

# **Annotated Bibliography on Water Marketing**

by Phyllis Park Saarinen and Gary D. Lynne

Annotations last modified Aug 18, 2000

The part of this Annotation covering papers through 1993 was prepared largely by Phyllis Saarinen, who at the time was a graduate student at the University of Florida.

Copyright 2000 by Gary D. Lynne. All rights reserved. Readers may make verbatim copies of this document for non-commercial purpose by any means, provided that this copyright notice appears on all such copies.

(This Adobe file is stored at the University of Nebraska-Lincoln: Contact [glynnel@unl.edu](mailto:glynnel@unl.edu) with comments. ).

**Anderson, Terry L., Water Crisis Ending the Policy Drought** (Baltimore Johns Hopkins University Press, 1983).

The author discusses property rights in water and the effect of administrative controls on the economics of water allocation, primarily in the setting of western prior appropriation doctrine. He describes a traditional resource economics based on central control, cost benefit analysis and wise managers in a setting where information and incentives for behavior are not emphasized and contrasts that with a new resource economics in which responsibility for opportunity costs is defined through the property rights structure. Instream and third-party externalities are seen to be caused more by restrictions on the market than by the prior appropriation doctrine, and privatizing instream flow is the best solution.

Groundwater management and inducing optimal extraction rates are discussed at length. Kern County, California, management policies are an example of effective allocation and resource protection through market-like incentives. The author concludes that water shortages are an institutional problem that society attempts to solve by technological means which generally promote conflict. Cooperative solutions to the water crisis are possible through a market institution.

**Anderson, Terry L., "The Market Alternative for Hawaiian Water," Natural Resources J.** 25, 893-910, October 1985.

The article advocates developing a water market in Hawaii as that state addresses the establishment of an agency to control and regulate its water resources for the benefit of the people. The historic water allocation process in Hawaii was based on customs and practices originating with the pre-European population which by 1959 supported a water rights market system. However, in *McBryde Sugar Company v. Robinson* (504 p.2d 1330, 1973) the Hawaiian Supreme Court ruled that the water belongs to the people of the state for their common use; in 1985 the U.S. Court of Appeals (*Robinson v. Ariyoshi*, 753 P.2d 1468, 9th Cir. 1985) overturned the earlier decision reinstating the earlier water system; and in the interim the Hawaiian constitution had been amended to require a new water policy. Thus the Advisory Study Commission on Water Resources was at the time of this article in the process of drafting alternative water codes for legislative consideration.

The author discusses the pros and cons of a system of transferable rights, including criticisms of the market process and the problem areas of third-party effects, instream flows and groundwater transfers. He also addresses several aspects of inefficiency and failure of a political administration process.

**Anderson, Terry L., and Donald R. Leal, "Building Coalitions for Water Marketing," J. Policy Analysis and Management** 8 (3), 432-445, 1989.

The article describes a stylized hydrologic schematic to demonstrate modifications to water allocation institutions which would improve protection for instream flow requirements. Instream flows and other water uses are either nonrival (additive) or rival in nature and thus must be evaluated by different criteria. Optimizing water allocation requires that the net marginal value of a unit of water diverted and not returned to the source equal the sum of the net marginal values of nonrival, nonconsumptive uses. In order for upstream transfers of consumptive use rights to make economic sense, they must have sufficient value to offset the sum of all downstream instream values.

Water allocation policies in California, Colorado and Montana are discussed in relation to defining and protecting instream flow values. The authors suggest that if states allow private parties to purchase existing consumptive rights for

instream purposes, innovative contractual arrangements may overcome the problems with private provision of public goods.

**Bowen, Richard L., James E. T. Moncur, and Richard L. Pollock,** "Rent Seeking, Wealth Transfers and Water Rights The Hawaii Case," Natural Resources J. 31, 429-448, Winter 1991.

For more than 30 years, the state of Hawaii and island of Oahu have been struggling to resolve the issues inherent in the need to transfer groundwater from agricultural uses to urban uses. During this period, the difference in value between the two uses has increased significantly. This paper discusses the rent-seeking activity taking place in Hawaii, and develops a method to estimate the unearned rents or scarcity rents which would be transferred to landowners if the transfer took the form advocated by the New Resource Economics. The authors note that potential efficiency gains in water use probably cannot be achieved under government planning and regulation, and conclude that efficiency gains would be realized by having the state auction the water rights to the highest bidder with the rights remaining in the private sector subject to a market allocation. Bid prices would reflect the scarcity value of the water and rents would accrue to the government.

**Brajer, Victor, Al Church, Ronald Cummings and Phillip Farah,** "The Strengths and Weaknesses of Water Markets as They Affect Water Scarcity and Sovereignty Interests in the West," Natural Resources J. 29 (2), 489-509, Spring 1989.

The authors remark on the "intellectual disarray among economists over the desirability of a market as a means of allocating scarce water resources," and then discuss at length the strengths and weaknesses of a market solution to resource allocation and a well functioning market. In defining the conditions for a perfect or well functioning market in western U.S. water (well-defined property rights, many buyers and sellers, mobile resources, and good information systems), the article addresses the effects of the 1982 Supreme Court decisions in *Sporhase v. Nebraska* and *Colorado v. New Mexico* on water property rights and states' proprietary interest. The New Mexico water market is compared with the characteristics of a well functioning market and found far from adequate. The changes necessary to improve the market are described.

The authors also discuss the impact of interstate water markets on state economies and planning efforts, and of making possible the sale of rights to federal water available through the Bureau of Reclamation which may collapse water rights values in many western basins.

**Brajer, Victor, and Wade E. Martin,** "Water Rights Markets Social and Legal Considerations," Am. J. of Economics and Sociology 49 (1), 35-44, January 1990.

Water resource development, transfers and use are subject to social and legal factors which contribute to uncertainties and externalities which may preclude an optimal economic condition. Among the factors is the community value of water, the argument that water is not just a commodity but is necessary to the economy and social structure of a society, and a threat to the system for allocating water is a threat to the communal enterprise. The community value of water leads to a divergence between the social and private benefits of water use and the failure of the market to achieve a Pareto efficient allocation. This failure provides a strong argument for central management of water allocation.

Recent court decisions denying state ownership of water resources, conflicting legal principles applied by the courts to surface and groundwater allocation, and the existence of different legal and administrative systems among the states have all heightened the uncertainties of the legal/institutional processes. The result of these uncertainties and the emerging recognition of the community value of water is that strict dependence on free market forces may not lead to an economically efficient solution. The authors conclude that water allocation must be based on an integration of sound economic reasoning into the

complex forum that recognizes that water is "different."

**Brajer, Victor, and Wade E. Martin,** "Allocating a 'Scarce' Resource, Water in the West," Am. J. of Econ. and Soc. 48 (3), 259-271, July 1989.

Water as an economic good amenable to allocation through markets and as a "different" resource which cannot be allocated efficiently through markets is discussed. Scarcity arises as a result of undercosting water through lack of recognition of the hidden overhead cost of federal, state and local subsidies and projecting demand through simple linear extrapolations. Scarcity is more appropriately defined as excess demand due to underpricing and historic reliance on supply augmentation rather than demand management. The authors assert that municipal and irrigation demand for water is price responsive and can be managed without significant economic impacts to either urban development or agricultural productivity.

In any groundwater allocation system, the need for detailed description of the groundwater resource is paramount and in most instances unavailable. Information would include yield factors, saturated thicknesses and hydrologic characteristics, hydraulic properties of alluvial materials, quantity of water discharged by phreatophytes, amount of recharge from irrigation water, relationship of ground and surface water and water quality. Hydrologically related external costs include land subsidence and groundwater quality degradation.

