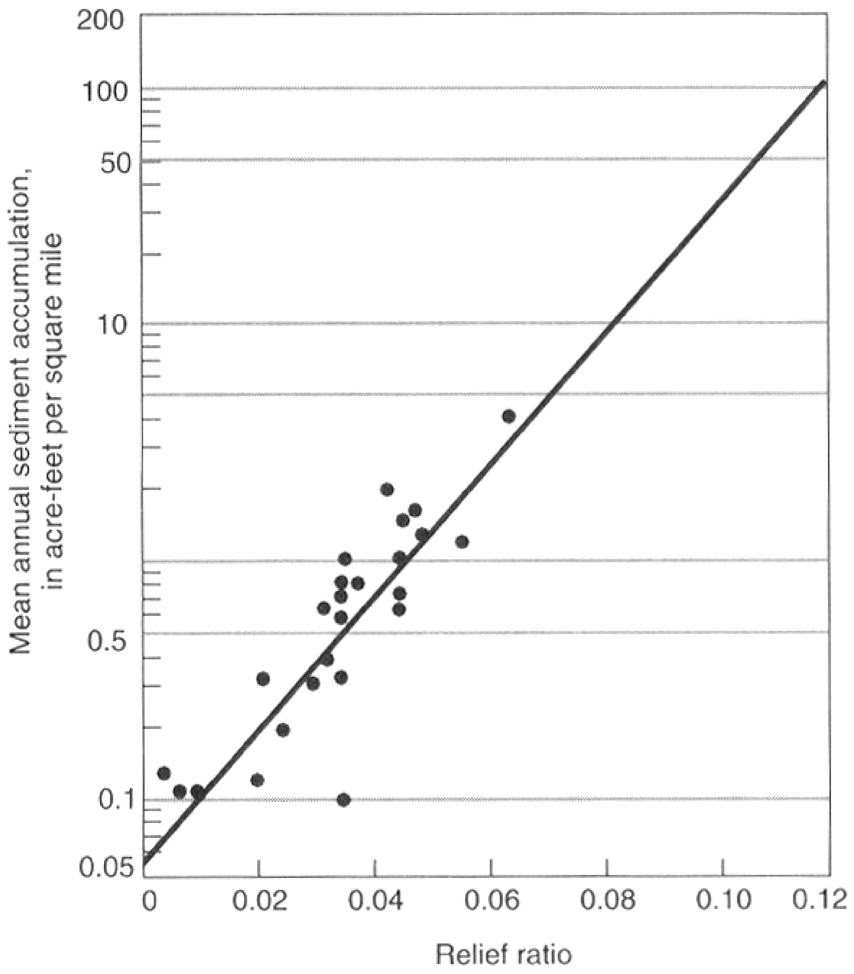
Basin size



River Processes

Drainage Basin Evolution - denudation

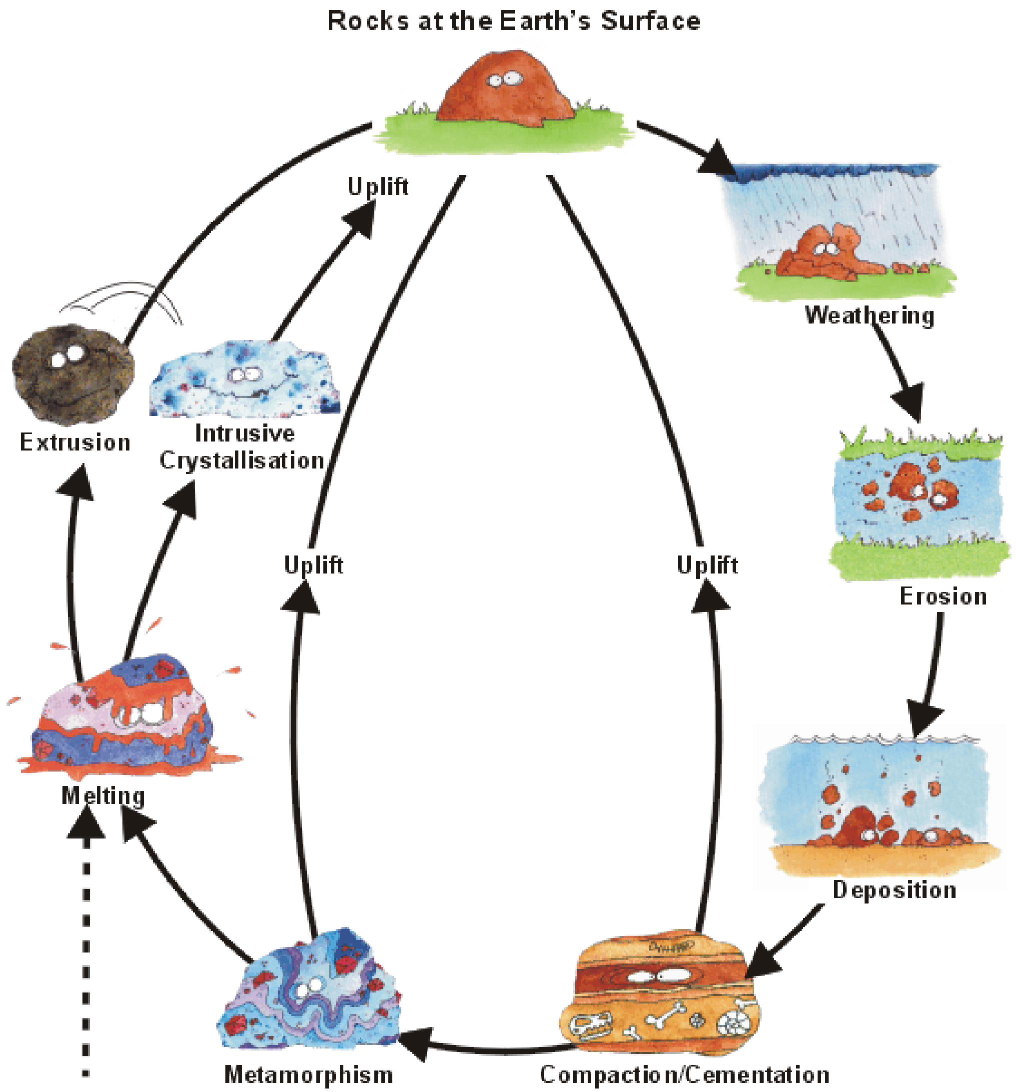
Elevation and relief



River Processes

Drainage Basin Evolution - denudation

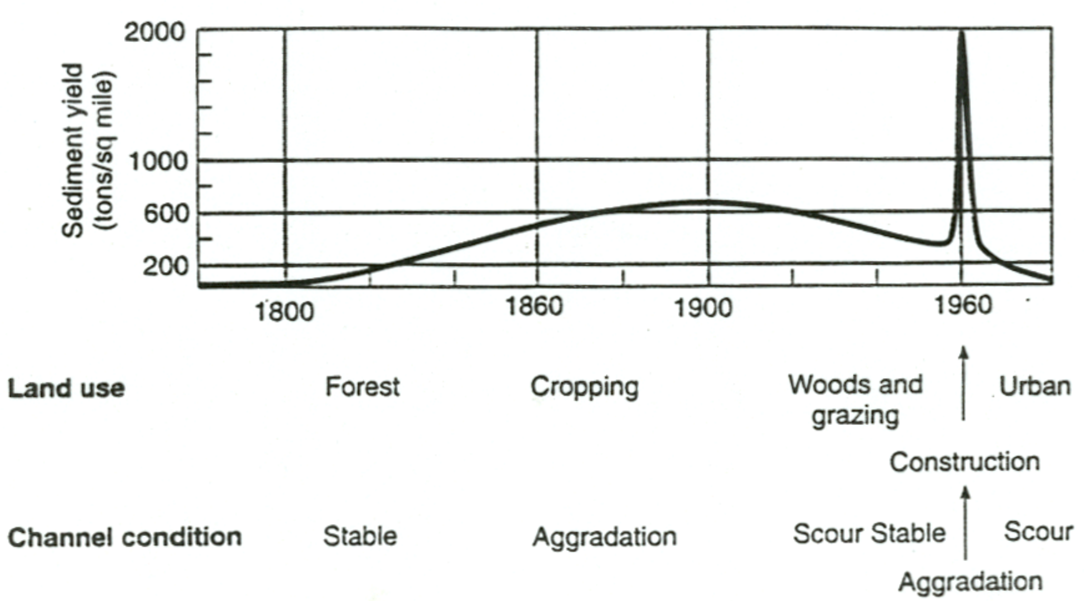
Rock type



River Processes

Drainage Basin Evolution - denudation

Human factor



Changes in sediment yield and channel behavior in one area under various types of land use.
(Wolman 1967)

River Processes

Drainage Basin Evolution - denudation

Rates of denudation - difficult to do, because quantifying human impact is vague. A valid estimate can be made only if

- the volume of sediment derived by erosive processes can be accurately determined,
