Water and Federalism: India's Institutions Governing Inter-State River Waters*

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Executive Summary

The paper analyzes the process of resolving inter-state water disputes. Indian water-dispute settlement mechanisms are ambiguous and opaque. A cooperative bargaining framework suggests that water can be shared efficiently, with compensating transfers as necessary, if initial water rights are well-defined, and if institutions to facilitate and implement cooperative agreements are in place. The paper also emphasizes the role of complementary investments, and the need to expand the scope of bargaining to include these where feasible. Delayed agreement over water can encourage inefficient, non-cooperative investments in dams, irrigation, and agriculture and industry more generally.

Additionally, we distinguish between situations where cooperation is possible, and situations where the initial allocation of rights is at stake, where there is pure conflict rather than potential gains from trade. In the pure conflict situation, which seems very relevant for Indian inter-state disputes, a search for a negotiated solution may be futile, and quick movement to arbitration or adjudication may be more efficient. However, in the Indian case, not only is this process slow, but, effectively, binding arbitration does not exist. The threat point of no agreement has been the outcome in several major disputes (e.g., Cauvery; Ravi-Beas). This can result in inefficient levels of investment by the individual, non-agreeing

states, generating a diversion of scarce investment resources, as well as inefficient use of the water itself. This in turn can have negative impacts on economic growth.

The problems are compounded by the entanglement of inter-state water disputes with more general center-state conflicts, and with everyday political issues. We argue that these impacts can be reduced by a more efficient design of mechanisms for negotiating inter-state water disputes. We present some of the possibilities, including a national water commission independent of daily political pressures, a federated structure incorporating river basin authorities and water user associations, and fixed time periods for negotiation and adjudication.

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1. Introduction

Because large areas of India are relatively arid, mechanisms for allocating scarce water are critically important to the welfare of the country's citizens. Water contributes to welfare in several ways: health (e.g. clean drinking water), agriculture (e.g., irrigation), and industry (e.g., hydroelectric power). Because India is a federal democracy, and because rivers cross state boundaries, constructing efficient and equitable mechanisms for allocating river flows has long been an important legal and constitutional issue. Numerous inter-state river-water disputes have erupted since independence: Ramana (1992) lists 14 such disputes[1], without being comprehensive. A recent example, involving the Yamuna river, and the states of Delhi, Haryana and Uttar Pradesh, provoked the following incident:

> "Thousands of women from Haryana marched last month to Delhi's busiest intersection carrying earthen pitchers, and in a dramatic protest, smashed them in demanding that their government stop supplying water to Delhi."[2]

This particular dispute was resolved by conferences involving three state Chief Ministers, as well as the central government, after prior intervention by the Supreme Court had failed. Not all disputes have happy endings, however: the larger dispute between Karnataka and Tamil Nadu over the waters of the Cauvery rages on. Inter-state water disputes are a persistent phenomenon in India.

This phenomenon is relatively poorly understood. Part of the difficulty is the plethora of actors and the complexity of the institutional environment within which the various parties reach (or fail to reach) agreement. Actors include state governments (which in turn must be decomposed into professional politicians, political parties, and interest groups), the national parliament, central ministries, the courts, and *ad hoc* water tribunals. These actors negotiate within a rich institutional setting. In general, river-water disputes have involved state and central politicians, as well as the courts and special tribunals and commissions set up to arbitrate. Although fairly explicit constitutional provisions govern inter-state river waters, it is unclear precisely whether existing mechanisms for adjudicating interstate water disputes are

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[1] See Ramana (1992), pp. 74-75.

[2] See *India Abroad*, June 16, 1995: "Rao's Mediation Wards Off Water Crisis".

efficient. Indeed, there is growing consensus that existing institutions are increasingly unable to generate acceptable outcomes which contribute to economic growth and national welfare.

Our research seeks to determine which arrangements for conflict resolution are more effective (more likely to yield an acceptable outcome) and more efficient. We do this by examining India's experience, and combining this with economic analysis to model the institutions and negotiating behavior of the actors in inter-state river disputes. In the remainder of this introduction, we briefly survey the institutions and issues, before proceeding to a more detailed treatment.

India's Federal Water Institutions

The relevant provisions of the Indian Constitution are

- Entry 17 in the State List,
- Entry 56 in the Union List, and
- Article 262.

The first provision makes water a state subject, but qualified by Entry 56 in the Union List, which states: "Regulation and development of inter-state rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by parliament by law to be expedient in the public interest."[3] Article 262 explicitly grants parliament the right to legislate over the matters in Entry 56, and also gives it primacy over the Supreme Court. As documented by Iyer (1994), parliament has not made much use of Entry 56. Various River Authorities have been proposed, but not legislated or established as bodies vested with powers of management. Instead, river boards with only advisory powers have been created.

Hence, the state governments dominate the allocation of river waters. Since rivers cross state boundaries, disputes are inevitable in this institutional setting. The Inter-State Water Disputes Act of 1956 was legislated to deal with conflicts, and included provisions for the establishment of tribunals to adjudicate where direct negotiations have failed. However, states have sometimes refused to accept the decisions of tribunals. Therefore, arbitration is not binding. Significantly, the courts have also been ignored on occasion. Finally, the center has sometimes intervened directly as well, but in the most intractable cases, such as the sharing of the Ravi-Beas waters among Haryana, Jammu and Kashmir, Rajasthan, and Punjab, central intervention, too, has been unsuccessful. An unambiguous institutional mechanism for settling inter-state water disputes does not exist. On the other hand, water disputes are sometimes settled. Economic analysis is necessary to illuminate whether and how water disputes get resolved in India.

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[3]See Ramana (1992) or Iyer (1994) for this and other relevant constitutional text.

The Economics of Water

It is widely recognized that water has a number of features which create potential market failure. These may include non-rivalry, non-excludability, externalities, merit good features, and significant transactions costs[4]. The presence of these factors means that although increased reliance on market forces, e.g., one state selling water to another, can contribute significantly to resolving water issues, there is no escaping from the need for parties to agree upon a set of rules, an enforcement mechanism, and a prior distribution of property rights. Property rights have been claimed on the basis of historical use, as well as on the basis of the "Harmon Doctrine", that "what falls on our roof is ours to use, without regard to any potential harm to downstream parties"[5]. As Richards points out, historical use can work against trading water rights, while the Harmon doctrine ignores externalities as well as past investments connected with water use. He makes a case for a third approach, that of the social contract *a la* Thomas Hobbes. A deal must be struck among the existing decision-making entities, typically Indian states in our context, which 1) decides on an initial allocation of property rights and 2) creates a mechanism to trade these rights, to regulate uses which generate externalities, etc. Consequently, institutions that support efficient bargaining are needed.

It is reasonable to analyze inter-state water disputes as cooperative games: states bargain and negotiate, and can make binding agreements. But this bargaining process takes place within an institutional context: other actors (e.g., the central government, river tribunals) also influence, but, as we have seen, do not "settle" outcomes. The cooperative game framework enables us to identify which set of institutions are more, and which less, likely to generate acceptable (i.e., feasible) and efficient outcomes.

The obvious starting point for thinking about bargaining over water is the Coasian perspective. Coase's (1960) ideal bargaining solution provides a benchmark against which one can compare reality. The main lesson of Coase is that one should not presume that central intervention is desirable or necessary in inter-state water disputes. However, there are situations in which bilateral or multilateral bargaining among concerned state governments may not be efficient or equitable on its own. One example is that the center can affect starting positions or threat points in the bargaining game between states. Another is that, when there is incomplete information, even imperfect central intervention can be better in expected terms than bilateral bargaining[6]. A third case is when there are multiple issues to be bargained over, that may also involve spillovers to non-riparian states: the Punjab-Haryana

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[4]See World Bank (1993) and Richards (1994).

[5]See Richards (1994) and Ramana (1992) for further detail on these ideas.

[6]See Farrell (1987) for a simple illustration of this point, as well a general evaluation of the "Coase theorem".

dispute is an example of such a situation. In this paper, however, we focus on bilateral bargaining.

Before turning to a more detailed analysis of some of the cases of inter-state water disputes, in section 2 we sketch the relevant legal theories and institutions in somewhat more detail. This provides some insight into the thinking and the history that have shaped India's recent experience with inter-state river water allocation. Section 3 discusses three cases in some detail, to give a flavor of the issues that have arisen in recent disputes. Section 4 provides a basic model, using the tools of cooperative bargaining theory, to provide more formal analysis of the issues. In particular, the model allows us to distinguish between issues of reallocation of water starting from well-defined initial rights - including mechanisms for compensatory transfers - from cases of contests over the allocation of rights themselves. The latter issue is discussed in section 5, which also provides a treatment of political and informational factors in the negotiation process. Section 4 also discusses the important aspect of investments which affect the productivity or the availability of water, and issues of cooperation in this dimension. In section 6, we tackle some of the issues raised previously in the context of the workings of Indian federalism more generally. Finally, section 7 concludes with some assessment and conclusions, by way of recommendations, from our analysis and case studies.

2. Legal Theories and Institutions

General Approaches

Initial claims to water in negotiations are often justified in terms of one of several simple legal doctrines. These doctrines are really rules of thumb, which seek to formulate a general approach to division of the scarce resource of river water. We first simply enumerate these rules, and then briefly outline some of their implications for resource allocation. We may identify five such "theories" or legal doctrines.

1. "**Theory of absolute territorial sovereignty"**. Under this doctrine, a riparian state can do what it pleases with its waters without regard to its effect on other co-riparian state and no riparian state has a right to demand the continued flow of water from other states. This is a variant of what is known as the "Harmon" doctrine in the United States.

2. "**Theory of natural water flow**" or the "**territorial integrity theory"**. According to this theory every lower riparian is entitled to the natural flow of the river without any interference from the upper riparian. This approach clearly has similarities to the Harmon doctrine, in that it claims rights based on natural bounty: the difference is in how nature's intentions are interpreted!

3. "**Theory of prior appropriation"**. This theory says that the first user who puts the water to beneficial use establishes a prior right and subsequent users can only appropriate

what is left by the first user. This doctrine allocates property rights to water on the basis of historical use.

4. "**Theory of community of interest"**. Under this theory the whole basin is regarded as a single economic unit. It cuts across all state boundaries and the water can be utilized to the maximum benefit of all in an integrated manner.

5. "**Theory of equitable utilization of Inter-State river waters"**. This theory stresses that there should be equitable utilization of common rivers by mutual agreement among concerned parties.

Needless to say, these rules of thumb have very different implications. The Harmon doctrine assigns a clear property right, but it ignores externalities as well as past investments connected with water use. A similar stricture applies to the second doctrine. The third rule, that of historical use, can work against trading water rights, and hence against efficiency, because it has the potential to convert regular but temporary trades of water into permanent or quasi-permanent transfers, thereby inhibiting the initial trade. Furthermore, the doctrine of prior appropriation does not have any formal legal status in India. For example, the Calcutta High Court refused to apply this theory in a dispute where the defendant (upper riparian) had constructed a dam across a stream, thereby cutting off the entire supply of water to the plaintiff (lower riparian). The court ruled that the upper riparian was entitled to reasonable use. The fourth theory underlies the opinion that rivers ought to be nationalized to prevent or solve inter-state river disputes. Nationalization would seem to violate the federal structures that govern water use in India (see below), nor is it necessitated by the internalization of externalities. This could be achieved by having a statutory body encompassing each river basin. There is a constitutional provision for this in India, as noted in the introduction, and we discuss this further, later in our paper.

The fifth rule deserves somewhat more extended discussion. The problem, of course, is defining "equitable allocation". The best known attempt to formulate principles for equitable allocation in the context of *international* water disputes, is the Helsinki Rules, adopted by the International Law Association in 1966 at Helsinki. The Helsinki Rules extend to 37 articles. Articles 4 and 5 cover procedures for preventing and settling disputes. According to Article 4, "each basin state is entitled, within its territory, to a reasonable and equitable share in the beneficial use of the water of an international drainage basin." Article 5 sets out 11 factors which will determine what is a reasonable and equitable share. The 11 factors are:

1) The geography of the basin, including the extent of the drainage area in the territory of each basin state.
2) The hydrology of the basin, including the contribution of water by each basin state.
3) The climate affecting the basin.
4) The economic and social needs of each basin state.
5) The population dependent on water of each basin state.

