

Downstream fining of bed sediment in the Dutch Rhine branches

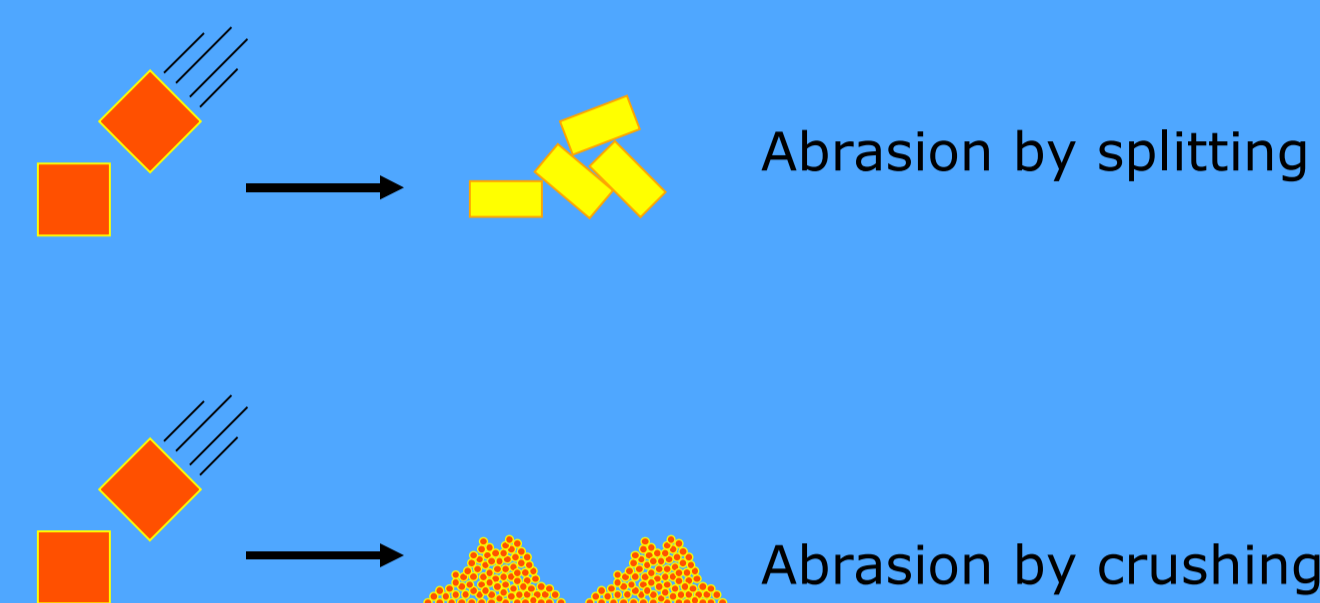
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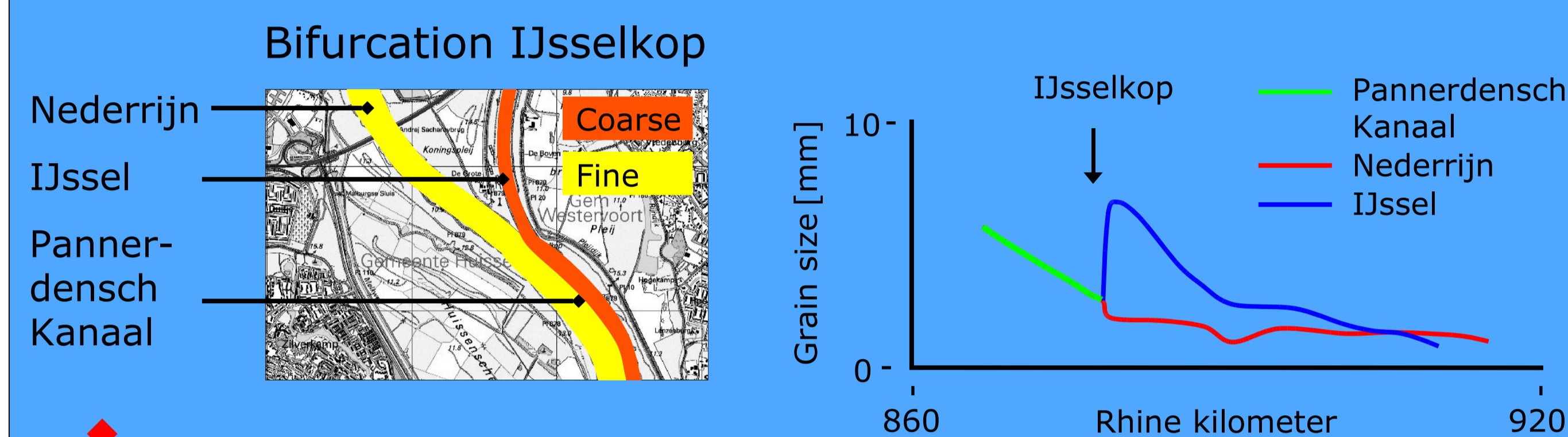
Abrasion