**Burness, H. Stuart, and James P. Quirk,** "Appropriative Water Rights and the Efficient Allocation of Resources," American Economic Review 69 (1), 25-37, March 1979.

The authors briefly compare the potential for water markets under riparian and prior appropriation doctrines and then discuss in detail the sources of allocative inefficiency within the appropriation doctrine under the simplifying assumption that all appropriators have the same profit functions and each acts to maximize profits. Several propositions are developed, including

1. The probability distribution facing any senior appropriator is unambiguously preferred by any potential user to that facing a junior appropriator.
2. Given two identical firms, the one with senior rights claims a larger quantity of water than does a firm with junior rights.
3. If increasing returns dominate for small claims and if the potential users of a stream are risk neutral, then the aggregate water rights at a long run competitive equilibrium is less than the maximum flow of the stream.
4. If the marginal cost of adding water claims is increasing, then equal sharing is the efficient allocation of claims and allocation under the appropriative system is inefficient.
5. Given the above conditions, the appropriative system with competitive markets in rights and diversion facilities leads to an efficient outcome (equal sharing). The price per unit of water varies monotonically with the seniority of the water supplier; the price per unit of capacity is constant across firms.
6. At a long run equilibrium equal sharing is a necessary condition for Pareto optimality and equal sharing can be achieved under an appropriative system through competitive markets in water rights.

**Bush, David B.,** "Dealing for Water in the West Water Rights as Commodities," J. American Water Works Assoc., 30-37, March 1988.

The article describes the various types of water rights transactions which are becoming commonplace in the western U.S. in an evaluation of the structure of emerging markets. Five types of water rights or commodities are defined riparian, appropriative, use permits, entitlements and mutual stocks. The author discusses sales, leases, options and negotiated adjustments for each type. The treatment of return flows, including recovered municipal wastewater, and conserved or salvaged water is discussed at length. The author concludes that western economic prosperity is tied to water rights that must provide not only security but the flexibility to accommodate new uses. This need for flexibility in the various forms of water rights is reflected in the diversity of emerging marketing systems.

**Chan, Arthur H.**, "To Market or Not to Market Allocation of Interstate Waters," Natural Resources J. 29 (2), 529-547, Spring 1989.

The author discusses the significance of the *Sporhase v. Nebraska ex rel. Douglas* U.S. Supreme Court decision (458 U.S. 941, 1982) as an extension of the commerce clause of the U.S. Constitution or, more precisely, its inverse, the dormant commerce clause. The dormant commerce clause is used to protect "the national union from being economically fragmented and thus weakened by individual states imposing burdensome measures, such as taxes or tariffs or bans on goods, which would impede commerce (Barnett, "Mixing Water and the Commerce Clause The Problems of Practice, Precedent, and Policy in *Sporhase v. Nebraska*," Natural Resources J. 24 (2), p.161, 1984)." He challenges the Supreme Court's implied belief that a market approach to interstate resource allocation will strengthen the national union by discussing in detail the definition and ultimate purposes of an economy.

Professor Chan uses the federal district court decision in *City of El Paso v. Reynolds* (563 F. Supp. 379, DNM 1983), which ruled in favor of the right of El Paso to appropriate groundwater from neighboring southeast New Mexico (over the objections of the state of New Mexico), to exemplify the adverse consequences of the *Sporhase* decision on national union and the rights and powers of each state to equitable treatment, participatory freedom and rational planning. He points out that the *Sporhase* decision applying the commerce clause to groundwater allocation is inconsistent with the Supreme Court's position on surface water allocation by equitable apportionment and ignores the hydrologic reality of the relationships between groundwater and surface water. Equitable apportionment as a form of regulation is consistent with the national unity goals of the commerce clause, while interstate market allocation of groundwater contributes to adversarial relationships among states and disunion.

**Chan, Arthur H.**, "To Market or Not to Market: Allocating Water Rights in New Mexico," Natural Resources J. 29 (3), 629-643, Summer 1989.

In light of the judicial decisions in *City of El Paso v. Reynolds* (597 F. Supp. 694, D.N.M., 1984) and *Colorado v. New Mexico* (467 U.S. 310, 1984), New Mexico is facing prospects of losing the right to large quantities of groundwater to Texas through appropriation and exportation and at the same time is under intense conservation pressure to maintain its present apportionment of the Vermejo River. The author questions whether a water market is the most effective process, exemplified by the case of New Mexico, to reach the highest and best use when conservation is the ultimate criterion. The discussion centers on whether competitive markets are inherently efficient, whether they promote efficiency and whether market allocation of water helps achieve societal goals.

The conclusion is that while a competitive market may be an efficient allocative process for achieving maximum profit/wealth, it is not an efficient allocative institution for achieving other social goals due to redundancy and infrastructure dislocation. It is not particularly good or efficient in achieving community goals such as ecological preservation, species protection, or welfare promotion for future generations.

**Christopher Nunn, Susan,** "The Political Economy of Institutional Change A Distribution Criterion for Acceptance of Groundwater Rules," Natural Resources J. 25, 867-892, October 1985.

The author addresses the redistributive effects of and resulting social resistance to groundwater reallocation proposals. She argues that traditional economic analyses which focus on the market allocation process to attain water use efficiency have diminished usefulness because they ignore or discount the significance of redistribution resistance, and that efficiency is not an important criterion in public decisions unless it satisfies the distributive criteria of the affected community.

The article compares the groundwater withdrawal history of the Roswell Basin artesian aquifer, New Mexico, with that of the Texas Panhandle High Plains Ogallala nonartesian aquifer in a demonstration of the operation of the classic "prisoners' dilemma," in which all irrigators in a common pool situation can improve over their best independent choice by binding themselves to a rule not to exercise their best choice. In the case of the Roswell Basin, the problem is the immediate cost of excessive annual demands on the artesian pressure and the affected community has been successful in creating a regulatory institution to redistribute the costs equitably. In the case of the Texas Ogallala aquifer, the problem is the cost of future scarcity to nonirrigators (municipal and industrial users) and the affected community of irrigators has been successful in denying the creation of any regulatory authority that could limit rates of pumping or irrigated acreage. Thus the future scarcity cost of present irrigation will be paid by West Texas cities and the "distribution-of-benefits" condition governs any prospective rule change. An alternative rule to conserve water for future high-valued uses would have to provide irrigators at least as much benefit as the current absolute ownership rule does.

The author concludes that in order to adjust property rules for resource reallocation, it is necessary to identify the limits of the necessary distribution of benefits and to make improvements that satisfy those parameters. Economic analysis in resource policy issues must consider distribution from the perspective of feasibility rather than equity.

**Christopher Nunn, Susan, and Helen M. Ingram,** "Information, the Decision Forum, and Third-Party Effects in Water Transfers," Water Resources Res. 24 (4), 473-480, April 1988.

The authors examine the decision-making process for water transfers as it takes place in different forums: the market, the legislature, the courts, special purpose districts, and the administrative agencies. The focus is on how and to what extent each of these decision forums addresses indirect and nonuser effects, particularly socio-economic impacts to the rural donor or seller (area-of-origin) community.

The authors conclude that all five forums are biased in the type of information generated and considered in decision making and that the choice of optimal forum depends upon priorities among values. Legislative bodies better register information about indirect and nonuser impacts but often distort information on the direct benefits and costs that are measured by markets. The authors suggest that negotiation arrangements in which special districts, local governments and state agencies have an input to a transfer decision are a possible alternative to the traditional political forums, and that such a negotiation arrangement would develop a richer information base.

