of the original version in German authored by Harald Fritzsch, published in 2005. The author is well qualified to narrate the exciting story of how we have arrived at where we are now. The discovery of the color quantum number was a crucial step in the acceptance of the reality of quarks themselves, and in establishing quantum chromodynamics as the correct field theory of strong interactions. The idea of a color quantum number evolved over a period of time, beginning with independent suggestions by B. Struminsky and O. W. Greenberg in the early 1960s. Other notable contributors include N. Bogoliubov, A. N. Tavkhelidze, M.-Y. Han, Y. Nambu, W. Bardeen, H. Fritzsch and M. Gell-Mann. A seminal 1973 paper by Bardeen, Fritzsch and Gell-Mann put the concept of colour charge on a firm footing. Taking a cue from the famous dialogue form favoured by Plato in *Timaeus* and by Galileo in *Dialogo* as well as *Discorsi*, Fritzsch has presented his account of the Standard Model and related matters in the form of an extended imaginary conversation, set in balmy California, between three well-chosen characters: Isaac Newton, Albert Einstein and 'a modern-day physicist named Adrian Haller, who comes from the University of Bern and is serving as a guest professor at Caltech in Pasadena'. The latter is the counterpart of Galileo's Salviati, and (understandably) does most of the explaining, bringing his elite fellow-conversationalists up to date on what has happened since their day, step by step. Newton and Einstein are of course very different from Galileo's Simplicio and Sagredo. The dialogue format permits them to make perceptive remarks and pose pertinent questions at appropriate junctures, so that Haller (as the alter ego of Fritzsch!) can carry the explanation forward without becoming monotonous.

The topics discussed range from the beginnings of modern ideas regarding the constants of nature and the fundamental interactions of nature, up to brief remarks on the early universe and some of the physics that may be expected beyond the Standard Model. The flow of ideas is coherent, and the pace is just right for a book at this level. The story roves back and forth between various acts in the drama of particle physics as it has unfolded in the second half of the 20th century. The dialogue form keeps the narration from flagging, and the interjections of Haller's alert audience raise (as intended) precisely the questions that arise in the reader's mind. As the narrative proceeds, Newton's share in the conversation falls distinctly below that of Einstein, showing how far we have come from the beginning of modern physics. Haller believes (as of 2005) that the mechanism of mass creation is different from the Higgs mechanism, and he has doubts about the chances of the Higgs particle being found in the LHC experiments. As we know, events have already overtaken him. I found a couple of minor inaccuracies, such as the statement (in the fictitious Einstein's share of the conversation, as it happens) that the group $SU(4)$ is isomorphic to $SO(6)$, and the group $SU(2) \times SU(2)$ is isomorphic to $SO(4)$. In each case the relationship is a 2-to-1 homomorphism, of course. On the whole, however, the book makes for a really good read, for students as well as professional physicists, especially for those in other areas who wish to get a quick bird's-eye view of what has been happening in particle physics. Haller succeeds in holding the attention of the reader throughout, and not just in the very brief, almost casual aside in which he recounts the dramatic escape of Fritzsch and a friend of his from East Germany in 1968, via Bulgaria to Turkey across the Black Sea in a folding canoe – an adventure that seems to have aroused the interest of the CIA, presumably because that agency was intrigued by the possibility of such a feat under the very nose of the Soviet Navy. Apart from realizing his goal of escaping a totalitarian regime, Fritzsch's daring led to another happy outcome. According to the author, it caught Gell-Mann's attention, and brought them together for their notable collaboration on an important part of the Standard Model.

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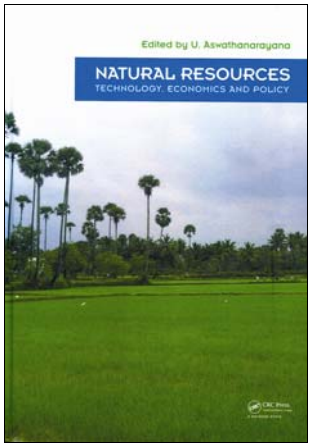

Natural Resources: Technology, Economics and Policy. U. Aswathanarayana (ed.). CRC Press/Balkema, P.O. Box 447, 2300 AK Leiden, The Netherlands. 2012. xxxv + 474 pp. Price: US$ 94.22.

Perceptions of water and energy management in India are sharply polarized in two diametrically opposite viewpoints. The paradigm which is practised all over India and elsewhere in the world too, is based on modern technology-based initiatives like dams, barrages, canals, irrigation systems, deep tube wells, agrochemicals, HYV seeds, may be even GM seeds, hydro/thermal/nuclear power, etc. Stacked against this is what can be called, for want of a better name, 'traditional wisdom' paradigm which argues that water and other natural resources management and agriculture practices reached their pinnacle in some unspecified past; all change thereafter has been only for the worse, and rejects all modern technology-based interventions.

The environment and rights-based opposition to large river-valley projects that started around 1985, has forced the practitioners of technology paradigm to get sensitized to the deficiencies in their practice of technology. This has resulted in significant, though not yet sufficient, improvements in the practice of technology. For example, a detailed EIA, public consultations, an elaborate R&R plan instead of a lump-sum monetary compensation, compensatory afforestation and watershed management, are now an integral part of the formulation process of large projects.

