

barrier for plant breeders. Application of moderate temperature pulse during meiosis alters chiasma distribution and provides a potential route for breeders to manipulate recombination. In another review, Keeney *et al.* explain how chromosome breakage is incorporated with meiotic progression and the precise role of feedback mechanism in creating double-stranded breaks. A review compiled by Bloom, sheds light on physical properties of DNA to get more insights into organization of centromere and its role in chromosome segregation. Centromeres are special domains of heterochromatin, which is distinguished by various histone modifications and by enrichment of cohesin, condensin and topoisomerase II proteins. The review points out the role of several components that play a role in building a functional centromere, viz. Skl1, Ndc80 and complexes like CCAN and CENP-A.

Replication of DNA forms a vital aspect of the central dogma of life. A review by Kelman and Kelman emphasizes on DNA replication in Archaea. Work on Archaeal systems with respect to bioinformatic, biochemical, structural and genetic studies has illustrated that the mechanisms and the proteins involved are almost similar to what is observed in eukaryotic DNA replication, as opposed to what is seen in bacteria. This review suggests that future studies should focus upon the poorly understood aspects of Archaeal replication process, like mechanisms regulating the initiation process, coordination between initiation and other cell cycle.

Integrity of genome is understood to rely on replication, repair and recombination; however, transcription is undermined and can actually result in compromising DNA integrity of organisms. The review by Robertson and Bhagawat focuses on the role of transcription in maintaining stability of DNA template and also possible evolutionary implications of transcriptional-associated mutagenesis. The review also indicates how comparative analysis of the genome will enhance understanding of how transcription modifies the outlook about mutation in both prokaryotes and eukaryotes evolutionarily.

The crucial step of transcription leads to the process of translation, which relies on an efficient machinery to decode message on mRNA to generate a functional protein without incorporating any errors.

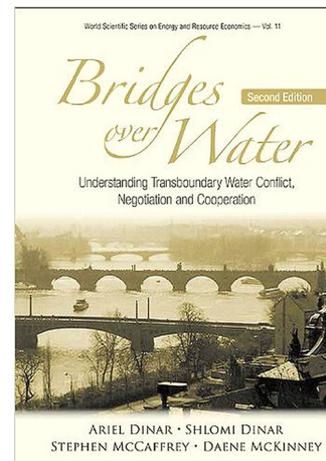
The review by Bullwinkle *et al.* focuses on incorporation of amino acids that are not directed by the genetic code. How non-proteinogenic amino acids would naturally accumulate into the system and the role of translation control machinery to avoid such accumulation are discussed.

Reviews describing various aspects of human diseases are well compiled in this volume as evident in the review by Emily *et al.* which provides an elaborate view on epigenetic mechanisms such as DNA methylation, histone modification and chromatin remodelling in causing diseases. The authors are of the opinion that identification of methylation profiles and epigenetic modifications may efficiently help in curing cancer and other syndromes related to epigenetic mechanisms. Another interesting review describing evolution of a human disease by Gerlinger *et al.*, discusses branched evolution of cancer with low-frequency driver events present in subpopulation of cells, which provide escape mechanisms for targeted therapeutic approach. This review suggests a possible genetic and epigenetic heterogeneity among cells within the same tumour, which adapt to changing environment during progression and therapy.

The recent findings from the field of genetics have been well encapsulated in this volume, providing an excellent resource for researchers working in different branches of genetics. Sincere efforts were made to cover various sub-fields of genetics, ranging from bacterial to plant genetics, and from *Drosophila* to humans, covering important metabolic processes of cells required for development and disease. This volume provides some valuable clues towards understanding some long standing questions from different sub-fields of genetics and also indicates future challenges in understanding molecular mechanism of disease-causing genes and in drug discovery.