6) The comparative costs of alternative means of satisfying the economic and social needs of each basin state.
7) The availability of other resources.
8) The avoidance of unnecessary waste in the utilization of waters of the basin.
9) The practicability of compensation to one or more of the co-basin states as a means of adjusting conflicts among uses.
10) The degree to which the needs of a basin state may be satisfied without causing substantial injury to a co-basin.
11) The past utilization of the waters of the basin, in particular existing utilization.

Unfortunately, this list is so general and encompassing that, while it provides a useful, comprehensive catalogue of what one might worry about in bargaining over water, it does not provide any practical guide for actual decision-making with respect to water sharing. Furthermore, it is not clear that equity across the parties to bargaining is a relevant factor, unless the decision is made by a higher-level arbiter (a court or central government) that has such preferences. Otherwise, the outcome of successful decentralized bargaining will depend instead on bargaining power, threats, outside options, and the like[7]. The lack of practical guidelines for agreement in the Helsinki Rules has led to an ongoing attempt to replace them: a new draft set of guidelines is currently being prepared by the International Law Association.

India's Federal Water Institutions

As is the case with several other aspects of modern India's laws and institutions, water institutions have their origins in pre-independence legislation. The history of institutional development in this area seems to be one of increasing decentralization (and hence opportunity for conflict) over time. Until the Government of India (GOI) Act of 1919, all irrigation works except those not exceeding Rs 10 lakhs[8] in cost were under the control of the central government, and subject to the sanction of the secretary of state. The GOI Act 1919, made irrigation a provincial subject, while matters of inter-provincial concern or affecting the relations of a province with any other territory were subject to legislation by the central legislature.

The GOI Act of 1935 drew attention explicitly to river disputes between one province or another or between a province in British India and a (federated) Indian state. The provincial legislative list (which became Entry 17 in the State List in the 1950 Constitution) included “water, that is to say water supplies, irrigation and canals, drainage and embankments, water storage and water power”. Sections 130 to 134 in the 1935 Act dealt

[7] However, it could be argued that considerations of fairness would affect how parties to a negotiation might view particular solutions, and thus affect the outcomes they find acceptable.

[8] A lakh is 100,000.

with the problem of "interference with water supplies". The provisions led down that a province or a princely state could complain to the Governor General if its interests were prejudicially affected in the water supplies from a natural source, due to the action of another province or princely state. If the Governor General considered that the issues involved were of sufficient importance, he was required to appoint a commission to investigate the matter and to report to him. After considering the report he was to give a decision he deemed proper. In effect, this arrangement provided for binding arbitration: in the end, the Governor General could theoretically impose his decision.

The only complaint under these provisions of the 1935 Act was made by the Sind government. It related to the possible prejudicial effect of the Bhakra dam contemplated by Punjab on Sind's inundation canals. In 1941, the Governor General appointed the Indus Commission to investigate this complaint. But the commission could not come to a conclusion before 15th August 1947. Subsequently the original dispute between Sind and pre-partition Punjab was subsumed in the Indus basin dispute between India and Pakistan.

The next stage of constitutional evolution was the draft constitution. At this stage the original Articles on the subject, viz., Articles 239 to 242 were worded on the same lines as sections 130 to 134 of the 1935 Act. Subsequently, an amendment was introduced and they were replaced by Article 262. We note the provisions of Article 262:

1) Parliament may by law provide for the adjudication of any dispute or complaint with respect to the use , distribution control of the waters of, or in any inter state rivers or river valleys.

2) Notwithstanding anything contained in this Constitution, Parliament may, by law, provide that neither the Supreme Court nor any other Court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in clause (1) of this Article.

Within the powers available under Entry 56 of the Union List and Article 262, Parliament enacted two laws, viz.,

1) River Boards Act of 1956,
2) Inter-State Water Disputes Act of 1956.

The first act made provisions for setting up of river boards or advisory bodies by the central government at the request of the interested parties. These boards were to have two functions:

1) They would help to bring about proper and optimum utilization of the water resources of inter state rivers.

2) They would promote and operate schemes for irrigation, water supply, drainage, development of hydroelectric power and flood control.

The second act can be briefly be described as follows:

> If a dispute arises from any legislation, or failure to implement the terms of any agreement on the part of another state, then the affected state can request the Central government to refer disputes relating to the use, distribution , or control of Inter-State river waters for adjudication by tribunal constituted under the Act.

If the Central government feels that the water dispute referred to it cannot be settled by negotiations, then it can refer the dispute to adjudication by a tribunal constituted under the Act. The tribunal shall then investigate the complaint and forward a report to the Central government known as order or award of the tribunal. Within three months of the report, the central government or any of the state government concerned can approach the tribunal for clarification. The central government shall publish the tribunal's decision in the official gazette, when the decision will be final and binding on the parties to the dispute. Neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any water dispute referred to a tribunal. India's water laws give the appearance of clarity. Actual practice, however, is far more opaque.

3. India's Experience

The Inter-State Water Disputes Act seems to provide fairly clear procedures for handling disputes. At the same time, however, the law permits considerable discretion, and different disputes have followed quite different paths to settlement, or in a few cases, continued disagreement. In this section, we provide an overview, and then some detailed discussion of some of the major disputes. Again, we suggest that a bargaining framework is well suited to sorting and explaining the very diverse outcomes of seemingly similar disputes.

Overview

The central government has given substantial attention to water disputes, which began to emerge soon after the framing of the Constitution. As far back as 1967, the following 15 cases were identified[9], divided into two groups. The first group was those cases where interstate agreements through mutual discussions and negotiations had been successfully reached:

1) Musakhand Project dispute between Uttar Pradesh and Bihar, settled in 1964.
2) Palar water dispute between Tamil Nadu and Karnataka, settled in 1956.
3) Tungabhadra Project High level canal dispute between Karnataka and Andhra Pradesh, settled in 1956.

[9] See Administrative Reforms Commission (1967-68), Volume II, pp. 126-134.

4) utilization of Ravi-Beas waters among Punjab, Rajasthan, Jammu and Kashmir, settled in 1965.
5) sharing of Subarnarekha river water among Bihar, Orissa and West Bengal, settled in 1964.
6) sharing of costs and benefits of Jamni Dam Project between Uttar Pradesh and Madhya Pradesh, settled in 1965.
7) exploitation of Mahi river water between Gujarat and Rajasthan, settled in 1966.

A careful examination of the above list suggests some common features of the easily settled disputes. Three of them (1, 3, 6) involved sharing costs and benefits of specific projects. Three others (2, 5, 7) involved relatively specific disputes over smaller rivers, mostly over well-defined projects or project proposals. Thus six of the seven settlements were characterized by specificity and well-defined technical and cost issues. The one "settlement" that does not fit this characterization, regarding the fourth case on the above list, was reopened with the division of Punjab into Punjab and Haryana in 1966, and this new dispute has still not been resolved: in fact, it has been one of the most contentious of inter-state water disputes. It is discussed in more detail below.

The second group discussed in the report consisted of those cases which had not been settled at that time:

1. The Krishna - Godavari waters dispute among Maharashtra, Karnataka, Andhra Pradesh and Orissa.
2. The Cauvery water dispute among Tamil Nadu, Karnataka and Kerala.
3. The Narmada water dispute among Gujarat, MP, Maharashtra and Rajasthan.
4. The Tungabhadra project issues other than the high level canal between Karnataka and Andhra Pradesh.
5. The issue of extension of irrigation from the Rangwan Dam of UP between UP and MP.
6. The Koymani river dispute between Bihar and West Bengal.
7. The dispute over the Keolari Nadi waters between MP and UP.
8. The Bandar Canal project, affecting Madhya Pradesh and Uttar Pradesh.

A study of the details of these cases clearly puts them in two groups. The first three on this list were or are major disputes, involving large river basins. They were all ultimately referred to tribunals, with varying degrees of success[10]. It is interesting to note that the Krishna and Godavari tribunals were not constituted until 1969, despite earlier requests from two of the involved states. These requests were not acceded to by the central government[11]. This kind of problem is discussed in section 5, in the context of our formal modeling of

[10] We discuss the Krishna-Godavari and Cauvery disputes below. The Narmada dispute and tribunal award are discussed in Shah (1994). He also discusses the other major cases.

[11] See Administrative Reforms Commission (1967-68), Volume III, p. 131.

strategic behavior by the center and states. While the tribunal on the Cauvery dispute is still working, and has yet to make a final judgement, its interim award has been strongly contested by Karnataka, which has recently decided to boycott the tribunal. Recent events in this dispute have therefore focused increased attention on the mechanisms of inter-state water dispute resolution for these major disputes. The last five cases on the list are actually closer in characteristics (relatively small and specific) to the most of the cases on the first list. Indeed, examining their status, even in the 1967 document, revealed that several were approaching settlement.

While smaller, more specific disputes may be settled more easily, as the above discussion suggests, this may still not be ideal. In particular, while river basins seem the natural unit for dealing with issues of water sharing, investment and management, they have been the focus of conflict rather than cooperation in the Indian case. As noted in the introduction, the Indian Parliament has not made much use of the powers vested in it by Entry 56 of the Union List. No river board has been set up under this Act. Several river boards exist for particular projects only. The Betwa River Board was set up under a separate enactment for the specific purpose of overseeing a particular project. The Brahmaputra Board was also set up under a specific Parliamentary enactment. This is an ineffective organization which has not been allowed to grow into a river basin authority. The Bansagar Control Board is meant to supervise specific projects. The Ganga Flood Control Commission is limited to the preparation of master plans for flood control. The Krishna Water Dispute tribunal envisaged the establishment of a Krishna River Authority but this never saw daylight[12].

Finally, with regard to water projects, India has often adopted project models used by other countries for its own execution. The Damodar Valley Corporation was modeled on the Tennessee Valley Authority of the USA. After its creation, tensions and conflicts developed between the corporation and the participating governments, which hampered its work. So it never became an autonomous regional river valley development corporation. This lack of clear delegation of authority, away from politicians, is a theme to which we shall return.

Cases

In order to give a better flavor for the nature of the bargaining process, we now discuss three cases in somewhat more detail:

(1)The Krishna-Godavari water dispute
(2)The Cauvery water dispute
(3)The Ravi-Beas water dispute

These cases involve important disputes, and illustrate well the variety of paths that disputes can take in the Indian institutional context. In the first case, relative success was achieved

[12] See Iyer (1994) for details of these cases.

through negotiations and through the working of a tribunal. In the other two cases, the institutional process has been relatively less successful: while these two disputes have both gone to tribunals, neither one has yet been successfully resolved. The Cauvery Tribunal is still deliberating, while the Ravi-Beas Tribunal gave its judgement, but is was not made official by the central government.

Krishna-Godavari water dispute[13]

The Krishna-Godavari water dispute among Maharashtra, Karnataka, Andhra Pradesh (AP), Madhya Pradesh (MP), and Orissa could not be resolved in spite of negotiations and discussions. Here Karnataka and Andhra Pradesh are the lower riparian states on the river Krishna and Maharashtra is the upper riparian state. The dispute was mainly about the inter-state utilization of untapped surplus water.

Background of the dispute

In the early 1950s, the Indian government adopted the First Five Year Plan, which outlined a path for economic development. The Planning Commission wanted to include some major schemes for irrigation and hydroelectric power on the rivers Krishna and Godavari . The commission asked the states of Bombay, Hyderabad, Madras and Mysore to suggest certain viable projects. An inter-state conference was convened in 1951 to discuss the utilization of water in the Krishna and Godavari and to assess the merits of the various projects suggested. The agreement provided for a review of allocations after 25 years. Karnataka, (then Mysore) did not ratify the agreement relating to the Krishna waters. In 1953, the states began to be reorganized on a linguistic basis. Andhra Pradesh came into existence in 1953, while in 1956 there was a further redrawing of state boundaries. Hence the 1951 agreement needed to be revised. Prolonged negotiations did not lead to a new agreement, and separate tribunals were constituted for the Krishna and the Godavari in 1969, but with the same membership.

