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# WATER POLICY AND WATER INSTITUTIONS IN NORTHERN INDIA: THE CASE OF GROUNDWATER RIGHTS\*

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## ABSTRACT

This paper examines groundwater problems which are emerging in northern India as a consequence of the green revolution. These problems are intrinsically related to the nature of the existing system of groundwater rights and the lack of other groundwater institutions. The economic performance of groundwater rights is analyzed and policy suggestions for the revision of groundwater rights and the promulgation of groundwater regulations are made. In particular, the correlative rights doctrine (a common property-related institution) may be useful in the solution of emerging groundwater problems in northern India.

## INTRODUCTION

The problems of water supply, water control, and water distribution are currently of particular significance in foodgrain production and agricultural development in India and many other developing nations.<sup>1</sup> Increased investment in groundwater and greater use of this resource which underlies the Indo-Gangetic plain have been associated with the wider use of the new cereal varieties, particularly wheat, in northern India. Due to economic, technological, and institutional factors, the traditional and low-capacity groundwater economy based on shallow dug wells and Persian wheels has been increas-

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\*This paper is based to a considerable extent on part of the author's doctoral thesis, *Economic Consequences and Policy Implications of the "Green Revolution" in India with Particular Emphasis on Water Resources Policy in Punjab* (unpublished Ph.D. Thesis, University of California, Berkeley, 1975). The author gratefully acknowledges the guidance of S. V. Ciriacy-Wantrup and the financial support of the Rockefeller Foundation for field research in India. Responsibility for any shortcomings in the paper, however, rests with the author.

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1. Yet, as Schultz observes, "the economics of water for Asian agriculture is still in its infancy despite the long history of investment in irrigation and drainage in populous parts of Asia." See T. Schultz, *Production Opportunities in Asian Agriculture: An Economist's Agenda*, reprinted in INDIAN SOCIETY OF AGRICULTURAL ECONOMICS, AGRICULTURAL DEVELOPMENT IN DEVELOPING COUNTRIES—COMPARATIVE EXPERIENCE 359 (1971).

ingly replaced by a system of deeper bored wells and mechanized pumping. Over time, in the absence of contravening policy, further substitution by even deeper mechanically drilled wells and more advanced pumpsets can be anticipated. Furthermore, based on experience from groundwater use in other parts of the world and in India itself, problems of interdependence among pumpers and, in the long run, secular depletion of the resource are likely to occur.<sup>2</sup>

The groundwater resource, therefore, poses special problems for public policy and management. These problems are intrinsically related to the nature of the existing system of groundwater rights and the lack of other adequate groundwater institutions in northern India. This paper utilizes a number of conceptual approaches in analyzing these emerging groundwater problems and examines the question of whether these problems are due to the alleged common property nature of the resource. Policy implications with respect to the revision of groundwater rights and the regulation of groundwater are drawn. It will be argued that common property institutions—in fact, a system of correlative rights which is based on the common property concept—can be helpful in the solution of groundwater problems in northern India.<sup>3</sup>

#### THE PROBLEM: THE IMPACT OF THE GREEN REVOLUTION ON THE AGRICULTURE AND WATER SECTORS IN NORTHERN INDIA

The Indian food grain problem is one of long standing. The green revolution has not fundamentally altered the post-independence rate of growth of either Indian food grain production or yield, yet it has created a need for a more adequate and better controlled water supply for food grain production.<sup>4</sup> The new cereal varieties have had important effects on foodgrain production in India. In particular, the high-yielding varieties of Mexican semi-dwarf wheat have led to a structural change in the production of wheat in India and in the northern state of Punjab.<sup>5</sup> The new cereal technology is essentially a technology for irrigated agriculture and its full potential is seriously constrained by the limited availability of irrigated land with suffi-

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2. Ciriacy-Wantrup, *Natural Resources in Economic Growth: The Role of Institutions and Policies*, 51 AM. J. AGRICULTURAL ECON. 1314 (1969).

3. Ciriacy-Wantrup & Bishop, "Common Property" as a Concept in Natural Resources Policy, 15 NAT. RES. J. 713 (1975).

4. For a discussion of this issue with respect to canal irrigation, see Reidinger, *Institutional Rationing of Canal Water in Northern India: Conflict between Traditional Patterns and Modern Needs*, 23 ECON. DEV. & CULTURAL CHANGE 79 (1974).

5. See Veeman, *supra* initial note and Veeman, *Indian Foodgrain Performance*, 2 FOOD POL'Y 168-171 (1977) for more detail on the nature and impact of the green revolution in the Indian context.

cient water and adequate water control. Groundwater development and use, primarily through private investment by farmers and especially in northern India, has sharply increased under the impact of the green revolution.<sup>6</sup>

In Punjab, for example, groundwater draft was estimated to have reached approximately nine million acre-feet by 1976. This draft, nearly all for agricultural use, was somewhat less than the flow component of the groundwater resource or annual average recharge, roughly estimated at twelve million acre-feet. It, however, was suspected to be drawing close to the usable portion of annual recharge which is recharged to non-saline aquifers. The stock component of the ground water resource had not been estimated but was thought to be very large. There is mounting evidence, therefore, that groundwater use in Punjab (and in the western districts of Uttar Pradesh) may soon exceed average annual recharge and impinge on the stock component of the resource. In addition, crude projections of future water use point to the conclusions that eventually the development of intensive, double-cropped irrigated agriculture will be retarded and that groundwater overdraft will occur in Punjab.<sup>7</sup> Furthermore, as groundwater development increases in importance and groundwater and surface water switch from being substitutes to complements in demand, the integration of the development and use of groundwater and surface waters becomes imperative.<sup>8</sup>