However, the reverse sensitization has not taken place. The advocates of 'traditional wisdom' paradigm do not seem to have improved their understanding of what are different technology interven-

tions and why these are necessary. It is seen that those who oppose the technology-based paradigm often have a background in arts and humanities, and not in sciences or engineering. And there is a paucity of reading material that would explain the technology paradigm in a manner, and restricting itself to a level, that would be understood by those not trained in S&T.

This void will be filled to a large extent by this book with contributions by 11 authors, and edited by U. Aswathanarayana, who is also the majority contributor. The book is an interesting mix of – as the title suggests – technology, economics and policy issues related to water, energy, minerals, biodiversity and even disaster management. After an introductory chapter, there follow over 30 essays in six sections.

Typically, books on water, energy, etc. tend to be devoted either entirely to technology, or entirely to policy with some economics. But the practice of technology per force requires factoring in economics and policy. This book serves an important purpose of bringing discussion on all the aspects in one volume.

Expectedly, over 40% of the discussion (and therefore also 40% of this review) is about water resources. Starting with basic concepts of water balance, it covers conjunctive use of surface and groundwater, pricing of water, policy perspectives, agriculture, degradation of water quality, diseases arising from toxic substances in water, wastewater reuse systems, remote sensing for water resources management, etc.

It would be a mistake to comment, as some might, that none of the topics is treated in adequate depth. For example, Chapter 2.6 'Wastewater reuse systems' is just 13 pages. But this reviewer is of the opinion that enabling the reader to design, say, a bio-pond purification system is perhaps not the intended purpose of this book. A practitioner/professional wanting to do that will have to refer to authoritative texts devoted entirely to wastewater treatment, and there are many such books. In 17 pages, any book can only provide an overview. But the importance of such an overview has perhaps been underestimated so far. During his tenure as Chief Engineer of the Upper Yamuna River Board, the present reviewer has often interacted with NGO activists who feverishly argue that Delhi sewage be treated to CPCB Class C specifications (BOD < 3), without any demonstrable understanding of how this can possibly, if at all, be achieved.

The era when civil engineers could plan and execute a Bhakra project, or atomic scientists could plan and execute a Tarapore atomic reactor, is over. Now, consultations with civil society actors is an integral part of the planning process to make use of natural resources, and it is necessary that an overview of the science of water management, or energy management, or any other topic, is presented to a non-S&T personnel.

Similarly, the book provides on overview of various minerals and their management, energy resources management, bio-resources and disaster management.

The reviewer's perception that the book fills a void that was needed to be filled, can best be explained by an example: Section 3.3, 'Control technologies for minimizing environmental impact of mining'. During the last few years, the mining industry has come under disrepute for causing environmental damage. When such instances come to notice, usually there is an outcry to stop the mining altogether. For example, the Western Ghats Ecology Expert Panel Report recommends a direct or indirect ban on all mining in entire Western Ghats. But, as C. N. R. Rao, Chairman, Science Advisory Council to the Prime Minister notes in his foreword, mining cannot be avoided. Unfortunately, the society seems to have lost sight of the fact that it is possible to do mining while minimizing environmental damage. Section 3.3 should help bring that back on the discussion table.

The book will also be found useful by the experts in a particular domain, for acquiring a working knowledge of other domains. Water resources engineers will find useful the chapters on minerals management, while mining engineers will find useful the chapters on, say, energy management. All technocrats working in water, energy and mining sectors would do well to read Section 5 on 'Bio resources and bio diversity'.

In the introduction to his celebrated book *A Brief History of Time*, Stephen Hawking says his publisher warned him that every equation in his book will reduce the number of readers by half. Hawking said despite his best attempts he could not avoid one equation, $e = mc^2$, and hoped this would not scare away half his potential readers. It is conceded that Aswathanarayana could not have written this book with just one equation. But there are many instances where the mathematics does not add any value. For example (p. 103), 'Land availability constraint. The extent of land used for various crops cannot exceed the total available land. Also, the land allocated to a given crop has to remain unchanged from sowing to harvesting' is clear. The equation that comes next,

$$\sum_{i=1}^{n} A_i \le TA$$

does not add any value.

Except for this one comment, or even with it, this book is strongly recommended for all, specialists as well as others.

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Annual Review of Physiology, 2012. David Julins and David P. Claphaw (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 74. xi + 539 pp. Price not mentioned.

Commenting on the release of the first volume of the *Annual Review of Physiology* in 1939, the *Journal of the American Medical Association* mentioned 'Its editors, confronted by the enormous dimensions of investigative work in the field of physiology, have chosen to advise the authors to attempt a critical appraisal of the contemporary field by an analysis and interpretation of the most significant contributions rather than a more comprehensive review'. That task has become even greater today with the blurring of the boundaries of physiology and the exponential increase in the quantum of experimental work. Over the years, the articles in the *Annual Reviews* have changed in character from more descriptive work to mechanistic insights and from more integrative physiology to cellular and molecular perspectives. In an attempt to ensure that the *Annual Reviews* retains its broad perspective, the chapters, as in the past, are cited within