The main issues in the Krishna-Godavari dispute were the following:

(1) The validity of the inter-state agreement of 1951 was questioned. Since the objective conditions had changed since 1951, Maharashtra, Orissa, Karnataka, MP demanded a new consideration of the allocation of the water of the two states.
(2) Karnataka and AP objected to the diversion of more water at Koyna by the upper riparian state, Maharashtra, for a hydroelectric project and other irrigation works as this would reduce downstream flow , with adverse consequences for agriculture and industry.
(3) Andhra Pradesh also objected to the construction of dams by the upper riparian state , Maharashtra, for irrigation purposes.

[13] See, for example, Shah (1994), for further details of this case.

(4) It was questioned whether Maharashtra could divert water westward for generating cheap hydroelectric power on the slopes of the Western Ghats.
(5) The upper riparian state also questioned Andhra Pradesh's intention to store more water at Nagarjuna Sagar.

The Tribunal's decision

The Krishna Tribunal reached its decision in 1973, and the award was published in 1976. The Tribunal relied on the principle of equitable apportionment for the actual allocation of the water. It addressed three issues:

(1) The extent to which the existing uses should be protected as opposed to future or contemplated uses.
(2) Diversion of water to another water shed.
(3) Rules governing the preferential uses of water.

The Tribunal's rulings were as follows:

- On the first issue, the Tribunal concluded that projects which were in operation or under consideration as in September 1960, should be preferred to contemplated uses and should be protected and that except by special consent of the parties, a project committed after 1960 should not be entitled to any priority over contemplated uses.

- On the second issue, the Tribunal concluded that diversion of Krishna waters to another waterline was legal when the water was diverted to areas outside the river basin but within the political boundaries of the riparian states. It was silent regarding the diversion of water of water to areas of non-riparian states.

- On the third issue the Tribunal specified that all existing uses based on diversion of water outside the basin would receive protection.

- As regards the westward diversion of the Krishna waters by Maharashtra for power production, it was agreed that the existing utilization for these projects were to be protected.

- The Tribunal ruled that the use of water for irrigation was to be preferred to the production of hydroelectric power for two reasons :

    1) Water is the only source of irrigation whereas coal, oil and other natural resources can be used for generating power.
    2) Considering the socio-economic needs of the population and their dependence on the Krishna water for irrigation, the Tribunal ruled that irrigation should be given preference to power.

- The Tribunal made provisions for review of its order any time after 31st May 2000.

The Godavari Tribunal commenced hearings in January 1974, after making its award for the Krishna case. It gave its final award in 1979, but meanwhile the states continued negotiations among themselves, and reached agreements on all disputed issues. Hence the Tribunal was merely required to endorse these agreements in its award. Unlike in the case of other tribunals, there was no quantification of flows, or quantitative division of these flows: the states divided up the area into sub-basins, and allocated flows from these sub-basins to individual states[14]. Another difference was that the agreement was not subject to review, becoming in effect, perpetually valid.

The Cauvery dispute[15]

The core of the Cauvery dispute relates to the resharing of waters that are already being fully utilized. Here the two parties to the dispute are Karnataka (old Mysore) and Tamil Nadu (the old Madras Presidency). The origin of the present dispute can be traced back to the 1892 agreement, between the then Mysore and Madras governments. This agreement specified the limits within which no new irrigation works could be constructed by Mysore state without previous reference to the Madras government objected to the new irrigation project proposed by the then Mysore state. The Madras farmers had acquired easement rights over the Cauvery waters by prescription from the Cholas, a medieval ruling dynasty in South India. The Madras government contended that these rights would be affected if the Mysore government were to build new irrigation works in the Cauvery.

In this 1892 agreement, we find that a lower riparian state (Madras) was given veto power over all the irrigation works of an upper riparian state (Mysore). Mysore had to accept this arrangement because it was controlled by British Resident. The second phase of development of irrigation under the Cauvery which can be dated from the 1892 Agreement, extends to include the 1924 agreement and the construction of Krishnarajasagar dam and the Mettur reservoir.

In 1909, the Mysore government proposed to construct the Krishnarajasagar dam across the Cauvery. The Madras government, fearing that this would affect the Thanjavur delta, protested against the construction of the dam. From the second half of 1921 to early 1924, exchanges were pursued through correspondence and technical meetings. But during the course of these negotiations, no consensus could be reached. The 1924 agreement was formally concluded by the governments of Mysore and Madras in February of that year.

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[14] This is similar to the successful Indus agreement between India and Pakistan, where the waters of different tributaries of the Indus were allocated to one country or the other.

[15] See Guhan (1993) for further details of this case.

According to the agreement the Mysore state was entitled to extend irrigation to an extent, then fixed at 110,000 acres in Mysore. The Madras government gave assent to the construction of the dam and reservoir at KRS to a height of 124 ft above the river bed and to a capacity of 44.827 TMC ft. There was also a provision that the clauses of 1924 agreement would be open to reconsideration after 50 years from its date of execution.

Between 1924-34 there was little irrigation work in the Cauvery basin. In Mysore, the total irrigated area remained stagnant at 1.1 lakh acres between 1900-30. In Madras, there was a one lakh acre increase in the same period. The total area under irrigation in the Cauvery basin was 14.4 lakh acres.

Understanding the history of irrigation development from 1934-1990 provides useful background to the emergence and exacerbation of the Cauvery dispute from the late 1960s onwards. The period 1934-90 can be divided into two subperiods. Between 1934-1972, the Mettur and other projects added 6.4 lakh acres to the pre Mettur extent of 14.4 lakh acres. Madras did not seek any extra water as there had been considerable expansion of irrigation, beyond what had been assured to it under the 1924 agreement. From 1972-1990 there was substantive ayacut development and change in the inter state utilization of the Cauvery waters. These factors formed the continuation of the dispute and led to negotiations.

Repeated meetings failed to produce agreement, leading to the formation of a tribunal. In mid 1950s, a series of meetings and correspondences took place between Karnataka and Tamil Nadu on the Cauvery waters. This was followed by more meetings in 1970 when Kerala was also included as one of the basin states. In February 1970, Tamil Nadu requested the GOI to refer the dispute to a tribunal under the ISWD Act 1956. When the central government did not comply with this request, Tamil Nadu moved the Supreme Court in August 1971 to refer the dispute to a tribunal and to direct Karnataka not to proceed with its new projects. Between 1968 and 1990, 26 meetings were held at the ministerial level but no consensus could be reached. The Cauvery Water Dispute tribunal was constituted on June 2, 1990 under the ISWD Act, 1956.

There has been a basic difference between Tamil Nadu on the one hand and the central government and Karnataka on the other in their approach towards sharing of Cauvery waters. The government of Tamil Nadu was of the view that as Karnataka was constructing the Kabini, Hemavathi, Harangi, Swarnavathi dams on the river Cauvery and was expanding the ayacuts[16], this would diminish the supply of waters to Tamil Nadu, and adversely affect the prescriptive rights of the already acquired and existing ayacuts. The government of Tamil Nadu also maintained that the Karnataka government had failed to implement the terms of the 1892 and 1924 Agreements relating to the use, distribution and control of the Cauvery waters. Tamil Nadu asserts that the entitlements of the 1924 Agreement are permanent. Only those clauses which deal with utilization of surplus water for further extension of irrigation in

[16] This term refers to irrigation works.

Karnataka and Tamil Nadu, beyond what was contemplated in the 1924 Agreement can be changed.

In contrast, Karnataka questions the validity of the 1924 Agreement. According to the Karnataka government, the Cauvery water issue must be viewed from an angle which emphasizes equity and regional balance in future sharing arrangements. It must embrace the following issues:

1) Eliminating or minimizing social, economic and regional imbalances among the basin states.
2) Providing equitable shares of water to the basin states.

The GOI proposals have stressed economy and efficiency in water uses. The Tribunal passed its interim order in June 1991. Firstly, Karnataka was directed to ensure that 205 TMC feet of water was made available at Mettur, from its reservoirs in a twelve month period from June to May until the final adjustment of the dispute by the Tribunal. The Tribunal recognized that a monthly pattern of release was necessary for meeting the seasonal cropping requirements of Karnataka. Tamil was directed to release 6 TMC ft of water to Pondicherry in a regulated manner. Secondly, Karnataka was directed not to increase its area of irrigation from the Cauvery waters beyond 11.2 lakh acres.

The Karnataka government questioned the soundness of the order on all possible grounds. After hearing Karnataka's standpoint, the Tribunal passed its clarificatory order in April 1992. The clauses of the Interim order 1991 were upheld. The Tribunal made it clear that if seasonal conditions so required, then it was willing to alter any interim order passed by it. It further specified that, the Tribunal's interim order would not in any way influence the final adjudication. In the subsequent months of 1992, the Tribunal has framed a comprehensive list of 50 issues for adjudication. All the basin states participated in the hearings. More recently (January 1996), Karnataka has opposed the Tribunal's interim award, and threatened to boycott further proceedings, although frantic negotiations between the prime minister and state chief ministers led to a compromise over the interim award. To date, there has been no final resolution of this dispute.

There are several reasons why did the negotiations of 1968-1990 failed to bring about a consensus.

1) In the current Cauvery dispute there has not been a single strong mutual interest between Karnataka and Tamil Nadu. The latter has sought to abide by the entitlements of 1924 Agreement. But, in 1974 Karnataka declared that the 1924 Agreement had become null and void.

2) There was a divergence of interest between Karnataka and Tamil Nadu on the question of pursuing negotiations. In 1970 , Tamil Nadu began pressing for a Tribunal. In 1971, it moved the Supreme Court for adjudication by a Tribunal. Tamil Nadu participated

in negotiations right until 1990. But Karnataka was interested in prolonging the negotiations and thwarting the reference to a tribunal. Karnataka did this to gain time to complete its new projects.

3) In the current dispute, the GOI did not play a consistent role. Though it had become clear as early as in 1978 that a mutual agreement could not be arrived at, the Tribunal was constituted only in 1990, after mediation by the Supreme court. The Karnataka government was opposed to referring the dispute to a Tribunal. But, Tamil Nadu believed that the center was allowing negotiations to be prolonged in accordance with Karnataka's wishes.

4) The Cauvery issue became intensely politicized in the 1970s and 1980s. The respective governments in the two states were run by different political parties. The Congress was in power in Karnataka during 1968-83 and in 1989-90, while the Janata Dal and the Janata were in power in 1983-89. In Tamil Nadu , the DMK was in power during 1967-76 and in 1989-91 and the AIDMK for the decade 1977-87, except for a short break. Active bipartisan politics in both states made an ultimate solution more difficult.

5) Between 1968 and 1990, there were three chief ministers in Karnataka belonging to three different political parties, while in Tamil Nadu, there were four chief ministers belonging to two parties. There were two long periods of President's Rule in Tamil Nadu. At the center, there were six changes of Prime Minister, spanning four political parties and eight different Union Ministers of irrigation. So, consecutive occasions when the same set of ministers from the same state and the center met were rare.

6) The ministerial meetings were held at regular intervals. No attempt was made to generate technical options to the sharing of Cauvery waters. Expert engineers were not able to work together for a common solution, rather they got involved in party politics.

Prolonged and inconclusive negotiations over two decades have failed to settle the Cauvery problem. There was no consistent attempt by the central government to mediate and conciliate differences between Tamil Nadu and Karnataka, during the process of negotiations. There was no binding arbitration, and the parties opted for their threat points, possibly leading to suboptimal use of water and suboptimal investments affecting the use and storage of water.

The Ravi-Beas dispute[17]

Punjab and Haryana, the main current parties in this dispute, are both agricultural surplus states, providing large quantities of grain for the rest of India. Because of the scarcity and uncertainty of rainfall, irrigation is the mainstay of agriculture. An initial agreement on the sharing of the waters of the Ravi and Beas after partition was reached in 1955, through an

[17] See Dhillon (1983) and Shah (1994) for further details of this case.

inter-state meeting convened by the central government. This agreement allocated the surplus beyond pre-partition use to the states of Punjab (then essentially including what is now Haryana), PEPSU (an amalgamation of former princely states), Rajasthan, and Jammu and Kashmir. In 1956, PEPSU was merged into Punjab, and their shares under the 1955 treaty were also combined, for a total of 7.2 m.a.f..