**Ciriacy-Wantrup, S. V.,** "Concepts Used as Economic Criteria for a System of Water Rights," Land Economics 32 (4), 295-312, November 1956.

A distinction must be made between economic criteria "in" water law and economic criteria "for" water law, and within these sets of criteria a dichotomy exists between security and protection of water rights, on the one hand, and flexibility and adaptability of water rights on the other. This dichotomy

implies a problem area between economic change and statics. The criteria for water law and in water law are connected by the concept of public interest.

The article examines these concepts as criteria, focusing on functional relations in economics and including welfare economics. The author advocates the use of economics to enhance long term water planning and to establish sound legal doctrine, pointing out that a conflict situation often be identified in economic terms before it has arisen in law as a controversy.

**Colby, Bonnie G.,** "Transactions Costs and Efficiency in Western Water Allocation," American J. of Agri. Economics 72 (5), 1185-1192, December 1990.

The article addresses the extent to which policy-induced transactions costs (PITC) facilitate efficient water allocation by accounting for social costs of transfers. PITC is defined as the cost of obtaining legal approval for proposed changes in water use and includes attorneys' fees, court costs and fees to state agencies, and cost of engineering and hydrologic studies. PITC is described in effect as a "Pigouvian tax," causing private decisions to account for social costs.

Findings made by others of PITC in various western markets are compared, and the author concludes that PITC are higher where the economic values that may be affected by the proposed transfer are higher, in areas where water is more scarce, transfers are more controversial (out of agriculture), and the externalities of the transfers are likely to be significant. The author suggests that water transfers be taxed directly to account for external impacts and that such a tax might reflect a more optimum accounting for externalities than relying on the present framework of autonomous, self-interested transfer applicants and protestants to incur costs to the point where it is no longer worthwhile to do so.

**Colby, Bonnie G.,** "Enhancing Instream Flow Benefits in an Era of Water Marketing," Water Resour. Res. 26 (6), 1113-1120, June 1990.

The increased judicial and legislative activity in the last several years related to instream flow protection indicates that the benefits of instream flows have become sufficient to stimulate changes in the western US legal framework historically focused on offstream water uses. The article reviews western state instream flow policies and details economic benefits generated by instream flows in terms of water quality, recreation values, local economic development, nonuser values and the potential impact on policy of recognition of these benefits. The incorporation of instream flow protection in water markets occurs through increasing transaction costs and, in those states which recognize instream flows as a beneficial use, through increasing purchases of water rights by both public agencies and private conservation efforts. Nevertheless, instream flow interests have not been highly represented due to limited legal access to water rights, to higher transactions costs for instream flow acquisition, and to public good characteristics of instream flows which make it difficult to translate collective values for instream flows into dollars to bid for water rights in the market.

The author concludes that the protection of instream values would be enhanced by

- o recognizing that instream values can be higher than benefits generated by offstream uses, particularly field-crop irrigation,
- o allowing private parties to appropriate, lease and purchase water rights for the purpose of maintaining instream flows,
- o legislating authority and funding to state and local governments to acquire water rights for instream flow maintenance, and
- o clarifying at the state level the criteria necessary to change the purpose and place of use of a water right from a consumptive use to instream flow maintenance in order to reduce transactions costs and uncertainties for both instream and offstream water users.

**Colby, Bonnie G.**, "Economic Impacts of Water Law--State Law and Water Market Development in the Southwest," Natural Resources J. 29 (4), 721-749, Fall 1988.

The article reviews the economic implications of key elements of water policies of six southwestern states: Arizona, California, Colorado, Nevada, New Mexico and Utah. Following a discussion of what constitutes a water market and how property rights affect the operation of a market and risk sharing within the market, the author briefly describes each state's policies for beneficial use and forfeiture/abandonment, use and transfer of conserved water, protection of third party water right holders, area-of-origin protection, public interest and public trust considerations, and instream flow protection.

**Colby, Bonnie G., Mark A. McGinnis and Ken Rait**, "Procedural Aspects of State Water Law Transferring Water Rights in the Western States," Arizona Law Rev. 31 (4), 697-719, 1989.

The article compares the procedures used to evaluate water rights change applications in eight western states: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming. The states' administrative processes are described with the intent of identifying the concerns addressed in state transfer approval procedures. Key differences among the state processes are summarized in tabular form.

In this issue of the Arizona Law Review the article is followed by six detailed descriptions of state water transfer law in New Mexico, California, Colorado, Wyoming, Arizona and Utah.

**Colby Saliba, Bonnie** "Do Water Markets 'Work,?' Market Transfers and Trade-Offs in the Southwestern States," Water Resour. Res. 23 (7), 1113-1122, July 1987.

The article describes active water markets in the Phoenix and Tucson Active Management Areas, Northern Colorado Water Conservancy District, Truckee River Basin (Nevada), the Gila-San Francisco Basin (New Mexico), and the Lower Sevier River Basin (Utah), emphasizing the institutional conditions of each. The five markets are then evaluated based on transfer patterns, marginal water values and market prices to determine whether water is efficiently allocated, how well the markets account for third-party effects and instream flow and water quality values.

The analysis demonstrates that in these five markets prices reflect not only values in the marginal water use but also expectations of economic growth and changes in future water values. Differences between current value in alternative uses and market prices indicate that nonuse values are an important element in western water transfers. Instream flow and water quality impacts, however, are not well accounted for in these markets.

**Colby Saliba, Bonnie, David B. Bush, William E. Martin, and Thomas C. Brown**, "Do Water Market Prices Appropriately Measure Water Values?," Natural Resources J. 27 (3), Summer 1987.

Five existing water markets in Arizona, Colorado, Nevada, New Mexico and Utah are studied with regard to four market characteristics: imperfect competition and market restrictions, external effects of market activities, uncertainty, and equity and conflict resolution. The water market history and institutional and hydrologic conditions for each of the five are discussed. In a comparison of prices across the market areas the authors describe demand and supply side forces and conclude that the markets and prices are not comparable because of very different institutional and hydrologic considerations.

The authors note that in some cases major water projects appear to be strategies for resolving conflicts among water user groups rather than economically beneficial supply augmentation measures. Supply augmentation proposals should be compared with alternative water management strategies, such

as increased water consideration and transfer of existing supplies from lower-valued uses to higher valued uses. Such a comparison may indicate that supply augmentation is not the most efficient means to accomplish regional water management objectives.

The study concludes that because of imperfect competition from market dominance in either the demand or supply side, restrictive public policies, sporadic market activity, uncertainty in market information and hydrologic and economic conditions, any application of market prices must be supplemented by an estimation of water's marginal value product in appropriate uses and/or recreation and other nonmarket values of water. Social and economic factors that are influencing expectations and observed prices must be accounted for. Nevertheless, observed prices may serve as a rough indicator of the marginal value of additions to regional water supply if the additional volume of water is small relative to the region's total supply although prices will not reflect nonmarket water use and third-party impacts.

**Colby Saliba, Bonnie, and David B. Bush, Water Markets in Theory and Practice - Market Transfers, Water Values, and Public Policy** (Boulder, CO Westview Press, 1987).

This primer on western United States water markets begins with a definition of water markets and describes the conditions under which they have developed and continues with a discussion of a market model of water allocation. From a fairly detailed description of the activity in water rights markets as they exist in Arizona, Colorado, New Mexico, Utah and Southern California, the authors evaluate the efficiency and equity of the market institution and discuss several alternative means of valuing water rights for public and private decision making in areas of market failure. They conclude that markets appear to be relatively efficient in allocating water rights among those who use water for purposes recognized as beneficial, and opportunity costs and third party effects generally are reflected in market decisions and prices. However, instream flow, water quality and other values are poorly accounted for in the markets examined.

