Game Theory and Water Resources: Critical Review of its Contributions, Progress and Remaining Challenges

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Dedication

For my eldest grandson Gideon Paz who featured frequently in my work and helped me demonstrate what an effective water policy looks like

Ariel Dinar

For my family, always

Margaret Bush Hogarth

Contents

Abstract

Game Theory (GT), both in its non-cooperative (NCGT) and cooperative (CGT) forms, has been pivotal in its contribution to the analysis of important aspects related to water resources. The 1942 seminal work of Ransmeier on The Tennessee Valley Authority is still considered essential; it continues to inspire many applications related to water allocation decisions. Since Ransmeier, GT models were developed and have been applied to various aspects of water management, such as decisions on cost and benefit allocation in multi-objective multi-use water projects, conflicts and joint management of irrigation projects, management of groundwater aquifers, hydropower facilities, urban water supplies, wastewater treatment plants, and transboundary water disputes.

World water resources face new challenges that suggest a renewed role for GT in water management. Scarcity, growing populations, and massive development have led to increased competition over water resources and subsequent elevated pollution levels. Climate change is expected to unevenly affect the hydrological cycle, leading to increased variability in water supplies across time and space and uncertainty in water allocation decisions. Future investments in water resource projects will be astronomical, needing much more stable rules for cost allocations among participating entities and over time. Levels of water disputes may vary from local to regional, state, and international levels. All of these suggest that while GT models and applications to water resources have advanced over the years, much more is expected.

This monograph will review the main contributions of GT in water resources over the past 70 years. It will compare the set of issues faced by water resources and those which the sector is most likely to face in the coming future. Based on this comparison, a future research agenda and priorities will be proposed. Following the literature's time line with a focus on various methodologies, sectoral applications (such as irrigation, hydropower, environmental water uses, navigation, etc.), and regional issues, we will also identify physical and behavioral features in the water sector that might be conducive to GT (such as scarcity,

externality, uncertainty, and competition-conflict) and some features of intervention (such as the important role for policy, regulation, and incentives), which all affect the likelihood of GT solutions in terms of acceptability and stability.

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1

Introduction

The use of Game Theory (GT) to address water resource management issues has been ever increasing since the 1942 seminal application by Ransmeier [1942] to the Tennessee Valley Authority investment project.[1] As is described in Guillermo Owen [1982], the seeds for the development of today's GT were planted in the work by Zermelo [1913] and were advanced to the understanding that economic situations can be modeled as games by Von Neumann and Morgenstern [1944]. GT applications were further developed for logistical purposes during World War II. GT has become one of the basic analytical tools for addressing strategic issues in many fields, including water resources. Following the various applications of GT in water resources over the past half century suggests that it traced a path similar to the state-of-water and water development in the world. This path will be described and analyzed in Section 2 of this monograph. Initially we want to distinguish water resources from other applications of GT.

What makes water an appropriate medium for the application of GT? We will suggest several aspects embedded in water and its interaction with society that make it perfect for GT analysis. First, water

[1] Fisheries will not be included in this review.

is a scarce resource that creates tension between competing users and uses. Conflicts between sectors that need water at different periods during the year, such as irrigation and hydropower are common [Moller, 2005]. In many situations water is characterized as a common pool resource (CPR), opening the door for strategic behavior of the users. Secondly and mostly related, water resources are subject to various types of externalities. One type of externality, the congestion externality, is associated with the CPR nature of water (e.g., groundwater). Another type of externality of water is associated with pollution and is most prominent when upstream–downstream relations prevail. Third, water is associated to a greater extent with uncertainty and asymmetry of information, thus reflecting on the strategic behavior of the agents involved.

Some other reasons for the strategic nature of water can be explained by the fact that not all players 'behave' strictly as profit maximizers. Water is seen by various individuals not only as a production resource but also as a source for spiritual needs with existence value. Therefore, 'optimal' prescriptions for social arrangements may not be acceptable for various groups in the society. For that reason, most water conflicts involve multi-party multi-objective solutions, and thus the incorporation of strategic behavior considerations, as GT can offer, is essential for socially acceptable arrangements. Such reasons provided the motivation for our work.

The use of GT in water resources by different disciplinary professions such as engineers, international relations experts, economists, and geographers, to name a few, is indeed impressive. The objective of this monograph is to collect the vast literature, catalogue it, and provide present and future practitioners of Game Theory in water resources with a source of information that can be useful for their research. For the sake of conserving space we kept the text explaining GT concepts to a minimum. We assume that readers of this monograph have the basic skills in GT. In places, we provide references to conceptual works for readers who might need help in understanding the relevant GT concepts.

Several databases and Google Scholar were iteratively used to gather literature for this review. Search terms were adjusted according to the vocabularies of each database and the results were analyzed and categorized. An attempt to analyze text using an automated text analyzer failed. For further details, please see Annex 1.

The monograph will be developed as follows. In Section 2, we report the historical trends observed in the accumulation of the GT publications on water between 1942 and 2013. Such trends indicate dynamics of relative importance of sectors and topics over time. They may be connected to global events or crises that took place in the world. Detecting such trends may be useful in explaining the relevance of GT to issues in water around the world. Section 3 describes the developments in Cooperative GT-methodologies to water issues. Cooperative Game Theory (CGT) applications ruled the GT applications during the period 1950–1990. Section 4 reviews the development of Non-Cooperative GT (NCGT) methodologies to various water issues. Then NCGT became more prominent in dealing with water-related issues that involve third parties. Section 5 provides a comprehensive review of GT surveys that have been published in the literature. Section 6 reviews Game Theory applications by sub-sector. We identified 11 sub-sectors and reviewed the applications of GT approaches to each of them. In total, this monograph reviews 289 publications that are directly or indirectly applied to water related issues. We end the monograph in Section 7 with a conclusion and identification of remaining problems to be addressed in the future.

References

D. Aadland and V. Kolpin. Shared irrigation costs: An empirical and axiomatic analysis. *Mathematical Social Sciences*, 35:203–218, 1998.

D. Aadland and V. Kolpin. Environmental determinants of cost sharing. *Journal of Economic Behavior & Organization*, 53(4):495–511, 2004a. doi: 10.1016/S0167-2681(03)00099-4.

D. Aadland and V. Kolpin. Erratum to "environmental determinants of cost sharing". *Journal of Economic Behavior & Organization*, 55:105–121, 2004b. doi: 10.1016/j.jebo.2002.08.001.

A. Abed-Elmdoust and R. Kerachian. River water quality management under incomplete information: Application of an N-person iterated signaling game. *Environmental Monitoring and Assessment*, 184:5875–5888, 2012. doi: 10.1007/s10661-011-2387-x.

G. Adams, G. Rausser, and L. Simon. Modelling multilateral negotiations: An application to California water policy. *Journal of Economic Behavior & Organization*, 30:97–111, 1996.

A. Akhmedjonov and A. Suyundikov. A game theory approach to salinization problem of the Aral Sea Basin. *Applied Ecology and Environmental Research*, 9:399–410, 2011.

R. R. Alexander and M. G. Bhat. Agricultural policy and social welfare: A game-theoretic rationalisation. Agricultural Policy Discussion Paper — Centre for Agricultural Policy Studies, Massey University, 1998.