The present dispute between Punjab and Haryana about Ravi-Beas water started with the reorganization of Punjab in November 1966, when Punjab and Haryana were carved out as successor states of erstwhile Punjab. The four perennial rivers, Ravi, Beas, Sutlej and Yamuna flow through both these states, which are heavily dependent on irrigated agriculture in this arid area. Irrigation became increasingly important in the late 1960s with the introduction and widespread adoption of high yielding varieties of wheat. While increased access to underground water through tube wells helped considerably, the sharing of river water became increasingly contentious.

After the reorganization of Punjab in November 1966, 40.16 m.a.f (one million acre feet) total water of all the four perennial rivers serving erstwhile Punjab was distributed between various states as shown in the table below :

Erstwhile Punjab inclusive of Delhi	26.24 m.a.f
Rajasthan	10.44 m.a.f
UP	2.79 m.a.f
Jammu & Kashmir	0.69 m.a.f
Total	**40.16 m.a.f**

Erstwhile Punjab was left with 26.24 m.a.f of water. In May 1967, Haryana asked the Punjab government's consent for a share of 4.8 m.a.f out of the total surplus of 7.2 m.a.f that had been allocated to Punjab (plus PEPSU) as a result of the 1955 agreement. In 1976, the central government issued a notification allocating 3.5 m.a.f. to Haryana. Punjab, argued that this award would hinder further development of canal irrigation. Now Haryana was a non-riparian and non-user in respect of the water of Ravi-Beas, while Punjab was a riparian and user. Punjab maintained that it would not spare any water of Ravi-Beas beyond what Haryana was entitled to as a successor state, under section 78 of the Act of Parliament, 1966, which reorganized Punjab. The law stipulated apportionment of waters as a result of the Beas project, having regard to purposes of the project. The dispute thus mainly centered around the interpretation and application of this law. Punjab further argued that Haryana could use the water of the two rivers for irrigation only through the use of large and costly lifts. It also argued that, while Haryana has access to the water of the Ganges, Punjab had no alternative to the Ravi-Beas water.

As a result of the protests by Punjab, further discussions were conducted (now including Rajasthan as well), and a new agreement was accepted in 1981. The available

surplus under the 1955 agreement was re-estimated and revised upward by 1.32 m.a.f., and Haryana and Punjab were allocated 3.5 and 4.22 m.a.f. respectively. This agreement, reached by a state government allied to the central government, became a source of continued protest by the political opposition, and lobbies outside the formal political process. Punjab entered a period of great strife, and a complex chain of events led to the constitution of a tribunal to examine the Ravi-Beas issue in 1986. The Ravi-Beas Tribunal further revised upward the estimate of the available surplus, and made an award in 1987 of 5 m.a.f. and 3.83 m.a.f. to Punjab and Haryana respectively. Both states sought clarifications of aspects of the award, but the center has not provided these. Hence, the award has not been notified, and does not have the status yet of a final, binding decision.

4. An Analytical Framework

Our initial model will only capture the bare bones of some of the issues discussed in the previous sections. We provide several generalizations and alternatives in the next section. We believe that such modeling can eventually generate concrete policy recommendations. We mainly use a cooperative bargaining framework, assuming that parties to an agreement can commit to it[18]. We allow for different groups within the states, to capture some of the intra-state bargaining issues that arise in the Indian context. We first present the model and notation, followed by analysis.

Model and Notation

There are two states, denoted by A and B, and two groups in each state. To reduce multiple subscripts, we number the groups sequentially, from 1 to 4. Groups 1 and 2 are in state A, while groups 3 and 4 are in state B. For example, these may be thought of as "city dwellers and industrialists" and "irrigated land farmers". There are two goods consumed by each group: water, denoted w, and a numeraire good, denoted y. There is no collective decision problem within any group, so each group has a well-specified utility function. We assume for tractability that all utility functions are quasi-linear, so that utility is transferable, and all Pareto frontiers are straight lines or hyperplanes. This considerably simplifies analysis. We will attempt to relax this assumption in future work. Initial allocations of the goods are assumed to be available to each group, and are denoted by bars over the

[18] See Harsanyi (1977), pp. 110-112 for a basic discussion of the relationship between cooperative and noncooperative games, and Binmore, Rubinstein and Wolinsky (1986) for an analysis of the connection between the axiomatic approach and the sequential strategic approach to bargaining. Essentially, the latter show that under some conditions, the Nash cooperative bargaining solution approximates the equilibrium of a two person noncooperative alternating offer bargaining game. Krishna and Serrano (1996) extend this result to many person games, with Harsanyi's generalization of the Nash solution approximating a suitable generalization of the two person noncooperative game.

corresponding letters, e.g., $\bar{w}$. Hence, with this notation, the initial utility of group i is given by

$$u_i(\bar{w}_i, \bar{y}_i) = v_i(\bar{w}_i) + \bar{y}_i$$

We assume that the functions $v_i(w_i)$ are strictly concave and differentiable. Within the states, the total quantities of water available are $\bar{w}^A$, $\bar{w}^B$, in A and B respectively.

The essential problem faced by the bargainers is that the initial allocation of water is suboptimal, both across groups within a state and across states. This can be explained by changing circumstances. Water may have been relatively abundant in the past, and all parties were able to get as much as they wanted. As populations and economic values change, however, the allocation determined by historical circumstances and traditional institutional mechanisms may no longer be optimal. In addition, the climate for negotiations may also fluctuate: it may be more propitious now than in the past.

We denote the optimal amounts of water by asterisks,e.g., w_i^* for group i. The conditions for the optimal allocation of water are given by the requirement that the marginal utility of water be equated for each group, i.e., $v'_i(w_i^*) = v'_j(w_j^*)$. Such a solution, transferring water from one group to another, will not be feasible without some compensatory transfers. Thus we have that final utilities are given by

$$u_i(w_i^*, y_i^*) = v_i(w_i^*) + y_i^* \equiv v_i(w_i^*) + \bar{y}_i + t_i^* .$$

The identity above defines the optimal transfer for group i as the difference between the final and initial amounts of the numeraire good. Unlike the optimal amounts of water, however, the transfers are not uniquely determined. Instead, they depend on the bargaining game. In particular, since we are going to use the Nash bargaining solution, the transfers will depend on the threat points of the parties engaged in bargaining. Note that where it is unambiguous, we will abbreviate expressions such as $u_i(w_i^*, y_i^*)$ to u_i^*.

It is instructive to provide an alternative interpretation of the transfers, that will be particularly useful when we discuss modifications to the basic model. Suppose that the result of the negotiations is an agreement to recognize initial allocations of water as representing *de facto* property rights, with an international market for water also being created. Let the price of water be p_w. Then, as long as the price is set appropriately, there will be market clearing at the optimal allocation of water. To see this, consider the problem of group i, which is now to maximize

$$v_i(w_i) + \bar{y}_i + p_w(\bar{w}_i - w_i).$$

The solution to this is to set the marginal utility of water equal to the price of water. Hence, all marginal utilities are equalized. Furthermore, there will be an excess supply or demand for water unless the price equals the shadow price of the constraint in the problem

max $\Sigma\ u_i(w_i, y_i)$ subject to $\Sigma\ w_i = \overline{w}$.

But with that price (which is the marginal utility of water for any of the groups at the optimum), the market solution will correspond to the optimal solution. The transfers are then the result of market transactions, with

$$t_i = p_w(\overline{w_i} - w_i).$$

Thus this market solution uniquely specifies the transfers. We use this case for comparison purposes, since creating water markets faces significant political and economic barriers in practice.

As noted, at the optimum allocation of water, the transfers are not uniquely determined unless one specifies the bargaining game. Any cooperative bargaining game will depend on recognizing the set of Pareto optimal points in utility space. The equation of the utility possibility frontier is given by

$$\Sigma\ u_i(w_i^*, y_i^*) = \Sigma\ v_i(w_i^*) + \Sigma\ \overline{y_i} \equiv H$$

The identity above defines the maximum total utility available. Note that in writing the middle expression, we use the fact that the sum of the numeraire good is unaffected by the transfers, or the sum of the transfers is zero. A final piece of initial notation is given by

$$d_i = u_i(\overline{w_i}, \overline{y_i}) = v_i(\overline{w_i}) + \overline{y_i}$$

Here the notation captures the fact that the initial utility level is potentially the disagreement payoff or threat point for the water bargaining game. We will introduce further notation as necessary.

Intra-State Negotiations Only

To begin with, consider the case where only intra-state negotiations and reallocation of water are possible. We will focus on state A, with the analysis for state B being parallel. Let w_1^A, w_2^A denote the optimal allocation of water in state A, i.e., the solution to

max $v_1(w_1) + v_2(w_2)$

subject to $w_1 + w_2 = \bar{w}^A$

Furthermore, let H^A be the maximized utility that results from this optimal allocation within state A. Using the Nash bargaining solution, the problem in state A is

max $(u_1 - d_1)(u_2 - d_2)$

subject to $u_1 + u_2 = H^A$

The solution is easily seen to be

$$u_1^D = \frac{1}{2}(H^A + d_1 - d_2), \quad u_2^D = \frac{1}{2}(H^A + d_2 - d_1)$$

Focusing on group 1, the utility from the Nash bargaining solution can be rewritten more explicitly as

$$u_1^D = \frac{1}{2}[v_1(w_1^A) + v_2(w_2^A) + v_1(\bar{w}_1) - v_2(\bar{w}_2)] + \bar{y}_1$$

Furthermore, the associated transfer is

$$t_1^D = \frac{1}{2}[(v_2^A - \bar{v}_2) - (v_1^A - \bar{v}_1)],$$

where we use the abbreviated notation.

It is instructive to compare the Nash bargaining solution with the market solution, which, for group 1, is given by

$$t_1^{DM} = v_1'(w_1^A)(\bar{w}_1 - w_1^A).$$

It is clear that the two approaches give different answers in general. Note that the market solution depends linearly on the initial allocation, while the Nash bargaining solution depends on it nonlinearly, through the threat points of the two groups. Hence, it is not possible to compare the two outcomes in terms of the magnitudes of the transfers.

Similar expressions can be derived for the second group in state A. In fact, since the transfers sum to zero, group 2's transfer is just the negative of group 1's. The utility expressions are symmetric. The same results can be derived for groups 3 and 4 in state B.

Inter-State Bargaining Followed by Intra-State Bargaining

We assume that the inter-state negotiations recognize that if they fail to reach an agreement, domestic negotiations will take place. Thus, the threat points for the groups are given by u_i^D. We also assume that if interstate bargaining fails, negotiations at that level will not be reopened. This could arise, for example, if there were a limited political window of opportunity. In this case, the Nash bargaining solution for the inter-state negotiations is given by

$$\max \ (u_1 + u_2 - u_1^D - u_2^D)(u_3 + u_4 - u_3^D - u_4^D)$$

subject to $\Sigma_{i=1}^4 u_i = H$

The solution for state A is given by

$$\hat{u}_A \equiv \frac{1}{2}(H + H^A - H^B),$$

with a similar expression for state B. Intra-state negotiations proceed based on this expression for the total utility, and again assuming that the inter-state agreement can not be implemented without intra-state agreement on how to internally divide the gains, yielding

$$u_1^{ID} = \frac{1}{2}(\hat{u}_A + d_1 - d_2), \quad u_2^{ID} = \frac{1}{2}(\hat{u}_A + d_2 - d_1).$$

Substituting for $\hat{u}_A$ yields an alternative expression for these utilities. Now

$$\hat{u}_A - H^A = \frac{1}{2}(H + H^A - H^B) - H^A = \frac{1}{2}(H - H^A - H^B).$$

The last expression is clearly positive, as long as there are gains to reallocation of water between the two countries. Hence, inter-state bargaining which recognizes that intra-state negotiations will still occur if inter-state agreement is not reached, followed by those intra-state negotiations, is preferred by all groups to intra-state negotiations alone.

Intra-State Bargaining Followed by Inter-State Bargaining

There are several possibilities to consider in this case. We will assume that the intra-state bargaining anticipates that the inter-state bargaining will succeed if the intra-state bargaining does. If inter-state negotiations were expected to fail, this would reduce to the case of only intra-state bargaining, which we considered first. However, different assumptions

are possible with respect to how the situation will be perceived if intra-state bargaining fails: these will affect the threat point of the intra-state bargaining game.