In the Punjab region and elsewhere in northern India, groundwater problems are emerging which require the development of appropriate policy and the design of effective institutions for their

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6. The number of tubewells in India increased from 100,000 in 1965 to 1,000,000 in 1975; during the same period, the number of electric and diesel pumpsets increased from 900,000 to 4,750,000, J. Jain, India: Underground Water Resources (paper presented at Symposium on Resource Development in Semi-Arid Lands organized by the Royal Society of England, London (1976)). According to the recently released agricultural census, wells and tubewells were the source of irrigation for 39.5 percent of the net irrigated area in India in 1970-71; the four northern states of Punjab, Hayana, Uttar Pradesh, and Bihar accounted for 94 percent of the area under tubewell irrigation *Agricultural Census*, 66 EASTERN ECONOMIST 33 (1976). In Punjab, the region which was intensively studied during the field research on which this paper is based, the share of net area irrigated from ground water sources increased from 40 percent in 1964-65 to approximately 55 percent in the early 1970's. About 85 percent of ground water in Punjab is pumped through private sources whereas about 15 percent is pumped through public or state tubewells, Veeman, *supra* initial note, at 158.

7. For example, the potential combined surface and ground water supply of 26 million acre feet would appear to meet only approximately one-half the annual water needs for irrigated agriculture if Punjab farmers attempted to grow two irrigated crops per year on 8.5 million acres, assuming a water requirement of three feet per acre.

8. S. Ciriacy-Wantrup, *Conceptual Problems in Projecting the Demand for Land and Water* (Giannini Foundation Paper No. 176, Berkeley, California Agricultural Experiment Station, 1959).

solution. For example, groundwater use by one farmer is beginning to have an effect on nearby users. Although the problem of localized well interference, particularly for farmers with shallow tubewells in poor aquifers, was not widespread in the early 1970's, it was beginning to concern irrigation officials. Moreover, the water table in the Punjab in the late 1960's and early 1970's was slowly receding—an indication that some form of overdraft might be occurring.

It is to the analysis of these emerging groundwater problems that the paper now turns. Central to this analysis is the question of the nature and the economic performance of the existing system of property rights in groundwater in northern India.

#### GROUNDWATER: COMMON PROPERTY OR FUGITIVE RESOURCE?

There is currently renewed interest, much controversy, and considerable ambiguity regarding conceptual and policy issues relating to natural resource property rights.<sup>9</sup> Ever since the seminal work of Scott Gordon on the fisheries,<sup>10</sup> it has been conventional for economists to regard resources such as groundwater as so-called common property resources.

Unfortunately, the term "common property" is applied too widely, imprecisely, and inaccurately to extremely heterogeneous types of resources and property rights situations.<sup>11</sup> Such conceptual and terminological confusion may be a serious barrier to analytical understanding of specific resource problems and to the design of public policy.<sup>12</sup> This is the case with groundwater in northern India. The study of groundwater problems and policy in northern India is further complicated by lack of documentation and agreement concerning the precise nature and status of property rights in groundwater.

Water legislation in northern India is essentially based on British common law.<sup>13</sup> There are no explicit statements or acts in Punjab,

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9. Recent contributions to this literature include: *Symposium on Natural Resource Property Rights*, 15 NAT. RES. J. 639-797 (1975); and THE GOVERNANCE OF COMMON PROPERTY RESOURCES (E. Haefele ed. 1974).

10. Gordon, *The Economic Theory of a Common Property Resource: The Fishery*, 62 J. POL. ECON. 124 (1954).

11. Ciriacy-Wantrup & Bishop, *supra* note 3 and Dorfman, *The Technical Basis for Decision Making in THE GOVERNANCE OF COMMON PROPERTY RESOURCES*, *supra* note 9, at 5.

12. Ciriacy-Wantrup, *The Economics of Environmental Policy*, 47 LAND ECON. 36 (1971).

13. For further brief expositions, see UNITED NATIONS, DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS, ABSTRACTION AND USE OF WATER: A COMPARISON OF LEGAL RÉGIMES 45-49 (1972); and UNITED NATIONS, ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST, WATER LEGISLATION IN ASIA AND THE FAR EAST, Part 2, 77-81 (1968).

for example, which clearly recognize and define the respective sectors of public rights and private rights in either surface or groundwater. The public ownership of surface water is implied, however, in regulations governing the use of water as outlined in the Northern India Canal and Drainage Act of 1873.<sup>14</sup> The distribution of canal water for agricultural use is accomplished through a rotational turn system known as *warabandi*.<sup>15</sup> Although the rotational turn—the farmer's claim to so many hours of irrigation time on the canal outlet—has many characteristics of a water right, it is not, strictly speaking, a legal right. Otherwise, the right to use surface water not subject to state diversion is a riparian right which is based on the ownership of land contiguous to the stream.