Water markets are an important policy issue which should be studied in terms of not only potential gains but also transaction and administrative costs of current and proposed policies to govern market activities. Information gathering on market activity is not sufficient to permit the needed study and analysis.

**Crouter, Jan P., "Hedonic Estimation Applied to a Water Rights Market," Land Economics 63 (3), 259-271, August 1987.**

The dissertation research which is the basis for this article developed a quantitative approach to assess the allocational efficiency of a regional water rights market, using Rosen's theory of hedonic price functions. The hypothesis is that where laws and institutions permit separate and piecemeal water transfers, the hedonic price function will be separable and linear in water. The impact of transactions costs is considered, and Weld County, Colorado (in the Northern Colorado Water Conservancy District), in the year 1970 is used as a case study.

The case study conclusion is that in 1970, a separate and competitive water rights market was not functioning, which the author finds surprising. A number of possible explanations are described.

**Curie, Madalene Mary, "A Distinct Policy Which Forms a Market Within the California State Water Project," Water Resources Research 21 (11), 1717-1720, November 1985.**

The article addresses the issue of transforming the existing predominantly nonmarket water allocation system in California to a market institution. There are so many law/policy/organization combinations, however, that the analysis must

be made on a case-by-case basis. The analysis process is developed and exemplified in an application to the California State Water Project (SWP), evaluating the relevant laws in terms of the characteristics of a continuous market, and making a distinct recommendation to modify the problematic law or policy in order to facilitate market formation and activity.

The author concludes that the primary obstacle to market formation in the case of the SWP lies in SWP policies rather than in the law, and provides a detailed discussion of these policies and necessary changes.

**Dragun, Andrew K., and Victor Gleeson,** "From Water Law to Transferability in New South Wales," Natural Resources J. 29 (3), 645-661, Summer 1989.

The authors describe the history of water rights development in Australia and New South Wales specifically, where the Water Act of 1912 changed the system from common law based riparian rights to an administrative allocation in which the right to the use of water is vested in the Water Resources Commission "for the benefit of the Crown." The temporary use of water is licensed to applicants, who need not be riparian landowners, but there are no specific criteria in the legislation for the licensing other than a requirement for public notice and an appeals process to address third-party effects. The Water Resources Commission has adopted licensing criteria based on water availability and perceptions of efficiency and equity. The quantity of water to be licensed is a criterion in certain designated areas, particularly downstream of reservoirs. Under a designated Volumetric Allocation Scheme, new water use applicants are licensed a proportional share of the existing capacity thus reducing the quantity (and/or reliability) available to those previously licensed. Under restrictive (drought) conditions, the supply priority is first to domestic, then to industrial and finally to irrigation.

Since 1983, limited short-term transfers have been permitted between irrigators but not between irrigators and other water uses. Within the shareholders of Private Irrigation Districts, created by NSW legislation in 1972, permanent water transfers are permissible by the the transfer of capital shares. However, there is no mechanism for transfer of water to nonirrigation uses.

**DuMars, Charles T., and Michele Minnis,** "New Mexico Water Law Determining Public Welfare Values in Water Rights Allocation," Arizona Law Rev. 31 (4), 817-839, 1989.

The article is a description of the scope and general character of New Mexico water law as it pertains to public welfare issues of water rights transfers.

**DuMars, Charles T.,** "The State as a Participant in Water Markets Appropriate Roles for Congress and the Courts," Water Resources Res. 21 (11), 1771-1775, November 1985.

The author addresses the U.S. Supreme Court decision in *Sporhase v. Nebraska* (1982) and its consistency (or lack of consistency) with previous decisions of the Supreme Court in disputes involving a state's right to own and manage resources which occur within the state. He concludes that the Court will allow a state to act as buyer or seller in the natural resource marketplace (but not as a regulator where interstate transactions are involved). Further, if a state is acting as buyer or seller, it can appropriate or buy water just as any private party and then elect either to reserve the water consistent with state law or to allocate it exclusively to state residents. State ownership might be more effective with the operation of basin-level public corporations that would lease water rights within a political process to evaluate nonmarket social goals for water resources.

Such a process "...would avoid piecemeal judicial decision making by judges as to what uses are or are not in the public interest and it might convince the

Supreme Court that when the States make these rational choices about their future, the decision to evaluate them rests with the Congress and not with the Court.... The fact that Congress could easily make the antitrust laws apply to abuses of sovereignty by the States, perhaps best illustrates why the Supreme Court may have its role entirely reversed with respect to commerce clause issues as applied to water (p. 1774)."

**Eheart, J. Wayland, and Randolph M. Lyon,** "Alternative Structures for Water Rights Markets," Water Resources Res. 19 (4), 887-894, August 1983.

The article describes the results of research to identify and compare alternative designs of marketable water permit systems for humid regions under the riparian rights doctrine. The design was considered a multiobjective optimization for economic efficiency, equity, ease of implementation and administration, and maintenance of instream flows for support of an aquatic ecosystem. A water use right is viewed as a function of flow in the surface water system, and two base rights definitions developed for the study are "prioritized steady use rights" (similar to prior appropriation) and "fractional flow rights" (proportional flow shares).

The authors evaluated the possibilities for market transfers in these rights definitions in interaction with two alternatives for addressing locational issues: the lentic system, which treats a (generally) downstream, lake-like waterway as separate markets for defined zones, and the lotic system, which treats a more up-stream, dendritic stream system as a separate market in each hydrologic watershed. Groundwater rights markets for deep aquifers are treated as a lentic system, in which total withdrawal would be limited to a conservative estimate of the average recharge rate. The initial distribution of rights by a government authority is discussed. The basis for an initial distribution is likely to be the subject of political debate. Both a free procedure and an auction procedure are described.

**Frederick, Kenneth D.** (ed.), Scarce Water and Institutional Change (Washington, D.C. Resources for the Future, 1986).

The book describes five case studies dealing with water transfers in scarcity situations under differing institutional arrangements

(1) "Competition Between Irrigation and Hydropower in the Pacific Northwest," by Walter R. Butcher and Philip R. Wandschneider, with Norman K. Whittlesey, addresses a case in southern Idaho and continuing conflict in the Columbia Basin between hydropower and irrigation. The study concludes that four institutional reforms are necessary to improve efficiency in water use: eliminate subordination of hydropower rights to potential future irrigation, correct interstate externalities, reconcile state and federal water law, and facilitate transferability of water rights.

(2) "Water Scarcity and Gains from Trade in Kern County, California," by H. J. Vaux, Jr., describes the shortage situation in surface water supply and consequent groundwater overdrafting in the intensely developed agricultural area and develops three possible resolutions to the problem the results of no change, of additional water supply facilities, and of legal and institutional changes necessary to create water markets.

(3) "Satisfying Southern California's Thirst for Water Efficient Alternatives," by Richard W. Wahl and Robert K. Davis, discusses the shortages and demand management problems of the Metropolitan Water District of Southern California and the prospects for their economically efficient resolution.

(4) "Costs of Water Management Institutions, The Case of Southeastern Virginia," by Leonard Shabman and William E. Cox, describes the source-of-water conflict in a water abundant region which has continued for several years in metropolitan southeastern Virginia as a result of institutional inadequacies, and proposes institutional reforms which will improve economic efficiency of water

use transfers under eastern U.S. water institutions.

