

Des rivières
et des hommes



Le concept de débit effectif et morphogène

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Dans le cadre de



RESCIF

Réseau d'excellence
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Source : étude de Wolman et Miller

Rôle des crues fréquentes dans les ajustements sédimentaires

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Wolman WG and Miller JP,
1959, Magnitude and frequency of forces in geomorphic processes, Journal of Geology. 68: 54-74

MAGNITUDE AND FREQUENCY OF FORCES IN GEOMORPHIC PROCESSES¹

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ABSTRACT

The relative importance in geomorphic processes of extreme or catastrophic events and more frequent events of smaller magnitude can be measured in terms of (1) the relative amounts of "work" done on the landscape and (2) in terms of the formation of specific features of the landscape.

For many processes, above the level of competence, the rate of movement of material can be expressed as a power function of some stress, as for example, shear stress. Because the frequency distributions of the magnitudes of many natural events, such as floods, rainfall, and wind speeds, approximate log-normal distributions, the product of frequency and rate, a measure of the work performed by events having different frequencies and magnitudes will attain a maximum. The frequency at which this maximum occurs provides a measure of the level at which the largest portion of the total work is accomplished. Analysis of records of sediment transported by rivers indicates that the largest portion of the total load is carried by flows which occur on the average once or twice each year. As the variability of the flow increases and hence as the size of the drainage basin decreases, a larger percentage of the total load is carried by less frequent flows. In many basins 50 per cent of the sediment is removed by at least one discharge which occurs at least once every five years.

Transport of sand and dust by wind in general follows the same laws. The extreme velocities associated with infrequent events are compensated for by their rarity, and it is found that the greatest bulk of sediment is transported by more moderate events.

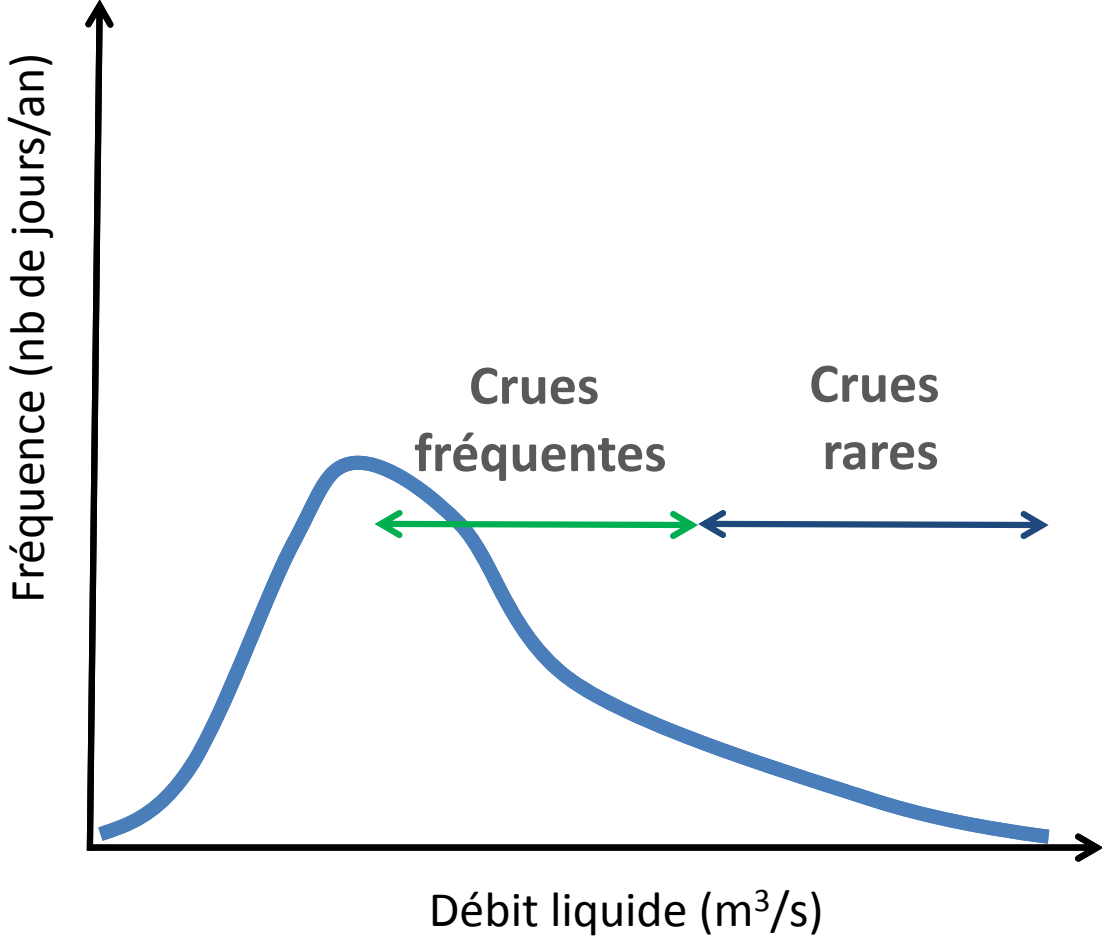
Many rivers are competent to erode both bed and banks during moderate flows. Observations of natural channels suggest that the channel shape as well as the dimensions of meandering rivers appear to be associated with flows at or near the bankfull stage. The fact that the bankfull stage occurs on the average once every year or two years indicates that these features of many alluvial rivers are controlled by these more frequent flows rather than by the rarer events of catastrophic magnitude. Because the equilibrium form of wind-blown dunes and of wave-formed beaches is quite unstable, the frequency of the events responsible for their form is less clearly definable. However, dune form and orientation are determined by both wind velocity and frequency. Similarly, a hypothetical example suggests that beach slope oscillates about a mean value related in part to wave characteristics generated by frequent events of differing magnitude and frequency. Where stresses generated by frequent events are incompetent to transport available materials, less frequent ones of greater magnitude are obviously required. Closer observation of many geomorphic processes is required before the relative importance of different processes and of events of differing magnitude and frequency in the formation of given features of the landscape can be adequately evaluated.