The rights of ownership and the rights of use of groundwater in northern India are much less clearly outlined than in the case of surface waters. Groundwater has never been declared to be publicly owned nor is public ownership implied through the operation of the various state tubewell acts which merely provide for the construction, improvement, and maintenance of state tubewell irrigation works.<sup>16</sup> The system of groundwater rights which prevails in India is best characterized as a version of the English doctrine of absolute ownership,<sup>17</sup> as an Indian farmer currently has an unrestricted right to make use of groundwater on his overlying land. While the unrestricted nature of the usufructuary right is not in doubt, the precise status of the ownership right to groundwater is less clear.

The doctrine of absolute ownership recognizes ownership of groundwater by the owner of overlying land and places no restriction upon the owner's right of use on his overlying land or elsewhere; indeed, this doctrine considers the owner of the land to be the owner of all the water in the underlying aquifer. In describing the English doctrine (variously termed the common law rule or the doctrine of absolute ownership) as it has existed in some parts of the United States, Wells Hutchins states:<sup>18</sup>

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14. Northern India Canal and Drainage Act 1873 (as amended and applied in Punjab and Haryana), Chandigarh: Jain Law Agency (1968). This basic enactment also applies to Uttar Pradesh.

15. For further discussion, see Wahi, *Irrigation Management in Punjab* in CENTRAL BOARD OF IRRIGATION AND POWER (India), SYMPOSIUM ON MANAGEMENT OF IRRIGATION WATERS 40-48 (1969); and Reiding, *supra* note 4.

16. Government of India, Planning Commission, Committee on Plan Projects, Minor Irrigation Team, Report on State Tubewells (Uttar Pradesh) 70-72 (1961).

17. UNITED NATIONS, WATER RESOURCES DEVELOPMENT CENTRE, LARGE-SCALE GROUND WATER DEVELOPMENT, at 40 and elsewhere (1960).

18. Wells A. Hutchins, *Reasonable Beneficial Use in the Development of Ground-Water Law in the West* in Committee on the Economics of Water Resources Development of the Western Agricultural Economics Research Council and Western Regional Research Committee, *Ground Water Economics and the Law*, Report No. 5, at 24 (1956).

In its original form, this theory accords exclusive property rights in the water to the landowner; it gives him the right to pump out the water at any time and in any quantity, for any legitimate enterprise, either on or off the overlying land. Various courts have imposed qualifications on this unlimited right, chiefly by way of requiring the water to be used without malice or negligence, or without unnecessary waste. But if the effect of heavy pumping by a landowner, while engaged in any legitimate enterprise that meets these requirements, is to exhaust the ground water supply of his neighbor by drawing all the water from the substrata of the latter's tract into his own heavily pumped well, it cannot become the ground of an action.

A recent irrigation report in India implicitly acknowledged the existence of the common law rule of absolute ownership of percolating ground water by the overlying landowner.<sup>19</sup> This report stated that, according to the custom in vogue in India, the ownership of ground-water rested with the owner of overlying land and there was no restriction upon the owner's rights of use of the water on his overlying land.<sup>20</sup>

There is a major qualification, however, to the preceding interpretation of groundwater rights in northern India which arises because of India's unique agrarian structure—in particular, its imperfectly developed system of private ownership of agricultural land. A reasonably strong case can be made that a proprietary or ownership right in land—and, by analogy, in groundwater—in northern India does not amount to complete or full ownership. The rights of property in land are regarded as a bundle or layering of rights<sup>21</sup> in which the “owner” has many rights but in which the state has control of the uppermost strand of the bundle. Thorner, for instance, has argued:<sup>22</sup>

The key fact about all of the British land settlement of the late eighteenth and nineteenth centuries . . . was that the new rights in the land were invariably subordinated to the rights of the State. To

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19. Government of India, Ministry of Food, Agriculture, Community Development and Cooperation, Report of the Working Group for Formulation of Fourth Five Year Plan Proposals on Minor Irrigation and Rural Electrification 89-90 (1968).

20. Not all irrigation officials in India espoused this view of ground water rights. Some irrigation officials in Punjab (private interviews, Chandigarh, November, 1969) considered that the owner of overlying land had only a right to make use of ground water and was not the owner of the “corpus” of water which lies in the aquifer. Some officials were inclined, in fact, to view ground water rights as riparian rights—an understandable misinterpretation, given the temptation to draw an analogy between ground water and surface water.

21. See S. CIRIACY-WANTRUP, *RESOURCE CONSERVATION: ECONOMICS AND POLICIES* 139-149 (3rd ed. 1968) for a discussion of the nature and importance of property rights as a primary social institution in the development and use of resources. In particular, note his reference to property as a “bundle” of rights in the use and transfer of natural resources.

22. D. THORNER, *THE AGRARIAN PROSPECT IN INDIA* 7 (1956).

no holder was granted the exclusive right to occupy, enjoy, and dispose of land which, in practice, is the hallmark of Western private ownership. . . . Some of the rights normally associated with private property in land (e.g., transfer, mortgageability, heritability) were indeed accorded to the new "owners." But their privileges were restricted by the simultaneous recognition of rights both superior and inferior to their own in the same land. The State, as a super-landlord (or ultimate owner), claimed a share of the rents; while the actual tillers exercised a traditional claim to occupancy.

There are convincing historical reasons, therefore, why property rights in land in India should be regarded as a blend of remnants from the past and modern Western concepts of private property. In particular, the claim of the state as an ultimate owner has descended from the claim of ancient Hindu and Mughul dynasties to a share of the produce of the land. This was reinforced, in days of British rule, by the claim of the imperial power to payment of land revenue. In independent India, land revenue must still be paid by several state governments.