(5) "Innovations in Water Management Lessons from the Colorado-Big Thompson Project and Northern Colorado Water Conservancy District," by Charles W. Howe, Dennis R. Schurmeier, and William D. Shaw, Jr., describes the evolution and operation of this small, relatively efficient water rights market. The market represents only 17 percent of total water supply but improves the economic efficiency of water use in the entire district by being an easily tradable margin of water.

**Gardner, B. Delworth**, "Removing Impediments to Water Markets," J. of Soil and Water Conservation, 384-388, Nov.-Dec. 1987.

In spite of increasing recognition of the benefits of and need for market exchanges of water in western states, there remain significant institutional barriers to functioning water markets in the form of equity protection, state protection of authority over in-state water, uncertainty of the status of federal Bureau of Reclamation Water and Indian claims, and state and regional water agency inconsistencies in policies for defining and approving transfers, quantities, prices and lease costs. The author observes efficient transfers in some limited instances and advocates streamlining the process even though some equity may have to be sacrificed.

**Gilliland, Martha W., Gerald P. Wallin, and Ronald Smaus**, "Water and Water Rights Transfers A New Policy for Nebraska," Water Resources Bull. 25 (1), February 1989.

Following the U.S. Supreme Court decision in *Sporhase v. Nebraska* (1982), which was decided in favor of *Sporhase*, who was transferring groundwater for irrigation from land in Nebraska to adjacent land in Colorado, the Nebraska Legislature in 1987 directed the State Water Management Board to develop a statutory framework that would, when enacted, establish an improved system for transferring surface and groundwater and surface water rights. The framework would also protect instream and wildlife habitat values and the rights of third parties and provide compensation to those adversely affected by transfers.

The article discusses the process by which this statutory framework was developed and the key factors considered--economic viability (evaluating price by "ability to pay" for irrigation and "least cost alternative" for municipal use), legal/regulatory choices and public involvement. The policy recommended by the Board reformed existing policy by promoting the concept of the highest and best economic use while regulating that use for the protection of environmental quality and third parties. The highest and best use was promoted by (1) eliminating inconsistencies in the allocation criteria, (2) allowing the use, sale or lease of water made available through salvage or conservation, (3) facilitating transfers by establishing the Board as a clearinghouse for buyers and sellers, and (4) giving the Board the authority to plan, construct and operate water projects. Environmental quality and third-party rights would be protected through an impact assessment process similar to that required at the federal level and compensation for unavoidable impacts to be fulfilled by the permit applicant.

**Gisser, Micha**, "Groundwater Focusing on the Real Issue," J. of Political Economy 91 (6), 1983.

A comparison between the water allocation systems of the states of Arizona and New Mexico (as of 1982) evaluates the relative efficiency of groundwater allocation under a regulatory system with that in a market system based on prior appropriation. The discussion includes identification of the New Mexico system as a "second-best solution," and the modifications that would be necessary to achieve a Pareto-optimal groundwater allocation.

Gisser argues that in order to achieve a Pareto optimum, absolute limits on groundwater withdrawals from an aquifer should not be fixed but rather each new user must be required to face the increasing third-party (and natural system) impacts of their withdrawals through a Coase negotiation. Compensation payments would be equal to the present value of all future additional externalities and could be viewed as a congestion fee. In order for the Pareto optimum to hold, aggregate demand is assumed to be intertemporally fixed over the long term. Third-party protection is more complicated in a rechargeable aquifer due to effects of groundwater withdrawals on surface systems and transactions costs are increased.

In New Mexico, groundwater interbasin transfers are permissible for only the consumptive portion of a total withdrawal which is assumed to eliminate the hydrologic impact of the transfer on the basin aquifer. The basins were defined by the state engineer as an area of 6-by-6 miles.

(Note Ref. to Brown, Gardner, Jr., "An Optimal Program for Managing Common Property Resources with Congestion Externalities," J. of Political Economy 82, 163-173, Jan-Feb 1974. In the absence of a market price, an imputed marginal value of the aquifer is used as a congestion fee "to induce the correct level of aggregate activity." (Quotes from Gisser.))

**Gould, George A.**, "Transfer of Water Rights," Natural Resources J. 29 (2), 457-477, Spring 1989.

The article focuses on the transfer of water among uses rather than on transfer of rights per se; the problems associated with water rights transfers are due to changes in purpose or place of use, not changes in ownership. In the western U.S. the history of water rights transfers demonstrates the development of a number of impediments to transferability that result from economic, social or political costs of the change in use. Legal prohibitions, for example, primarily represent political and policy issues rather than legal ones. The "no-injury" or third-party effects rule are a substantial impediment, with high costs and uncertain outcomes associated with the determination of third-party effects. While an often presented solution is to define transferable water rights in terms of consumption rather than diversion, the author suggests that a more effective means is demonstrated by the Northern Colorado Water Conservancy District, which retains title to all return flows and thus is able to ignore third-party effects.

Other aspects of water transfer which are impeded by various effects in various western states include the utilization of salvaged or conserved water, temporary transfers (such as short term leases), and the introduction of public interest and public trust doctrines in administrative and judicial decision-making. Two significant institutional uncertainties which are having the effect of interfering with transfers are the status of transferability of Indian water rights and federal Bureau of Reclamation water.

**Gray, Brian E.**, "A Primer on California Water Transfer Law," Arizona Law Rev. 31 (4), 745-781, 1989.

Of the western states, California appears to have one of the strongest statutory mandates to promote the voluntary transfer of water and water rights; paradoxically there have been far fewer transfers of water in California than in most western states where active water markets have developed. This article analyzes the legislative inducements to the creation of a broad-based water market and suggests the need for research on the disparity between intent and performance.

**Howe, Charles W.**, "Economic, Legal, and Hydrologic Dimensions of Potential Interstate Water Markets," American J. of Agricultural Economics, 1226-1230, December 1985.

Professor Howe briefly describes the information needs of states in the face of possibly increasing interstate water transfers in the western United States through leases, sales or other means total resource availability; economic effects in exporting regions; demand level for interstate transfers and its relationship to growth, supply alternatives and political uncertainties; impact on instream uses; impact of Indian water rights; and others. He assesses these issues in the Colorado River Basin.

Given a typical pattern of basin development of a lower basin to develop earlier in time than an upper basin, it can be expected that there will be a difference in the marginal value products of water, generating lower basin demands for upper basin water. Since water for new uses in the West will generally come from transfers and conservation primarily in agriculture, a crude supply curve from existing (low value) agricultural uses can be developed by arranging crops in increasing order of net crop returns per acre-foot of consumptive use. State income losses are difficult to estimate but are seen as significant for out-of-state water transfers. More research is needed for a better understanding of the changes in water use and community and state-wide effects of interstate water transfers.

**Howe, Charles W., Jeffrey K. Lazo and Kenneth R. Weber,** "The Economic Impacts of Agriculture-to-Urban Water Transfers on the Area of Origin A Case Study of the Arkansas River Valley in Colorado," American J. of Agri. Economics 72 (5), 1200-1204, December 1990.

Economic impacts of water transfers from agriculture to urban uses are generally considered to be negative or even devastating to the area of origin, and many studies do not include either positive externalities or indirect negative effects linked through the market. The case study reported here considers an area of Colorado from which significant transfers have been made and even larger transfers are anticipated. A state-wide input-output model was used to assess the economic impacts of historic transfers. Although the statewide direct and indirect employment and income losses stemming from the transfers appear to have been small relative to the costs of alternative urban water supply development, the incidence of the costs is upon the rural area of origin while the benefits accrue largely to the urban buyers. Significant uncompensated costs are imposed on the local economy the effects of which are exaggerated by the use of sales proceeds to repay farm debt and the absence of local investment opportunities for the proceeds. The authors conclude that transitional assistance to the area of origin is warranted.

