

## Book Review

Adaptation and resilience: The economics of climate, water and energy challenges in the American Southwest, edited by Bonnie G. Colby and George B. Frisvold; 2011, Hardback, 256 pages. ISBN 978-1-933115-93-1

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Adaptation to climate change is an increasingly relevant topic, not only for developing countries but also for rich, industrialized states like the USA. Climate change in the arid Southwest of the USA will add to the already fierce competition for water by agriculture, recreational activities, electricity generation, urban households and natural ecosystems. In their book *Adaptation and Resilience: The Economics of Climate, Water and Energy Challenges in the American Southwest*, editors Colby and Frisvold from the University of Arizona bring together a set of 12 chapters on this topic. In each chapter, one of the editors is involved as an author collaborating with one or two co-authors. Chapters are not disparate as sometimes is the case with edited books; they frequently refer to each other. Overall, the authors display a profound knowledge of the region and a thorough historic and legal background of water accessibility and distribution.

The first chapter sets the scope of analysis and defines resilience as the ability of systems to undergo changes while still maintaining their fundamental structure and function. The methods used to investigate resilience are diverse and well explained. Even though working very quantitatively, the authors want to be accessible to non-economists and explain their analyses carefully step by step.

Chapters 2 to 4 look at water markets, but do not really address the question of how these markets can increase resilience. Chapter 2 develops a water demand model in which both quantity and price are endogenous variables. In a multivariate regression analysis the authors find that water transactions in New Mexico and California are positively correlated with regional droughts. Agricultural water is traded at lower prices than municipal water. Surprisingly, in New Mexico larger trades command higher unit prices – probably due to time-consuming authorization procedures for large quantities. The chapter does not provide groundbreaking new results, but a thorough analysis of water demand relations in the Southwest.

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Chapter 3 aims at dispelling doubts about the usefulness of game theoretical concepts in modelling water transfers from agricultural to municipal consumers. The authors use a Nash bargaining model in which urban demand drives the amount of transfers up, while an increase in profitability of irrigated agriculture brings them down. Improved efficiency can, under certain conditions, increase agricultural demand for water, depending on how responsive the crop is to further irrigation. Applied to a large water transfer agreement between the irrigation area in California's Imperial Valley and the city of San Diego, the model suggests that water consumption increases with transfers because, with water being transferred from rural California to San Diego, there are less flows of used agricultural water to the countryside – a prime example for externalities of water transfers.

The lining of the All-American Canal provides another example for externalities of water transfers. The All-American Canal is the longest irrigation canal in the world, bringing water from the Colorado River to farms in the Imperial Valley. The positive side of the construction project for the lining of the canal is an increase in future transfers by saving water. In the past, however, seepage from the All-American Canal has recharged the aquifer beneath the Mexicali Valley. Now Mexican farmers have to cope with greatly reduced water and the Mexican government sued unsuccessfully to block the lining project. The legal situation is unclear, as the USA and Mexico have not signed any comprehensive agreement on the management of transboundary groundwater resources. The authors propose to link this issue to water negotiations in which Mexico is the upstream, advantaged country in order to improve its bargaining position relative to the USA. With the issue linkage strategy, game theory predicts a relatively better outcome for Mexico. However, one wonders whether the lining of the canal rectifies a positive externality Mexican farmers have illegitimately taken advantage of – given that without the canal Mexico would not have received any water at all – or if it deprives them from a resource they are entitled to and therefore constitutes external costs. Game theory gives advice on how parties could deal with the unsatisfactory legal situation but can do only little on the policymaking side. Chapter 3 shows that game theory can model the status quo but cannot replace legal, political and ethical analysis for policy making.

In Chapter 4, the authors identify price ranges at which agricultural water users would be willing to lease out water during dry periods. They estimate the net returns to water above the variable costs and take this as the minimum amount farmers would accept as a price for water transfers. The approach makes intuitive sense but needs to be complemented by the authors' agricultural knowledge: even though returns to water for head lettuce in Arizona are high, risk costs are too (due to perishability, unstable prices and extensive planning) and make the lettuce less profitable. Moreover, in order to find the cheapest transfer deals, one needs to consider agricultural cycles in Arizona: in late spring and summer, growers can cease irrigation at the least cost.

