Geophysical Research Abstracts
Vol. 19, EGU2017-8514, 2017
EGU General Assembly 2017

Turbulence control of the flux of particulate matter, nutrients and pathogens in the river-estuary transition zone of a shallow macrotidal estuary.

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The River-Estuary Transition Zone (RETZ) is the region where fluvial and tidal modulations of converging fresh water in the tidally influenced river and salt water in the upper estuary give rise to strong gradients in water dynamics and properties that vary significantly on tidal to seasonal time scales. Biogeochemical components (e.g. nutrients) and biological components (e.g. pathogens) from the land must traverse the RETZ in order to progress to the sea; as such the RETZ is a globally significant boundary. Suspended particulate matter (SPM) is potentially a key mediator of biogeochemical and biological fluxes through the RETZ since particles carry carbon and other nutrients and microbial pathogens.

Observations of dynamics and SPM properties made over spring-neap cycles in the RETZ of the Conwy system in North Wales during four observational periods show that turbulence controls both the particle size and flux of SPM. Turbulence dissipation inversely scales on median particle size: high turbulence on flood and ebb breaks up the flocculated particles of SPM while low turbulence at high water gives rise to aggregation of large particles and rapid settling. Measurement of nutrients and pathogens associated with SPM shows that these biogeochemical components are preferentially adhered to small and medium size flocs rather than to large flocs

Moreover, mixing due to turbulence results in fractionation of particle size. In the upper estuary, tidal straining associated with an axial convergent front allows stratification of the water column on the flood tide so that turbulence is reduced; this does not occur on the ebb. So although current velocities are greater on the flood than on the ebb, turbulence is greater on the ebb than on the flood. The reduced turbulence on the flood leads to reduced mixing of large resuspended flocs upwards from the bed, so the flux of large flocs is also reduced on the flood; however, with increased turbulence there is greater flux of large flocs on the ebb. The result is that there is a net seaward flux of large flocs. In the tidally influenced river, tidal pumping results in a net landward flux of small and medium flocs. The net landward flux of small flocs in the tidally influenced river is, by mass, an order of magnitude greater than the seaward flux of large flocs in the upper estuary.

This results in a net landward flux of nutrients and pathogens associated with small and medium flocs, contrasting with a much smaller seaward flux associated with large flocs. The biogeochemical components are therefore pumped landwards into the tidally influenced river which acts as a sink; the seaward export to the estuary is much smaller. Turbulence in the RETZ effectively sorts particles and particulate components and determines whether the RETZ acts as a sink or a bypass zone.