**Howe, Charles W., Dennis R. Schurmeier, and W. Douglas Shaw, Jr.,** "Innovative Approaches to Water Allocation The Potential for Water Markets," Water Resources Research 22 (4), 439-445, April 1986.

The authors identify six criteria for efficiency in water allocation which together define the conditions for an economically efficient market flexibility (through a proportionally small tradable margin), security of tenure, opportunity cost identified to the market, predictability, public perception as equitable and fair, and reflecting public values. The authors then discuss market weaknesses and possible solutions. They also describe a model for the joint optimization of water allocation and water quality, finding that (1) optimal water allocation cannot be determined independently from water quality considerations and (2) an optimal water allocation rule is generally neither a priority rule nor a proportional rule but some combination of both. The Northern Colorado Water Conservancy District and the federal Colorado-Big Thompson Project are described as an example of (1) basing an allocation system on a tradable margin to provide a level of flexibility adequate to eliminate short-term shortages and user conflicts, (2) incorporating proportionality to enhance the market's response to short term shortages, and (3) renting excess water on an annual basis.

Interstate water markets are briefly discussed and recommendations are made for future research in legal, hydrologic, engineering, financial and economic aspects in order to derive general principles of market functioning and to

analyze specific market situations. Specific case studies are needed to identify realistic opportunities for substituting markets for other types of systems, tailoring market arrangements to specific legal, hydrologic and historical settings.

**Kiker, Clyde, and Gary D. Lynne,** "Water Allocation Under Administrative Regulation Some Economic Considerations," So. J. of Agricultural Economics, 57-63, December 1976.

As increasing competition for water has increased the levels of uncertainty in allocation rights under the common law riparian rights doctrine applicable to most eastern states, these states have adopted administrative water allocation regulations. The regulations are also subject to uncertainty. The authors use the Florida Water Resources Act of 1972 as a basis for modifications to an administrative allocation system which would incorporate some features of a competitive market. Marketable certificates for a certain quantity of water for a certain time period would be issued by the water agency. The agency could protect public interest by participating in the market and reduce hydrologic uncertainty by investing water certificate revenues in water conservation technology.

**MacDonnell, Lawrence J.,** "Changing Use of Water in Colorado Law and Policy," Arizona Law Rev. 31 (4), 783-816, 1989.

The article is a comprehensive survey of Colorado law governing the transferability of water resources. The author concludes with suggestions to change state policy and law to evolve the transfer process in ways that will improve its efficiency and equity.

**McEntire, Joanne,** "Water Farms and Transfer Conflicts in Arizona, USA A Proposed Resolution Process," Environmental Management 13 (3), 287-295, 1989.

The Arizona 1980 Groundwater Management Act (GMA) intends to reduce agricultural consumption and reallocate the conserved water to rapidly growing municipal and industrial uses. Further stimulating that reallocation, the GMA requires any new development within Active Management Areas to certify a 100-year assured water supply. The result has been the development of thousands of acres of "water farms" where the land becomes unmanaged, desolate areas of soil erosion, tumbleweed invasion, subsidence and lowered water tables in riparian habitats.

The area-of-origin of the water transfer has no legal power to regulate transfers based on fiscal, environmental, economic or quality-of-life criteria; only a rural water user who is damaged by pumping for urban uses can sue the transferrers for damages, and such a suit will not stop the transfer. The basic conflict is between issues of equity and economic efficiency. Transfers may be economically inefficient because equity issues are not included in the transactions.

The author recommends in some detail a mediation process, in which all parties' goals are realized through accommodation rather than compromise. The costs of the mediation and agreed-upon compensation, if any, are thus input to the water transfer mechanism and indirect third-party effects are accounted for.

**Metzger, Philip C.,** "Protecting Social Values in Western Water Transfers," J. American Water Works Assoc., 58-65, March 1988.

Western U.S. water rights doctrine developed largely through state statutes and judicial decisions of earlier periods under social and environmental conditions and values different than today. Although a free market in water rights is widely discussed as a solution to historically induced inefficiencies, efficiency is only one of three distinct values essential to water resources

management. Equity and environmental quality are now recognized as equally important.

The author discusses means to incorporate these values in the water rights transfer process through retaining water to sustain community stability. Public limitations on private rights include public interest criteria, area of origin regulations, permanent right of recapture and reservation of specified quantities. The private market can also be broadened by injecting public values into the market processes for determining price. Stabilizing effects would be gained by more efficient agricultural water use and compensation to the area of origin. Compensation can be in the form of guaranteeing future water availability to the area and also payments to donor communities in lieu of tax revenues that would have been raised from economic activity removed from the area with the water.

State appropriation of unappropriated water may be an answer to the need for state control of water in the face of the interstate transfer effects of *Sporhase v. Nebraska*. However, it may also be seen as a subsidy for in-state water users. It is important to the success of the effort that it be a part of long term state water planning.

**Milliman, J. W.**, "Water Law and Private Decision-Making A Critique," J. of Law and Economics 2, 41-63, 1959.

The author reviews riparian and prior appropriation doctrines (prior to 1959) as they affect the allocation processes through public agency decisions and economic market function. He criticizes an apparent movement toward administrative allocation and reliance on "reasonable and beneficial use" criteria, and concludes that a system of water law should emphasize private property concepts and the market process in order to assure the efficient allocation of water.

**Moncur, James E. T., and Richard L. Pollock**, "Scarcity Rents for Water A Valuation and Pricing Model," Land Economics 64 (1), 62-72, February 1988.

In the absence of clear ownership of rights and markets, the scarcity value of water frequently goes unrecognized. Ignoring scarcity rents in water pricing results in water prices that are too low, inducing excessive extraction, capacity investment and consumption. Efficient water prices call for at least two corrections (1) use of marginal extraction costs in place of the generally lower average figures and (2) incorporation of the scarcity value of the water in situ to the price faced by final users.

The authors model the scarcity value of water in situ, extending D. A. Hanson's analysis of the efficiency price path for a natural resource (1980, "Increasing Extraction Costs and Resource Prices Some Further Results," Bell J. of Econ. 7371-78), and from the model results impute scarcity rent. The model is applied in a case study of the Honolulu Board of Water Supply groundwater withdrawals and pricing. The resultant large implied price increase reflecting in situ value highlights the importance of demand management and rational pricing policies.

**National Research Council, Committee on Western Water Management** (A. Dan Tarlock, Chair), Water Transfers in the West: Efficiency, Equity, and the Environment (Washington, D.C.: National Academy Press, 1992), 300 pp.

Noting that market transfers of water use entitlements are increasingly accepted and facilitated in western states, the Committee offers in this text a discussion of the pressures for change, potential impacts and opportunities for third parties, the role of law in the transfer process and an assessment of water transfers and their effects. The assessment describes recent trends or shifts in allocation processes to address third party impacts, highlighting seven case studies: Truckee-Carson Basins, Nevada; Colorado Front Range; Northern New

Mexico; Yakima Valley, Washington; Central Arizona; Central Valley, California; and Imperial Valley, California.

**Randall, Alan**, "Property Entitlements and Pricing Policies for a Maturing Water Economy," The Australian J. of Agricultural Economics 25 (3), 195-220, December 1981.