- the boundaries of the source area are definable, and
- the time interval of sediment accumulation can be ascertained within reasonable limits.

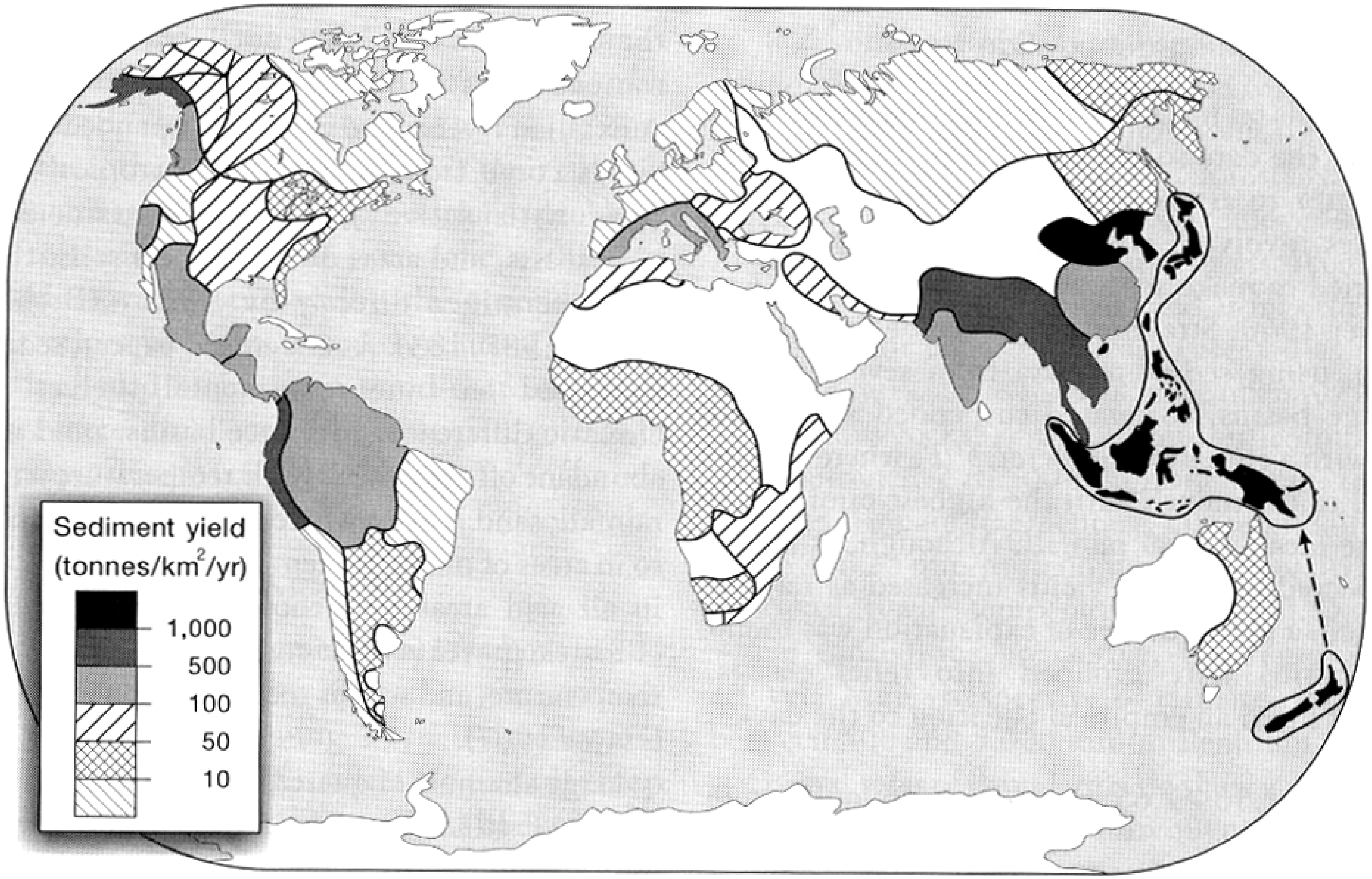
River Processes

Drainage Basin Evolution - denudation

Continent	Chemical denudation[a]		Mechanical denudation[b]		Ratio of mechanical to chemical denudation	Specific discharge (l/s/km^2)
	Drainage area (10^6 km^2)	Solute yield (t/km^2/yr)	Drainage area (10^6 km^2)	Solute yield (t/km^2/yr)		
Africa	17.55	9.12	15.34	35	3.84	6.1
North America	21.5	33.44	17.50[c]	84	2.51	8.1
South America	16.4	29.76	17.90	97	3.26	21.2
Asia	31.46	46.22	16.88	380	8.22	12.5
Europe	8.3	49.16	15.78[d]	58	1.18	9.7
Oceania	4.7	54.04	5.20	1,028[e]	19.02	16.1