K. P. ARUNKUMAR\*  
NAGRAJ SAMBRANI

Laboratory of Molecular Genetics,  
Centre for DNA Fingerprinting and  
Diagnostics,  
Tuljaguda Complex, Nampally,  
Hyderabad 500 001, India  
\*e-mail: arun@cdfd.org.in



**Bridges Over Water: Understanding Transboundary Water Conflict, Negotiation and Cooperation, Second Edition.** Ariel Dinar *et al.* World Scientific Series on Environmental and Energy Economics and Policy, World Scientific Publishing Co Pte. Ltd, 5 Toh Tuck Link, Singapore 596224. 2013. Volume 11. 432 pp. Price: US\$ 435.

Water is the elixir of life and billion people worldwide suffer due to its scarcity<sup>1,2</sup>. Four out of five persons rely on renewable freshwater resources, which primarily originate in mountains and forests. Unplanned developmental projects coupled with burgeoning population, rapid urbanization and globalization have led to deforestation and water quality deterioration. This has affected the availability of water for human use and ecological needs. Hydrologic regime in the river basins is sensitive to changes in climatic conditions and land use land cover (LULC) changes<sup>3-5</sup>. About 40–45% of the world population resides in drainage basins, which account for 60% of global river flows and are a part of the territory of 145 countries. Anthropogenic-induced climatic changes are expected to significantly affect the water cycle. The available freshwater is declining rapidly, exacerbating the problems of sectorial allocation. The stakes have also been increasing with increase in number of riparian states, and unilateral developments by some riparian states are giving way to precarious situations with conflicts. Parallel developments in international river basin modelling, application of game theory, optimization of water and benefits allocation in the context of imminent climate changes have also aided in conflict resolution.

About 25% of global water consumption is overused at the cost of environmental flows and other competing uses<sup>1</sup>. Several economic and political forces play an important role in water resource management of transboundary rivers. With an increase in per-capita water competition, threat of conflict, securitization and exclusion, the need for cooperation is ever intensifying, more so in the case of transnational water bodies, where political, economic and ethnic undercurrents may undermine rational allocation of water. Responses of basin states in the face of conflicting uses and varying water supply, also affect the sustainability and perceived fairness of river-water allocation. International river basins have been studied for several years, but most of these studies lack quantitative methods for an effective comparison of cases<sup>2</sup>. Commonly used descriptive techniques do not take into account strategic behaviour, externalities and the interdependence of water with economic, political and social stability.

This book presents lucidly facets of water cooperation, progressing from concepts to their application. It provides insights into transboundary water conflicts, negotiations and cooperation in the context of international law, international negotiations, international relations and economics. This edition, in comparison to the earlier one, includes quantitative analytical framework with examples from international water negotiation issues, apart from updating of chapters, inclusion of annexure of sample treaties and examples of an application of river basin cooperation game theory (CGT). The book is a consolidation of quantitative analysis of several facets relating to transboundary rivers, which will enable better comparison between case studies and greater accuracy in projecting outcomes of proposed actions. However, it does not discuss the issues of ecosystem services rendered by these river systems, or the impact of a treaty on ecosystem services.

Chapter 1 explains water-use patterns and how prosperity, population, climate change and the state of technology affect water availability and the river itself. Basin states and competing users are interdependent; poor coordination, increasing scarcity and water variability may lead to conflict for dominance or cooperation. The authors observe that parties are less likely to cooperate when there is high scarcity and abundance.

Chapter 2 provides an overview of international relations, conflict negotiation and cooperation over shared waters based on a comprehensive review of the literature related to the disciplines of geography, law, economics and negotiation on transboundary water. Topics discussed include game theory and the role of information asymmetry, geographic location, side-payments and interdependencies in negotiation. This provides an appraisal of the strengths and weaknesses of the international water law in addressing efficiency and sustainability of the resource allocations. The chapter does not analyse the environmental impact of treaty obligations, as treaties and institutions often ignore ecological, social and cultural aspects of the river, and this leads to institutional failure.

Chapter 3 presents the evolution of the international water law and the linkages with it. Select case studies presented in this section, summarize the evolution and application of the international water law to transboundary rivers to resolve disputes. The fundamental rule is that of equitable and reasonable utilization of shared freshwater resources (UN Convention, 1997; Articles 5 and 6). The next obligation is to prevent the causing of significant harm to other states through activities related to an international watercourse (UN Convention, 1997; Article 7), consistent with their rights and obligations of equitable utilization, to eliminate or mitigate it. The third basic obligation is to provide timely advance information of new projects that may adversely impact other states sharing an international watercourse. Another obligation is to prevent and control pollution, and to protect and preserve the ecosystems of watercourses.