The water economy of Australia is observed to have entered a mature phase, characterized by sharply rising incremental costs of water supply, more direct and intense competition among different uses and greatly increased interdependence among uses. This maturity necessitates attention to the role of water price in (1) generating revenues for facilities, (2) moderating demand, and (3) reallocating in response to scarcity, externalities and conflicting uses. The author includes the cost of supplying the resource, opportunity cost and social cost in discussing a system of short-term marketable water entitlements which would be auctioned by the water agency.

The author demonstrates a significant efficiency loss from current water pricing and allocation policy in Australia and proposes and describes a system of transferable water entitlements.

**Saleth, R. Maria, John B. Braden, and J. Wayland Eheart**, "Bargaining Rules for a Thin Spot Water Market," Land Economics 67 (3) 326-339, August 1991.

Rental or spot markets for water can improve efficiency by allowing reallocation in response to changing conditions, but such markets may be thin, that is, may have few participants, and are likely to be manipulated by a dominant bargainer. The authors examine how the efficiency of a thin water market is affected by the relative bargaining strength of the participants. They conclude that in small markets incomplete information enhances efficiency by reducing the players' incentives for strategic bargaining. The extent of market manipulation is a function of the magnitude of the potential gain from trade as well as the individuals' perception of their relative potential shares of the gain. The careful design of bargaining rules can thus reduce the social losses due to strategic bargaining behavior.

**Shupe, Steven J., Gary D. Weatherford, and Elizabeth Checchio**, "Western Water Rights, The Era of Reallocation," Natural Resources J. 29 (2), 413-434, Spring 1989.

The article summarizes water reallocation mechanisms through involuntary loss of water rights (forfeiture and abandonment, eminent domain, public trust doctrine) and voluntary transfers (sale of total entitlement, leases, dry-year options, subordination of seniority agreements, conservation offsets, exchanges). The format of recent market transactions is described in water ranches, water district shares, standing purchase offers, individual sales, speculative investments and groundwater markets.

The authors discuss some major issues and controversies of water reallocation using recent (as of 1988) court rulings and legislation. Issues reviewed are (1) mitigation of effects on tax base erosion and economic erosion of out-of-region transfers, (2) trans-jurisdictional and interstate markets stimulating states to take a proprietary position on water rights and forcing challenges to interstate basin compacts, (3) transferring federally supplied irrigation water to different uses, and (4) marketing salvaged water from improvements in irrigation efficiency.

**Smith, Rodney T.**, "Water Transfers, Irrigation Districts, and the Compensation Problem," J. of Policy Analysis and Management 8(3), 446-465, 1989.

In spite of numerous expressions of encouragement to water markets by western courts, federal agencies and political organizations and facilitating

legislation, water trades have not flourished. The author investigates the role of the structure of water supply organizations in interfering with the distribution of the benefits of trading and thus creating political opposition. Focusing on California, he concludes that irrigation districts must assume the role of trustees to landowners, holding legal title to water for the equitable and beneficial interest of landowners. A solution to the compensation problem is to adopt a transfer based on negotiated corporate tender offers in which the district board negotiates an agreement with a potential buyer and repurchases water certificates from existing water users. In effect, the board negotiation with the potential buyer sets a price and water users set the quantity response to that price. Alternatively, a specified quantity of water can generate a price response. Sale proceeds are divided among compensation to water users, downstream and environmental indirect effects, and local community indirect effects.

**Squillace, Mark**, "Water Marketing in Wyoming," Arizona Law Rev. 31 (4), 865-903, 1989.

The article briefly reviews Wyoming water transfer law, and proceeds to explain the reasons for the conservative philosophy which continues to limit water market functioning in Wyoming. The author suggests changes in the water transfer law to encourage more efficient use while protecting environmental values and other users.

**Stansbury, J., W. Woldt, I. Bogardi and A. Bleed**, "Decision Support System for Water Transfer Evaluation," Water Resources Res. 27 (4), 443-451, April 1991.

A maturing water economy is characterized by greater competition between water users and more complex problems for water managers. The decision support system (DSS) described develops a best solution among various alternatives of surface and groundwater withdrawals, irrigation schemes, and resulting economic, social and environmental impacts. The DSS consists of a conjunctive ground/surface water model, impact analysis using a GIS and trade-off analysis using a multicriteria decision-making programming method. A case study is described for a three-county area of south-central Nebraska in an agricultural region having significant groundwater reserves as well as important wildlife habitat and recreational resources in the Platte River.

The DSS is a valuable aid in that it forces consideration of a wide range of impacts from social, economic and ecological environments, allows decision makers to incorporate complex and technical information into the decision-making process, it is personal computer based, and the GIS output facilitates the impact analysis and interpretation of results. The final output is in easily interpreted graphic and tabular form.

**Swaney, James A.**, "Trading Water: Market Extension, Social Improvement or What?," J. Econ. Issues 22 (1), 33-47, March 1988.

The author reviews neoclassical and institutionalist economics and environmentalist perspectives on emerging adjustments of western US water allocation processes toward water marketing or trading. In the orthodox neoclassical position that the market is the premier allocator and prices measure value, the author points out several flaws such as the static value assumption, market short-sightedness and "the tyranny of small decisions" and applies them in a discussion of water market experience in the western US. He notes that the neoclassical position admits a major problem in avoiding third-party effects in a free market system and suggests that the reason that existing institutions are complex and rigid is because the third-party or external costs of water trades are significant and unavoidable.

From the institutionalist perspective, the author argues that while water is not a market commodity and should not be allocated strictly on the basis of its profit making potential, a market mechanism has a constructive role to play

in water allocation. He points out the appropriately gradual legislative and institutional changes which are facilitating the development of markets in the western US and adds that trading water is only one of a complex set of promising institutional reforms and does not appear to lead to a price-making market, which according to Karl Polanyi imposes widespread social costs.

**Tarlock, A. Dan,** "New Water Transfer Restrictions The West Returns to Riparianism," Water Resources Res. 27 (6), 987-994, June 1991.

Western water law is evolving in such a way that a number of stopgap measures to assess the costs and benefits of large-scale transfers which raise serious environmental and social equity issues are being developed in order to mitigate those costs. Many transfer restraints modify the law of prior appropriation and reintroduce the assumption that river systems should be managed on an ecosystem basis. It is not unreasonable to speculate that the expanded recognition of transitional and new third party rights could produce a new riparianism in the western states. The author discusses the emergence and effect of several areas of watershed protection rules, including protection of junior appropriators, changing transfer policies of the federal Bureau of Reclamation, and area of origin statutes. He also describes judicial decisions and new legislation recognizing third-party stakeholders: in-stream flow appropriations, Indian tribe water rights, and cultural claimants and public interest review.

Tarlock concludes that as the scale and distance of transfers increase, institutions must weight the costs and benefits for traditional and nontraditional users and other third parties. There is a need to decide which third party interests count and to design institutions that allow reallocation in the context of river system management.

**Thorson, John E.,** "Water Marketing in Big Sky Country An Interim Assessment," Natural Resources J. 29 (2), 479-488, Spring 1989.

The 1985 Montana Legislature created a limited water marketing system in recognition of the state's need to control and condition large water uses, of already existing local water market opportunities under the law, and of the need for permitting transfers in Indian water rights. The major new market changes were in regional marketing, where the Legislature established a limited water-leasing program based on either out-of-basin transfer or uses in excess of 4000 acre-feet per year. As water is leased, it is appropriated in the name of the state. Several aspects of indirect impacts of transfers are incorporated into the leasing process public interest, instream flows and the public trust.