First, consider the case where it is expected that if intra-state bargaining fails, there will be no inter-state negotiations. Then the threat points for the groups in internal negotiations are the d_i's. Hence, the intra-state negotiations anticipating the inter-state agreement yield a bargaining game identical to the one where they are subsequent to the inter-state agreement. If the latter is not based on the naive expectations, the solution will be identical to the previous case, labeled with the superscript ID.

Now consider the expectation that inter-state negotiations will still go ahead, even if the intra-state negotiations fail to reach an agreement. Again, if this inter-state bargaining assumes intra-state agreement will be reached whatever the inter-state negotiation outcome (because intra-state negotiations can successfully reopen), we will get the 'ID' solution.

Investment and Noncooperative Behavior

In the model analyzed so far, there is essentially only one decision at stake: how much will suppliers of water be compensated? This may be determined by cooperative bargaining, or by a market-type mechanism. We have suggested that bargaining is closer to actual practice than are market mechanisms. The allocation of water itself is basically determined by the conditions for Pareto optimality. The nature of the allocation mechanism used, in particular the structure of the two-level negotiations, can have an impact on the final transfers of numeraire (money) made, through its effect on threat points, but the allocation of water itself is invariant to the choice of the allocation mechanism, provided it is efficient. The simple structure we used, particularly quasi-linear utilities, ensured this property, and allowed us to focus on exploring the different possible structures for inter-state and intra-state bargaining.

We now introduce a significant complication. We recognize that the productivity or utility of a given quantity of water will very likely depend on the level of complementary investments. These may be dams, irrigation projects, or even more general complementary investments in agriculture[19]. Here we will focus on the implications of such investment, through its timing and its productivity effects, for the conduct and outcome of two-level water negotiations. We will initially take the most simple case, and assume no direct effects of investment on water availability as such, but will discuss relaxing this after we have analyzed the simpler case.

[19] For example, the introduction of HYVs of seeds in India - the Green Revolution - increased the importance of irrigation and the regular availability of water in general.

Hence, we still assume that the total availability of water is $\bar{w}$, with each group having a *de facto* initial allocation of $\bar{w}_i$. We now assume, however, that the utility function of group i, evaluated at the initial allocation, is given by

$$u_i(\bar{w}_i, k^j \bar{y}_i) = v_i(\bar{w}_i, k^j) + \bar{y}_i.$$

Here, k^j is the investment made by state j. Thus, we are keeping matters simple by assuming that there are no direct externality effects of investment, in addition to assuming that water availability is unaffected by such investments. We also assume that investments are made only at the state level: intra-state groups do not control them, nor can they make group-specific investments. Note also that the utility function is defined gross of the costs of investment. These are given by the strictly convex, twice differentiable function $c_j(k^j)$. We will discuss later how these costs may be shared between the two groups in a state.

We use the following notation. $\partial_w v_i$, $\partial_k v_i$, $\partial^2_{wk} v_i$ denote, respectively, the partial derivative of v with respect to w, the partial derivative of v with respect to k, and the second partial derivative of v with respect to w and k. We assume that all these derivatives are positive. In particular, the third assumption means that investment is complementary to water in the standard sense.

In the remainder of this section, it is convenient to suppress the $\bar{y}_i$'s, by assuming that they are zero, or that utility is scaled to be measured from the initial numeraire allocation as origin. This reduces inessential notation.

Optimal Allocation of Water and Investments

First suppose that the investment levels are arbitrarily given. The first order conditions determining the optimal allocation of water are given by

$$\partial_w v_i(w_i, k^j) = \lambda,$$

where λ is the multiplier associated with the aggregate resource constraint. As long as the utility functions are not addictively separable, these equations imply that the optimal allocation of water depends on the investments in *both* states. Hence, even though there are no direct externalities as a result of the investment, the conditional optimum of water allocation involves a linkage of both states. What state A does with its investment will affect the optimal amount of water that state B should receive, where the optimum is based on a utilitarian criterion encompassing both states. This effect operates through the aggregate resource constraint. Clearly this will be important in negotiations, and will be an important point in our subsequent analysis.

For example, suppose that we have

$$v_i = w_i^a (k^j)^{1-a}.$$

In this case, we can easily solve explicitly for the conditional optimum allocations of water. for example, we have

$$w_i = \frac{k^A \overline{w}}{2(k^A + k^B)}.$$

Note that the optimal amount of water for a group in state A decreases with the level of investment by state B, but increases with its own investment. These are consequences of the complementarity of water and investment in the utility functions. We state the point illustrated by this example more formally in the following.

In general, let the conditional optimum amounts of water be denoted by $w_i^*(k^A, k^B)$. Furthermore, let $v_i^*(k^A, k^B) = v_i(w_i^*(k^A, k^B), k^j)$. Thus the v_i*'s are the utilities assuming that whatever the decisions on investments, the allocation of water will be optimal conditional on those decisions. Finally, for state A, let

$$V_A^*(k^A, k^B) = v_1^*(k^A, k^B) + v_2^*(k^A, k^B),$$

with a similar expression for state B. These are the gross utilities, before the costs of investment are subtracted off. It will be convenient to work with these functions.

We can now simply note that the optimal choice of investments is given by the following first order conditions:

$$\partial_{k^A} V_A^*(k^A, k^B) + \partial_{k^A} V_B^*(k^A, k^B) = c_A'(k^A)$$

$$\partial_{k^B} V_A^*(k^A, k^B) + \partial_{k^B} V_B^*(k^A, k^B) = c_B'(k^B)$$

These equations determine the optimal investments, and hence the optimal allocation of water is determined.

Now suppose that both investments and the allocation of water are the subject of inter-state negotiations. The above solution will determine the Pareto frontier. The outcome of the negotiations will include a joint agreement on the allocation of water between the states, as well as a joint agreement on the levels of investment within the two states. This part of the

outcome will be invariant to the specific form of the negotiations, as long as the cooperation on both dimensions is possible. However, the specific form of the negotiations will affect the money transfers that accompany the agreement, as we saw in the previous analysis. Suppose we restrict attention to case 'ID'. The threat point for the inter-state negotiations is the outcome of successful intra-state negotiations in the absence of an inter-state agreement. Since we are assuming that the investments have not been recommitted, but are included in the inter-state negotiations, they are potentially different for the threat situation. Clearly, we can work out the investments for this case in two steps as before. The first step is to obtain the optimal intra-state reallocation of water given an arbitrary investment level (and now this no longer depends on investment in the other state, since there are no direct externalities). This reduces the problem to the investment dimension, and the state government can choose the optimal level of investment.

At this stage, we need to address the issue of how costs of the state investment are to be allocated to the two groups. If we were to think of this being done through a market or market-like mechanism, where groups would pay user charges based on operating and capacity costs, we could derive the appropriate allocation of the joint costs of the investment through a standard exercise, to ensure optimal usage of capacity. Here, we make no distinction between capacity and its utilization, and we shall simply assume that the state government decides on a particular split of the costs, say 50:50. Note that if this is outside the control of the intra-state groups, it does not affect their behavior, and the split is irrelevant in the aggregate since utilities of groups are merely added up to obtain the state level objective function.

Noncooperative Investments

While investments such as dams may plausibly be the subject of inter-state negotiation, it is less likely that states are willing or able to negotiate broadly over general investments that affect the utility or productivity of water in the state economy. Hence we turn to an examination of the consequences of noncooperative investment behavior.

We introduce another piece of notation to make our expressions more compact. Let $V_A^A(k^A)$ denote the total utility in state A, gross of investment costs, with a similar expression for state B. This amount is relevant for the threat point of the inter-state bargaining. Each state is forward-looking in its investment decisions, which are now assumed to be recommitted before the inter-state bargaining takes place. The inter-state negotiation is now only over water. Following the standard solution for the relevant Nash bargaining game, the outcome of the inter-state bargaining for state A is

$$\frac{1}{2}[V_A^*(k^A, k^B) + V_B^*(k^A, k^B) - c_A(k^A) - c_B(k^B) + (V_A^A(k^A) - c_A(k^A)) - (V_B^B(k^B) - c_B(k^B))]$$

The first four terms together give the Pareto optimal aggregate utility, conditional on the state investments, while the next two pairs are the disagreement payoffs or threat points for A and B respectively. Because we are now assuming that the investments are recommitted, they are the same with or without an inter-state agreement.

Each state now chooses its investment to maximize its own utility, anticipating the effect on the inter-state bargaining outcome. For state A, the solution satisfies the first order condition

$$\frac{1}{2}[\partial_{k^A} V_A^*(k^A, k^B) + \partial_{k^A} V_B^*(k^A, k^B) + \partial_{k^A} V_A^A] = c_A'(k^A)$$

For state B, a similar condition is obtained. Clearly, these are different from the case where the investments are chosen cooperatively.

Whether the investment is higher or lower in the strategic noncooperative case depends, given the investment by the other state, on the relative magnitudes of $\partial_{k^A} V_A^*(k^A, k^B) + \partial_{k^A} V_B^*(k^A, k^B)$ and $\partial_{k^A} V_A^A$. The latter derivative is the marginal benefit of investment when only intra-state reallocation of water takes place. If state A would transfer water as a result of inter-state bargaining, $\partial_{k^A} V_A^*(k^A, k^B)$ might be smaller than $\partial_{k^A} V_A^A$, because of the lower amount of water used by state A in that case (compensated by monetary transfers). Since $\partial_{k^A} V_B^*(k^A, k^B)$ is negative, this would make the marginal benefit in the cooperative case smaller, and investment lower in the cooperative case, other things equal. This comparison requires, however, the strategic effects of investment on water allocations to be relatively equal in the two cases, or small overall. In general, the comparison of investments in the cooperative and noncooperative cases is ambiguous.

Note also that the outcome in the strategic case is different from the simple noncooperative case. If state A were to choose its domestic investment noncooperatively, but not recognizing the strategic implications for future international negotiations, it would satisfy

$$\partial_{k^A} V_A^*(k^A, k^B) = c_A'(k^A).$$

This also is not optimal, but in a different way than in the strategic case. Since $\partial_{k^A} V_B^*(k^A, k^B)$ is negative, then given the investment by the other state, the nonstrategic noncooperative investment is higher than in the cooperative case. A further comparison of these cases is also useful. Suppose that $V_B^*(k^A, k^B)$ did not depend on investment in state A. Then the ordinary noncooperative solution would coincide with the cooperative solution. However, the strategic noncooperative solution would still be different.

At this stage, it is useful to point out that, while our model is quite different in scope and implications, as well as specific formulation, from that of Grossman and Hart (1986), the central comparison of the noncooperative and cooperative cases is very similar.

It is easy to introduce complications into the above model of investments that are complementary to water use. These include allowing for investments to directly affect water availability[20], or create direct externality effects. Clearly, our reduced form expressions above can encompass such cases. A different extension is to allow group-specific investments. This would be plausible if the groups are local or regional, and there is a federal system at the state level. Similar considerations will clearly apply at the level of intra-state groups: if they can, they will choose their investments strategically, to affect the outcome of subsequent negotiations.

A different sort of modification involves the timing of investments. Return to the case of state level investments. Suppose that inter-state negotiations take place before state level investments are determined. Then, if all agreements over water are binding, the choices of state investments will be made given allocations of water. Since the allocations of water will be different at the threat points, the investments in that case will also be different than in the case of inter-state agreement. Now, forward-looking negotiators will recognize the effects of their agreement on investment as well. For example, for state A, the objective function will have the form

$$v_1(w_1, k^A(w_1, w_2)) + v_2(w_2, k^A(w_1, w_2)) - c_A(k^A(w_1, w_2)).$$

The negotiation at the inter-state level can be thought of as proceeding as follows. The two states can work out the full optimum in terms of water allocations and domestic investments. The inter-state agreement, which can only be over water by assumption, implements the optimal allocation of water corresponding to the optimal state investments. Now if each state can decide its level of investment before the intra-state negotiations take place, since there are no externalities, it will independently choose the optimal level of investment. This is because the possibility of affecting water allocations through investments, which was the focus of the previous analysis, and the source of inefficiency there, does not arise in this case.