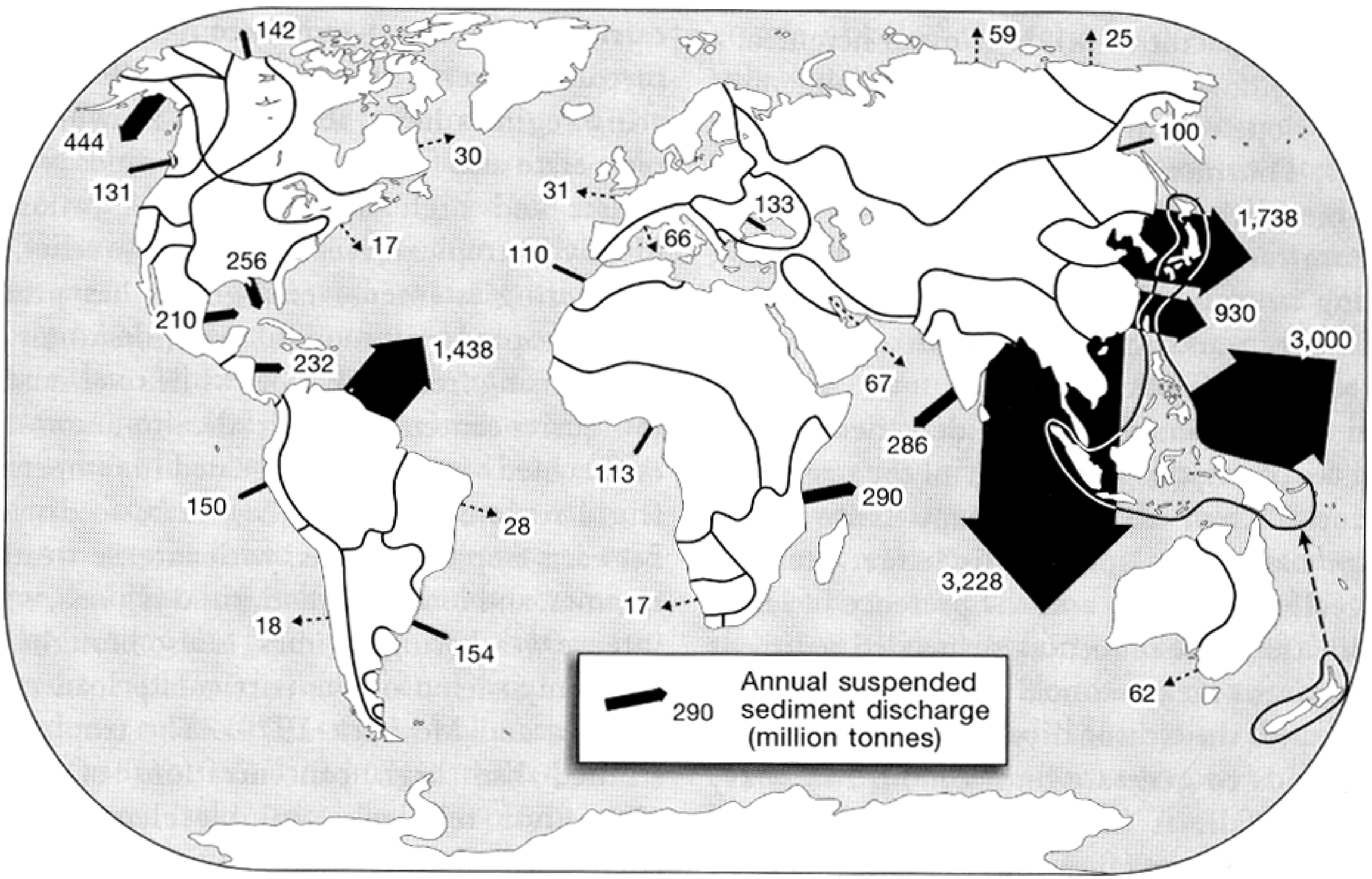
River Processes

Drainage Basin Evolution - denudation



River Processes

Drainage Basin Evolution - denudation



River Processes

Drainage Basin Evolution - denudation

Sediment budgets

To make a complete sediment budget analysis one must identify and quantify:

- ***sediment mobilization*** (processes that initiate motion and move sediments any distance),
- ***sediment production*** (sediment reaching or given access to a channel), and
- ***sediment yield*** (sediment actually discharged from the basin).