With reference to groundwater, a plausible case can be made that since ownership rights in groundwater are derived from ownership rights in land, a similar hierarchical structure of rights in groundwater exists. One can postulate that the individual farmer has control of most of the bundle of rights relating to groundwater—he can use it, sell it with his land, or pass it on to his heirs with his land. However, the state could be regarded as being the "ultimate owner" of groundwater in the same sense that the state is the "ultimate owner" of land.

From the preceding discussion of groundwater rights, it seems clear, therefore, that it is a misnomer to call groundwater in India a common property resource. The most satisfying definition of the common property concept is that which refers to "a distribution of property rights in resources in which a number of owners are co-equal in their rights to use the resource."<sup>23</sup> Inherent in this definition is the fact that a common owner does not have the right to

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23. Ciriacy-Wantrup & Bishop, *supra* note 3, at 714. This definition has a basis in legal-historical tradition and is compatible with the concept of common property as outlined in Juergensmeyer & Wadley, *The Common Land Concept: A "Commons" Solution to a Common Environmental Problem*, 14 NAT. RES. J. 361 (1974). A major problem with Dorfman's conceptualization of common property (*supra* note 11, at 7) is that he errs in suggesting this concept makes no reference to property rights. The difficulty with Fisher and Krutilla's discussion of a common property resource (*Managing the Public Lands: Assignment of Property Rights and Valuation of Resources*, with subsequent comment by Marion Clawson, in *THE GOVERNANCE OF COMMON PROPERTY RESOURCES*, *supra* note 9, at 35) is that they mistakenly equate a common property resource with an open access resource and suggest that common property is invariably overused.



transfer the resource. Such a situation of common ownership<sup>24</sup> does not prevail for groundwater in India: Groundwater is not, at least at this point in time, a true common property resource (*res communes*). Nor is it fruitful to regard groundwater as an open access resource: the right to pump water is restricted to those who own land over the aquifer. Moreover, as Dorfman points out, it is misleading to say that difficulties arise in the alleged common property situation because there are no property rights or because they are ill defined; typically, and certainly in the case of groundwater in India, nothing could be further from the truth.<sup>25</sup> There are clearly established property rights to groundwater, subject to the qualification that the uppermost strand of the bundle of property rights might be construed as belonging to the state, and the remaining rights of ownership and use are vested in the hands of individual private farmers.

The groundwater resource in northern India is best regarded, in the interests of conceptual and terminological clarity, as a fugitive resource for which (essentially) private property rights exist. However, these private rights of ownership and use are indefinite for the individual user because other pumpers may take possession of the mobile resource in the meantime.<sup>26</sup> Resource tenure is not definite<sup>27</sup> in the case where hundreds of separate owners have land overlying a common groundwater basin and where control of the groundwater resource is essentially vested in the landowners. In these circumstances, the motivation of the individual resource user is to exploit the resource as quickly as possible so that the fluid and mobile resource will not be captured by others.<sup>28</sup> The paramount significance of indefiniteness of property rights is that it can lead to resource depletion over time, although wasteful depletion of groundwater is not yet an apparent problem in northern India. However, in the absence of effective social institutions to guide resource use,

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24. It should be noted that common property is not synonymous with public property. In fact, in the United States, "contrary to widespread belief, common lands are private and not public property," Juergensmeyer & Wadley, *supra* note 23, at 376.

25. Dorfman, *supra* note 11, at 7-9.

26. "Indefiniteness of property rights" occurs for that class of resources which must be reduced to physical possession by the user before they are legally owned. Such resources are termed "fugitive" because they must be captured through use. For further discussion, see S. CIRIACY-WANTRUP, *supra* note 21, at 141-5.

27. It should be noted that a distinction is being drawn, somewhat arbitrarily, between resources with poorly defined property rights and resources with indefinite property rights.

28. Definite property rights belong only to those who are in possession—that is, who gets there "fastest with the mostest." Every user tries to protect himself against others by acquiring ownership through capture in the fastest possible way. Deferred use is always subject to a great uncertainty: others may capture the resource in the meantime.

CIRIACY-WANTRUP, *supra* note 21, at 142.

private groundwater use can be predicted eventually to generate excessive investment and extraction costs; induce a pumping rate which is greater than socially optimal and which may lead to irreversible depletion; dissipate economic rent or producers' surplus; and, in general, create economic waste or resource inefficiency.<sup>29</sup>

The conceptual clarification that groundwater should be regarded as a fugitive, rather than as a common property, resource is important as a basis for the development and management of the groundwater resource. To view groundwater in northern India as a common property resource might lead to complacency and unfruitful efforts with respect to its regulation. Common property as an institution frequently facilitates the setting up of a regulatory framework to guide resource use.<sup>30</sup> In northern India, any groundwater regulatory scheme must take cognizance of the fact that private property rights in groundwater exist and that an institutional basis for management may be difficult to achieve.

#### ECONOMIC ANALYSIS OF THE PERFORMANCE OF THE SYSTEM OF GROUND WATER RIGHTS IN TERMS OF SECURITY AND FLEXIBILITY

A useful conceptual approach which has been suggested for the examination of the performance of a system of water rights and for the analysis of problems which might be associated with that system involves the concepts of "security" and "flexibility" of the water rights system.<sup>31</sup> In the analysis of current and anticipated social performance of groundwater rights, the concepts of security and flexibility are regarded as intervening criteria which serve to maintain and to increase national income under constantly changing conditions.<sup>32</sup> Security of water rights is especially significant for water development, whereas flexibility of water rights is important for water allocation among users, uses, and regions.