Constraints on the regional market system exist through the limitations of the state water purchase and revenue sharing agreement with the U.S. Bureau of Reclamation which controls several major reservoirs. Also, the absence of an interstate apportionment on the Missouri River system constrains marketing. Local water market activity is discouraged by the lack of water rights quantification and other uncertainties.

**Torell, L. Allen, James D. Libbin, and Michael D. Miller,** "The Market Value of Water in the Ogallala Aquifer," Land Econ. 66 (2), 163-175, May 1990.

A market value for water in farming areas overlying the Ogallala Aquifer is calculated as the price difference between irrigated and dryland farm sales using detailed information on more than 7200 farm sales between January 1979 and February 1986. The data include 6312 dryland sales and 986 irrigated sales. A basic assumption is that the price differential between the two farm types is the result of increased income earning potential because of water availability.

The study concludes that aquifer characteristics are important in determining land value but the price difference between dryland and irrigated farms has declined during the study period and thus the implied value of water

in the aquifer has fallen. Water value as a percentage of total irrigated farm value is estimated to average more than 60 percent in New Mexico decreasing to 30 to 40 percent in Oklahoma, Kansas and Nebraska.

**Trelease, Frank J.**, "Policies for Water Law Property Rights, Economic Forces, and Public Regulation," Natural Resources J. 5 (1), 1-48, May 1965.

In seeking to define a supportive philosophy for a functional water resource law, Professor Trelease discusses the relationships between the economic concepts of maximization, optimization and cost-benefit analysis and the legal concepts of private property rights, their definition, security and flexibility, and public values. The general goal of all law, quoted from John Dewey (1922, Human Nature and Conduct, "The Nature of Aims") may be applied to water resources "a plan for organizing otherwise independent and potentially conflicting energies into a scheme which avoids waste, a scheme allowing a maximum utilization of energy." An ideal water law will encourage the best decisions on water use for both private and public interests. Private water rights, like other property rights, should be subject to regulation in the public interest. The public interest is recognized to include the "major intangible" of recreational and environmentally valuable instream uses.

**Wahl, Richard W.**, Markets for Federal Water - Subsidies, Property Rights, and the Bureau of Reclamation (Washington, D.C. Resources for the Future, 1989).

This book is a comprehensive discussion of the federal reclamation movement, the historical subsidization of western irrigation and then the modern effort to limit reclamation subsidies. The possibilities for promoting the voluntary transfer of water rights either by sale or lease are described and several existing cases are summarized and federal policy changes important to facilitating transfers and efficiency gains are discussed. Four detailed case studies are included: Kesterson Reservoir, California; Central Arizona Project; Colorado River water quality; and the prospects for leasing compact rights on the Colorado. The author concludes that modern amendments to the original legislation have strengthened the subsidization of wasteful water use and enhanced capital formation for large-scale irrigation projects, and that a system of voluntary transfers of water structured to protect third parties and public uses of water would serve the country better than the existing federal program.

**Wahl, Richard W., and Frank H. Osterhoudt**, "Voluntary Transfers of Water in the West," National Water Summary 1985 (U.S. Department of the Interior, Office of Policy Analysis).

Several forms of water transfers common in the western states are described, including isolated, negotiated transactions; short-term water exchanges to alleviate drought; transfers to and from water banks; and transactions involving established water markets. Eleven case studies from seven western states are discussed in detail and each is evaluated for its degree of market functioning. For these case studies, established markets functioned in areas where the water supply was supplemental and where there was a clear realization that the water supply would not be needed every year or in a uniform amount by everyone within the district. Trading is facilitated by individual ownership of water use rights and by a water agency owning the return flows.

**Weatherford, Gary D., and Steven J. Shupe**, "Reallocating Water in the West," J. of the American Water Works Assoc. 63-71, October 1986.

The reallocation of water in the western states occurs through several means: water project reauthorization, voluntary transfers of water rights (sales, leases, options, sharing rights, conservation offsets, exchanges, and contractual and regulatory priorities) and involuntary transfers. The multitude of legal and institutional factors which influence reallocation include transferability of the water right; rights to salvage water; acquisition,

transaction and treatment costs; origin and destination conditions; and access to transport facilities. The authors briefly describe recent transfers in five western states and discuss legal reforms important to improving the functioning of water markets. They conclude that a new iron triangle is emerging in western water management, representing public concern for efficiency, equity and environmental quality.

**Weatherford, Gary D. (ed.), Water and Agriculture in the Western U.S. Conservation, Reallocation, and Markets (Boulder, CO Westview Press, 1982).**

This book consists of six sections by six parties

(1) "Thematic Overview of the Conserve-and-Transfer Strategy of Water Management," by Gary Weatherford, concludes that while conservation facilities and methods are being designed into much of new irrigation development in the west, the enforcement of anti-waste and reasonable use standards is inconsistent.

(2) "Institutional Framework for Agricultural Water Conservation and Reallocation in the West A Policy Analysis," by Dean Mann summarizes physical, institutional and definitional difficulties of agricultural water policy and describes two resolution strategies: bureaucratic and market-oriented.

(3) "Factors Underlying Irrigation Efficiency in the Tulare Basin of California," by Gary Weatherford, Dean Mann, Steve Riley, Dean Birch and Albert Marsh, describes a survey of perceptions and practices of farmers, water districts and technical advisors in various irrigation districts of the Tulare Basin of Fresno, Tulare and Kern counties, California.

(4) "The Navajo Indian Irrigation Project A Study of Legal, Political, and Cultural Conflict," by Charles DuMars, Helen Ingram, Ronald Little, Bahe Billy and Phil Reno, illustrates that the quantification of native American water rights does not necessarily dispose of all troublesome issues involving those rights.

(5) "A Willingness to Play Analysis of Water Resources Development in Arizona," by Helen Ingram, William E. Martin and Nancy K. Laney, discusses a survey of conservation attitudes of farmers within the Central Arizona Project and how those attitudes have or have not changed over the long time period of CAP development. Contrary to expectations, farmers' attitudes and involvement in the CAP did not change in response to changing conditions, water availability and prices.

(6) "Water Reallocation, Market Proficiency, and Conflicting Social Values," by Lee Brown, Brian McDonald, John Tysseling and Charles DuMars, defines and summarizes value conflicts in Arizona, New Mexico, Colorado and Utah. The authors conclude that existing western water institutions were originally shaped to the need for water allocation and that modern needs for reallocation of a now scarce resource are not being met by the existing institutions, resulting in conflicts and stresses.

**Wong, B. D. C., and J. W. Eheart, "Water Resources Planning Using Integrated Systems of Marketable Water Rights and Reservoir Design and Operation," University of Illinois Water Resources Center Rpt. No. 193, Dec. 1985.**

The relationship between water market allocation and the design and operation of reservoirs is addressed using a case study of a corn irrigation market in Illinois. Assuming a market which includes both long term and short term water rights transfers, information derived from the market can be used to optimize the sizing and release schedule of the storage facility. The authors conclude that it is possible to achieve high levels of economic efficiency using a market-based approach to reservoir planning and operation.

**Woodard, Gary C., and Elizabeth Checchio, "The Legal Framework for Water**

Transfers in Arizona," Arizona Law Rev. 31 (4), 721-743, 1989.

The article describes the historical setting of water farming, and the legal and social forces driving the current water farming activity. The current legal framework for transferring water in Arizona is presented, including recent legislation dealing with negative impacts of water farming on areas of origin and the possible consequences of a court decision on the legal status of effluent. Unresolved policy issues and earlier legislative attempts to pass comprehensive transfers legislation also are discussed.