In places, the chapter reads like an advertisement for water option markets. Unlike other researchers who also argue for water markets (Brewer *et al.*, 2007; Grafton *et al.*, 2010), the authors do not mention that water transfers are necessary in the first place because farmers do not pay the full cost of water.

Chapters 5 to 7 deal with the sector impacts of climate change. Chapter 5 analyses the possible reactions to a 25% drop in water supply in the Southern Mountain region and a 5% drop in Southern California. The rationing model suggests that following due to rationed water supply would amount to a loss of US\$ 15–65 million in irrigators' income. All in all, agriculture is found to be quite resilient, though particular crops and regions are relatively vulnerable to the water supply shock, e.g., alfalfa, cotton, wheat, corn and barley, in Arizona and New Mexico. However, the chapter does not discuss potential efficiency gains in household and industrial water use at all. Already today, a substantial part (between 12 and 52%) of the total water consumption in the American Southwest goes to

households and industry, and increasing use efficiency could contribute to a reduced rationing need: Karpiscak *et al.* (2005) show that single-family residences in Arizona could significantly decrease demand for domestic water without reducing the residents' quality of life. Houses were retrofitted with water-conserving fixtures, rainwater harvesting and gray water reuse systems, which led to a reduction of municipal water use by 66% over a 4-year period.

In Chapter 6, multivariate time-series data of visits to Southwestern nature parks are used to examine how climate, energy price and other variables affected annual park visits. Chapter 7 considers the implications of climate change for the Southwest's ski industry and develops a financial model that examines returns to investment in snowmaking. Even though these two chapters yield interesting results, one wonders why tourism features so prominently in a book on climate, water and energy. The numerous nature parks provide important contributions to rural economies, and skiing is taken as a 'canary in a coal mine' example for the costs of adaptation to climate change. However, bearing the title of the book in mind, it is not very enlightening to read about which national parks will benefit from an increase in visitors due to climate change or under which circumstances snowmaking will be profitable, while we learn nothing about the water footprint of energy and the water efficiency improvement potential of urban households and industries.

Chapters 8 to 11 are summarized under the subheading 'Information, technology, and adaptation' and look at the role of information technology in climate change adaptation. While interesting, this seems not to be the most relevant aspect of water-related adaptation; a discussion of the political economy of adaptation measures would certainly have been more relevant. The chapters bring together data from the US Department of Agriculture's Farm and Ranch Irrigation Survey, from electricity utilities and own surveys. Backed up by solid statistical methods, the chapters yield the following results:

- Larger farms use more data sources to make irrigation management decisions. For smaller farms, districts served as a source for irrigation information and often decided the timing of irrigation (Chapter 8).
- Reliance on sprinkler irrigation, which is more water efficient than gravity systems, increases with farm size, potential for erosion, energy costs and reliance on groundwater. Sprinkler irrigation increases and then decreases with cropland-weighted mean temperature, i.e., very high temperatures discourage sprinkler irrigation, which indicates that there may be limited scope for farmers to adapt to climate warming by switching from gravity to sprinkler technology, especially in hot regions such as Arizona or Southern California (Chapter 9).
- Chapter 10 deals with electricity and the authors improve a time-series electricity demand model by 2.5% through the introduction of weather factors. This does not seem to be much but could save millions of dollars annually. However, the fundamental issues lying at the core of future energy decisions are, again, not touched.
- Chapter 11 develops a model of the demand for weather information. Diversification within agriculture encourages weather data use; off-farm income discourages it. Only 40% of Arizonan farmers have internet access, but that does not significantly restrict access to information. The authors conclude that supplying information is not enough but providers of information should find out more about the users they address.

The book's most obvious drawbacks are the sidelining of the energy sector and the uncritical support of irrigation subsidies, even if water markets were introduced. Although the link between water and

energy supply, the backbone of today's wealthy economies, is emphasized in the introductory Chapter 1, the editors do not discuss this link until Chapter 10, which evaluates how climate information improve utility load forecasts. Nothing can be found on the impacts of climate change and water shortages on the energy supply. What is the most water-efficient way to satisfy increasing energy needs? Can water and fossil fuel dependency be substantially reduced by promoting selected renewable energies (bioenergy from waste, solar photovoltaic, wind turbines), as some studies (e.g. Dennen *et al.*, 2007) suggest?