29. See Haveman, *Common Property, Congestion and Environmental Pollution*, 38 Q. J. ECON. 278 (1973).

30. Ciriacy-Wantrup, *supra* note 12.

31. Ciriacy-Wantrup, *Concepts Used as Economic Criteria for a System of Water Rights*, in *ECONOMICS AND PUBLIC POLICY IN WATER RESOURCE DEVELOPMENT* 251 (Smith & Castle eds. 1964). In this analytical framework, institutions such as ground water rights are conceptualized as social decision systems on the second level of a three level hierarchy and they can be analyzed with respect to their structure, functioning, and performance, see Ciriacy-Wantrup, *Water Policy and Economic Optimizing: Some Conceptual Problems in Water Research*, 57 AM. ECON. REV. 179 (1967).

32. Ciriacy-Wantrup, *Concepts Used as Economic Criteria for a System of Water Rights*, *supra* note 31, at 268. In their adaptation of this conceptual approach to the appraisal of water rights in Arizona, Kelso, Martin, and Mack emphasize:

Two aspects of water rights most significant for an understanding of man's behaviour relative to water and to one another over water are: (1) the security of their expectations that whatever rights they hold to water and its use will

The two main facets of security are physical security and tenure security.<sup>33</sup> Groundwater rights, from the point of view of physical certainty, are reasonably secure. The holder of groundwater rights in northern India has a reasonable degree of certainty that the physical supply of water available to him will not be affected by the vagaries of nature. This degree of security is partially the result of the fact that groundwater can be stored in the underground aquifer from season to season and from year to year. For instance, in years of heavy monsoon rains and above average recharge, any recharged water in excess of the average is stored in the aquifer and is available for use in another year when recharge is below normal. The degree of physical security varies somewhat among landowners, depending on such factors as local differences in depth to the water table, the transmission properties of the aquifer, and local variations in the "draw-down" or "cone of depression" in the water table during pumping.<sup>34</sup>

The major problem, however, with groundwater rights in northern India centers on the question of tenure security. Though not a problem in the short run, groundwater rights are insecure with respect to the certainty of tenure over the long run. Given the present nature of groundwater rights, there is no protection for the individual right holder against variability over time of the quantity (or, for that matter, the quality) of water usable under the right due to the lawful acts of others. In some respects, however, the groundwater right can be construed as being secure with respect to certainty of tenure. The landowner in northern India has a largely unrestrained right of access to groundwater which lies beneath his land; that right is not lost through non-use. The landowner is not yet protected against unreasonable use or water export by his neighbor, although this is a possible direction in which groundwater law might evolve, as it has in the southwestern United States.

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be stable and dependable over time, and (2) the flexibility permitted to them to effect changes in use and location of use of the water covered by their rights, and to acquire and transfer water rights from and to others. . . . Security and flexibility are the twin essences of socially efficient property relations.

See M. KELSO, W. MARTIN & L. MACK, *WATER SUPPLIES AND ECONOMIC GROWTH IN AN ARID ENVIRONMENT: AN ARIZONA CASE STUDY*, 52 & 54 (1973).

33. Physical security is concerned with "protection against physical uncertainty, that is, against variability over time of the quantity of water usable under the right due to seasonal or annual variability of natural runoff and groundwater recharge"; on the other hand, tenure security is concerned with "protection against uncertainty of water tenure, that is, protection against variability over time of the quantity of water usable under the right due to lawful acts of other individuals or groups, private or public." Ciriacy-Wantrup, *supra* note 31, at 253.

34. M. KELSO, W. MARTIN & L. MACK, *supra* note 32, at 67.

Currently in northern India, so long as annual draft does not exceed recharge, farmers are relatively secure with respect to certainty of tenure. In the long run, however, tenure rights to groundwater are particularly insecure given the distinct possibility that collective extraction from the common aquifer will exceed recharge. This insecurity is enhanced by the unrestrained right of the individual farmer to pump all the water he needs; he has no liability of any kind to other overlying owners for any adverse effects on water availability caused by his pumping.

The most pertinent economic implication of security of groundwater rights is its relationship to investment in groundwater development and its consequent impact on the extraction of groundwater.<sup>35</sup> Normally, when rights to a resource are insecure and a rights holder is unprotected against uncertainties in the income flow which the resource generates, aggregate investment in the development of the resource tends to be depressed. The case of groundwater is an exception to this general rule.

Despite the considerable potential for tenure insecurity with respect to the groundwater resource in northern India, investment in groundwater development can be anticipated to be stimulated due to the indefinite nature of property rights for this fugitive resource. Each farmer tries to protect himself against the lawful acts of others by acquiring ownership through capture in the fastest possible way. As a result, aggregate investment in the extraction of the resource is stimulated<sup>36</sup> and there is a motivation for depletion, rather than conservation, of the resource.<sup>37</sup>

The second intervening criteria by which a system of groundwater rights might be appraised is flexibility. Flexibility primarily focuses on the relative ease of transferability, both voluntary and involuntary, between uses and users. Groundwater rights in northern India are inflexible in some respects and flexible in others: Inflexible, in that the voluntary transfer of groundwater rights requires the concomitant transfer of land and in that there is no market in groundwater rights *per se*; flexible, in that the sale of surplus groundwater by one farmer to his nearby neighbors is permitted and encouraged

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35. Ciriacy-Wantrup, *supra* note 31, at 258-60.