River Processes

Drainage Basin Evolution - denudation

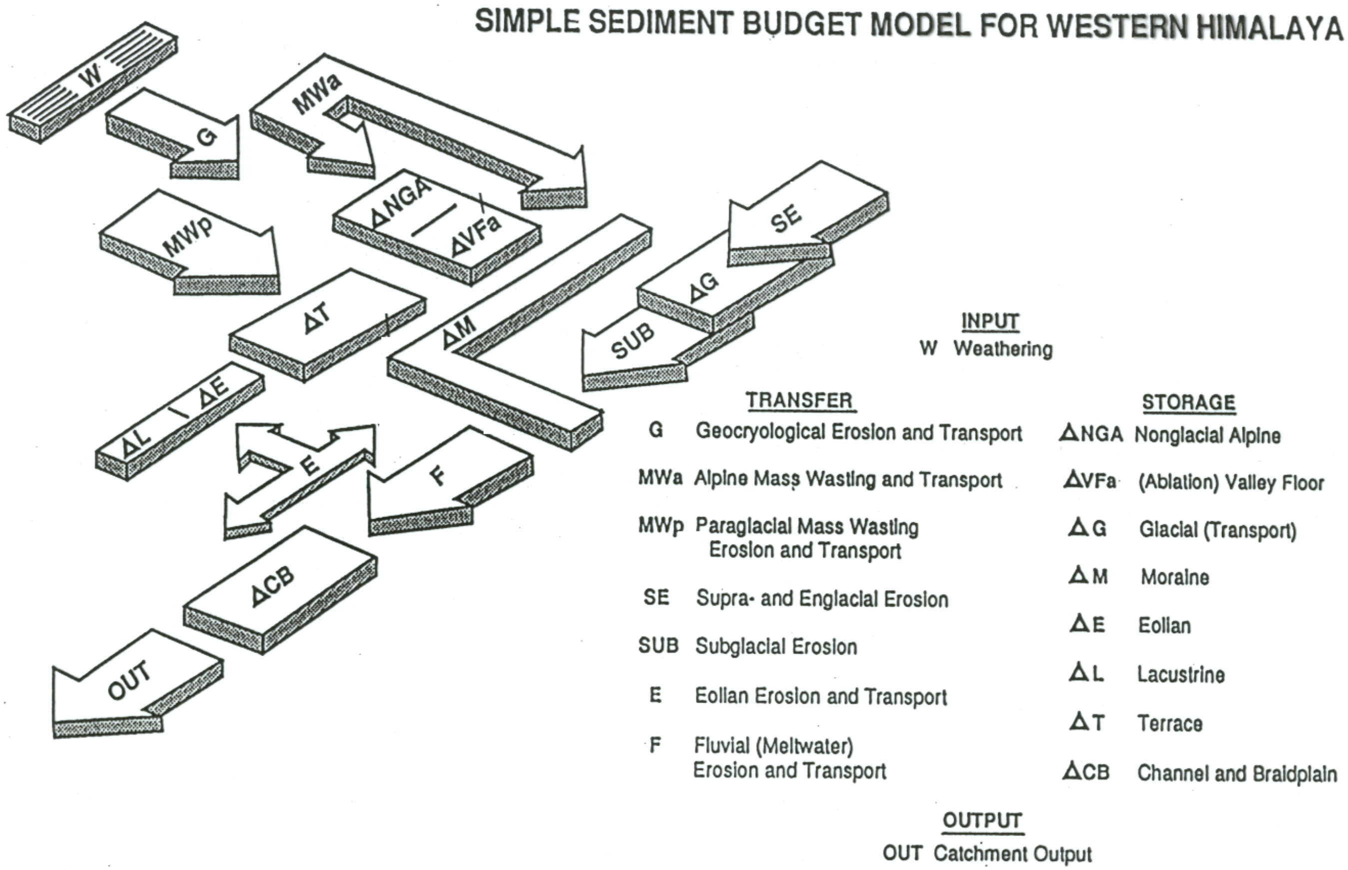
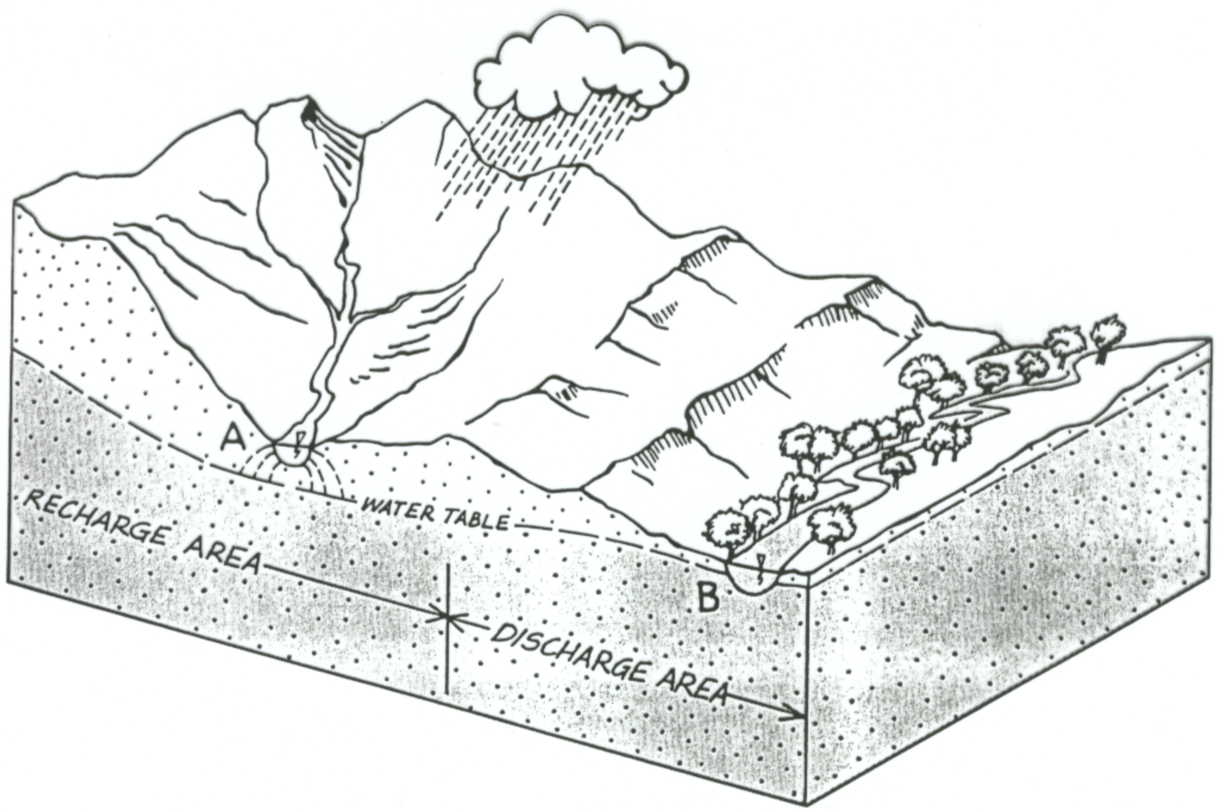


Figure 2 Sedi nent-budget model for the Western Himalaya, based on a compilation of the work by Caine, 1974; Church and Ryder, 1972; Clark, 1987; Harbor and Warburton, 1993; and Slaymaker and McPherson, 1977. This model emphasizes mass wasting, glacial, and fluvial transfers and storages.

River Processes

Drainage Basin groundwater hydrology

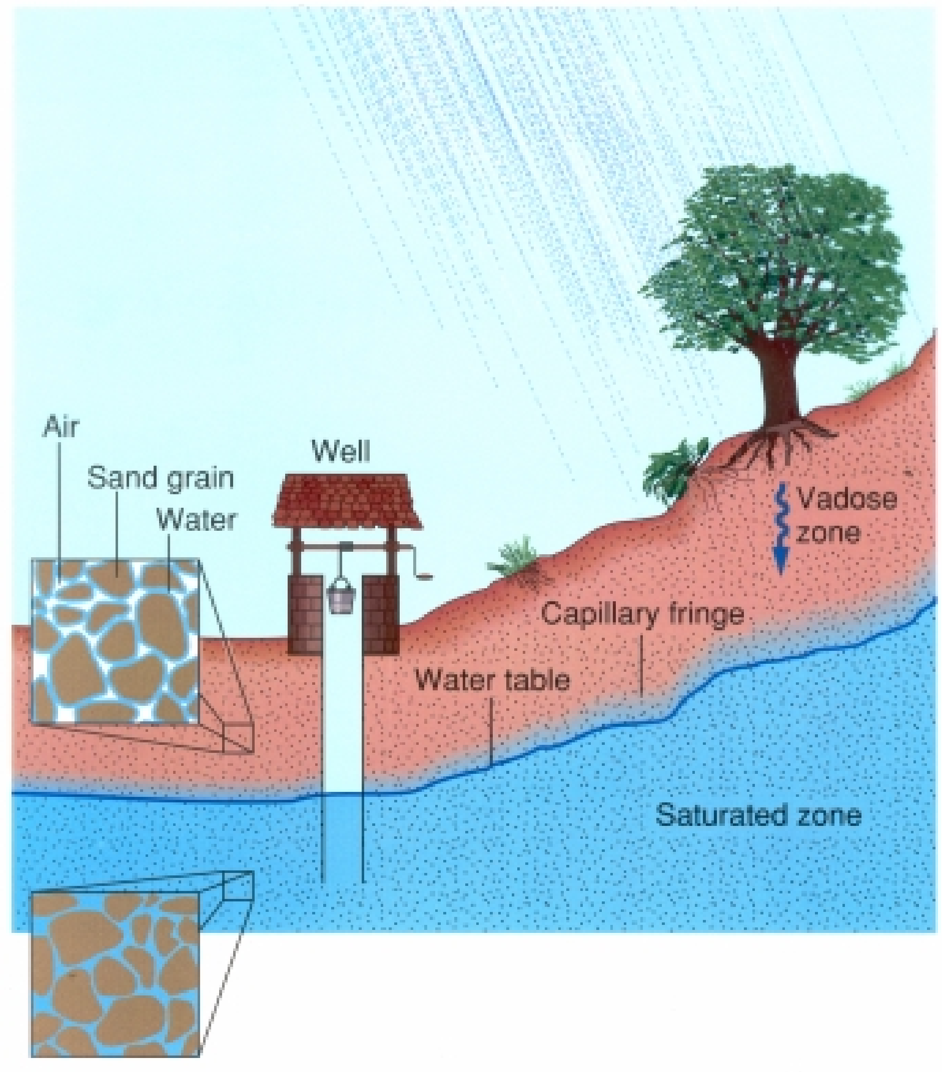


River Processes

Drainage Basin groundwater hydrology

The groundwater profile:

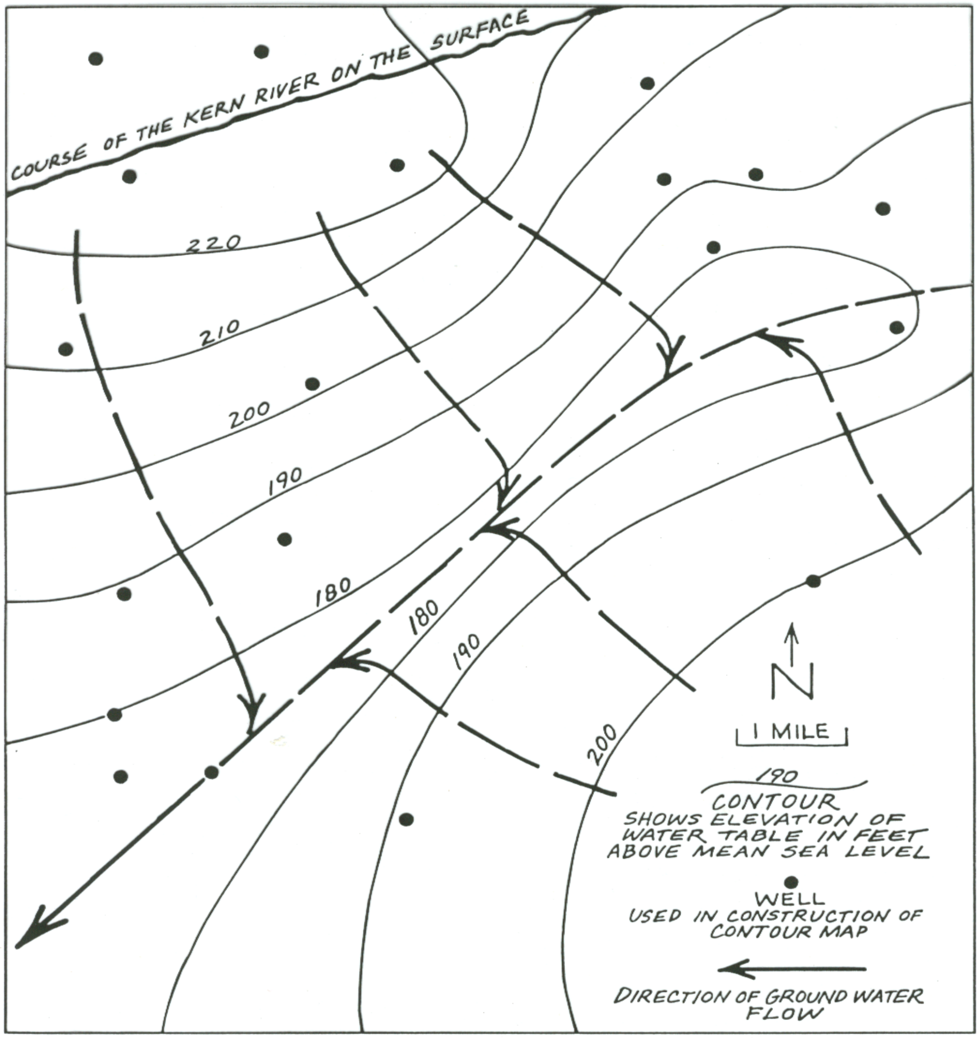
1. **Zone of moisture**
2. **Vadose zone**
3. **Capillary fringe.**
4. **Saturated zone**
5. **Water table**



River Processes

Drainage Basin groundwater hydrology – movement of groundwater

Equipotential surfaces



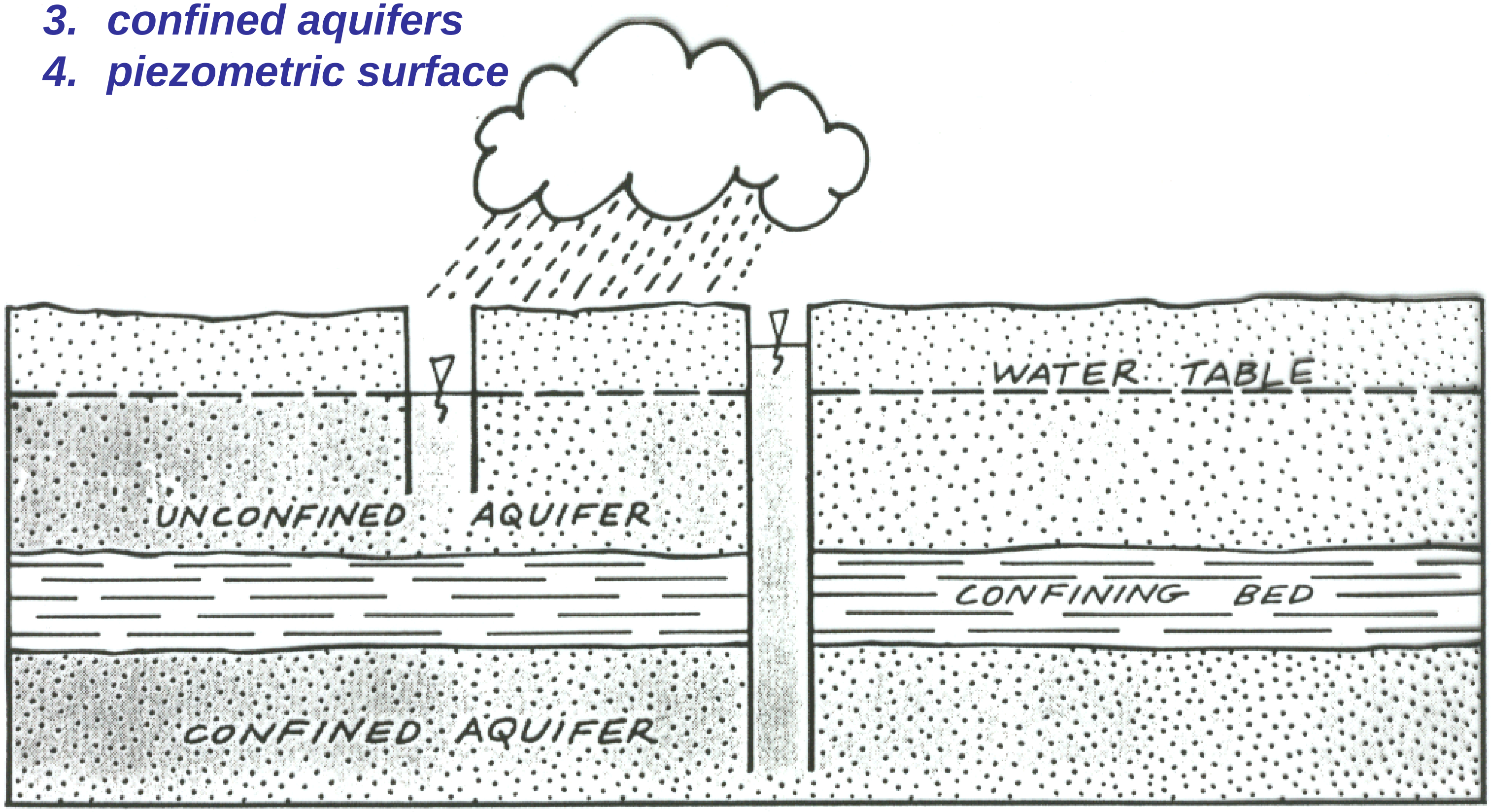
Contour map of 1976 water table, Gosford Quadrangle, Kern County, California.