Abrasion, the breakdown of individual grains, is negligible in sand bed rivers (e.g. Waal), but can be significant in sand-gravel bed rivers (e.g. Bovenrijn, IJssel).



River bifurcations

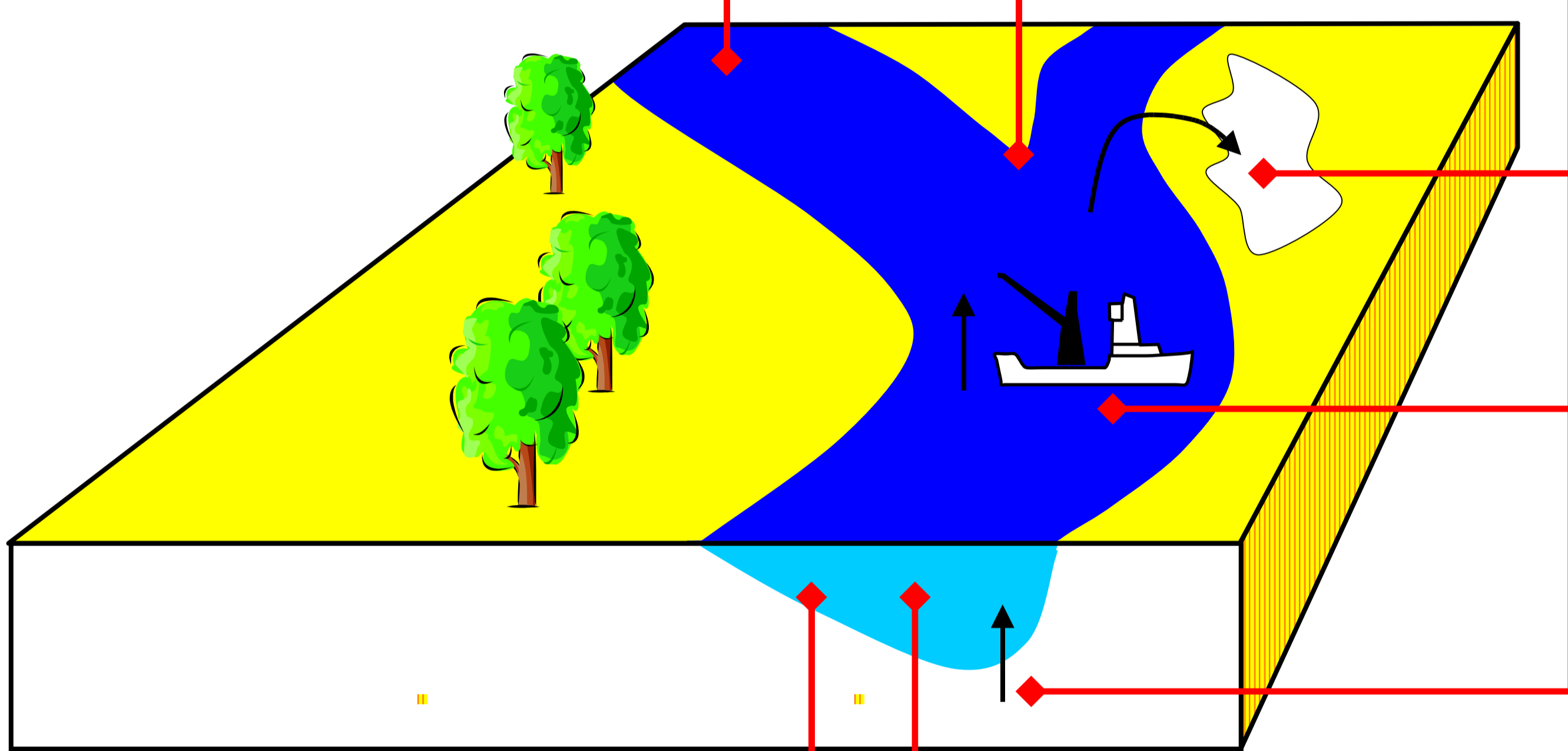
The horizontal sorting of sediment in the meander bend upstream of a **river bifurcation** determines the size composition of the load entering the two branches.



