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The influence of neap and spring tide on stratification and salt intrusion in alluvial estuaries

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Salt intrusion in alluvial estuaries is affected by the interaction between fresh water and saline water. When the river discharge is practically stable, the degree to which salt water from the ocean penetrates landward depends on the tide.

The 1-D longitudinal dispersion is the parameter that describes the mixing between fresh and saline water. The dimension of this parameter is [L^2/T], representing the spreading of a substance (e.g., salinity) per unit of time. The dimensionless dispersion is a function of the stratification, described by the estuarine Richardson number. But which physical parameters should be used to make the dispersion dimensionless? Basically, it should be scaled by a spatial distance (the mixing length) and a measure for the spreading velocity. However, the questions are: 1) which mixing length to use: the depth of the estuary (as a measure for vertical gravitational circulation), the tidal excursion (as a measure for the exchange with longitudinal salinity gradient and trapped pockets on the banks), or a mixture of the two? and 2) which velocity to use: the tidal amplitude (as a measure for the flow velocity), or the shear velocity (as a measure for the turbulence). Using the depth instead of the tidal excursion implies that the stronger the tide (e.g., spring tide), the smaller the stratification and the shorter the intrusion length, while using the tidal excursion implies that the weaker the tide (e.g., neap tide), the shorter the intrusion length. If we use the tidal velocity amplitude instead of the shear velocity, the effect of bottom shear is not taken into account explicitly.

Most observational data in real estuaries are available during spring tide, when the estuaries are better mixed and when salinity is supposed to intrude furthest inland. On top of this, it is questionable if the neap-tide variations lead to approximate steady state salt intrusion at the extremes. Hence, the field data so far can't provide unequivocal answers to these questions. Hence, the main question of this research is what the effects of neap and spring variations are on salt intrusion based on field observations.