S. Ambec and L. Ehlers. Sharing a river among satiable agents. *Games and Economic Behavior*, 64:35–50, 2008. doi: 10.1016/j.geb.2007.09.005.

S. Ambec and Y. Sprumont. Sharing a river. *Journal of Economic Theory*, 107 (2):453–462, 2002. `http://www.sciencedirect.com/science/journal/00220531`.

S. Ambec, A. Dinar, and D. McKinney. Water sharing agreements sustainable to reduced flows. *Journal of Environmental Economics and Management*, 66(3):639–655, 2013. `http://www.sciencedirect.com/science/journal/00950696`.

R. K. Amit and P. Ramachandran. A fair contract for managing water scarcity. *Water Resources Management*, 24:1195–1209, 2010. doi: 10.1007/s11269-009-9491-5.

G. Anandalingam and V. Apprey. Multi-level programming and conflict resolution. *European Journal of Operational Research*, 51:233–247, 1991.

E. Ansink. *Game-Theoretic Models of Water Allocation in Transboundary River Basins*. Wageningen Universiteit (Wageningen University), Wageningen Netherlands, 2009.

E. Ansink and A. Ruijs. Climate change and the stability of water allocation agreements. *Environmental and Resource Economics*, 41:249–266, 2008.

R. J. Aumann and J. H. Dreze. Cooperative games with coalition structures. *International Journal of Game Theory*, 3(4):217–237, 1974. doi: 10.1007/BF01766876.

R. J. Aumann and S. Hart, editors. *Handbook of Game Theory with Economic Applications*. North-Holland, Amsterdam, 1992.

R. J. Aumann and S. Hart, editors. *Handbook of Game Theory 2, Handbooks in Economics, 11,2*. North-Holland, Amsterdam, 1994.

R. J. Aumann and S. Hart, editors. *Handbook of Game Theory with Economic Applications*, volume 3. Elsevier, Amsterdam, 2002.

R. J. Aumann and M. Maschler. The bargaining set for cooperative games. In M. Dresher, L. S. Shapley, and A. W. Tucker, editors, *Advances in Game Theory, Annals of Mathematical Studies*, pages 443–476. Princeton University Press, Princeton, 1964.

P. Bardhan. Analytics of the institutions of informal cooperation in rural-development. *World Development*, 21:633–639, 1993.

R. Beard. The river sharing problem: A review of the technical literature for policy economists. University Library of Munich, Germany, 2011.

R. Beard and S. McDonald. Time-consistent fair water sharing agreements. In *Advances in Dynamic Game Theory: Numerical Methods, Algorithms, and Applications to Ecology and Economics*, pages 393–410. Birkhauser, 2007.

N. Becker and K. William Easter. Cooperative and noncooperative water diversion in the Great Lakes basin. In A. Dinar and E. Loehman, editors, *Water Quantity/quality Management and Conflict Resolution: Institutions, Processes, and Economic Analyses*, pages 321–336. Praeger Publisher, Westport, Conn, 1991.

N. Becker and K. William Easter. Water diversions in the Great Lakes basin analyzed in a game theory framework. *Water Resources Management*, 9: 221–242, 1995. doi: 10.1007/BF00872130.

N. Becker and K. William Easter. Water diversion from the Great Lakes: Is a cooperative approach possible? *International Journal of Water Resources Development*, 13:53–65, 1997.

N. Becker and K. William Easter. Conflict and cooperation in managing international water resources such as the Great Lakes. *Land Economics*, 75:233–45, 1999.

N. Becker, N. Zeitouni, and D. Zilberman. Issues in the economics of water resource. In T. Tietenberg and H. Folmer, editors, *The International Yearbook of Environmental and Resource Economics 2000/2001: A Survey of Current Issues*. Edward Elgar Publishing, Cheltenham UK, 2001.

L. L. Bennett, S. E. Ragland, and P. Yolles. Facilitating international agreements through an interconnected game approach: The case of river basins. In R. E. Just and S. Netanyahu, editors, *Conflict and Cooperation on Trans-Boundary Water Resources*, pages 61–85. Kluwer Academic, Boston, 1998.

Bennett, et al. Facilitating international agreements through an interconnected game approach: The case of river basins. In D. D. Parker and Y. Tsur, editors, *Decentralization and Coordination of Water Resource Management*, pages 61–85. Kluwer Academic Publishers, Boston, MA, 1997.

M. G. Bhat, R. R. Alexander, and B. C. English. Toward controlling nonpoint source pollution of groundwater: A hierarchical policy formulation game. *Natural Resource Modeling*, 11:379–403, 1998.

G. C. Biddle and R. Steinberg. Common cost allocation in the firm. In H. Peyton Young, editor, *Cost Allocation: Methods, Principles, Applications*, pages 31–54. North-Holland; distributed in the U.S. and Canada by Elsevier Science, New York, Amsterdam and Oxford, 1985.

I. Bogardi and F. Szidarovszky. Application of game theory in water management. *Applied Mathematical Modelling*, 1:16–20, 1976.

E. Brill, U. Chakravorty, and E. Hochman. Transboundary water allocation between Israel and Gaza strip. In A. Al-Kawaz, editor, *New Economic Developments and Their Impact on Arab Economies*, pages 599–626. Elsevier Science, North-Holland, Amsterdam; New York and Oxford, 1999.

M. Buckley and B. M. Haddad. Socially strategic ecological restoration: A game-theoretic analysis shortened: Socially strategic restoration. *Environmental Management*, 38:48–61, 2006. doi: 10.1007/s00267-005-0165-7.

C. Carraro and A. Sgobbi. Modelling negotiated decision making in environmental and natural resource management — a multilateral, multiple issues, non-cooperative bargaining model with uncertainty. *Automatica*, 44 (6):1488–1503, 2008.

C. Carraro, C. Marchiori, and A. Sgobbi. Applications of negotiation theory to water issues. World Bank Policy Research Working Paper, 2005.

C. Carraro, C. Marchiori, and A. Sgobbi. Negotiating on water: Insights from non-cooperative bargaining theory. *Environment and Development Economics*, 12:329–349, 2007. doi: 10.1017/s1355770x06003536.

P. Chander and H. Tulkens. Theoretical foundations of negotiations and cost sharing in transfrontier pollution problems. *European Economic Review*, 36:388–398, 1992.

P. Chander and H. Tulkens. The core of an economy with multilateral environmental externalities. *International Journal of Game Theory*, 26:379–401, 1997.

P. Chander and H. Tulkens. Cooperation, stability and self enforcement in international environmental agreements: A conceptual discussion. CORE Discussion Paper 2006-3, Department of Economic Sciences, Catholic University of Louvain, 2006.

D. J. Choi and M. H. Lee. Applying game theory for strategy transboundary river: The case of Han River in North and South Koreans. *Journal of Korea Water Resources Association*, 41:353–363, 2008. doi: 10.3741/jkwra.2008.41.4.353.

P. Colat-Parros. International water conflicts and depletion of water resources. Science into Policy: Water in the Public Realm, Bozeman, Montana, June 30-July 2, 1999, 1999.

A. R. Collins and P. Maille. Group decision-making theory and behavior under performance-based water quality payments. *Ecological Economics*, 70:806–12, 2011. doi: 10.1016/j.ecolecon.2010.11.020.

