Groundwater

Book Review/ Alan E. Fryar/Book Editor

Integrated Groundwater Management: Concepts, Approaches and Challenges

reviewed by Philip Brunner

Groundwater is a hidden, yet essential resource in all climatic zones. It is the most important global source of drinking water and industrial production and mining operations rely on it heavily. Groundwater constitutes approximately 50% of worldwide irrigation water, which greatly increases the efficiency of agriculture. A wide range of valuable ecosystems relies exclusively on groundwater. However, the days of unconcerned use of groundwater are long over. Groundwater depletion and pollution worldwide have reached a level so critical that the above-mentioned functions of groundwater can no longer be maintained or guaranteed for current (let alone future) generations.

Given the very different functions and various roles of groundwater, one could expect that groundwater management routinely integrates and considers physical, economic, ecological, and social aspects. However, this integration is very challenging and rarely achieved, which can result in inefficient, one-sided, or unsustainable policies. The open-access book by Jakeman et al. (2016), whose goal is to synthesize the current state of the art across a very wide range of topics and fields relevant for groundwater management, is an exceptional piece of work. It provides a general introduction to integrated groundwater management (Part I), followed by comprehensive introductions to governance (Part II), biophysical aspects (Part III), socioeconomics (Part IV), and modeling and decision support (Part V). It is an ideal starting point not only for groundwater scientists, but also for managers and biologists who want to gain a better understanding of the interdisciplinary relevance and importance of groundwater. Because of the length of the book (756 p.) and its scope, this review focuses on Part III of the book (biophysical aspects). Other reviews have addressed other aspects of the book (Filatova in press; Giupponi 2017).

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Part III includes six chapters (153 p. total) that cover much of the gamut of biophysical aspects of integrated groundwater management. As with the other sections, a range of illustrative case studies is provided in every chapter. The overarching emphasis is on the links between groundwater, management, ecology, and biology. The section provides useful overviews on readily applicable methods and approaches that can be used to tackle the problems discussed. Even though the section is written without equations, several flow charts, diagrams, and a very comprehensive reference list are provided. A justifiable omission is a chapter on groundwater modeling, since there are already many texts on this topic at various levels.

Chapter 12, the first chapter of this section, provides an introduction to the development of ecohydrology, illustrates its role for different climatic conditions, and provides examples of how to incorporate ecohydrology into integrated groundwater management. Chapter 13 provides a solid overview of groundwater-dependent ecosystems (GDEs) in various geological and climatic environments. Different methods to identify GDEs are briefly discussed, including satellite-based remote sensing and isotopic methods. In Chapter 14, the authors present excellent examples of how water quality is related to integrated groundwater management. Chapter 15 discusses one of the world's most universal pollutants: salt. The physical and chemical processes that trigger soil salinity are introduced, as well as a useful overview of the hydrogeochemical changes during soil salinization. A very strong contribution of this chapter is the presentation of conceptual diagrams illustrating the links between water and salt management as well as the relevant physical processes. The two case studies are also very illustrative and underscore the importance of an integrative approach to water and soil management. Seawater intrusion is very briefly mentioned and the interested reader should consult additional literature for a comprehensive overview. The same is true for monitoring and assessment methods of soil salinity.

Chapters 16 and 17 discuss managed aquifer recharge. In Chapter 16, a comprehensive overview of the relevant issues as well as options and opportunities are discussed.

The discussion includes the different technologies used for managed aquifer recharge and the geological and regulatory constraints as well as health and environmental risks. A case study in France illustrates several of the above-mentioned aspects. Chapter 17 explicitly integrates managed aquifer recharge and water resources management, with several very useful graphical illustrations demonstrating the key links between management, hydrogeology and hydrology. The chapter presents two carefully chosen and well-illustrated case studies that allow the reader to appreciate the complexity as well as the potential of managed aquifer recharge.

As a groundwater scientist mainly working on the physical aspects of groundwater, I found this section on biophysical aspects an inspiring and extremely useful contribution. The section itself integrates seamlessly with the other topics through cross-references, linked tables, a consistent style, and narrative. This is a remarkable editorial achievement for a book written by 74 different authors.

I strongly recommend the book to everyone working in the field of groundwater—be it as an engineer, a policy maker, an ecologist, a groundwater scientist, or a social scientist. It illustrates very clearly the urgent need for reaching out to fields and topics beyond the core competencies of the individual disciplines. I consider this book a tremendously valuable tool that helps us extend our work, understanding and vision beyond our comfort zones.

References

Filatova, T. 2017. Book review. Integrated groundwater management: Concepts, approaches and challenges. *International Journal of Water Resources Development*. In press.

Giupponi, C. 2017. Integrated groundwater management: Concepts, approaches and challenges. *Environmental Modeling & Software* 93: 161–162.

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