

Book review

Elicitation of Expert Opinions for Uncertainty and Risks

B.M. Ayyub, CRC Press, 2001, ISBN 0-8493-1087-3, US\$ 79.95 hardcover, 302 pages

A landmark publication by Harold J. Barnett and Chandler Morse in 1963 (*Scarcity and Growth: The Economics of Resource Availability*, Johns Hopkins University Press for Resources for the Future, Baltimore) renewed a longstanding debate on the prospect of sustained economic growth under natural resources availability constraints. Their main argument was that substitutability of resources and technological progress would sustain economic growth indefinitely even in the presence of exhaustible natural resources. A decade and a half later, a forum of experts mainly from economics, energy, and mineral resources (including Barnett and the now recent Nobel laureate Joseph E. Stiglitz) reviewed the issue (*Scarcity and Growth Reconsidered*, Johns Hopkins University Press for Resources for the Future, Baltimore, 1979). Not surprisingly, there was no consensus as to whether or not the scarcity of natural resources would curb or eventually halt economic growth.

The surprising fact, however, is that a prestigious institution, two dedicated analysts, and a distinguished forum of experts (working with the benefit of hindsight, years after the publication of the *Limits to Growth* report by the Club of Rome) completely missed the point simply because they were looking for the right answer for the wrong question. We know now that economic growth will be eventually self-limited by our incapacity to dissipate into space the heat generated by processing the increasing amounts of resources required to sustain economic growth. Global warming, rather than global scarcity, seems to be the main threat to sustained economic growth.

The story is illustrative of the many facets and potential liabilities of expert opinion elicitation and use for policy decision making. Was it sensible to set up a closed-ended scenario for analyzing the problem? Did the opinions of the experts reflect knowledge or rather advocacy? Did a forum offer the most appropriate environment for the kind of questions requiring expert scrutiny? These and a host of other key topics are covered in Ayyub's book. As stressed in the book's preface, it is generally recognized that experts are valuable sources of knowledge but they can have divergent views and be wrong in their beliefs. This is rather unsurprising considering that many vitally important issues are characteristically complex and cannot be settled experimentally, hence requiring expert involvement. A number of highly sensible ecological domains (e.g. pollution, conservation) are still heavily reliant on expert opinion and will probably remain so for the foreseeable future.

Only a handful of books have been published in the last decade or so that deal specifically with expert opinion elicitation and applications; Ayyub's is probably the most comprehensive of them since the publication of R.M. Cooke's *Experts in Uncertainty* (Oxford University Press, 1991). Mainly aimed at engineering and science professionals, the book covers an array of topics and techniques. The material is arranged in a preface section, seven chapters, bibliography, and index; exercise problems are presented at the end of most chapters.

Chapter 1 introduces needed definitions of terms and concepts, and provides a comprehensive background on the historic evolution of knowledge views. It covers most relevant theories and beliefs from pre-Socratic to contemporary philosophers. Knowledge, information, opinion, and ignorance are considered from both a philosophical and an operational point of view. The chapter includes a quite complete perspective on and

taxonomy of ignorance. Chapter 2 covers system analysis and modeling of engineering processes. Decision analysis tools (decision trees, influence diagrams) and models for representing different types of ignorance and uncertainty are incorporated in this chapter, mostly written for a civil engineering audience.

Chapters 3–6 form the core of the book, are mostly self-contained, and could be read independently of the rest. Chapter 3 focuses on characterizing the field by presenting definitions for *expert* and *expert opinion*, and providing fairly complete background information on expert elicitation methods. The catalogue of expert elicitation methods includes pioneer work at the legendary RAND Corporation whose first and most impressive achievement was the timely and accurate prediction of the launching of the Soviet Sputnik, the first space satellite. I found the section on methods of social research (including guidelines on formulating questions and presenting issues) particularly illustrative and useful for professionals with limited skills in small group interaction.

The kind of information requested from experts may be variable in both form (e.g. verbal, graphic) and information content. The expression and modeling of expert opinion require the use of some formal framework for supporting the transmutation of opinions into values and distributions on appropriate scales. Chapter 4 covers most common formal alternative frameworks: fuzzy sets, rough sets, probability theory, theory of evidence, and possibility theory. The fuzzy sets section of the chapter is a tour de force, probably a reflection of the author's background and expertise.

Consensus achievement and other forms of aggregating opinions are treated in Chapter 5.

Main topics in this chapter are weighting and assessment of uncertainty of opinions, and criteria and methods for combining opinions. Chapter 6 offers some guidelines on the process of expert opinion elicitation but seems to be misplaced after Chapters 4–5. For teaching purposes, its content would be much more effectively taught as part of Chapter 3. The description of applications in Chapter 7, although probably interesting for a civil engineering audience, may be a little shallow and too removed from ecology to be of any immediate value for ecological engineering purposes.

Most of the book's material seems to have been student-tested and may provide the core for an advanced undergraduate or graduate level course. Prior exposure to fuzzy arithmetic and some probability theory may be helpful, but no additional mathematical skills are required to benefit from reading this book.

The primary value of Ayyub's book for ecology practitioners lies in its fairly complete coverage of methods and issues involving elicitation and application of expert opinion. The book is somewhat repetitive in parts and it does not incorporate some recent literature in relevant subjects such as assessing and modeling agreement and disagreement among experts, category distinguishability in expert classification, and utilitarian vs. egalitarian visions on uncertainty and risk in societal contexts. Granted, the field is ample, diverse, and controversial.

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