River Processes

Drainage Basin groundwater hydrology – movement of groundwater

Aquifers

1. ***unconfined aquifers***
2. ***aquitards***
3. ***confined aquifers***
4. ***piezometric surface***

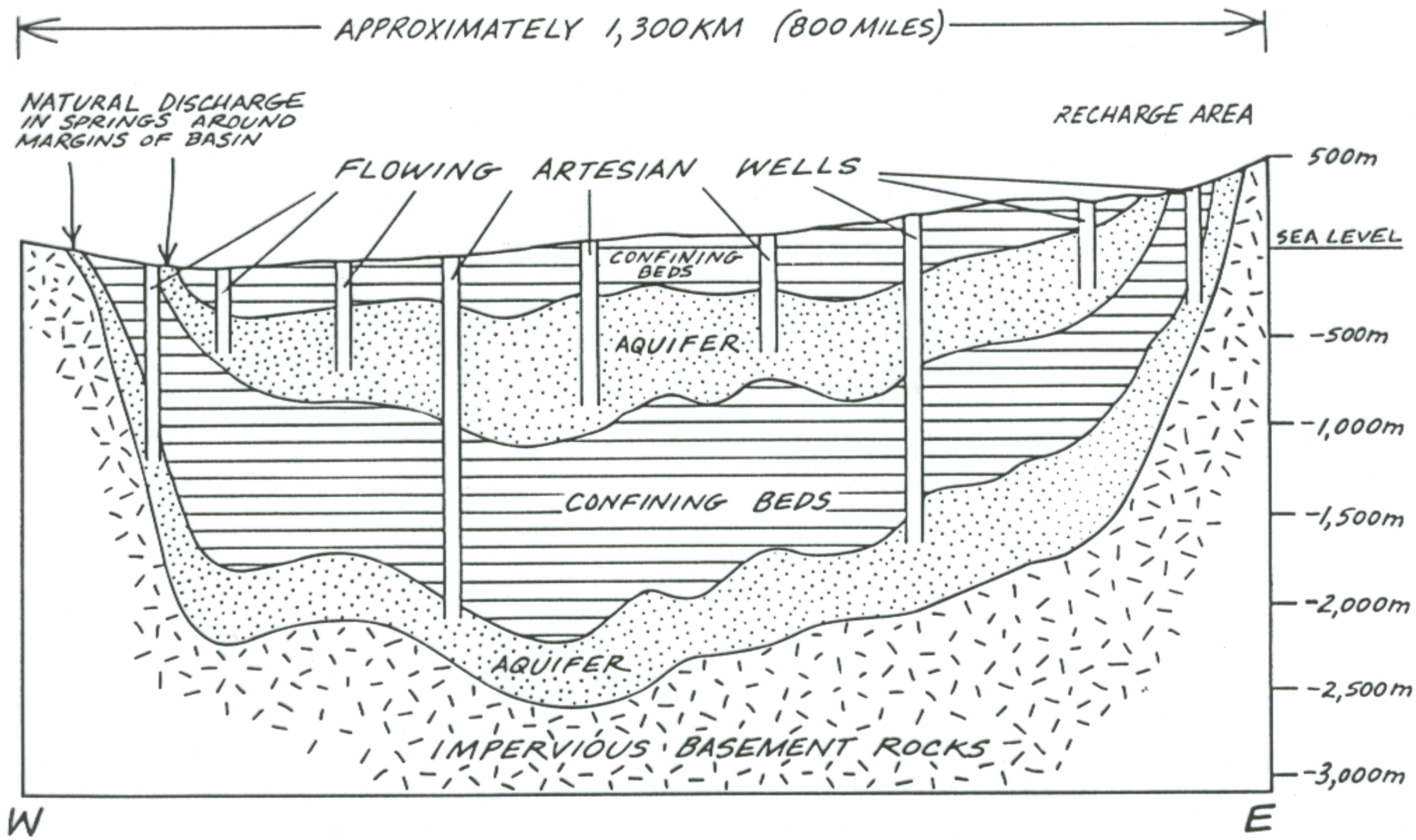


River Processes

Drainage Basin groundwater hydrology – movement of groundwater

Aquifers

5. ***artesian flow***

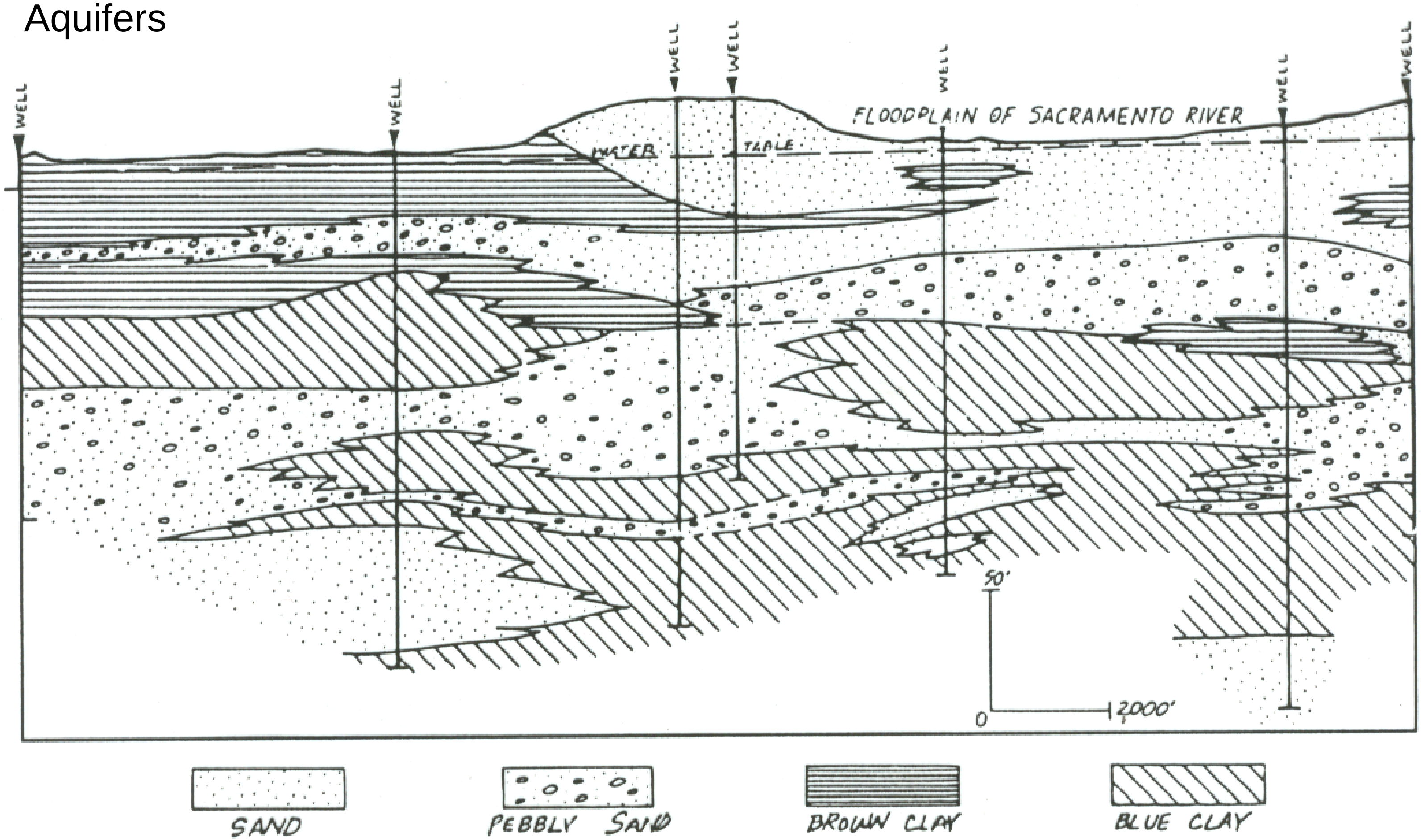


Generalized east–west cross-section of Great Artesian Basin

River Processes

Drainage Basin groundwater hydrology – movement of groundwater

Aquifers

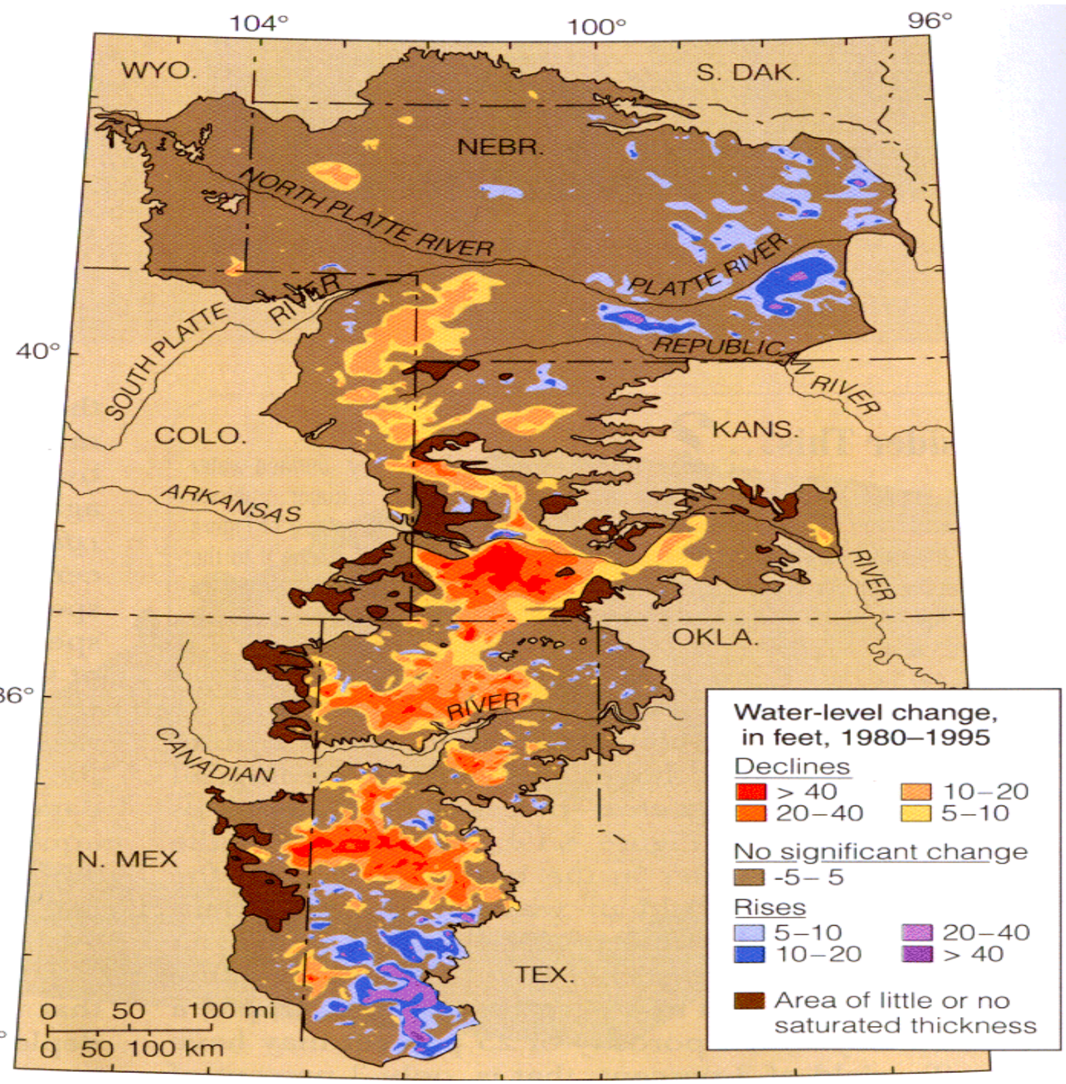


Cross-sectional view of alluvial sediments just west of Sacramento, California.

River Processes

Drainage Basin groundwater hydrology – movement of groundwater

The Ogallala aquifer – largest freshwater aquifer in the western hemisphere.



River Processes

Drainage Basin groundwater hydrology – porosity and permeability

Permeability – ability of a material to transmit water – **Darcy's Law**:

Porosity (*n*) - volume of voids relative to the volume of total.

$$\boldsymbol{n = Vv/Vt}$$

where:

Vv refers to the volume of the voids (liquid and gas phases), and

Vt refers to the total volume of a representative volume of rock.

Drainage Basin groundwater hydrology – porosity and permeability

Table 5.1 Range of Permeability Values for Different Soil Material

Permeability

$Ft^3/Ft^2/Day$ (ft/day)

10^5	10^4	10^3	10^2	10^1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}

$Ft^3/Ft^2/Min$ (ft/min)

10^1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}

$Gal/Ft^2/Day$ ($gal/ft^2/day$)

10^5	10^4	10^3	10^2	10^1	10^{-1}	10^{-2}	10^{-3}	10^{-4}

$Ms^3/M^2/Day$ (m/day)

10^4	10^3	10^2	10^1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}

Relative Permeability

Very High	High	Moderate	Low	Very Low

Representative Materials

Clean gravel —	Clean sand and sand and gravel —	Fine sand —	Silt, clay, and mixtures of sand, silt, and clay —	Massive clay

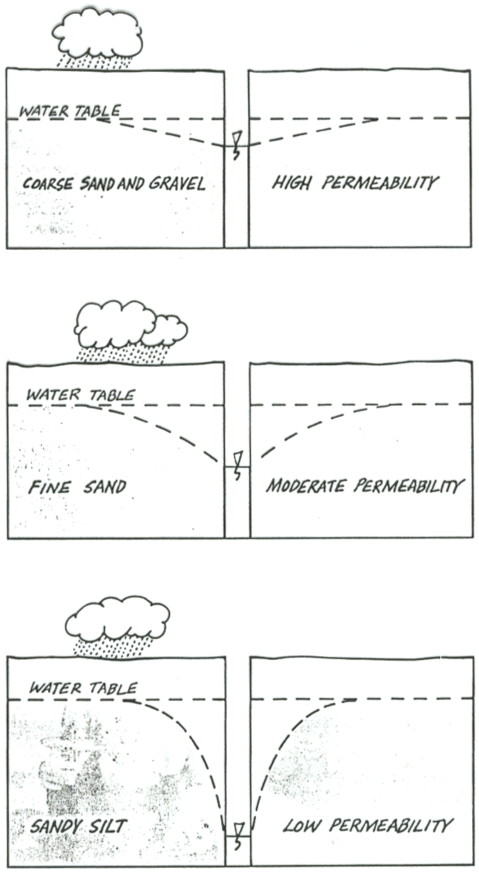
Source: Modified from USBR, 1981.