I. J. Curiel, M. Maschler, and S. H. Tijs. Bankruptcy games. *Zeitschrift fur Operations Research*, 31:A143–A159, 1987.

E. A. da Costa and C. P. Bottura. A game-inspired modeling framework for multiple intelligent agents control systems — a water resources regulation problem application. In *IEEE 22nd International Symposium on Intelligent Control*. Singapore, 2007.

N. Dagan and O. Volij. The bankruptcy problem: A cooperative bargaining approach. *Mathematical Social Sciences*, 26(3):287–297, 1993. http://www.sciencedirect.com/science/journal/01654896.

A. Dakhlaoui. Dynamic games in the wholesale electricity market. In *5th International Conference on the European Electricity Market*. EEM, Lisboa, Portugal, 2008.

M. Davis and M. Maschler. The kernel of a cooperative game. *Naval Research Logistics Quarterly*, 12(3):223–259, 1965.

M. D. Davis. *Game Theory: A Nontechnical Introduction*. Dover Publications, 1983.

R. E. Dickinson and J. P. Heaney. Methods for apportioning the cost of a water resource project. *Water Resources Research*, 18:476–482, 1982.

A. Dinar. Scale and equity in water resource development: A Nash bargaining model. *Natural Resource Modeling*, 14:477–494, 2001.

A. Dinar and R. E. Howitt. Mechanisms for allocation of environmental control cost: Empirical tests of acceptability and stability. *Journal of Environmental Management*, 49(2):183–203, 1997. doi: 10.1006/jema.1995.0088.

A. Dinar and A. Rapoport. *Analyzing Global Environmental Issues: Theoretical and Experimental Applications and Their Policy Implications*. Routledge, New York, 2013.

A. Dinar and A. Wolf. Economic-potential and political considerations of regional water trade — the Western Middle-East Example. *Resource and Energy Economics*, 16:335–356, 1994a.

A. Dinar and A. Wolf. International markets for water and the potential for regional cooperation — economic and political perspectives in the Western Middle-East. *Economic Development and Cultural Change*, 43(1):43–66, 1994b.

A. Dinar and Aaron Wolf. Economic and political considerations in regional cooperation models. *Agricultural and Resource Economics Review*, 26:7–22, 1997.

A. Dinar, D. Yaron, and Y. Kannai. Sharing regional cooperative gains from reusing effluent for irrigation. *Water Resources Research*, 22:339–344, 1986.

A. Dinar, A. Ratner, and D. Yaron. Evaluating cooperative game theory in water resources. *Theory and Decision*, 32:1–20, 1992. doi: 10.1007/BF00133625.

A. Dinar, S. Farolfi, F. Patrone, and K. Rowntree. Water allocation strategies for the Kat Basin in South Africa: Comparing negotiation tools and game theory models. World Bank Policy Research Working Paper 4083, December 2006, 2006.

A. Dinar, S. Moreti, F. Patrone, and S. Zara. Application of stochastic cooperative game theory in water resources. In R. Boetz and D. Braga, editors, *New Frontiers in Water Resource Economics*. Springer, 2006b.

A. Dinar, S. Dinar, S. McCaffrey, and D. McKinney. *Bridges over Water: Understanding Transboundary Water Conflict, Negotiation and Cooperation*, volume 3 of *World Scientific Series on Energy and Resource Economics*. World Scientific, Hackensack, N.J. and Singapore, 2007.

A. Dinar, J. Albiac, and J. Sanchez-Soriano, editors. *Game Theory and Policymaking in Natural Resources and the Environment*. Taylor and Francis, Routledge, Routledge Explorations in Environmental Economics. London and New York, 2008.

A. Dinar, S. Dinar, S. McCaffrey, and D. McKinney. *Bridges Over Water Understanding Transboundary Water Conflict, Negotiation and Cooperation*, volume 11 of *World Scientific Series on Environmental and Energy Economics and Policy*. World Scientific, 2nd edition, 2013.

L. S. Dixon, editor. *Common Property Aspects of Ground-Water Use and Drainage Generation, The Economics and Management of Water and Drainage in Agriculture*. Kluwer Academic Publishers, Dordrecht; Netherlands, 1991.

I. Dombrowsky. *Conflict, Cooperation and Institutions in International Water Management: An Economic Analysis*. Elgar, Advances in Ecological Economics. Cheltenham, U.K. and Northampton, Mass., 2007.

B. Dong, D. Ni, and Y. Wang. Sharing a polluted river network. *Environmental & Resource Economics*, 53:367–387, 2012. doi: 10.1007/s10640-012-9566-2.

T. Driessen. *Cooperative Games, Solutions and Applications*. Kluwer Academic Publishers, Dordrecht; Boston, 1988.

T. Driessen and S. H. Tijs. Cost gap method and other cost allocation methods for multipurpose water projects. *Water Resources Research*, 21:1469–1475, 1985.

C. M. Dufournaud and J. J. Harrington. Temporal and spatial distribution of benefits and costs in river-basin schemes: a cooperative game approach. *Environment and Planning A*, 22:615–628, 1990.

C. M. Dufournaud and J. J. Harrington. A linear constraint formulation for spatial and temporal cost imputations in accord with Shapley Values. *Environment and Planning A*, 23:1517–1521, 1991.

E. Eleftheriadou and Y. Mylopoulos. Game theoretical approach to conflict resolution in transboundary water resources management. *Journal of Water Resources Planning and Management*, 134:466–473, 2008.

E. Esteban and A. Dinar. Cooperative management of groundwater resources in the presence of environmental externalities. *Environmental and Resource Economics*, 54:443–469, 2013. `http://springerlink.metapress.com/link.asp?id$=$100263`.

L. Fernandez. Trade's dynamic solutions to transboundary pollution. *Journal of Environmental Economics and Management*, 43:386–411, 2002. doi: 10.1006/jeem.2001.1187.

L. Fernandez. Coastal watershed management across an international border in the Tijuana river watershed. *Water Resources Research*, 41:W05003, 2005.

L. Fernandez. Wastewater pollution abatement across an international border. *Environment and Development Economics*, 14:67–88, 2009.

J. A. Filar and L. A. Petrosjan. Dynamic cooperative games. *International Game Theory Review*, 2(1):47–65, 2000. `http://www.worldscientific.com/loi/igtr`.

M. Finus. Stability and design of international environmental agreements: The case of transboundary pollution. In H. Folmer and T. Tietenberg, editors, *International Yearbook of Environmental and Resource Economics*, pages 82–158. 2003.

H. Folmer, P. V. Mouche, and S. Ragland. Interconnected games and international environmental problems. *Environmental and Resource Economics*, 3:313–335, 1993.

N. M. Fraser and K. W. Hipel. Solving complex conflicts. IEEE Transactions on Systems, Man and Cybernetics, 1979.

N. M. Fraser and K. W. Hipel. *Conflict analysis: Models and resolutions*, volume 11 of *North-Holland Series in System Science and Engineering*. North-Holland, New York, 1984.

G. B. Frisvold and M. F. Caswell. Transboundary water management: Game-theoretic lessons for projects on the US-Mexico border. *Agricultural Economics*, 24:101–111, 2000.

G. Fronza, A. Karlin, and S. Rinaldi. Reservoir operation under conflicting objectives. *Water Resources Research*, 13:296–302, 1977.