INTRODUCTION

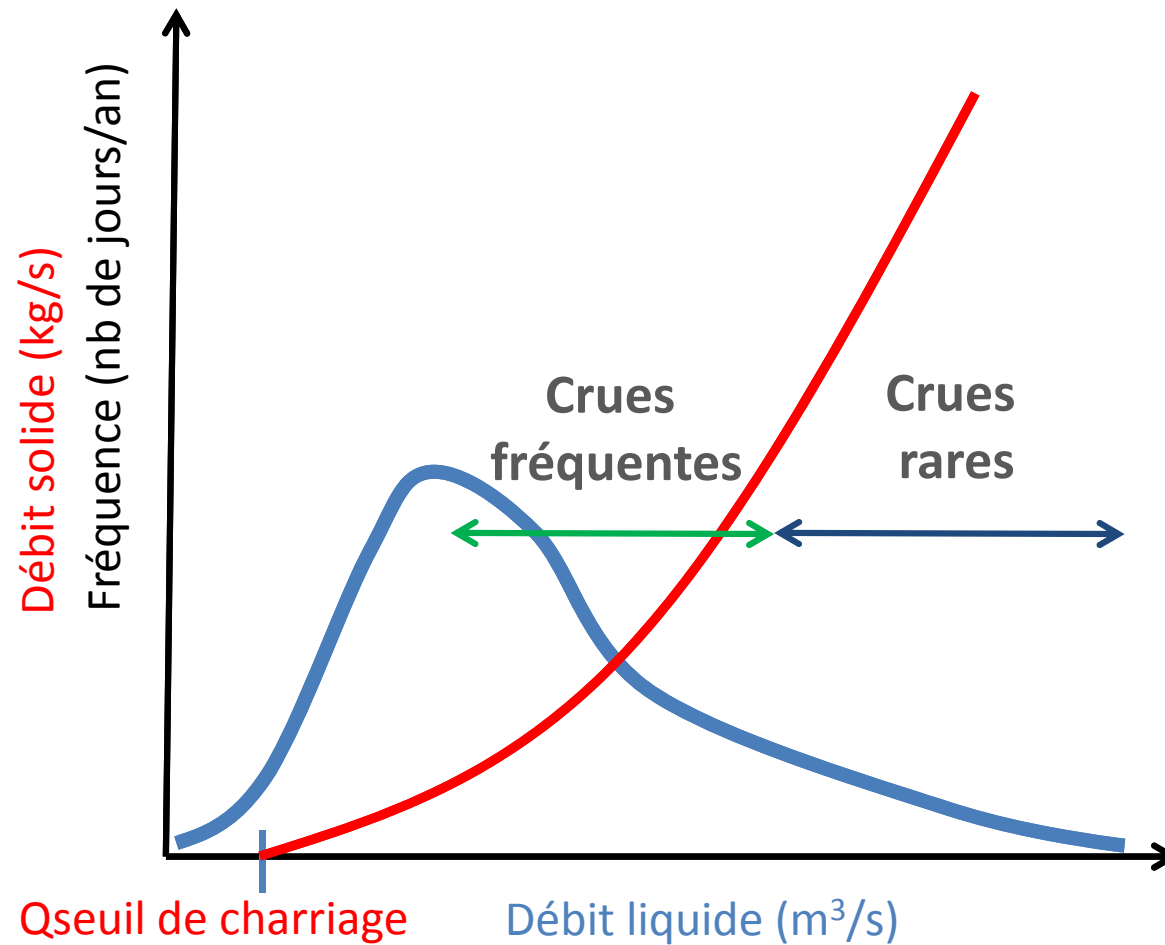
Denudation of the earth's surface and modification of existing land forms involve forces which are ultimately controlled by highly variable atmospheric influences coupled with the unvarying effects of gravity. Almost any specific mechanism requires that a certain threshold value of force be exceeded. However, above this threshold or critical limit there occurs a wide range in magnitude of forces which results from variations in intensity of precipitation, wind speed, etc. The problem to be examined in this paper is the relative importance of the effectiveness expressed in terms of material moved and modification of surface form. Thus this is a re-examination of the concept of "effective force" in landscape development.

