

Interactive comment on “A method for calculating the duration and intensity of salt intrusions: the Yangtze River estuary” by M. Webber et al.

M. Webber et al.

mjwebber@unimelb.edu.au

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The reviewer makes 5 general comments.

[1] To overcome the problem that observations of both discharge and salt intrusion are limited, the paper presents a statistical model representing the relationship between salinity and discharge and subsequently uses Monte Carlo simulations to reconstruct the probability of different intensities and durations as a function of discharge. I wonder why this rather concocted equation was used instead of the physics based equation between salinity and river discharge that exists and has proven its value, as published in Zhang et al. (2011), which the authors cite. Surely that equation would have provided a better functional basis for the predictions.

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The Zhang et al. paper is certainly useful and has informed our work. That model is designed to estimate salinity along the separate branches of the estuary and at different distances from the sea, which is a different problem from that which we confront. The problem we have combines frequent observations of discharge, infrequent observations of salinity and the task of estimating salinity and its duration at a point, Shanghai's Qingcaosha storage intake. Whereas Zhang et al. could calibrate their model parameters from observations on one day and then evaluate the model with observations on only another two days, we sought a method that combined the known data [over 300 observations] with a search for more robust estimates of chlorinity. In short we believe that it is important that there exist different methods for approaching the task of predicting the risk of saline intrusions. Our method is attuned to duration, and its probabilistic nature accords with incomplete knowledge about the dynamics of the Yangtze estuary.

[2] It is a bit hard to see the innovation of this paper. The application of a complex autoregressive function is not really the innovation. So the innovation lies in the combination of a salinity-discharge relation with a Monte Carlo simulation method to construct high intrusion periods, and to analyse which of these have a critical duration.

Precisely! Unlike all previous analyses of saline intrusions in the Yangtze River, we estimate not only their chlorinity, but also their duration. Because we know daily discharges for over 50 years, we can estimate the probability of critical discharges, below which saline intrusions are highly likely and we can estimate the probability that these intrusions last for more than specified lengths of time.

[3] Because the authors have used an auto-regressive function that lacks physical foundation, the risk is that this model works well for the calibration period, but fails during the critical periods the method has been designed for.

The calibration period includes observations from five separate years. In all of those observations, discharges lay in the range 6000 – 16000 cu m / sec, which is precisely the

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range within which chlorinity is variable. No lower discharges have ever been recorded; at higher discharges, saline intrusions are demonstrably unlikely. The calibration intervals are precisely those that are the critical periods for saline intrusions. Of course, the model may fail outside the calibration period. But our calibration period extends over five separate years and more than 300 observations. Like any prediction, only time will tell.

[4] The authors mention that: "All of these modifications (physical interventions) will affect the probability of salt intrusions in the estuary and it is important to calculate their effects". Only a physics-based model will be capable of simulating the effects of these interventions (dredging, sea level rise, changing seasonality, etc.), whereas the statistical method cannot.

The modifications that are going to be important are water abstractions from the river basin [principally the south-north transfer], the operation of large dams, changing seasonality and sea-level rise. All of these changes are either modifications to discharge or equivalent to modifications of discharge and are therefore readily accommodated within the model that we have estimated.

[5] Finally, as an aside, the main problems of salinity near the intakes for Shanghai, are the result of relatively saline water from the North Branch spilling into the South Branch during low flows. This effect is impossible to take into account in this statistical model, while it is this phenomenon that is most probably critical for the water supply of Shanghai.

The paper mentions that this is what actually happens during an intrusion. Our model is in effect a method for identifying when this occurs. The Zhang et al. model is not a model of this spill-over effect, either.

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