Sediment exchange

The *extraction* of fine bed material through **dredging** or **floodplain sedimentation** prevents a rapid fining of the bed.

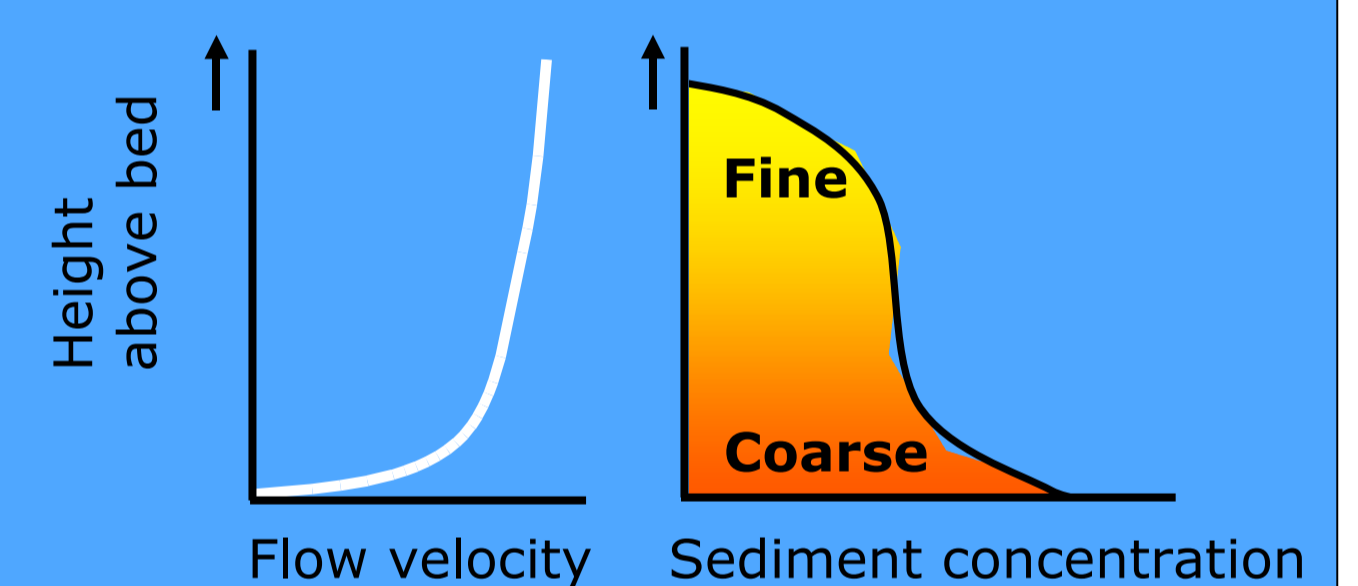
The *introduction* of material with a different composition (e.g. through **bed degradation**), also affects the downstream fining trend.



Suspended load transport

Selective transport (the preferential downstream transport of fine grains) is usually considered to be the primary cause of downstream fining. The degree of selective transport is strongly enhanced if a part of the sediment load travels in **suspension**.

1. The suspended load transport is faster than the bed load transport and has a finer composition.
2. Also the suspended load transport itself is size-selective. Fine grains are present higher in the fluid column, where the flow velocity is higher.