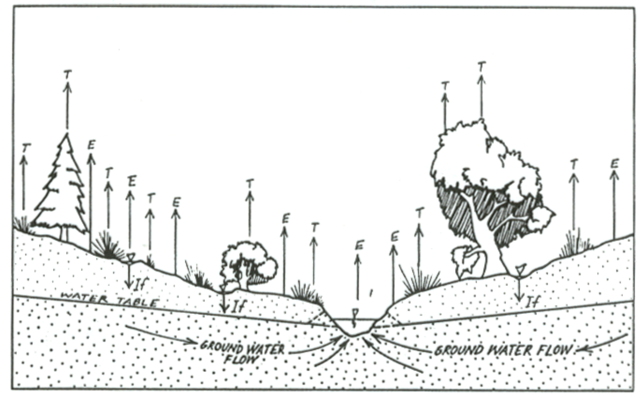
River Processes

Drainage Basin groundwater hydrology – movement of groundwater

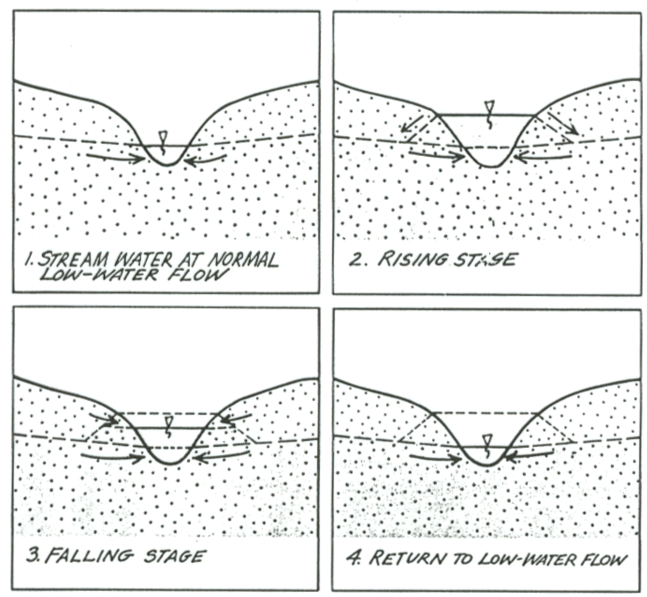
Aquifers

- Groundwater/surface water interactions
- Water tables and pumping



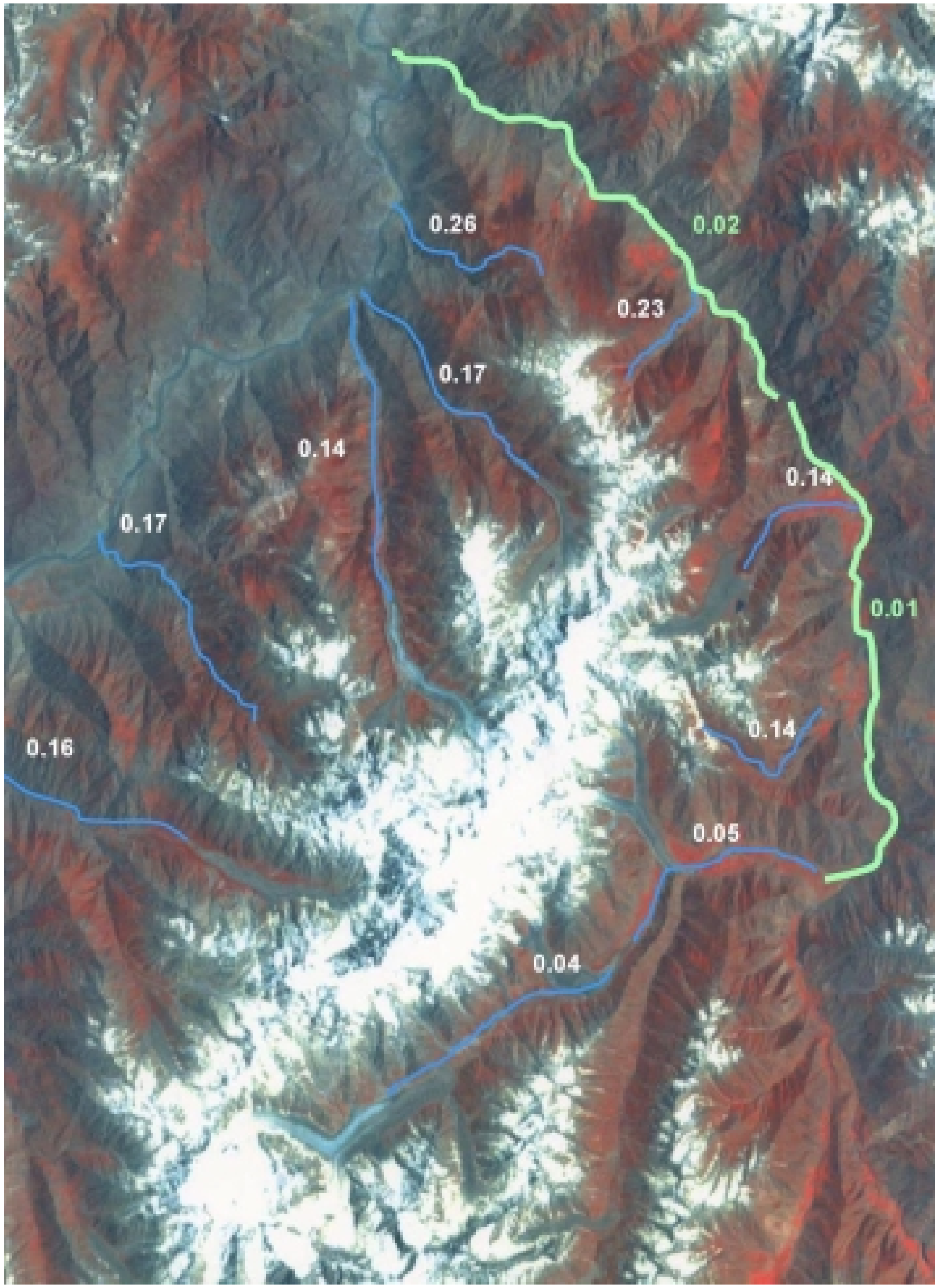


Runoff cycle ends as rain stops and landscape begins to dry out (transpiration, T; evaporation, E).



Bank storage.

links


0.26
0.02
0.23
0.17
0.14
0.17
0.14
0.01
0.16
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0.05
0.04