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REVIEW

River Mixing. By J. C. RUTHERFORD. Wiley, 1994. 347 pp. ISBN-0-471-94282-0. £59.95.

I would recommend this book to any engineer or scientist who seeks an understanding of mathematical modelling for mixing processes in rivers. J. C. Rutherford places mathematical modelling as the secure foundation from which field observations and laboratory experiments can best be interpreted. The introduction gives powerful advocacy for the importance of idealized models – which I shall be quoting in my future grant applications. However, mathematicians might get the false impression that in the subject of River Mixing the existing models are so good that there are only peripheral research issues left for mathematicians to deal with.

This is a very carefully structured book. The chapters begin with numbered summaries of the key points to be raised and end with complete lists of notation for that chapter. Also, the chapters need not be read in sequential order. These features make it possible to read this book in spare moments, despite the technical complexities. Indeed, this book has been companion in a variety of non-academic circumstances.

The first chapter covers the entire topic of mechanisms and models. Rutherford uses molecular diffusion as the paradigm relative to which Reynolds averaging, eddy diffusivities, depth averaging and Taylor dispersion coefficients are natural extensions. The full complexities of three-dimensional flows are contended with, even when this requires second-order tensors. The chapter ends with a description of curvilinear coordinates and metric coefficients for the analysis of tracer concentrations in a meandering river. Bearing in mind that the work of G. I. Taylor (1953) on shear dispersion was an outstanding intellectual achievement, the rapidity of the derivations here is breathtaking. For most readers I would expect chapter 1 to have to be read and re-read over numerous sessions and long after the other chapters had been understood.

Chapters 2, 3 and 4 apply the mathematical models to vertical, transverse and longitudinal mixing respectively. For the eddy diffusivity and Taylor dispersion models, the mathematics is neat and straightforward. Numerous complications are considered: helical secondary currents, non-uniform depth/velocity/diffusivity, buoyancy effects, discharges with large volume or large momentum, meandering of the river and changes in bathymetry. Great emphasis, totalling over 20 figures, is given to the importance of the location of a tracer source. Pollution minimization is one of my own obsessions, so I am pleased that Rutherford points out that careful discharge positioning can simultaneously minimize both the mixing distance and the concentrations at boundaries.

Chapter 5 has the title 'Field measurements of mixing'. It concerned me that simulated data were used in which random errors were superimposed on the model predictions. The true status of mathematical models is better surmized from a quotation given in an earlier chapter: Day & Wood (1976) state that they are '... unaware of any Gaussian concentration distribution ever being recorded from flow in an open channel...'

Chapter 6, the last, gives mathematical models for mixing between sediments and river water. This chapter was not as well structured as the rest of the book. Possibly, like the reviewer's attitude to mathematics, Rutherford is most aware of the shortcomings in his own area of research.

The extensive appendices, references, author index and subject index complete this carefully drafted book. I was mildly amused at the quirk which transformed my Loughborough colleague Jim McGuirk into McQuirk.

No-one has yet managed to make the subject of mixing in rivers easy. With this book, J. C. Rutherford has given a clear, consistent and complete account of a difficult subject.

REFERENCES

DAY, T. J. & WOOD, I. R. 1976 Similarity of the mean motion of fluid particles dispersing in a natural channel. *Wat. Resour. Res.* **12**, 655–666.

TAYLOR, G. I. 1953 Dispersion of soluble matter in solvent flowing slowly through a tube. *Proc. R. Soc. Lond.* A **219**, 186–203.

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