36. Investment in ground water has primarily increased in northern India, of course, because such investment is characterized by a reasonable degree of divisibility, a relatively short gestation period, and, most significantly of all, a short "pay-off period" given the enhanced profitability of the new high-yielding varieties used in conjunction with assured supplies of fertilizer and water.

37. The discussion in this section on the economic implications of security of groundwater rights does not imply that water management in northern India should suddenly be redirected toward policies of conservation rather than depletion.

and in that a groundwater pumper has considerable leeway with respect to the use to which he puts groundwater on his farm. So long as the predominant use of groundwater is agricultural, no major flexibilities should arise. However, inflexibilities in water allocation will likely occur as greater urbanization and industrialization occur, because, since the groundwater right is currently tied to the land base, there may be difficulties in satisfying the future increasing demands of non-agricultural, urban, and industrial users.

The most significant conclusions which emerge from an analysis of the security and flexibility of the system of groundwater rights in northern India are the following: groundwater rights are relatively secure against physical uncertainty but relatively insecure, particularly in the long run, with respect to certainty of tenure; the indefiniteness of property rights associated with a fugitive resource such as groundwater leads to its rapid development and, perhaps, depletion; and groundwater rights, while not posing a problem for water allocation at the moment, may prove increasingly inflexible as regions such as Punjab progressively develop.<sup>38</sup>

There are convincing reasons to conclude that the performance of the current system of groundwater rights will prove increasingly inadequate over time. Due to its inherent tenure uncertainty and potential for inflexibility, the current system of groundwater rights will tend to impede, rather than facilitate, increases in national income in the long run. As a consequence, a critical area in public water policy in northern India is the question of revision of the current water law involving groundwater rights.

#### ANALYSIS OF WELL INTERFERENCE AND OVERDRAFT

Since the beginning of the green revolution, water table levels in most irrigation tracts in the Punjab region have declined.<sup>39</sup> Typically, many groundwater problems, ranging from localized, well failure to a generalized decline in water table levels, are labeled "overdraft." In the analysis of current and future overdraft problems, six

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38. Such problems are currently manifest in other regions of India, notably in the more poorly endowed ground water basins of southern India. In the Coimbatore region of the state of Tamil Nadu, for instance, ground water depletion was already a very serious problem in the 1960's. The water table in the Coimbatore ground water basin is declining by approximately two feet per year. Individual farmers attempt to maintain their supply of water from huge open wells, often 125 feet deep, by laboriously removing another two or three feet of stone per year.

39. Uppal, *Serious Waterlogging in Punjab and Haryana—How Cured and Measures to Prevent its Recurrence* in CENTRAL BOARD OF IRRIGATION AND POWER (India), SYMPOSIUM ON WATERLOGGING—CAUSES AND MEASURES FOR ITS PREVENTION, vol. II, 1 (1972).

types of overdraft can be conceptually distinguished: local or pseudo-overdraft (localized well interference); developmental or shortrun overdraft; seasonal or annual overdraft; cyclical or periodic overdraft; secular or long run overdraft; and, finally, critical overdraft.<sup>40</sup> Though not yet widespread, problems of local overdraft are anticipated to intensify in the Punjab region. Local overdraft occurs when pumping by one user affects the conditions of production experienced by neighboring users, primarily through the influence of the cone of depression created by withdrawal. This effect, however, is localized in nature and is not associated with a general decline in water table levels in the groundwater basin.

The current decline of water table levels in the Punjab region is characterized by developmental overdraft—a phase of groundwater development in which draft on the groundwater stock lowers the water table sufficiently to permit a greater degree of utilization of the storage capacity of the aquifer. Developmental overdraft, then, is not only a necessary, but also a socially useful, stage in groundwater development and use. It allows man to take complete advantage of both the stock and flow components of the groundwater resource. Furthermore, it helps to prevent natural discharge through evaporation and the associated problems of salinity and alkalinity.

Seasonal and cyclical overdraft are present to some extent in Punjab, but they appear to be relatively unimportant to the groundwater economy of the region. The potential problems of secular and critical overdraft, however, pose serious policy concerns. Long run or secular overdraft refers to the continual mining of the groundwater stock which occurs when annual draft perennially exceeds average annual recharge. Though not necessarily reducing economic welfare, long run overdraft typically imposes significant social costs on society. One kind of immoderate social loss to be avoided is the irreversible destruction of the storage capacity of the aquifer which can occur when sustained long run overdraft leads to compaction of the aquifer.<sup>41</sup> Long run overdraft typically occurs in semi-arid environments as the needs or irrigated agriculture outstrip a limited water supply.

The emerging groundwater problems in the Punjab region can also be analyzed in terms of cost and revenue interrelationships associated with groundwater use. The problem of local overdraft (or well interference), for example, can be conceived as a problem of cost and

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40. J. Snyder, *Ground Water in California: The Experience of Antelope Valley* (Giannini Foundation Ground Water Studies No. 2, Berkeley, 1955).