While water market transactions rightly play a prominent role in the book, the authors propose them to be grafted onto the existing inefficient system of subsidization of agricultural water use. Given a rapidly increasing population – it is projected to grow between 15% in New Mexico and more than 100% in Arizona and Nevada from 2000 to 2030 – and given a supply shortage, the higher willingness to pay of urban households compared to farmers would lead to the transfer of water from the agricultural sector (which currently uses 80% of water) to urban centres. But before we engage in water trading, the removal of subsidies for irrigated agriculture, which can lead to a water price difference between agricultural and urban users of a factor of 100 (Brewer *et al.*, 2007), should be the highest priority. If subsidies are not removed before water trading starts, irrigators would receive large windfall profits from water transfers. Surprisingly, the editors (as well as the authors of Chapter 5) argue against a removal of subsidies for water, as trading combined with a subsidy removal would be more costly to producers than a pure rationing of water. It seems that the editors have not considered that subsidized water prices coupled with water transfers or quantity restrictions are neither efficient (as two policies need to be designed and administered), nor do they lead to an equitable distribution (as irrigators receive windfall profits). Obviously, it would be politically very difficult to phase out water subsidies but in other policy fields, with equally entrenched subsidy regimes (such as is the case with coal mining), subsidy removal has been possible (IEA *et al.*, 2010).

When discussing water trading, transport subsidies should also be addressed, as long distance water transport schemes frequently benefit from highly subsidized infrastructure and electricity tariffs (Sharp, 2007).

The book is well researched, backed up by rich data and empirical analysis, and the authors' enthusiasm for the topic is obvious. They are excellent observers and analysts but lack a coherent vision for the water and energy sector in America's Southwest, whilst the link to climate change is sometimes tenuous. Rather than questioning water subsidies, the authors propose building another transaction cost-intensive policy mechanism on top of the existing subsidies. Instead of assessing the link between energy and water, such as future plans to invest heavily in water-intensive geothermal energy (Adee & Moore, 2010), they observe the demand for climate-related information that could potentially lead to water efficient irrigation.

The book should probably have simply been entitled *Water transfers, demand for climate information and the impact of climate change on recreation in the American Southwest*. Then, however, it would have become apparent how little these topics are related.

## Disclaimer

The interpretations and conclusions expressed in this review are entirely those of the author of the review.

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Adaptation and Resilience. The Economics of Climate, Water, and Energy Challenges in the American Southwest. EDITED BY. Bonnie G. Colby and George B. Frisvold. Rff press. H ^ ^ M resources for the future. Washington, DC & London. Contents. List of Figures. ix. Contributors.Â Bonnie G. Colby and Paulo Tanimoto. 11 Use of Climate and Weather Information in Agricultural Decisionmaking George B. Frisvold and Anand Murugesan. 229. Part IV Conclusion. 12 Modes of Adaptation and Regional Resilience to Climate Change Bonnie G. Colby and George B, Frisvold. 251 253. Index. Buy Adaptation and Resilience (9781933115931): The Economics of Climate, Water, and Energy Challenges in the American Southwest: NHBS - Edited By: George B Frisvold and Bonnie G Colby, Resources for the Future.Â Foreword 1. The Climate-Water-Energy Nexus in the Arid Southwest PART I: VOLUNTARY WATER TRANSFERS AS ADAPTATION MECHANISMS 2. Negotiated Water Transactions and Climate Change Adaptation 3. Applying Bargaining Theory to Western Water Transfers 4. Economic Tools For Climate Adaptation: Water Transaction Price Negotiations PART II: SECTOR IMPACTS OF CLIMATE CHANGE 5. Water Shortages in the Southern Mountain States: Economic Impacts on. Adaptation and resilience: The economics of climate, water and energy challenges in the American Southwest, edited by Bonnie G. Colby and George B. Frisvold; 2011, Hardback, 256 pages. ISBN 978-1-933115-93-1. Article.Â The allocation of these new resources is to be balanced between adaptation and mitigationâ€™ (UNFCCC, 200 Cite. Request full-text. Path dependence of negotiation structures in international organizations: The impact of Annex I membership on discussions within the UNFCCC. Article. Full-text available.