The nexus between political and water disputes, the effect of breaching a treaty on water rights, water variability and hegemony are considered. Compared to most countries, Israel and Jordan factor groundwater in their water treaty, which highlights the need for further understanding on the law and management of international groundwater.

Principles of cooperation and its implementation in international river basins is discussed in chapter 4. This chapter provides insights into the resolution of conflicts along transnational rivers through cooperation and strategic behaviour mechanisms with their strengths and weaknesses. These include: (i) the voluntary

principle of joining and leaving the co-operation arrangements, (ii) the democracy principle of managing, (iii) the autonomy principle of self-sustainability, (iv) the universality principles with a set of goals, (v) the equity principle of participating and benefit sharing, and (vi) economic efficiency arrangements. However, factors such as high rainfall variability, divergent economic growth, high population growth rates and growing water-related needs necessitate an immediate action than a long-term vision. This necessitates developing, monitoring and enforcement mechanisms to ensure compliance, creation of institutional structures for addressing potential conflicts, which form the basis for international cooperation. Bilateral treaties are more effective in the short term, while a 'grand-coalition' ensures long-term stability and universal participation.

Statistically, water cooperation is more likely than water conflict, even during a war. 'Expanding the cake' inclusion of non-water concerns further enhances cooperation, while adding to political leverage in resolving conflicts. Cooperation among basin-states helps to mitigate climate change and river pollution.

The conceptual basis and application of CGT models to water resources issues are discussed in chapter 5, focusing on conflict-cooperation cases. Applications of CGT have helped in determining relative power, preferred outcomes, ensuring stable solutions, and minimizing dissatisfaction in water allocation and quality scenarios.

CGT solution concepts are discussed in chapter 6, demonstrating empirical applications. The cost-benefit of water extraction, through a 'groundwater game' excludes transboundary externalities. Externalities can be managed by joint management. A 'mixed strategy' of bargaining and negotiation allows payoffs that would otherwise have not been possible. Of the allocation solutions discussed, proportional allocation is the most stable in high and low water-flow scenarios.

Chapter 7 introduces principles of negotiation with the analysis of success and failure of negotiations, focusing on quantitative aspects, whereas chapter 8 presents the aspects related to negotiations through the lens of hydro-politics or the politics of water. The framework adopted accounts for issues including status-quo, geographic location, reciprocity,

credible threats, information exchange, time sensitivity, domestic policies, and the price, flow, allocation and use of water resources. The Best Alternative to a Negotiated Agreement (BATNA) is applied to conflict-resolution between hydroelectricity and irrigation: the seasonal demand of one adversely affects the other. Parties may have a series of mutually beneficial trade-offs and concessions instead of a zero-sum game. Negotiation is harder to predict in multi-party and multiple issue games, due to partial coalitions and changing priorities.

Chapter 8 also examines water conflicts and cooperation through international relations and political theory. The terms of negotiation are often based on contributions of epistemic communities. Conflict is more likely in an upstream-downstream configuration than border-creator rivers, where reciprocal harm is possible. Upstream states usually enjoy relative power, as they can withhold water and refuse to cooperate.

Chapter 9 discusses water allocation and dispute resolution with case studies of the Rio Grande, Indus, Mekong and Senegal water treaties. Chapter 10 discusses the link between treaty and post-treaty interactions, analysis of treaty stability and compliance to international legal principles. Changes in the climate enhance conflicts with water vulnerability, affecting cooperation. Provisions for dispute resolution, a joint river commission and allocation of a percentage of the flow or minimum quantities based on availability enable flexible and continued cooperation. Side payments, comprising non-water issues, are discussed through case studies. This and strategic interaction make the treaty self-enforcing.