V. Galaz. Stealing from the poor? game theory and the politics of water markets in Chile. *Environmental Politics*, 13:414–437, 2004. doi: 10.1080/0964401042000209649.

A. Ganji, D. Khalili, and M. Karamouz. Development of stochastic dynamic Nash game model for reservoir operation. i. The symmetric stochastic model with perfect information. *Advances in Water Resources*, 30:528–542, 2007. doi: 10.1016/j.advwatres.2006.04.004.

D. Gately. Sharing the gains from regional cooperation: A game theoretic application to planning investment in electric power. *International Economic Review*, 15:195–208, 1974.

M. F. Gengenbach, H.-P. Weikard, and E. Ansink. Cleaning a river: An analysis of voluntary joint action. *Natural Resource Modeling*, 23:565–590, 2010.

G. P. Georgakopoulos, A. S. Zorba, P. K. Tolikas, and E. Sidiropoulos. Cooperation and punishment in simulated aquifer exploitation. *WSEAS Transactions on Environment and Development*, 2:1–8, 2006.

A. C. V. Getirana and V. de Fatima Malta. Investigating strategies of an irrigation conflict. *Water Resources Management*, 24:2893–2916, 2010. doi: 10.1007/s11269-010-9586-z.

A. C. V. Getirana, V. de Fatima Malta, and J. P. S. de Azevedo. Decision process in a water use conflict in Brazil. *Water Resources Management*, 22 (1):103–118, 2008. doi: 10.1007/s11269-006-9146-8.

R. J. Giglio and R. Wrightington. Techniques for allocating costs among participants in a regional system, 1971. Joint National Conference on Major Systems (abstracts only received) Anaheim, CA, USA, 25-27 October 1971 Operations Res. Soc. America, IEEE, Systems, Man and Cybernetics Group.

R. J. Giglio and R. Wrightington. Methods for apportioning cost among participants in regional systems. Water Resource Research, 1972.

J. M. Guldmann and M. Kucukmehmetoglu. International water resources allocation and conflicts — the case of the Euphrates and the Tigris. 42nd European Congress of the Regional Science Association, Dortmund, Germany, August 27–31, 2002, 2002.

S. S. Guner. Evolutionary explanations of Syrian-Turkish water conflict. *Mountains: Sources of Water, Sources of Knowledge*, pages 1–19, 2008.

E.-Y. Gura and M. Maschler. *Insights into Game Theory: An Alternative Mathematical Experience*. Cambridge University Press, Cambridge and New York, 2008.

H. Hamandawana, R. Chanda, and F. Eckardt. Hypergame analysis and hydroconflicts in the Okavango drainage basin. *Water International*, 32: 538–557, 2007.

M. Hanemann and C. Dyckman. The San Francisco Bay-Delta: A failure of decision-making capacity. *Environmental Science & Policy*, 12:710–725, 2009. doi: 10.1016/j.envsci.2009.07.004.

N. Hanley and H. Folmer, editors. *Game Theory and the Environment*. Elgar; distributed by American International Distribution Corporation, Williston, Vt, Cheltenham, U.K. and Northampton, Mass., 1998.

J. C. Harsanyi. A bargaining model for the cooperative n-person game. In A. W. Tucker, H. W. Kuhn, A. W. Tucker, M. Dresher, P. Wolfe, and R. D. Luce, editors, *Contributions to the Theory of Games*, volume 3, 4, pages 325–355. Princeton University Press, Princeton, NJ, 1959.

J. C. Harsanyi. A simplified bargaining model for the n-person cooperative game. *International Economic Review*, 4:194–220, 1963.

J. C. Harsanyi. Utilitarian morality in a world of very half-hearted altruists. In W. P. Heller, R. M. Starr, and D. A. Starrett, editors, *Essays in honor of Kenneth J. Arrow*, volume 1 of *Social Choice and Public Decision Making*, pages 57–73. Cambridge University Press, Cambridge; New York and Sydney, 1986.

J. P. Heaney and R. Burke III. *Collective Decision Making in Water Resource Planning*. Lexington Books, Lexington, 1976.

L. M. Hermans. *Agenda Setting in Policy Analysis: Exploring Conflict for a Case of Water Resources Management in the Philippines*. Washington, DC, United States, 2003.

K. W. Hipel and Y. Ben-Haim. Decision making in an uncertain world: Information-gap modeling in water resources management. *IEEE Transactions on Systems Man and Cybernetics Part C-Applications and Reviews*, 29:506–517, 1999.

K. W. Hipel and S. B. Walker. Conflict analysis in environmental management. *Environmetrics*, 22:279–293, 2011. doi: 10.1002/env.1048.

K. W. Hipel, R. K. Ragade, and T. E. Unny. Metagame analysis of water resources conflicts. *Journal of the Hydraulics Division — ASCE*, 100(10): 1437–1455, 1974.

K. W. Hipel, R. K. Ragade, and T. E. Unny. Metagame theory and its applications to water resources. *Water Resources Research*, 12:331–339, 1976.

K. W. Hipel, D. M. Kilgour, and X. Yin. Whistle-blowing in enforcement of environmental regulations. *IEEE International Conference on Systems, Man, and Cybernetics*, 1994.

J. Hoffman. *The Cooperation Challenge of Economics and the Protection of Water Supplies, Routledge Explorations in Environmental Economics*. Taylor and Francis, Routledge, London and New York, 2010.

M. J. Holler and X. Li. *Efficient Public Good Pricing: An Application of Cooperative Game Theory*. University of Hamburg, Institute of Economics, 1996.

M. Homayoun-Far, A. Ganji, D. Khalili, and J. Harris. Two solution methods for dynamic game in reservoir operation. *Advances in Water Resources*, 33: 752–761, 2010. doi: 10.1016/j.advwatres.2010.04.001.

M. Homayoun-Far, A. Ganji, and C. J. Martinez. A novel solution for stochastic dynamic game of water allocation from a reservoir using collocation method. *Water Resources Management*, 25:3427–3444, 2011. doi: 10.1007/s11269-011-9863-5.

H. Houba. Computing alternating offers and water prices in bilateral river basin management. *International Game Theory Review*, 10:257–78, 2008.

H. Houba, P. K. Hang Do, and X. Zhu. Saving a river: A joint management approach to the Mekong River Basin. *Environment and Development Economics*, 18:93–109, 2013. doi: 10.1017/s1355770x12000435.

J. Howard. Using game theory to explain the behaviour of participants involved in a regional governance process. *Rural Society*, 16:254–270, 2006.

L. Hurwicz. Issues in the design of mechanisms and institutions. In E. T. Loehman and D. M. Kilgour, editors, *Designing Institutions for Environmental and Resource Management. New Horizons in Environmental Economics*, distributed by American International Distribution Corporation, Williston, Vt., pages 29–56. Elgar, Cheltenham, U.K. and Northampton, MA, 1998.

M. Israel, J. R. Lund, and G. T. Orlob. Cooperative game theory in water resources. 21st Annual Conference on Water Policy and Management: Solving the Problem, Denver, CO, USA, 1994.

F. Ji and Y. Wang. Cooperation mechanism design of water environmental management for river basin based on game theory. 3rd International Conference on Wireless Communications, Networking, and Mobile Computing — WiCOM '07, Shanghai, China, 21–25 September, 2007.