41. See CIRIACY-WANTRUP, *supra* note 21, chs. 3 & 18, for a discussion of depletion problems associated with flow resources with critical zones.

revenue relations between users of groundwater.<sup>42</sup> Use of groundwater by two pumpers is competitive in costs because an increase in use by one pumper leads to an increase in marginal costs of pumping for the second pumper. In addition, where local overdraft occurs, there is a problem concerning the incidence of costs and revenues.<sup>43</sup> The private pumper whose extraction of water causes drawdown in nearby wells bears only his private costs of additional withdrawal. Part of the cost of additional pumping is imposed on neighboring users whose conditions of pumping are adversely affected. In these circumstances, the private marginal costs of pumping by the individual user are less than the social marginal costs—a classic case of a technological external diseconomy.

The problem of long run overdraft, on the other hand, can be conceived as a question of cost and revenue relations over time—that is, relationships between rates of use of the groundwater resource in different planning intervals.<sup>44</sup> Overpumping or the “mining” of groundwater means that rates of use of the resource are competitive in costs because an increase in the use rate in one interval increases the marginal costs of the rate of use in a second interval. In other words, current and future rates of groundwater use are interrelated because excessive extraction in a current period increases the marginal costs of extraction in a future period. As water tables drop, the marginal cost of pumping from greater depths increases.

Although cost and revenue relations over time can arise without fugitiveness, the fact that groundwater in northern India is a fugitive resource strengthens the case that use rates will be interrelated over time. Where resource tenure is indefinite, as previously discussed, it is in the self-interest of each pumper to bring as much water to surface as quickly as possible. Consequently, resource users tend to ignore the possible future value of the resource, thus mining it too rapidly.<sup>45</sup> The individual pumper is motivated, moreover, to develop additional wells, to expand the rate of pumping from existing wells, or to invest in deepening existent wells and substituting more sophisticated pumping equipment as the water table recedes due to secular overdraft. The end results of groundwater pumpers attempting to capture the resource in the fastest possible way are that the average

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42. See *id.* at 43-45 and 381 for a discussion of cost and revenue relations between uses (or users) and between resources.

43. *Id.* at 235-38.

44. *Id.* at 66-75 and 381.

45. J. Bredehoeft & R. Young, *Two Studies in Water Resources Management* 3-7 (RFF Reprint No. 103, 1972). In other words, resource users tend to ignore “user cost” principles.

and marginal costs of pumping in the groundwater sector are increased and the resource may be allocated inefficiently over time.

#### POLICY IMPLICATIONS WITH RESPECT TO GROUNDWATER LAW

The preceding discussion of the existing system of groundwater rights and the outline and analysis of emerging groundwater problems in the Punjab region point to the impending necessity for public policy with respect to groundwater development and use in northern India. Through formulation of a policy, the present system of groundwater rights can be altered to improve its degree of security. Public policy is needed to remedy the potential for wasteful depletion caused by indefiniteness of property rights in groundwater, and to deal with the more immediate problem of local overdraft or well interference, as well as to set the foundation to combat eventual long run overdraft. Such policy will require the modification and adjudication of water rights, the integration of surface water and groundwater development, and the framing of appropriate groundwater regulations.<sup>46</sup>

A policy approach to the revision of groundwater rights which could prove useful in the solution of emerging groundwater problems in northern India involves the modification of the existing system of rights in line with the doctrine of correlative rights which has evolved out of the Californian experience.<sup>47</sup> In this evolution, the essence of the system of riparian rights for surface water was grafted on to the system of groundwater rights in the situation where the common law rule of absolute ownership was proving untenable for the environmental and economic conditions of California. Beginning with the case of *Katz v. Walkinshaw* in 1902-03,<sup>48</sup> the common law rule was either modified or repudiated and replaced by the doctrine of correlative rights.<sup>49</sup> The doctrine of correlative rights "must be regarded as a direct descendant of riparian law" and riparian law, in turn, is based on the concept of common property.<sup>50</sup> It is ironic that rather than common property being the cause of groundwater problems in northern India, common property-related institutions might prove promising in their solutions.

The chief feature of the California correlative doctrine is that

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46. Ciriacy-Wantrup, *supra* note 2, at 1322.

47. The discussion of the Californian doctrine of correlative rights is based on W. HUTCHINS, *THE CALIFORNIA LAW OF WATER RIGHTS* (1956) and Ciriacy-Wantrup, *Some Economic Issues in Water Rights*, 37 J. FARM ECON. 875 (1955).

48. 141 Cal. 116, 70 P.663 (1902), 74 P.766 (1903).

49. W. HUTCHINS, *supra* note 47, at 431.

50. Ciriacy-Wantrup & Bishop, *supra* note 3, at 722.



owners of all lands that overlie a common supply of percolating groundwater have correlative and coequal rights to the reasonable beneficial use of the water of that supply on or in connection with their overlying lands. Furthermore, in the event that the demand for groundwater based on coequal rights exceeds the supply and some form of rationing among the overlying landowners is necessary, the water may be apportioned by court decree (adjudication) among them in accordance with their respective reasonable beneficial needs and in proportion to their historical use. For instance, in the seriously overdrawn Raymond Basin in southern California, the principle of water rationing among landowners in accordance with "safe yield" of the basin was established in the case of *Pasadena v. Alhambra*.<sup>51</sup>

The correlative rights doctrine has several attractive features. Under this doctrine, the vested rights of overlying owners are partially protected. The doctrine does not ensure complete security of water supply for each pumper (in line, for instance, with historic levels of pumping). But the fact that each groundwater user is entitled to his reasonable share of the total water supply when the supply is insufficient to meet the needs of all users means that certainty of tenure with respect to groundwater use has been substantially increased. The ownership of groundwater under the correlative rights doctrine is considered to lie in that part of the public comprising the owners of all overlying lands; individual landowners have (private) rights of use based upon their ownership of the overlying land but not private ownership in the water itself until it has been reduced to actual possession.<sup>52</sup> This altered ownership status under the doctrine of correlative rights has two significant implications. First, a basis for the public regulation of groundwater can be established. Second, given that the correlative right to groundwater is in many respects analogous to the riparian right to surface water, an effective institutional basis for the integration of the development and use of surface and groundwater is also established. Since most surface water in northern India is allocated through the canal system and is not directly diverted by individual riparian landowners under the riparian rights system, it is important to note that correlative rights to groundwater, once adjudicated, could be integrated with the rotational time-turn associated with canal water deliveries.