Now suppose that intra-state negotiations also take place before the investment decisions are made. This is plausible in that investment decisions may take time, while intra-state negotiations can follow quickly on an inter-state agreement. We have treated the inter-state agreement as including an allocation of water for each group in each state, but it may

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[20]This is very similar to the case analyzed by Ostrom and Gardner (1993). They provide a numerical example where labor investments determine the amount of water available in a local irrigation system. Here we explicitly incorporate the benefits from water use, something not done in their example.

actually only be binding at the level of inter-state transfers of water and money (in opposite directions). This did not matter earlier, since investment was fixed or recommitted in all those cases. Now, however, the possibility arises that, given the overall inter-state agreement, the state groups will negotiate over the internal distribution of water, taking account of the fact that the internal distribution will affect investment decisions. However, if the national government always responds by maximizing total net utility, it is easy to see by the envelope theorem that the condition for the optimal allocation of water is unaffected by this possibility.

The above discussion suggests that there is a strong case for avoiding delays in negotiations and agreements, as well as for making agreements permanent, or not subject to review, provided that the information is available is relatively complete. This will tend to force efficient investments. Unforeseen changes in costs and benefits can then be dealt with by trading water, rather than reallocating quantities *de novo*.

5. Property Rights, Politics and Information

The analysis conducted in the previous section makes several simplifying assumptions. In this section, we discuss relaxing these assumptions and hence extending the analysis. The extensions are motivated by the Indian case of inter-state river disputes, as well as other inter-state and international river disputes. We will examine three issues here: bargaining over the property rights themselves (rather than over a trade, given initial - possibly just *de facto* - rights); political motivations of governments; and problems of uncertainty and of incomplete information.

Bargaining over property rights

One can view much of the conflict or disagreement over inter-state river waters in India as an attempt to influence or determine the initial allocation of property rights over water. In the context of the framework constructed in the last section, the quantities $\overline{w_i}$ are not given, but are precisely the main subject of negotiations. In many cases, there is some *de facto* allocation of rights based on historical usage, but there is a surplus of currently unutilized water that can be used (often only if appropriate investments are made) once it is unambiguously allocated. It is important to recognize that in such cases, the situation is one of pure conflict: more for one party means less for another when there is a given total amount of the resource. It is conceptually important to separate out this sort of situation, therefore, from one where initial property rights are well-defined, and cooperation is potentially feasible. In particular, there is no presumption that negotiation among the parties attempting to share water from a particular river basin will lead to an agreement, and there is a clear role for a higher level authority. Thus the suggestion by some analysts of Indian cases that tribunals or courts create an adversarial situation seems to miss the point: tribunals become necessary when the situation is inherently adversarial.

To analyze this problem, it is useful to draw an analogy with the rent-seeking literature, where, in the simplest case, a fixed rent is shared between contestants based on (i) their respective lobbying efforts and (ii) the sharing rule. This is particularly appropriate in thinking about states' attempts to sway central political decision-makers in their favor. Alternatively, and perhaps a closer analogy for the case of tribunals, is the expenditure of effort and money by litigants in a suit which potentially involves a transfer of money. In the latter case, litigants often settle because going to trial is costly. We examine both these frameworks for understanding inter-state water disputes in India.

We restrict attention, for simplicity, to the state level, neglecting intra-state distributional issues, which could be modelled similarly. Suppose e^j is the lobbying effort expended by state j. The share of water that j receives could be given by $s^j(e^A,e^B)$, where the share is increasing in own effort and decreasing in the other state's effort. For example, A's share might be $e^A/(e^A + e^B)$. If units are chosen appropriately, e^j could also be the cost to state j. This is the standard sort of rent-seeking model. We can embed it into the water allocation game as follows.

Given the rent-seeking effort levels, the initial allocation of water is determined to be

$$\bar{w}^j(e^A,e^B) = s^j(e^A,e^B)\bar{w}$$

The utility that state j receives in the absence of an agreement on further water sharing is therefore given by

$$d^j = v^j(\bar{w}^j(e^A, e^B)) + \bar{y}^j - e^j$$

Recall that the optimal allocation of water is independent of the initial allocation, since we have assumed quasilinear utilities. The Nash bargaining solution for state A, based on trading for water from the situation determined by the lobbying game, is given by

$$u^A = \frac{1}{2}[v^A(w^A) + v^B(w^B) + v^A(\bar{w}^A(e^A, e^B)) - v^B(\bar{w}^B(e^A, e^B))] + \bar{y}^A - e^A$$

with a similar expression for state B. Now it is easy to derive the first order conditions for the noncooperative choices of the lobbying expenditures by the two states. The situation is, in fact, very similar to the case of noncooperative choices of investments, analyzed in the previous section. The major difference here, of course, is that the lobbying expenditures do not have any productive role: they affect only the threat points, and not the benefits from a final agreement on water sharing. It is possible to introduce investment into this model as well. This will give a very rich menu of possible sequences of actions, but it is not clear if any specific result would emerge. One possibility that would require modifying the model substantially is that states might expend lobbying efforts to delay the allocation of explicit

initial rights, in order to make investments that will tilt subsequent bargaining in their favor[21].

Note that the last expression does not require a particular sharing rule to be specified: the actual rule could depend on political weight, fairness, or other factors. However, the assumption that the allocation of water rights is all that is determined by the rent-seeking process is not the only one possible. The higher political authority might look at the overall surplus, and attempt to make a division based on lobbying efforts by the states. In this case, the initial allocations of water are only indirectly relevant, since the cooperative bargaining game is superseded by an overall rent-seeking game. This case seems less close to Indian experience, so we do not pursue it here[22].

We now turn to the case of a tribunal allocating initial rights to water, providing a discussion of the stylized process involved. From one perspective, the case of a tribunal is not that different from the political lobbying model. States expend effort to influence the tribunal, which makes its award accordingly. The difference, in this interpretation, is in the nature of the states' efforts, the public nature of the process, and the objective function of the tribunal. An alternative view of the tribunal process, using the analogy with litigation, assumes that the costs of the process, once entered into, are relatively fixed, and not subject to choice as in the lobbying model. In the simplest case, the decision of the tribunal may be an exogenous random variable, and the parties in the dispute have estimates of what this decision will be. If the estimates are imprecise, so there is greater uncertainty about the tribunal's decision, and the costs of the process are relatively low, the parties are likely to go ahead with the tribunal rather than settling[23]. If circumstances are the opposite, that is, high costs and good estimates of the tribunal's likely judgement, settlement is likely. Note that in such a model, the possibility of an exogenous, costly decision on the initial property rights changes the initial pure conflict game into a situation where there is a surplus to be shared, this being the saved costs of the tribunal process.

Political objectives

The model of lobbying implicitly includes some political considerations for the center, beyond maximizing the joint welfare of the two parties to the dispute. It is possible to incorporate such objectives, as well as self-interested behavior, more explicitly. We begin with a detailed presentation of an alternative specification of the political game, including the possibility of referring to a tribunal. Rather than the rather passive role assigned to the center

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[21] For example, in the Cauvery dispute, Karnataka might have an incentive to delay agreement until its dams or storage facilities are completed.

[22] Another possibility is that the center can, anticipating the outcome of the lobbying and the subsequent bargaining, commit to a particular sharing rule based on its objective function.

[23] See Kennan and Wilson (1993) for a formal presentation of such a model.

in the standard rent-seeking model, we can think of it having its own objective function, and bargaining with the two states: the states have political support to offer the center, in return for a favorable decision on the water issue. This seems to be a key feature of the Indian institutions for settling interstate water disputes.

The model is as follows. There are three parties to the bargaining: the center and two states, denoted C, A and B, respectively. While states may have some existing water rights, there is some quantity of water in dispute, and this is *de facto* the property of the center. While the center cannot use the water directly, it can effectively decide on an allocation of water for the states, receiving political support from the states in return. This political support provides it with some benefits, but is costly for the states to provide. For example, it may be in the form of monetary transfers to be used for electoral campaigns. The outcome is assumed to be the Nash solution of the three agent bargaining game[24]. This model allows us to explore the consequences of having tribunals as an alternative to negotiations, and the effects of changes in political regime. However, we assume away intrastate allocation and bargaining issues here.

We now introduce the notation, which follows the earlier notation wherever possible. The utility of each state is given by

$$u_j(w_j, \sigma_j) = v_j(w_j) + \overline{\sigma_j} - \sigma_j,$$

where j = A,B, and $\overline{\sigma_j}$, σ_j represent the state's stock of political support and the amount provided to the center, respectively. We assume that the latter cannot exceed the former. The center's utility is given by $u_C(\sigma_A, \sigma_B, \theta)$, where θ represents the relative value of the political support from the two states, and utility is increasing in both political support arguments. The total amount of water to be allocated is $\overline{w}$. As noted, this can be thought of as the amount available above the existing, undisputed rights[25]. We shall assume that utilities are scaled so that, in the absence of any transfers, they are all zero. The Nash bargaining solution then maximizes

$$[v_A(w_A) + \overline{\sigma_A} - \sigma_A]\ [v_B(w_B) + \overline{\sigma_B} - \sigma_B]\ u_C(\sigma_A, \sigma_B, \theta)$$

with respect to the political support variables and the allocation of water, given the total amount of water available, and constraints on political support. We will assume that the latter

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[24] As before, we can think of this as an approximation to the appropriate noncooperative alternating offer bargaining game. See footnote 16.

[25] This approach has been used by interstate tribunals in the past: see the discussion of cases in section 3. In the most recent, contentious case, of the Cauvery, where there is essentially no surplus water to be allocated, we can still think of the decision as potentially operating from some baselines of water use in each state.

constraints are not binding, that is, there is an interior solution for the amounts of political support provided.

Since the states' utilities are assumed to be quasilinear, and since the Nash bargaining solution is Pareto optimal, we can deduce that the allocation of water will be, as in the case of bargaining between parties with well-defined property rights (considered in section 4), given by $v'_A(w_A*) = v'_B(w_B*)$. Furthermore, the assumed linearity of states' utilities in the political support variables implies that, for Pareto optimality, $\partial_{\sigma_A} u_C = \partial_{\sigma_B} u_C$. This equation, together with the first order conditions for the above maximization, can be solved to give the levels of political support that would obtain in the bargaining game.

The solution may be denoted $u*_A(\theta), u*_B(\theta), u*_C(\theta)$. We first discuss this kind of solution in the case where a tribunal is also available. Denote the outcome for the states of the tribunal's decision by u^T_A, u^T_B. The tribunal process has costs of its own, and these are netted out in these utilities. It is quite likely that the outcome will be different in the two processes. Clearly, each state will prefer the process, political negotiations or a tribunal, that will favor it. There is no guarantee that the states will have unanimous preferences in this regard. Thus, while each mechanism is designed to overcome the problem of resolving conflict in the absence of property rights, the presence of alternative mechanisms raises the problem of conflict over which mechanism to use. The problem is simply pushed back one step further, and delays occur. Of course, in India it is specified that if negotiations fail, a tribunal must be appointed. However, this is done at the discretion of the center and, in the above situation, the center would actually prefer a political solution, where it barters an award for political support. Reducing discretion, such as specifying short time limits for negotiation, with a tribunal to take over thereafter,is essential in such a situation. Such a recommendation is an old one, and has been reiterated often[26]: our analysis helps to make a more formal and transparent case for it.

The above framework can be used to analyze some additional problems with the political bargaining case, even in the absence of a tribunal as an alternative. These problems arise due to the uncertainty of political regimes. While water agreements are typically very long term, or should be, to permit efficient investments (see section 4), governments change every few years. Recall that the parameter θ above represents the relative value of political support from the two states. This could change dramatically with a change in government, or a change in the electoral balance[27]. Suppose that there are two values of θ, θ_1 and θ_2, with the first being relatively favorable for state A, and currently prevailing. Suppose there are

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[26] See Administrative Reforms Commission (1969), and Iyer (1994a, b).