J. M. Johnson, M. H. Whithed, and G. P. Johnson. Enhancing water resource planning effectiveness: A simulation gaming approach. In et al. V. T. Chow, editor, *Water for the Human Environment, Special Sessions*, pages 238–248. International Water Resources Association, Champaign, Illinois, 1973.

R. E. Just and S. Netanyahu. The importance of structure in linking games. *Agricultural Economics*, 24:87–100, 2000.

R. E. Just and S. Netanyahu. Implications of "victim pays" infeasibilities for interconnected games with an illustration for aquifer sharing under unequal access costs. *Water Resources Research*, 40:1–11, 2004. doi: 10.1029/2003wr002528.

E. Kalai and M. Smorodinsky. Other solutions to Nash's bargaining problem. *Econometrica*, 43(3):513–518, 1975.

A. Kampas and B. White. Selecting permit allocation rules for agricultural pollution control: A bargaining solution. *Ecological Economics*, 47(2–3):135–147, 2003. http://www.sciencedirect.com/science/journal/09218009.

D. M. Kilgour and A. Dinar. Flexible water sharing within an international river basin. *Environmental and Resource Economics*, 18:43–60, 2001.

D. M. Kilgour, K. W. Hipel, and L. Fang. Graph model for conflicts. *Automatica*, 23:41–55, 1987.

D. M. Kilgour, N. Okada, and A. Nishikori. Load control regulation of water-pollution — an analysis using game-theory. *Journal of Environmental Management*, 27:179–194, 1988.

A. Kindle. *Freshwater, Law, and Game Theory: Strategies for Navigating the Troubled Waters of a Canada/U.S. Bulk Water Export Conflict*. University of Toronto, 2009.

J. Kolodziej, K. Jauernig, and A. Cieslar. HGSNash strategy as the decision-making method for water resource systems with external disagreement of interests. *International Symposium on Parallel Computing in Electrical Engineering*, 2006.

K. Kong and Z.-H. Xu. On methods of water rights original allocation and reallocation. *International Conference on Environmental Science and Information Application Technology*, ESIAT:312–315, 2009. doi: 10.1109/esiat.2009.427.

A. F. Kononenko. Game-theory analysis of a two-level hierarchical control system. *USSR Computational Mathematics and Mathematical Physics*, 14 (5):72–81, 1974.

M. Krawczak and K. Mizukami. Game-theoretic approach to river pollution control: discrete case. In *Proceedings of the IFAC/IFORS Symposium, Large Scale Systems: Theory and Applications 1983*. Warsaw, Poland, 11–15 July 1983, 1984.

M. Krawczak and A. Zioskowski. Nash model of water reservoir pollution. In *Proceedings of the 2nd International Symposium, Systems Analysis and Simulation 1985*. Berlin, West Germany, 26–31 August 1985.

J. B. Krawczyk and M. Tidball. A discrete-time dynamic game of seasonal water allocation. *Journal of Optimization Theory and Applications*, 128: 411–429, 2006. doi: 10.1007/s10957-006-9020-0.

M. Kucukmehmetoglu. A game theoretic approach to assess the impacts of major investments on transboundary water resources: The case of the Euphrates and Tigris. *Water Resources Management*, 23:3069–3099, 2009. doi: 10.1007/s11269-009-9424-3.

M. Kucukmehmetoglu. An integrative case study approach between game theory and pareto frontier concepts for the transboundary water resources allocations. *Journal of Hydrology*, 450:308–319, 2012. doi: 10.1016/j.jhydrol.2012.04.036.

M. Kucukmehmetoglu and J.-M. Guldmann. International water resources allocation and conflicts: The case of the Euphrates and Tigris. *Environment and Planning A*, 36:783–801, 2004.

M. Kucukmehmetoglu, Z. Sen, and M. Ozger. Coalition possibility of riparian countries via game theory and fuzzy logic models. *Water Resources Research*, 46, 2010. doi: W12528 10.1029/2009wr008660.

C.-S. Lee. Multi-objective game-theory models for conflict analysis in reservoir watershed management. *Chemosphere*, 87:608–613, 2012. doi: 10.1016/j.chemosphere.2012.01.014.

S. Lee, W. Park, and H. Park. Investigating the cooperative strategies between China and North Korea for the Tumen River Area Development Programme. *Water SA*, 37:255–264, 2011.

R. P. Lejano and C. A. Davos. Cost allocation of multiagency water-resource projects — game — theoretic approaches and case-study. *Water Resources Research*, 31:1387–1393, 1995.

R. P. Lejano and C. A. Davos. Cooperative solutions for sustainable resource management. *Environmental Management*, 24:167–175, 1999.

J. K. Levy, K. W. Hipel, and D. M. Kilgour. Modelling compliance in a groundwater pollution problem. IEEE International Conference on Systems, Man and Cybernetics. Intelligent Systems for the 21st Century, 1995.

I. Lippai and J. P. Heaney. Efficient and equitable impact fees for urban water systems. *Journal of Water Resources Planning and Management-ASCE*, 126:75–84, 2000.

H. A. Loaiciga. Analytic game — theoretic approach to ground-water extraction. *Journal of Hydrology*, 297:22–33, 2004. doi: 10.1016/j. jhydrol.2004.04.006.

E. Loehman. Cooperative solutions for problems of water supply. In A. Dinar and E. Loehman, editors, *Water Quantity/Quality Management and Conflict Resolution: Institutions, Processes, and Economic Analyses*, pages 301–319. Praeger Publisher, Westport, 1995.

E. Loehman and A. Whinston. A new theory of pricing and decision-making for public investment. *The Bell Journal of Economics and Management Science*, 2:606–625, 1971.

E. Loehman and A. Whinston. A generalized cost allocation scheme. In S. A. Y. Lin, editor, *Theory and Measurement of Economic Externalities*. Academic Press, New York, 1976.

E. Loehman, J. Orlando, J. Tschirhart, and A. Whinston. Cost allocation for a regional wastewater treatment system. *Water Resources Research*, 15: 193–202, 1979.

J. C. Loughlin. The efficiency and equity of cost allocation methods for multipurpose water projects. *Water Resources Research*, 13:8–14, 1977.

J. C. Loughlin. Efficiency and equity of cost allocation methods for multipurpose water projects — reply. *Water Resources Research*, 14:1197–1197, 1978.

B. Lussier, G. E. Mohr, and I. C. Goulter. Conflict analysis of the Shoal Lake subdivision. *Water Resources Bulletin*, 25:111–116, 1989.

K. Madani. Game theory and water resources. *Journal of Hydrology*, 381: 225–238, 2010. doi: 10.1016/j.jhydrol.2009.11.045.

K. Madani. Hydropower licensing and climate change: Insights from cooperative game theory. *Advances in Water Resources*, 34:174–183, 2011. doi: 10.1016/j.advwatres.2010.10.003.

K. Madani and A. Dinar. Cooperative institutions for sustainable common pool resource management: Application to groundwater. *Water Resources Research*, 48, 2012a. doi: 10.1029/2011wr010849.

K. Madani and A. Dinar. Non-cooperative institutions for sustainable common pool resource management: Application to groundwater. *Ecological Economics*, 74:34–45, 2012b.