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51. 33 Cal.2d 908, 207 P.2d 17 (1949), *cert. denied sub nom.* California-Michigan Land & Water Co. v. Pasadena, 339 U.S. 937 (1950); *see* W. HUTCHINS, *supra* note 47, at 444-46.

52. *Id.* at 428.

The transformation of groundwater rights to a correlative rights system, therefore, could be accomplished without explicit statutory declaration that ground water in India was public property. The California alternative also has practical appeal because it bypasses the problems of confiscation of private property and of compensation that might be associated with eminent domain procedures. The doctrine of correlative rights has certain advantages, too, over an appropriation doctrine that might be legislatively based on the "police powers" of the state. Under an appropriation system,<sup>53</sup> prospective groundwater users apply to a public agency for the right to pump a specific quantity of water. Respective claims to water at a point in time are typically judged in terms of a preference ordering for various uses (municipal, agricultural, industrial, recreational). Once appropriation is completed, the time element alone confers preferential rights. A considerable disadvantage of an appropriate system of water rights is, then, that it may impede flexibility in the use of water in the course of economic change. For instance, in the event of a water shortage, a senior (in time) appropriative right for a relatively low-valued use of water would not yield to a junior right for a higher-valued use.

A further advantage of the correlative doctrine is that it might more readily accommodate the future use of groundwater by small landowners who do not currently use groundwater. The correlative right, like the riparian right, does not depend upon use and is typically not lost by disuse. A considerable disadvantage of zoning regulations which prohibit further wells in certain tracts or of appropriation type doctrines ("first in time, first in right") could be their rigidity with respect to accommodating the needs of small farmers over time. Finally, the correlative doctrine, as developed in California, is generally regarded to have facilitated the development of both groundwater and surface water in the course of economic change.<sup>54</sup>

Undeniably, there would be difficulties in attempting to modify the existing system of groundwater rights in northern India in accordance with the correlative rights doctrine. One problem might lie in the difficulties of finding a relatively cheap and effective method of adjudication of water rights among a great many small farm owners in a particular groundwater sub-basin. A further problem is the need for appropriate water organizations or water management institu-

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53. For further discussion of the appropriation doctrine of water rights, see HUTCHINS and Ciriacy-Wantrup, *supra* note 47.

54. Ciriacy-Wantrup, *supra* note 47, at 879.

tions to manage an integrated water rights and water resources system.<sup>55</sup> These difficulties, however, should prove surmountable.

With the establishment of an integrated water rights and management system, an effective institutional basis for the promulgation of groundwater regulations would exist. Groundwater regulations are needed to combat such emerging problems as localized interference between wells or the potential of long run overdraft. The choice of instruments or tools in ground water regulation depends considerably on the specific problem at hand. Well spacing, for example, is an effective means of dealing with the problem of localized interference between wells. In this situation, which is characterized by cost and revenue relations between users, a policy tool with spatial characteristics is particularly well suited to mitigate spatial relationships between users.<sup>56</sup> On the other hand, well spacing is an inappropriate policy instrument to deal with secular overdraft which is characterized by cost and revenue relations over time. A more effective tool for dealing with overdraft would be restriction on the volume of water pumped in combination with limitation on the number of wells. An indirect means of alleviating an overdraft problem would involve groundwater laws for the provision and operation of recharge facilities, which would increase the rate of replenishment.

In the Punjab region of northern India, the problem of localized interference between wells is the most immediate groundwater problem. Groundwater regulations involving rules for well spacing should be a priority policy concern.

#### CONCLUDING COMMENTS

The use of groundwater in northern India now requires the development of effective water institutions. In order to deal with emerging groundwater problems in northern India and to establish a basis for the regulation and management of groundwater, the existing system of groundwater rights must be modified and revised. The English rule of absolute ownership will prove increasingly ill-suited to the environmental and economic conditions of northern India as progressively more water is needed to extend and modernize irrigated agriculture. Therefore, the existing system of groundwater rights should be re-oriented towards a system of correlative rights, rather than towards a system of appropriative rights. Under a correlative rights

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55. See Veeman, *supra* initial note, ch. 8 for a discussion of public water districts as potential water management organizations in northern India.

56. See CIRIACY-WANTRUP, *supra* note 21, ch. 19 for a discussion of the economic characteristics of zoning.

system, individual groundwater pumpers would retain private rights of use to a reasonable share of the groundwater supply. Moreover, an effective institutional basis for the public regulation of groundwater, as well as for the integration of use of ground- and surface water, would be established. Without the development of appropriate water policy and water institutions, the full potential of the new cereal technology will not be realized in northern India.