The spirit of a treaty depends more on the water needs of the parties than the principles of water law. Historical (often downstream) uses take precedence over new potential uses. Treaties that mention equity are more likely to be equitable. Although all basin states have property rights to a river, universality is rare, even in multilateral basins. Treaties rarely codify enforcement mechanisms, and the codification of environmental protection and protection from significant harm has reduced. All basin states have property rights to the river.

Chapter 11 discusses the creation and application of river models to maximize socio-economic benefits and minimize damage at basin, district and user level.

Models discussed in this chapter take into account emergencies, floods, early warning systems, accidental chemical spills and non-point source pollution (watershed models), but rarely account for groundwater.

To include trade-offs, the authors suggest using priority-based economic and hybrid (simulation and optimization) allocation models. Through side payments of compensation (previously, heating fuel in winter) and release of water in summer, basin states of the Syr Darya resolved the trade-off between irrigation and hydroelectricity. Due to persistent drought, Mexico's water debt obligations toward the US were carried forward. Basin-wide modelling was undertaken to maximize net benefits, restore the environment, establish a regular water supply and ensure resilience of crops.

Due to successful institutional set-up, countries with lesser per-capita water availability are less affected by scarcity than those with higher per-capita water availability. Timelines of conflict and cooperation need further examination. Economic viability of cooperative agreements is a stepping stone to enhanced cooperation. The two annexes to the book explain how to create a river-basin model and an example of CGT in rivers. Additionally, there are five basin-wide case studies that analyse transboundary issues.

The book focuses on trade-offs between irrigation and hydroelectricity generation, and ignores the impairment of ecosystem services and environmental flows, which influence the success or failure of the negotiation, now or in the foreseeable future. Water treaties often overlook trans-boundary ecosystem services. Mexico relies on the Mexicali aquifer, which the US lined for the All-American Canal, for its economy and ecology. Had the states negotiated a composite treaty for biodiversity and water-sharing, it is likely that this exercise would have been more successful. Two recent publications discuss similar issues on cooperation, albeit qualitatively and in less detail<sup>6,7</sup>. However, the book under review does not discuss adaptive governance useful in understanding dynamism in international river basins<sup>8</sup>. In a subsequent work, Dinar *et al.*<sup>9</sup> discuss flexibility and adaptability of treaty obligations, as a point between rigidity and vagueness, stating that allocation: (i) of entire rivers, (ii) of percentage flows,

(iii) based on slabs correlating to water availability; (iv) of  $n$ -year averages and (v) based on treaty amendments<sup>10</sup>; flexible with stable allocation models. Authors' contributions to the subject domain are evident from citations of their recent publications in the literature pertaining to riparian relations, etc.

This book is relevant and timely as resolution of conflict and cooperation over freshwater requires an interdisciplinary approach, considering hydrological, environmental, legal, economic and political aspects. Strength of this publication is application of quantitative approaches such as river basin modelling, simulation, optimization and game theory with case studies of transboundary water bodies. As academicians (from varied disciplines), we enjoyed reading this book a couple of times as it offers understanding of shared water resources and caters to multi-discipline audiences. Publications of these authors at regular intervals have also added value to the book with latest information. Multi-disciplinary approaches with the integration of thoughtful case studies and advances in governance strategies make the book useful to researchers, trainers and students. We hope global decision-makers would take advantage of this book and translate a potential conflict into a situation of cooperation, thereby ensuring water to all.

The book is useful in understanding the dynamics of international water treaties. With its acid-free paper, the book is sure to stand the test of time and is an asset on the bookshelf. The chapter-wise discussion of various concepts along with the practice questions make it an ideal textbook for graduate and Master's students in engineering, environmental law, international relations, and more importantly, to professionals and decision-makers in water resource management, international water issues and water policy.

1. Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: Synthesis*, Island Press, Washington, DC, 2005, p. 155; <http://www.millenniumassessment.org/documents/document.356.aspx.pdf>
2. Dinar, A. and McKinney, D., *J. Polit. Sci. Educ.*, 2010, 6, 118–209.
3. Ramachandra, T. V., Subash Chandran, M. D., Gururaja, K. V. and Sreekantha, *Cumulative Environmental Impact*

## BOOK REVIEWS

- Assessment*, Nova Science Publishers, New York, 2007, p. 540.
4. Ramachandra, T. V., *J. Biodivers.*, 2014, 5(1,2), 11–32.
  5. Ramachandra, T. V., Joshi, N. V., Rao, G. R., Dhanpal, G., Gururaja, K. V. and Amit S. Yadav, *Indian For.*, 2014, 140(4), 331–347; <http://ojms.cloudapp.net/index.php/indianforester/issue/view/4162>
  6. Grafton, R. Q. *et al.* (eds), *Global Water: Issues and Insights*, ANU E Press, Australia, 2014, p. 248; <http://press.anu.edu.au/wp-content/uploads/2014/05/whole.pdf>
  7. Connel, D. and Grafton, R. Q., *Basin Futures: Water Reform in the Murray-Darling Basin*, ANU E Press, Australia, 2011, p. 500; <http://press.anu.edu.au/wp-content/uploads/2011/08/whole5.pdf>
  8. Scholz, J. T. and Stiffler, B. (eds), *Adaptive Governance and Water Conflict: New Institutions for Adaptive Governance and Collaborative Planning*, Resources for the Future Press, Washington DC, 2005, p 25; <http://ageconsearch.umn.edu/bitstream/10440/1/cp07ha01.pdf>
  9. Dinar, S., Katz, D., De Stefano, L. and Blankespoor, B., *Polit. Geogr.*, 2015, 45, 55–66.
  10. Ambec, S., Dinar, A. and McKinney, D., *J. Environ. Econ. Manage.*, 2013, 66, 639–655.

T. V. RAMACHANDRA\*  
MUKTA BATRA

*Energy and Wetlands Research Group,  
Centre for Ecological Sciences,  
Indian Institute of Science,  
Bengaluru 560 012, India  
\*e-mail: cestvr@ces.iisc.ernet.in*

## CURRENT SCIENCE

### Display Advertisement Rates

India		Tariff (Rupees)*					
Size	No. of insertions	Inside pages		Inside cover pages		Back cover pages	
		B&W	Colour	B&W	Colour	B&W	Colour
Full page (H = 23 cm; W = 17.5 cm)	1	15,000	25,000	22,000	35,000	30,000	40,000
	2	27,000	45,000	39,000	63,000	54,000	72,000
	4	52,000	87,000	77,000	1,22,000	1,04,000	1,37,000
	6	75,000	1,25,000	1,10,000	1,75,000	1,50,000	2,00,000
	8	93,000	1,56,000	1,40,000	2,21,000	1,92,000	2,51,000
	10	1,12,000	1,87,000	1,65,000	2,62,000	2,22,000	2,97,000
	12	1,25,000	2,06,000	1,83,000	2,90,000	2,52,000	3,31,000
Half page (H = 11 cm; W = 17.5 cm)	1	8,500	15,000	We also have provision for <b>quarter page</b> display advertisement: <b>Quarter page (H = 11 cm; W = 8 cm):</b> Rs 5,000 per insertion  <b>Note:</b> For payments towards the advertisement charges, Cheque (at par/multicity) or Demand Drafts may be drawn in favour of ' <b>Current Science Association, Bengaluru</b> '.			
	2	15,500	27,500				
	4	29,000	52,000				
	6	40,000	75,000				
	8	51,000	93,000				
	10	60,000	1,12,000				
	12	66,000	1,25,000				
Other Countries		Tariff (US \$)*					
Size	No. of insertions	Inside pages		Inside cover pages		Back cover pages	
		B&W	Colour	B&W	Colour	B&W	Colour
Full page (H = 23 cm; W = 17.5 cm)	1	300	650	450	750	600	1000
	6	1500	3000	2250	3500	3000	5000
Half page (H = 11 cm; W = 17.5 cm)	1	200	325				
	6	1000	2000				

\*25% rebate for Institutional members

Contact us: Current Science Association, C.V. Raman Avenue, P.B. No. 8001, Bengaluru 560 080 or e-mail: csc@ias.ernet.in

Last date for receiving advertising material: Ten days before the scheduled date of publication.