It is widely believed that the infrequent events of immense magnitude are most effective in the progressive denudation of the earth's surface. Although this belief may seem to be supported by some individual events such as tsunamis,

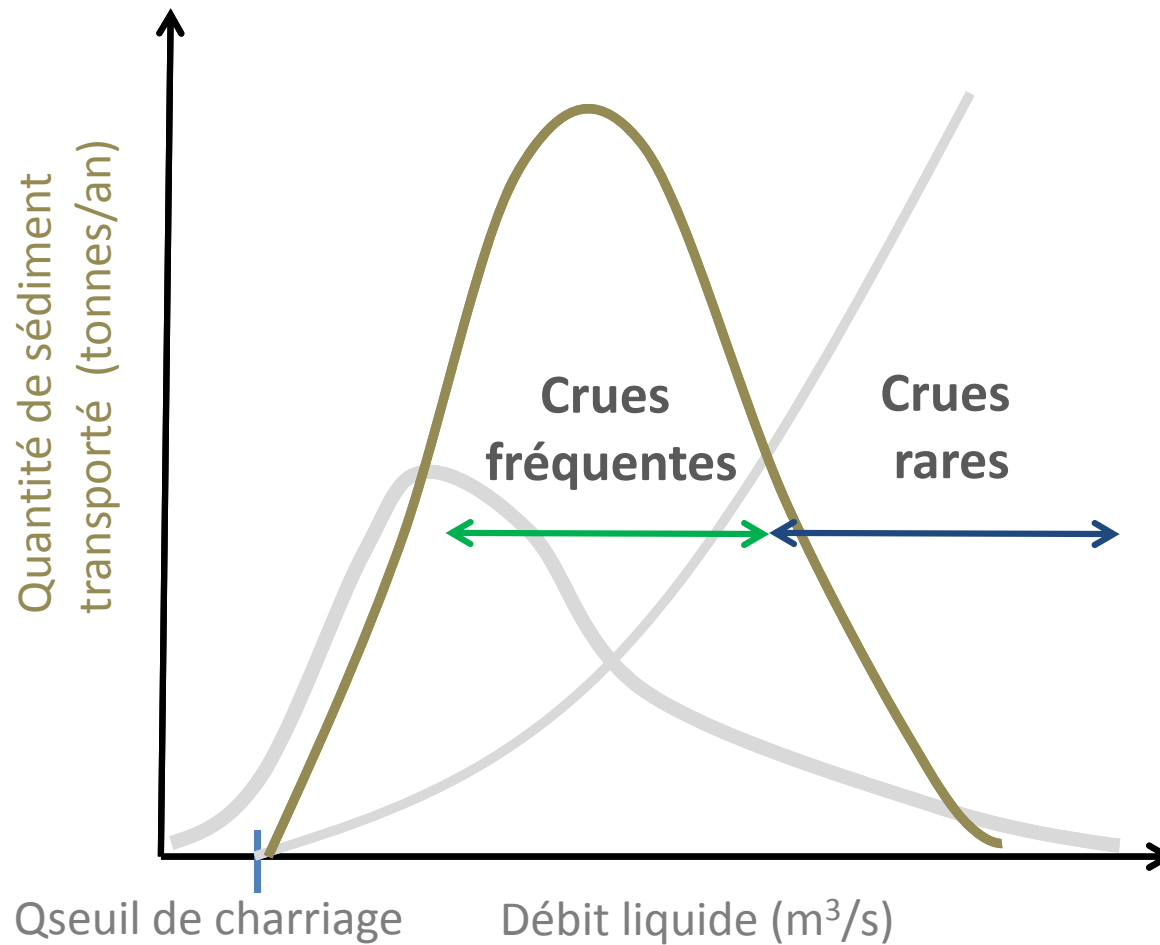
Distribution fréquentielle de débit



Débit solide vs. débit liquide