[27] The outcome of the recent general election in India illustrates this very well. Of course this point applies very broadly, and not just to water issues. See, for example, Waldman (1996).

two periods, and the probability of a regime change in the next period is π, while the discount factor is β. Then, for some parameter values, it will be true that the expected utility of waiting for state B, which is given by

$$\beta[\pi u_B(\theta_2) + (1 - \pi)u_B(\theta_1)],$$

may be greater than $u_B(\theta_1)$. This alone does not imply that there will be a delay in reaching an agreement. If each discounted expected utility serves as the disagreement payoff for the first period political bargaining (so that the threat points are no longer the no agreement payoffs), there will be a different first period bargaining outcome. However, it is possible that, since the utility possibility frontier changes with the regime, this potential disagreement point is outside the current bargaining set. In that case, state B will prefer to wait it out. The two possibilities are illustrated in Figure 1. The idea is straightforward: if the bargaining situation is likely to change strongly to your advantage, you have a strong incentive to wait for the new situation[28]. The implication for the Indian case is that, if the above analysis does capture some of the problems that have led to delays in agreements, there is a strong case for removing the political element as much as possible, and relying more on arbitration that is not subject to political uncertainties. This will admittedly be a major step, since it requires the center to commit itself to not intervening, something that it cannot easily do under the current institutional framework, where it has even conducted political level negotiations during the functioning of a tribunal, in the ongoing Cauvery dispute.

The above discussion was in terms of bargaining at the level of the center and the states, it is also possible to apply these ideas in the context of the groups that ultimately use the water, with the state government being the higher level entity seeking political support. In this case, it may be argued that it is less likely that groups at the state level, without the legal status of governments, can commit to a binding agreement: thus the Nash bargaining solution may be somewhat less appropriate. However, one can revert to a model of noncooperative lobbying by the user groups within a state, as discussed above, or use the kind of common agency model developed by Bernheim and Whinston (1986)[29]. We shall briefly illustrate these ideas in the context of the intra-state division of water.

Accordingly, suppose that an inter-state agreement results in an amount of water w^A in state A (the analysis for the other state would be essentially identical). The allocation between the two groups in state A is not based on cooperative bargaining, but on lobbying. Each group chooses a lobbying schedule, while the state government maximizes a weighted

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[28] This idea of delay due to uncertainty is different from the usual models of delay, where incomplete information is the source of delay. Merlo and Wilson (1995) provide a general, though abstract analysis of bargaining with uncertainties of the kind discussed here, in the context of noncooperative bargaining.

[29] See also Grossman and Helpman (1995) for an application of the Bernheim-Whinston model to trade policy.

sum of group utilities and contributions from the groups. The government's choice is of the allocation of water, which we can think of as being the entire amount available, or the amount beyond some status quo level. Groups choose the contribution functions taking account of the response of the government. Thus, the government acts as the agent of the multiple principals, the interest groups.

Formally, let $L_i(w_1,w_2)$ be the contribution schedule of group i. Then

$u_i(w_i, \bar{y}_i, L_i) = v_i(w_i) + \bar{y}_i - L_i(w_1,w_2)$

is the utility of group i. The objective of the government now balances direct political considerations, through incorporating weighted values of the group utilities, with self interest and indirect political considerations, through the contributions received. Thus the government objective function is

$\Sigma_i L_i(w_1,w_2) + \Sigma_i \theta_i u_i(w_i, \bar{y}_i, L_i)$,

where the θ's are political weights, as in the bargaining model above. Given the contribution schedules, the government chooses its allocation of water to maximize its objective. Each group chooses its contribution schedule to maximize its utility, taking account of how the government will adjust policy in response to a change in the schedule. In this case, it can be shown that the equilibrium allocations of water will maximize the sum of government welfare and the welfare of each lobby (Bernheim and Whinston, 1986, Lemma 2).

Two simplifications can be made. First, since $w_1 + w_2 = w^A$, we can reduce the government's choice to a one variable problem in this case. Secondly, the government's objective function can be rewritten by expanding the group utilities, gathering terms in the contribution schedules, and redefining the weights, to obtain $\Sigma_i L_i(w_1,w_2) + \Sigma_i \bar{\theta}_i v_i(w_i)$. Assuming differentiability, and using the above-mentioned lemma, it can be shown that the first order conditions imply

$v_i' = \partial_i L_i - \partial_j L_i$, for i, j = 1, 2, i ≠ j.

This says that the contribution schedules are set so that the marginal change in the amount for a small change in the government's allocation matches the effect of the change in the allocation on the group's gross utility[30]. Furthermore, note that noncooperative behavior here leads to an inefficient allocation of water, since the marginal utilities are not necessarily equated, even with the quasilinear utility functions assumed. This suggests a further problem with this kind of political solution to resolving water disputes, in addition to the ones discussed earlier in this section.

Incomplete information

[30] This property is called local truthfulness by Grossman and Helpman (1995). The equilibrium is a truthful Nash equilibrium in Bernheim and Whinston's (1986) terminology.

An important issue in water negotiations in practice may be that each party has private information. There are potentially two kinds of information: technical and subjective. In principle, technical information may be shared and verified, but in practice this can be an arduous task, as the lengthy proceedings of Indian water tribunals seem to indicate. Estimates of costs and benefits in general, as they enter the utility functions privately and subjectively, may not be objectively verifiable. This complicates matters further.

The Nash bargaining solution can not be applied directly to analyze situations with incomplete information. While several ways of extending it have been proposed[31], they are potentially cumbersome. Alternatively, one can use a noncooperative framework of Bayesian equilibrium, and examine specific bargaining procedures. We briefly discuss the implications of this kind of approach for understanding the Indian experience.

As noted in the introduction, Coase's (1960) ideal bargaining solution provides a benchmark against which one can compare reality. In this and the previous section we have examined the outcomes of efficient bargaining, and possible sources of inefficiency. When there is incompleteness of information, of the sort that cannot necessarily be removed by technical investigations, the efficiency of bargaining, even with well-defined property rights, is less clear. This point is made by Farrell (1987) in the context of an externality example, but it carries over readily to the case of allocating water between two groups or states. The essential feature is that the groups differ in their preferences over the allocation: this will certainly be the case if each only cares about its own allocation. For example, the preferences of group i may be given by $u_i(w_i, y_i, \alpha_i)$, where α_i is a preference parameter known only to the group. We may consider three possible schemes, where each group has some private information about its preferences. First, the government can design an auction of water rights, with payments based on information provided by the groups, in a way that achieves the full information allocation: this is the standard mechanism design solution. Secondly, the government may base its decision on the aggregate expected welfare of the groups, taking the expectation over the preference parameters: Farrell calls this the "bumbling bureaucrat" solution. Finally, one or other group may be awarded the property right, and may sell or bargain away water under the situation of asymmetric information. This is the Coasian solution, with the complication of incomplete information.

The main comparison is between the second and third schemes. Farrell shows that the bumbling bureaucrat may do better on average than decentralization through the allocation of property rights, even though neither is the ideal outcome. However, this conclusion assumes two things: first, that the bureaucrat is benevolent, and second, that there is no lobbying or other influence activity. Our discussion of these issues suggests that one cannot conclude that centralized allocation is better. However, Farrell's analysis does reinforce the earlier point that these kinds of decisions may better be removed from the direct political arena. Whether

[31] See, in particular, Myerson (1991).

this can be done for such an important distributional issue is, perhaps, something that needs to be examined in the broader context of Indian federalism.

6. Water and Indian Federalism

The history and main features of India's legislation with respect to the inter-state allocation of water were reviewed in section 2. In section 3, we examined how disputes had progressed in practice, including some detailed case studies. Some of the problems with dispute resolution in these cases were illuminated by the analytical material in sections 4 and 5. However, before turning to our conclusions, it is useful to discuss the issue of water disputes in the larger context of Indian federalism. We have alluded to this to some extent in our discussion of the Ravi-Beas case, and in our modelling of political factors. The issue of inter-state water allocation, while it involves special legal and technical features, has been clouded by some of the general problems of Indian federalism. We consider these issues here, but also will suggest that the subject is specific enough for more effective institutions to be developed, without getting bogged down in the more general difficulties. Of course, inter-state river water disputes in India have long been recognized as an important federal issue. The Sarkaria Commission on center-state relations (Government of India, 1988) devoted an entire chapter to the problem, and made a series of recommendations. We close this section with a review of the commission's analysis, and our additional perspectives.

India has been characterized as having a "quasi-federal" structure[32], because of the large degree of central discretion and control permitted by the constitution. The main illustrations of this are the power of the central government over state governments through dismissals and the appointment of politically motivated state governors, and the central government's greater command over resources, relative to expenditures (resulting in a "vertical fiscal imbalance"). While the former problem may be inherent, to some extent, in a parliamentary system with a strong executive-style parliamentary leader, fiscal federalism in India has been enhanced by a particular institutional structure, namely, the central Finance Commission[33]. This body has provided a rule-bound or formulaic mechanism for sharing of revenues between the center and the states. Even though it has only advisory status, and has

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[32] See, for example, Verney (1995).

[33] More specifically, the Finance Commission is constituted every five years with a charge to make recommendations that cover a period concurrent to the period of a five year plan. Its membership includes academics as well as civil servants and politicians, but the government selects, and therefore to some extent controls, who serves on each commission. Its existence and broad functions are mandated in the Indian constitution. Such a constitutional body seems to be unique to the Indian brand of fiscal federalism. See Kletzer and Singh (1995) for more detail.

also been subject to political influence, it has established precedents, and conducted itself relatively independently of everyday political considerations. To the extent that the center is bound by such rules, such an institution reduces the control of the center over the states[34].

From a federal perspective, a key feature of India's Constitution is the existence of separate lists demarcating central (the Union List) and state responsibilities. This demarcation creates a broad framework of assignment of expenditure responsibilities, an essential feature of a federalist system[35]. With respect to water, it has been extensively pointed out that water is in the State List of the Constitution (Entry 17), but that the entry there is qualified, "subject to the provisions of Entry 56 of List I" (the Union List), which states:

> Regulation and development of inter-State rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest.

Iyer (1994), provides a particularly lucid discussion of these points, and comments (p. 192):

> The legislative competence of the State Governments under Entry 17 of the State List remains unfettered only because Parliament has not made much use of the powers vested in it by Entry 56 of the Union list.

He also notes the provisions of Article 262 of the Constitution (see section 2 above), which give the center power to deal with inter-state river disputes. While this Article was used to pass the Inter-State Water disputes act, the broader powers under Entry 56 have not been used by the center. I think understanding this (Iyer does not seem to pursue an explanation) must be seen in the broader federal context, as well as the specific nature of water as a resource.

Essentially, Indian federalism, while marked by a relatively powerful center, has consistently involved coalition-building to create such a center. This has meant a high level of explicit or implicit "horse-trading" among the center and states that are potentially key elements of a central coalition[36]. Kletzer and Singh (1995) have analyzed this in a median voter model of the allocation of public goods, and discussed the costs of influence activities in the Indian federal system, with particular attention to fiscal issues. Singh and Wright (1995) have extended this to a broader consideration of coalition formation, in the context of specific center-state political conflicts that became violent (Punjab and Kashmir). One possible interpretation, therefore, is that the center wishes to preserve a system which allows it flexibility or discretion in bargaining over center-state issues in general, with water being

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[34] This is what Lewis (1995) calls "delegating sideways".

[35] See Inman and Rubinfeld (1994) and Kletzer and Singh (1995) for detailed discussions of issues of assignment of tasks in a federal system.

[36] Once again, the current situation in India illustrates this nicely. See Waldman (1996).

one of them. This fits with the formal models presented in the previous section. A related feature of Indian political economy is the problem of multiple vetoes (Bardhan, 1984), which would help explain why, with discretion preserved, it may not be used decisively. This, too, seems relevant to the case of water, where negotiations have dragged on, and where the central government has sometimes prolonged them, by failing to speedily appoint a tribunal, even when asked.

A striking case of inaction, which illustrates several of the above problems, is the Ravi-Beas dispute, which is essentially between Punjab and Haryana. The main details of the case were reviewed in section 3. Here we examine further the general issues of federalism involved. The river water dispute has been just one component, albeit an important one, of a serious confrontation between the center and some groups in Punjab. We may think of this as a multidimensional bargaining problem and, as such, it could be solvable in principle along the lines of the approach taken in section 4, if the assumptions there were satisfied. Therefore we have to try and identify where difficulties have arisen. Incomplete information might be a greater problem with many issues bundled together, but there is no compelling evidence of this as a difficulty. With respect to water, the fact that initial rights are not defined with respect to the quantity of water beyond historic usage, so that the situation is one of conflict over property rights (as in section 5) rather than mutually beneficial exchange, has clearly hindered agreement. Uncertainty over the future political situation has also mattered, with different parties at different times waiting for more favorable bargaining situations rather than reaching agreement[37]. Thus a different arena for bargaining over water might have helped.