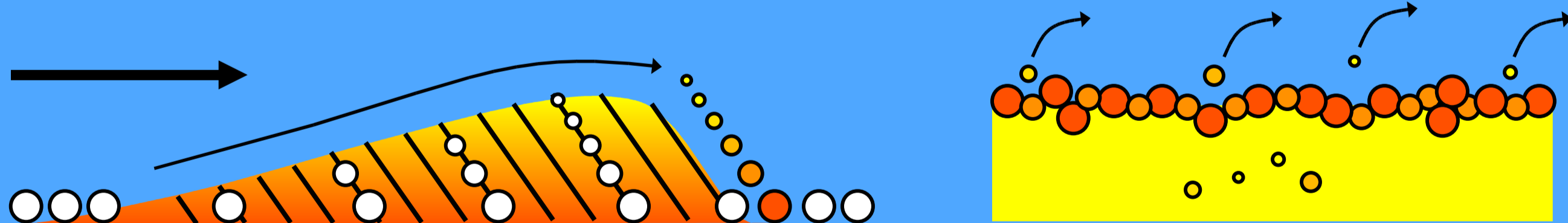


Vertical sorting

Two competitive processes influence the degree of selective transport

Dune sorting concentrates coarse grains in deep bed layers, which are only mobile at high discharges, so decreasing the mobility of these coarse grains.

Armouring concentrates coarse grains at the bed surface, where they are easily entrained.

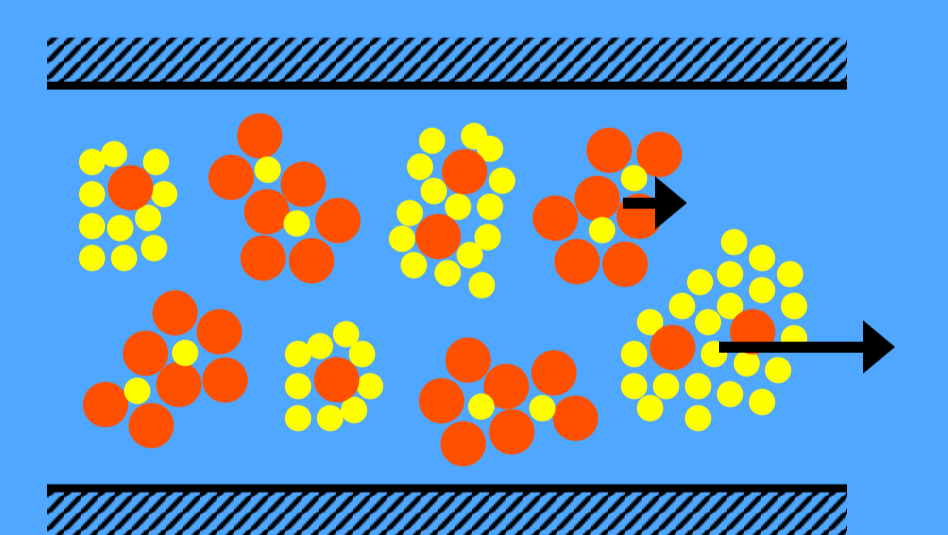


Horizontal sorting

It is known from gravel bed rivers that the river bed often consists of coarse and fine **patches**. Even if all grains within a patch have the same transport velocity, the (bed load) transport process will be size-selective, because fine patches move faster than coarse patches.

It is hypothesized that the same effect is present in sand bed rivers and sand-gravel bed rivers, though the origin of patches may be different.

(Patches can result from bend sorting, dune migration etc.)



Ph.D. research 2003-2007

1. Detailed description of the downstream fining patterns in the Dutch Rhine branches.
3. Determination of the effect of abrasion processes on sand-gravel mixtures.
5. Determination of the effect of vertical and horizontal sorting processes on the degree of transport selectivity.
7. Study of the suspended load transport of non-uniform sediment mixtures and its effect on the degree of transport selectivity.
5. Construction of a fraction-wise sediment balance incorporating the effects of dredging, floodplain sedimentation and bed degradation.
6. Determination of the fraction-wise sediment distribution over the bifurcations IJsselkop, Merwedekop and Pannerdensch Kop.
7. Scenario studies using an (adapted) existing downstream fining model, to determine the relative importance of the several downstream fining processes, and to determine the time-scales of downstream fining development.

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