K. Madani and A. Dinar. Exogenous regulatory institutions for sustainable common pool resource management: Application to groundwater. *Water Resources & Economics*, 2–3:57–76, 2013. doi: 10.1016/j.wre.2013.08.001.

K. Madani and K. W. Hipel. Non-cooperative stability definitions for strategic analysis of generic water resources conflicts. *Water Resources Management*, 25:1949–1977, 2011. doi: 10.1007/s11269-011-9783-4.

K. Madani and J. Lund. California's Sacramento-San Joaquin Delta Conflict: From cooperation to chicken. *Journal of Water Resources Planning and Management-ASCE*, 138:90–99, 2012. doi: 10.1061/(asce)wr.1943-5452.0000164.

N. Mahjouri and M. Ardestani. A game theoretic approach for interbasin water resources allocation considering the water quality issues. *Environmental Monitoring and Assessment*, 167:527–544, 2010. doi: 10.1007/s10661-009-1070-y.

N. Mahjouri and M. Ardestani. Application of cooperative and noncooperative games in large-scale water quantity and quality management: a case study. *Environmental Monitoring and Assessment*, 172:157–169, 2011. doi: 10.1007/s10661-010-1324-8.

C. Marchiori. Concern for fairness and incentives in water negotiations. *Environmental & Resource Economics*, 45(4):553–571, 2010. doi: 10.1007/s10640-009-9328-y.

C. Marchiori, S. Stratton Sayre, and L. K. Simon. Bargaining and devolution in the Upper Guadiana Basin. *Environmental & Resource Economics*, 51 (3):453–470, 2012a. doi: 10.1007/s10640-011-9507-5.

C. Marchiori, S. Stratton Sayre, and L. K. Simon. On the implementation and performance of water rights buyback schemes. *Water Resources Management*, 26(10):2799–2816, 2012b. doi: 10.1007/s11269-012-0047-8.

F. Missfeldt. Game-theoretic modelling of transboundary pollution. *Journal of Economic Surveys*, 13:287–321, 1999.

N. Moes. Cooperative decision making in river water allocation problems. Amsterdam Publication 544 of the Tinbergen Institute Research Series, Vrije University (544), 2013.

L. C. Moller. Transboundary water conflicts over hydropower and irrigation: Can multilateral development banks help? CREDIT Research Paper, 05/09, 2005.

S. M. Msangi. Managing groundwater in the presence of asymmetry: Three essays. Ph.D., University of California, Davis, 2004.

R. B. Myerson. *Game Theory: Analysis of Conflict*. Harvard University Press, Cambridge, MA, 1991.

M. Nakao, D. Wichelns, and J. Montgomery. Game theory analysis of competition for groundwater involving El Paso, Texas and Ciudad Juarez, Mexico. Annual Meeting of the American Agricultural Economics Association, Long Beach, California, July 28–31, 2002, 2002.

J. Nash. Two-person cooperative games. *Econometrica*, 21(1):128–140, 1953.

D. H. Negri. The common property aquifer as a differential game. *Water Resources Research*, 25:9–15, 1989.

S. Netanyahu, R. E. Just, and J. K. Horowitz. Bargaining over shared aquifers: The case of Israel and the Palestinians. In R. Just and S. Netanyahu, editors, *Conflict and Cooperation on Trans-boundary Water Resources*, pages 41–60. Kluwer Academic Publishers, Boston, 1998.

M. H. Niksohan, R. Kerachian, and M. Karamouz. A game theoretic approach for trading discharge permits in rivers. *Water Science and Technology*, 60: 793–804, 2009. doi: 10.2166/wst.2009.394.

N. Okada. Cost allocation in multi-purpose reservoir development. In *Proceedings of the 8th Triennial World Congress of the International Federation of Automatic Control, Control Science and Technology for the Progress of Society*, volume 7 of *Appropriate Technology and Education and Economic Management*. Kyoto, Japan, 1982.

N. Okada and K. Tanimoto. Interpreting and extending conventional cost allocation methods for multipurpose reservoir developments by use of cooperative game theory. In *IEEE International Conference on Systems, Man, and Cybernetics*. 1996.

N. Okada, K. W. Hipel, and Y. Oka. Hypergame analysis of the Lake Biwa conflict. *Water Resources Research*, 21(7):917–926, 1985.

N. Okada, K. Takano, H. Sakakibara, and H. Tatano. Efficiency and stability of self-organizing cooperation networks: Roles of a cost allocation scheme for regional joint water distribution systems. In *IEEE International Conference on Systems, Man, and Cybernetics*. 1998.

M. J. Osborne and A. Rubinstein. *A Course in Game Theory*. MIT Press, 1994.

E. Ostrom, R. Gardner, and J. Walker. *Rules, Games, and Common-Pool Resources*. University of Michigan Press, With Arun Agrawal et al. Ann Arbor, 1994.

G.-J. Otten. Characterizations of a game theoretical cost allocation method. *ZOR, Methods and Models of Operations Research*, 38:175–85, 1993.

G. Owen. *Game Theory*. Harcourt Brace; Academic Press, San Diego; London and Toronto, 1982.

G. Owen. *Game Theory*. Harcourt Brace; Academic Press, San Diego; London and Toronto, 3rd edition, 1995.

S. Pande and M. McKee. Valuing certainty in a consensus-based water allocation mechanism. *Water Resources Research*, 43, 2007. doi: 10.1029/2004WR003890.

T. B. Parker. Allocation of the Tennessee Valley Authority projects. *Transactions of the American Society of Civil Engineers*, 108:174–187, 1943.

I. Parrachino, A. Dinar, and F. Patrone. Cooperative game theory and its application to natural, environmental, and water resource issues: 1. Basic theory. World Bank Policy Research Working Paper No. 4072, 2006a.

I. Parrachino, A. Dinar, and F. Patrone. Cooperative game theory and its application to natural, environmental, and water resource issues: 3. Application to water resources. World Bank Policy Research Working Paper No. 4074, 2006b.

H. J. M. Peters and H. Peters. *Cooperative Game Theory*. University of Maastricht, 1997.

K. H. Pham Do, A. Dinar, and D. McKinney. Transboundary water management: Can issue linkage help mitigate externalities? *International Game Theory Review*, 14:1–20, 2012. `http://www.worldscinet.com/igtr/igtr.shtml`.

K. H. Pham Do, K. Hang, and A. Dinar. The role of issue linkage in managing non-cooperating basins: The case of the Mekong. Massey University School of Economics and Finance, Discussion Paper: Massey University School of Economics and Finance, Discussion Paper, 2014.

H. Poorsepahy-Samian, R. Kerachian, and M. Reza Nikoo. Water and pollution discharge permit allocation to agricultural zones: Application of game theory and min-max regret analysis. *Water Resources Management*, 26: 4241–4257, 2012. doi: 10.1007/s11269-012-0142-x.

B. Provencher and O. Burt. The externalities associated with the common property exploitation of groundwater. *Journal of Environmental Economics and Management*, 24:139–158, 1993.

G. Rabow. The social implications of nonzero-sum games. *IEEE Technology and Society Magazine*, 7:10–18, 1988. doi: 10.1109/44.3227.

J. S. Ransmeier. *The Tennessee Valley Authority; A Case Study in the Economics of Multiple Purpose Stream Planning*. Vanderbilt University Press, Nashville, 1942.

