Development of a new model capable of calculating the spatial distribution of age of seawater which has entered a river mouth

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1. Introduction

Riverine estuaries have complex water environments where fresh water from the river and seawater are mixed in various proportions both in temporally and spatially. This research is intended to support water quality and ecosystem preservation plans for riverine estuaries by clarifying the mechanism which produces oxygen deficient water masses in the bottom layers and various other water quality phenomena which are problems for riverine estuaries by developing a new model[1)] which can be used to quantitatively evaluate the elapsed time (age) after sea water flows into the riverine estuaries.

2. Age calculation model

Normal numerical analysis of salinity in riverine estuaries and inner bays calculates the mass balance of salinity for each grid. This process is expressed in terms of advection and diffusion. Necessary values for this calculation such as flow velocity and diffusion coefficients are given from a hydrodynamic model which analyzes the temporal and spatial distribution of flow. The mass balance equation based on advection and diffusion is shown in Figure 1, but if the flow velocities and diffusion coefficients are given by the hydrodynamics model, the only unknown variable is the salinity *C*, so the equation in the Figure 1 can be treated as a linear equation. Thus, even if the calculation is done treating the fractionated salinity by the time each flowed into the river mouth as separate variables, when these are totaled, the value is identical to the concentration calculated in the ordinary way without fractionating the salinity.

If the salinity is fractionated by the time it flowed from the sea through the lateral section of the boundary between the ocean and the river into the river channel, it is possible to obtain the concentration and age for each of the fractionated salinities, so the average age of the existing salinity can be computed for each calculation grid set in the riverine estuaries.

Figure 2 shows the salinity at the river mouth and the average age after flow into the river mouth in vertically two-dimensional distribution, revealing that the age is longer on the upstream side.

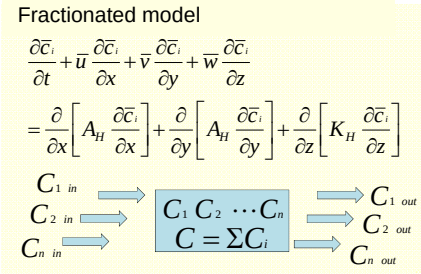

Figure 1. Salinity Mass Balance Equation and Salinity Fractionation

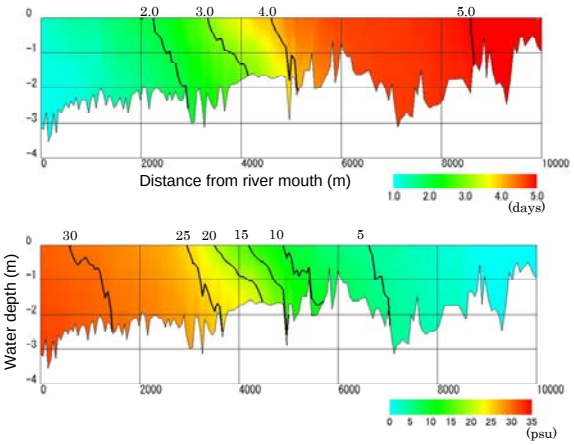

Figure 2. Average Age (Days) of the Salinity and the Salinity (psu)

3. Conclusion

The elapsed time (age) of the water mass plays an important role in the fluctuation of water quality in a riverine estuaries. Our new model can quantitatively evaluate this, permitting the clarification of the mechanisms of water quality fluctuation in such areas.

[Reference]
1) Amano et al.: Numerical analysis of environmental effects on the retention time of sea water in riverine estuaries, Journal of the Japan Society of Civil Engineers G (Environment), v. 6, n 7, 2011.