Quantité de sédiment transporté

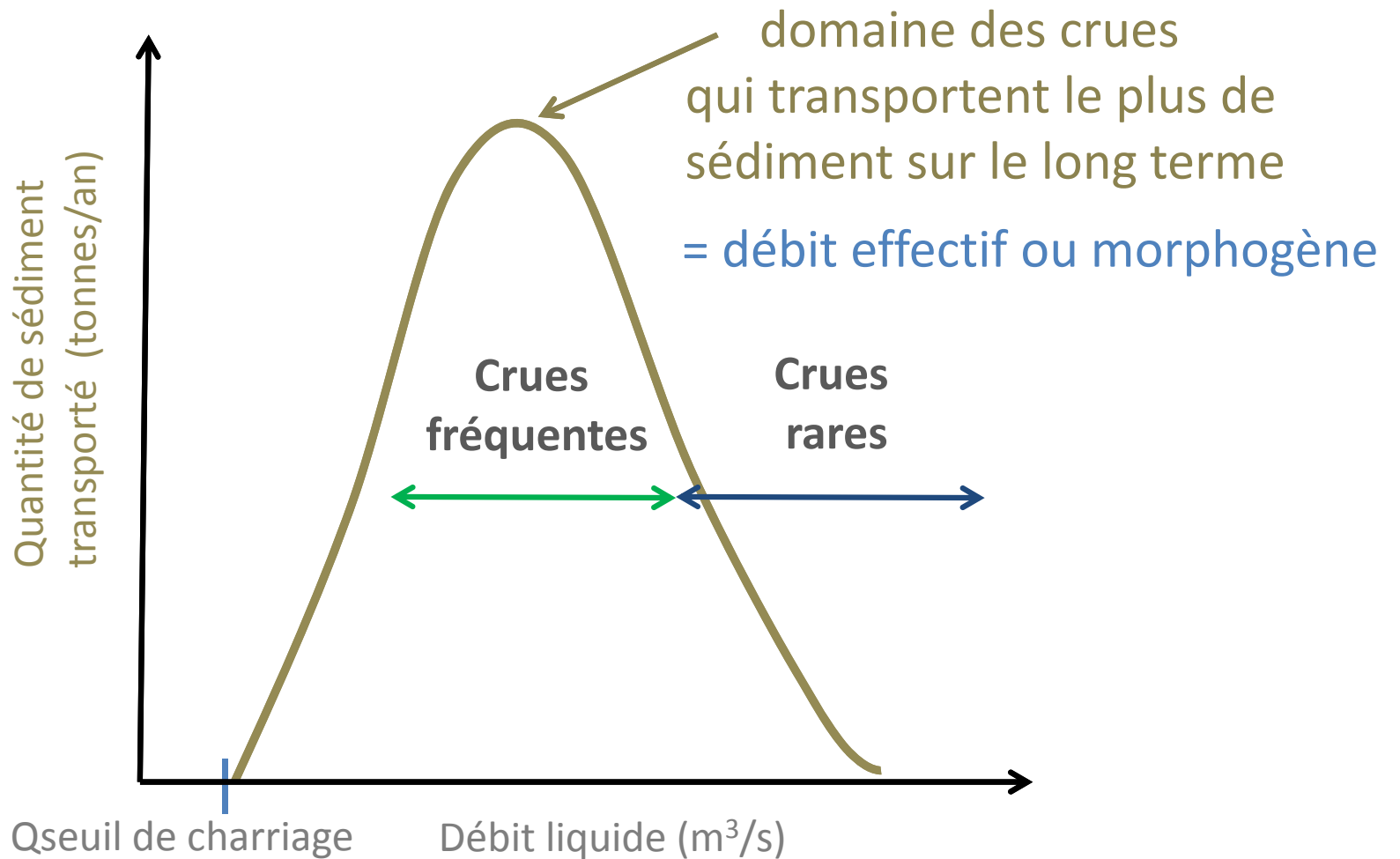


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Quantité de sédiment transporté



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Réalisation



Avec le soutien de



Réalisation multimédia



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