G. Rausser and L. Simon. A non-cooperative model of collective decisionmaking: A multilateral bargaining approach. Dep. of Agric. and Resour. Econ.: Univ. of Calif., Berkeley, 1991.

G. C. Rausser, S. S. Sayre, and L. K. Simon. Property rights and water transfers: Bargaining among multiple stakeholders. *Strategic Behavior and the Environment*, 1(1):1–29, 2011. http://nowpublishers.com/journals/Strategic%20Behavior%20and%20the%20Environment/3.

A. Richards and N. Singh. Two level negotiations in bargaining over water. *Game Theoretical Applications to Economics and Operations Research*, 18: 257–273, 1997.

P. Rogers. A game theory approach to the problems of international river basins. *Water resources research*, 5:749–760, 1969.

P. Rogers. The value of cooperation in resolving international river basin disputes. *Natural Resources Forum*, 17:117–131, 1993.

P. Rogers. A model to generate pareto-admissible outcomes for international river basin negotiations. Milan, Italy: Nota di Lavoro Fondazione Enrico Mattei, 1994.

M. D. Rosen and R. J. Sexton. Irrigation districts and water markets: An application of cooperative decision-making theory. *Land Economics*, 69: 39–53, 1993.

A. E. Saak and J. M. Peterson. Groundwater use under incomplete information. *Journal of Environmental Economics and Management*, 54:214–228, 2007. doi: 10.1016/j.jeem.2006.12.005.

M. Sadegh and R. Kerachian. Water resources allocation using solution concepts of fuzzy cooperative games: Fuzzy least core and fuzzy weak least core. *Water Resources Management*, 25:2543–2573, 2011. doi: 10.1007/s11269-011-9826-x.

M. Sadegh, N. Mahjouri, and R. Kerachian. Optimal inter-basin water allocation using crisp and fuzzy Shapley games. *Water Resources Management*, 24:2291–2310, 2010. doi: 10.1007/s11269-009-9552-9.

H. Sakakibara, N. Okada, and D. Nakase. The application of robustness analysis to the conflict with incomplete information. *IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews*, 32 (1):14–23, 2002.

R. Salazar, F. Szidarovszky Jr. E. Coppola, and A. Rojano. Application of game theory for a groundwater conflict in Mexico. *Journal of Environmental Management*, 84:560–571, 2007. doi: 10.1016/j.jenvman.2006.07.011.

R. Salazar, F. Szidarovszky, and A. Rojano. Water distribution scenarios in the Mexican Valley. *Water Resources Management*, 24:2959–2970, 2010. doi: 10.1007/s11269-010-9589-9.

Y. Saleh, U. Gurler, and E. Berk. Centralized and decentralized management of groundwater with multiple users. *European Journal of Operational Research*, 215(1):244–256, 2011. doi: 10.1016/j.ejor.2011.05.048.

R. M. Saleth, J. B. Braden, and J. W. Eheart. Bargaining rules for a thin spot water market. *Land Economics*, 67:326–339, 1991.

S. M. A. Salman. The Helsinki rules, the UN watercourses convention and the Berlin rules: Perspectives on international water law. *Water Resources Development*, 23(4):625–640, 2007.

Y. Sawaragi, S. Ikeda, H. Nakayama, T. Tanino, and C. Okumura. An interactive optimization method for a water resource problem with multiple objectives. In *Environmental Systems Planning, Design and Control*. Kyoto, Japan, 1–5 August 1977, 1978.

D. Schmeidler. Competitive equilibria in markets with a continuum of traders and incomplete preferences. *Econometrica*, 37(4):578–585, 1969. http://www.econometricsociety.org/tocs.asp.

G. M. Sechi, R. Zucca, and P. Zuddas. Water costs allocation in complex systems using a cooperative game theory approach. *Water Resources Management*, 27:1781–1796, 2013. doi: 10.1007/s11269-012-0171-5.

R. Selten. Reexamination of the perfectness concept for equilibrium points in extensive games. *International Journal of Game Theory*, 4(1):25–55, 1975.

M. Serghini. The allocation of water resource development costs. *New Medit*, 1:27–37, 2002.

A. Sgobbi and C. Carraro. A stochastic multiple players multi-issues bargaining model for the Piave River basin. *Strategic Behavior and the Environment*, 1(2):119–150, 2011. http://nowpublishers.com/journals/Strategic%20Behavior%20and%20the%20Environment/3.

L. S. Shapley. A value of n-person games. In *Annals of Mathematics Studies Contributions to the Theory of Games*, pages 307–318. 1953.

L. S. Shapley. On balanced sets and cores. *Naval Research Logistic Quarterly*, 14:453–460, 1967. doi: 10.1002/nav.3800140404.

L. S. Shapley. Cores of convex games. *International Journal of Game Theory*, 1:11–26, 1971. doi: 10.1007/BF01753431.

L. S. Shapley and M. Shubik. A method for evaluating the distribution of power in a committee system. *American Political Science Review*, 48:787–792, 1954.

M. Sheehan and K. C. Kogiku. Game-theory analyses applied to water-resource problems. *Socio-Economic Planning Sciences*, 15:109–118, 1981.

M. Shubik. *Game Theory in the Social Sciences: Concepts and Solutions*. MIT Press, Cambridge, MA, 1982.

A. Soubeyran and A. Tomini. Water shortages and conflict. *Revue D Economie Politique*, 122:279–297, 2012.

F. A. Souza Filho, U. Lall, and R. La Laina Porto. Role of price and enforcement in water allocation: Insights from game theory. *Water Resources Research*, 44, 2008. doi: 10.1029/2007wr006163.

P. D. Straffin and J. P. Heaney. Game theory and the Tennessee Valley Authority. *International Journal of Game Theory — International Journal of Game Theory*, 10(1):35–43, 1981.

S. E. Stratton, L. K. Simon, and C. Marchiori. Promoting groundwater reform in the Guadiana Basin. *American Journal of Agricultural Economics*, 90 (5):1343–1349, 2008. doi: 10.1111/j.1467-8276.2008.01228.x.

R. Supalla, B. Klaus, O. Yeboah, and R. Bruins. A game theory approach to deciding who will supply instream flow water. *Journal of the American Water Resources Association*, 38:959–966, 2002.

R. J. Supalla. A game theoretic analysis of institutional arrangements for Platte River management. *International Journal of Water Resources Development*, 16:253–264, 2000.

P. Suttinon, A. Mumtaz Bhatti, and S. Nasu. Option games in water infrastructure investment. *Journal of Water Resources Planning and Management-ASCE*, 138:268–276, 2012. doi: 10.1061/(asce)wr.1943-5452.0000168.

M. Suzuki and M. Nakayama. Cost assignment of the cooperative water resource development: A game theoretical approach. *Management Science*, 22:1081–1086, 1976.

Y. Suzuki and Y. Iwasa. Conflict between groups of players in coupled socio-economic and ecological dynamics. *Ecological Economics*, 68:1106–1115, 2009. doi: 10.1016/j.ecolecon.2008.07.024.

H. Tamura and H. Suzuki. Total emission control for managing regional water quality. A game theoretic decision process. In *Proceedings of the Eighth Triennial World Congress of the International Federation of Automatic Control, Control Science and Technology for the Progress of Society*. Kyoto, Japan, 24–28 August 1981, 1982.

R. L. Teasley and D. C. McKinney. Calculating the benefits of transboundary river basin cooperation: Syr Darya Basin. *Journal of Water Resources Planning and Management-Asce*, 137:481–490, 2011. doi: 10.1061/(asce)wr.1943-5452.0000141.

A. Thiel. Transboundary resource management in the EU: Transnational welfare maximization and transboundary water sharing on the Iberian Peninsula? *Journal of Environmental Planning and Management*, 47:331–350, 2004.

S. Thoyer, S. Morardet, P. Rio, L. Simon, R. Goodhue, and G. Rausser. A bargaining model to simulate negotiations between water users. *Journal of Artificial Societies and Social Simulation*, 4, 2001.

S. H. Tijs and T. S. H. Driessen. Game theory and cost allocation problems. *Management Science*, 32:1015–1028, 1986.

J. Tirole. *The Theory of Industrial Organization*. MIT Press, Cambridge, 1988.

J. G. Tisdell and S. R. Harrison. Estimating an optimal distribution of water entitlements. *Water Resources Research*, 28:3111–3117, 1992.

United Nations Environment Programme. Report of the United Nations Conference on the Human Environment. Stockholm, 5–16 June 1972, 1972.

United States Army, Corps of Engineers. Proposed practices for economic analysis of river basins. In *Report to the Federal Inter-Agency River Basin Committee*. Washington, D. C., 1950.

R. Van den Brink, G. Van der Laan, and N. Moes. Fair agreements for sharing international rivers with multiple springs and externalities. Tinbergen Institute, Tinbergen Institute Discussion Papers: 10-096/1, VU University Amsterdam; VU University Amsterdam; VU University, 2010.

G. van der Laan and N. Moes. Transboundary externalities and property rights: An international river pollution model. *Journal of Environmental Economics and Management*, 63(3):388–403, 2012. http://www.sciencedirect.com/science/article/pii/S0095069611001574.

J. Villar and H. Rudnick. Hydrothermal market simulator using game theory: Assessment of market power. *Transactions on Power Systems, IEEE*, 18 (1):91–98, 2003.

J. Villar and H. Rudnick. Closure on "hydrothermal market simulator using game theory: Assessment of market power". *Transactions on Power Systems, IEEE*, 19(1):691–692, 2004.

J. Von Neumann and O. Morgenstern. *Theory of Games and Economic Behavior*. Princeton University Press, Princeton, 1944.

H. Von Stackelberg. Market structure and equilibrium: 1st edition translation of the 1934 paper into English. Bazin, Urch & Hill, Springer 2011, XIV, 134 p, 2011.

L. Z. Wang, L. Fang, and K. W. Hipel. Water resources allocation: A cooperative game theoretic approach. *Journal of Environmental Informatics*, 2: 11–22, 2003.

L. Z. Wang, L. P. Fang, and K. W. Hipel. Integrated hydrologic-economic modeling of coalitions of stakeholders for water allocation in the South Saskatchewan River Basin. *Journal of Hydrologic Engineering*, 13:781–792, 2008. doi: 10.1061/(asce)1084-0699(2008)13:9(781).

X. Wang, Y. Zhang, Y. Zeng, and C. Liu. Resolving trans-jurisdictional water conflicts by the Nash bargaining method: A case study in ZhangWeiNan canal basin in North China. *Water Resources Management*, 27:1235–1247, 2013. doi: 10.1007/s11269-012-0233-8.

Y. Wang. Trading water along a river. *Mathematical Social Sciences*, 61: 124–130, 2011. doi: 10.1016/j.mathsocsci.2010.11.003.

Y. Wang and D. Ni. Sharing a polluted river. *Games and Economic Behavior*, pages 176–186, 2007. doi: 10.1016/j.geb.2006.10.001.

S. Wei and A. Gnauck. Simulating water conflicts using game theoretical models for water resources management. *Ecosystems and Sustainable Development Vi*, 106:3–12, 2007.

S. Wei, H. Yang, K. Abbaspour, J. Mousavi, and A. Gnauck. Game theory based models to analyze water conflicts in the Middle Route of the South-to-North Water Transfer Project in China. *Water Research*, 44(8):2499–2516, 2010. doi: 10.1016/j.watres.2010.01.021.

M. E. Wetzstein and T. J. Centner. Regulating agricultural contamination of groundwater through strict liability and negligence legistlation. *Journal of Environmental Economics and Management*, 22:1–11, 1992.

M. A. Williams. An empirical test of cooperative game solution concepts. *Behavioral Science*, 33(3):224–237, 1988.

X. Wu and D. Whittington. Incentive compatibility and conflict resolution in international river basins: A case study of the Nile Basin. *Water Resources Research*, 42, 2006.

Z. Yang, Y. Zeng, Y. Cai, and Q. Tan. An integrated game-theory based model for trans-boundary water resources management in North China: A case study in the Guanting Reservoir Basin (GRB), Beijing. *International Journal of Software Engineering and Knowledge Engineering*, 18:461–483, 2008.

D. Yaron. An approach to the problem of water allocation to Israel and the Palestinian entity. In *Economics of Water Resources: The Contributions of Dan Yaron*, volume xxi of *Collected by Ariel Dinar and David Zilberman. Natural Resource Management and Policy, vol. 24*, pages 236, 201–217. Kluwer Academic, Boston; Dordrecht and London, 2002.

H. P. Young. Monotonic solutions of cooperative games. *International Journal of Game Theory*, 14(2):65–72, 1985. doi: 10.1007/BF01769885.

H. P. Young. An evolutionary model of bargaining. *Journal of Economic Theory*, 59(1):145–168, 1993. `http://www.sciencedirect.com/science/journal/00220531`.

H. P. Young. *Equity: In Theory and Practice.* Princeton University Press, Princeton, N.J., 1994a.

H. P. Young. Cost allocation. In R. J. and S. Hart Aumann, editors, *Handbook of Game Theory*, pages 1215–1217. Elsevier Science, 1994b.

H. P. Young, N. Okada, and T. Hashimoto. *Cost Allocation in Water Resources Development — A Case Study of Sweden.* Laxenburg, Austria, September 1980, 1980.

H. P. Young, N. Okada, and T. Hashimoto. Cost allocation in water resources development. *Water Resources Research*, 18:463–482, 1982.

H. M. Zadeh, A. Ghaheri, and L. Karp. A model of non-cooperative dynamic game to conflict resolution among common natural resource operators. *Journal of Applied Sciences*, 9:2156–2161, 2009.

F. Zagonari. Sustainable, just, equal, and optimal groundwater Management strategies to cope with climate change: Insights from Brazil. *Water Resources Management*, 24:3731–3756, 2010. doi: 10.1007/s11269-010-9630-z.

S. Zara, A. Dinar, and F. Patrone. Cooperative game theory and its application to natural, environmental and water resource issues: 2. Application to natural and environmental resources. World Bank Policy Research Working Paper 4073, November 2006, 2006.

E. Zermelo. Über eine anwendung der mengenlehre auf die theorie des schachspiels. In *Proceedings of Fifth Congress Mathematicians*, pages 501–504. (Cambridge 1912), Cambridge University Press, 1913.