In this case, two additional implications of the multidimensional nature of the issues reinforce the above conclusion. First, while there is a relatively formal mechanism for negotiating over inter-state water issues, many of the other subjects of dispute in the case of Punjab have been ones requiring *ad hoc* mechanisms of negotiation between the center and groups in the state. One weakness of this approach has been the inability by both sides to commit to an agreed upon course of action: the agreements have not been self-enforcing (there have been *ex post* incentives to deviate), and there is no well-defined mechanism for external enforcement in such cases of informal negotiation and agreement[38]. Of course some of these problems of commitment have been present with water dispute resolution institutions, and we will return to this issue in the conclusion. The second special implication of the case of Punjab has been the problem of reputation effects for the center. While water disputes might be considered a particular, somewhat technical problem, to be resolved case by case, in Punjab, the combination of water with other, larger questions of religion and identity may have made it harder for the center to resolve the water sharing issues, for fear of altering its

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[37] In fact, one may generalize the political bargaining model of section 5 to allow for regime changes among any of the negotiating parties.

[38] See Singh and Wright (1995) for further details.

reputation in future disputes over identity or autonomy[39]. Both these additional features of the Punjab case support the establishment of water dispute resolution mechanisms that are outside the center-state political hierarchy, just as the Finance Commission, to some extent, provides such an institution for fiscal transfers.

In the context of the above analysis, we next discuss the institutions that have, in fact, been created since 1980[40]. The central ministry of irrigation published a document that year, outlining a proposed study of India's national water resources[41]. This led to the formation of the National Water Development Agency (NWDA) in July 1982, to "carry out the water balance and other studies...for optimum utilization of water resources..."[42]. This agency is a Government of India Society in the Ministry of Water Resources, and not a body with any statutory backing. Furthermore, its scope is technical, and separate from the institutional realities of water allocation. In 1983, the National Water Resources Council (NWRC) was created by a central government resolution. Its composition includes chief ministers of states, lieutenant governors of union territories, several central government ministers, and the prime minister as chairman. This group met first in October 1985, and adopted a National Water Policy in 1987. This policy emphasizes an integrated and environmentally sound basis for developing national water resources, but provides no specific recommendations for institutions to achieve this. Though the council was created out of disenchantment with the adjudicatory process for inter-state river disputes, it has not provided concrete proposals to improve that process, nor has it provided the useful alternative that was hoped for, as the persistence of the Ravi-Beas and Cauvery disputes indicates. Our discussion and analysis above indicates that this should not be a surprise. The NWRC does not meet any of the required criteria required: it does not provide specific mechanisms for dispute resolution, it does not delegate sideways to achieve commitment possibilities, and it does not have any statutory force. While it may provide a useful talking shop for long range planning and information exchange, its usefulness otherwise has been limited

We finally turn to the issue of enforcement of tribunal awards. This issue was given some attention by the Sarkaria Commission. It noted that section 6 of the ISWD act of 1956 provides that

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[39] Once again, see Singh and Wright (1995), and the references therein.

[40] We draw on Government of India (1988) and Iyer (1994b).

[41] See Government of India, Ministry of Irrigation (1980).

[42] National Water Development Agency, (1992).

> the Union Government shall publish the decision of the Tribunal in the Official Gazette and the decision shall be final and binding on the parties to the dispute and shall be given effect by them[43].

The commission's report goes on to suggest that the center cannot enforce the tribunal award if a state government refuses to implement the award. It notes that the amendment of the act in 1980, inserting section 6A, which provides for an agency to implement a tribunal award, is not sufficient because such an agency cannot function without the cooperation of the states concerned. The Sarkaria Commission's recommendation is, therefore, that a water tribunal's award

> should have the same force and sanction behind it as an order or decree of the Supreme Court. We recommend that the Act should be suitably amended for this purpose[44].

This has not been done, but it should be noted that water tribunals already have such court-equivalent powers for a narrow range of issues, including gathering of information, requiring witnesses to testify, and recovering the costs of the tribunal[45]. Furthermore, the ISWD Act, Section 11 states that

> Notwithstanding anything contained in any other law, neither the Supreme Court nor any other court shall have or exercise jurisdiction in respect of any water dispute which may be referred to a Tribunal under this Act[46].

One possible interpretation of this provision is that it does implicitly give water tribunals broadly an equivalent status to the Supreme Court, and their decisions must have the same force[47]. Hence the center can theoretically deal with a recalcitrant state by dismissing the state government. However, this penalty, the only one seemingly available, is so great that it is hard to imagine it being used solely for a water dispute, although it has been used extensively under other pretexts. Once again, the resolution of water disputes is complicated by being tangled in the general difficulties of center-state federal issues. Thus the recommendation to amend the act might not get to the crux of the problem.

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[43] Government of India (1988), Chapter 17.4.18, p. 491.

[44] Government of India (1988), Chapter 17.4.19, p. 491.

[45] See section 9 of the ISWD Act, as reproduced in Ramana (1992), p. 60.

[46] See Ramana (1992), p. 90.

[47] This interpretation was suggested to Nirvikar Singh by Mr. R.R. Iyer and Mr. R.B. Shah in conversations in December 1995 and January 1996 in New Delhi. However, the presentation here should not be necessarily taken as a reflection of their views.

The Sarkaria Commission's other recommendations were based on the same kinds of difficulties in resolving past disputes as have been described in this paper. Two recommendations related to placing time limits on constituting tribunals and having them deliver decisions. These merely echoed the recommendations of the Administrative Reforms Commission nearly 20 years before[48]. Another recommendation was that the center could appoint a tribunal without being asked to do so by a state government. A final recommendation was for the establishment of a national level data bank and information system. None of these recommendations has been carried out. However, we would like to suggest that this failure partly reflects the fundamental nature of the problem, that water issues are tangled with broader difficulties in the federal structure. The solution, while including all the above recommendations, must include the creation of a quasi-independent hierarchy of institutions to manage the allocation of water. This will insulate the process from political uncertainties, and permit a greater degree of commitment and cooperation. The central point to be emphasized is that appropriate institutions can play a vital role in shaping and constraining the incentives of the actors in inter-state water allocation. We expand on this in our final section.

7. Conclusions and Recommendations

We end this paper with a summary of some of the salient issues, the implications of our analysis, and recommendations. While our focus is on institutions for the resolution of inter-state water disputes, our analysis and recommendations carry over more broadly to issues of water allocation more generally, and we discuss this briefly, also.

Dispute settlement procedures

Constitutionally and legislatively, Indian inter-state river dispute settlement procedures involve either of two processes: negotiations and compulsory legal adjudication. Furthermore, there is room for voluntary processes such as mediation, conciliation and voluntary arbitration, often by the prime minister or other members of the central government. Such processes do not foreclose arbitration or adjudication on specific areas of conflicts which remain unresolved after mediation and conciliation. Guhan (1993) suggests that mediation and conciliation do not have enough scope in resolving water disputes, and that "adjudication inevitably leads to adversarial positions and maximal claims"[49]. Iyer (1994b) points out that this criticism of adjudication misses the point, since the difficulty of reaching an agreement may be structural, and assisted negotiations (that is, conciliation and mediation by a third party) may be as problematic as unassisted negotiations. He emphasizes the importance of goodwill, and willingness to accept an "objective settlement", but does not really come to grips with the structural issues. Our modelling does this by emphasizing the difference

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[48] Administrative Reforms Commission (1969), Chapter V.

[49] This characterization is from Iyer (1994b), p. 195.

between situations where property rights are well-defined (possibly *de facto* rather than by formal legal mechanisms), and situations where the dispute is over the property rights themselves. In the former case, there is room for a mutually beneficial exchange, and one can think of several different ways of implementing or facilitating a cooperative outcome such as the Nash bargaining solution (section 4 above), which does incorporate some elements of fairness, a major component of "objective settlements". On the other hand, legal adjudication under the ISWD Act, is a non-voluntary imposed procedure, but it, or some similar externally imposed procedure, may be necessary in situations where the dispute is conflictual in nature, and not over sharing the potential gains of a mutually beneficial exchange, as we have discussed in section 5. The real issue in such cases is setting up adjudicatory processes or institutions that all parties can agree *ex ante* to be bound by *ex post*, and focussing on voluntary negotiations may be somewhat misguided.

A key insight of our analysis and discussion is that the processes and institutions as they currently exist for resolving inter-state river disputes are not well-defined or definite enough. There are too many options, and too much discretion at too many stages of the process. Since water is being more and more fully utilized, the possibility of disputes of the conflictual nature arising increases, and it is crucial that the dispute resolution mechanism be better defined, in terms of the order of the steps to be taken. Of course, parties to a negotiation can continue to bargain in such cases, and even reach an agreement, as has happened in the case of the Godavari dispute. In fact, the existence of an expected outcome from adjudication may provide a somewhat definite disagreement point, and help to convert a conflictual situation to one of bargaining over (expected) mutual gains. Given this option, a possible recommendation would be the automatic and immediate referral of any dispute to a tribunal if requested by the center or any party to the dispute, with the tribunal bound to ratify any agreement reached by negotiation before it had delivered its decision.

Delays

Extreme delays have been a very costly feature of the process of resolving inter-state water disputes in India. There have been three components or dimensions of delay.

1) There has been extreme delay in constituting tribunals. Under Section 4 of the ISWD Act, the Union government is required to set up a tribunal only when it is satisfied that the dispute cannot be settled by negotiations. The center can thus indefinitely withhold the decision to set up a tribunal on the ground that it is not yet satisfied that negotiations have failed. Examples of delay include all the major disputes. The Narmada Tribunal was constituted in 1969 while Gujarat had lodged a complaint in 1968 but the dispute itself dates back to 1963. The Godavari and Krishna disputes started around 1956. The states began formal requests for reference from 1962 onwards. Ultimately the Godavari and Krishna disputes were referred to tribunals in 1969. In the case of Cauvery dispute, two of the basin states, Tamil Nadu and Kerala had asked for reference to a tribunal back in the 1970s. The tribunal was constituted only in 1990, after the Supreme Court mediated.

2) Tribunals have taken long periods of time to give their awards. This can be traced to two factors: first, time taken for assembling facts and hearing arguments and second, abortive attempts to bring about solutions at a political level, which delayed the functioning of constituted tribunals. It took nine years from reference in the case of the Narmada Tribunal, four years in the case of the Krishna Tribunal and ten years in the case of the Godavari Tribunal.

3) There have been delays in notifying the orders of tribunals in the Government of India's official gazette; this has resulted in delays and uncertainty in enforcement. The process took three years in the case of the Krishna Award and one year in the case of the Godavari Award. These delays naturally tend to complicate the dispute settlement process.

The kinds of recommendations with respect to delays are old ones, going back to the Administrative Reforms Commission report of 1969, and repeated by the Sarkaria Commission in 1988. To reduce delays, the center as well as any state that is involved in a dispute should be able to request adjudication. The process of adjudication should began within a prescribed time (for example, six months or one year) and conclude within a prescribed time (for example, three or five years). Unlike the Sarkaria Commission, we would not recommend an escape clause, whereby a tribunal could ask for an extension. While there can be no absolute guarantee that a tribunal will reach a decision in the prescribed time, making it easy to extend the time seems self-defeating.

It is worth noting that delays can be extremely costly. They can result in beneficial projects being delayed (the World Bank, for example, has declined to fund projects related to disputed river basins), and it can lead to inefficient investments being undertaken. This problem can arise even when property rights are not the issue, and bargaining parties use this to strengthen their bargaining positions: this was illustrated in our analysis in section 4. The problem is compounded when the initial rights are themselves contested. this seems to have characterized some of the actions taken by Karnataka in the Cauvery dispute, for example. The issue of investment related to water use will become more and more important as the Indian economy continues to grow, and delays will become increasingly damaging, highlighting the importance of dealing with this issue.

Enforcement

We noted the problem of enforcement in section 6. State governments have sometimes rejected tribunal awards, as in the case of Ravi-Beas Tribunal and the Punjab government. In this case, the central government avoided notifying the tribunal's award, to prevent further deterioration of the conflictual political situation in Punjab. In the case of the Cauvery dispute, the tribunal's interim order was sought to be nullified by the Karnataka government through an ordinance. Though the Supreme Court pronounced that the ordinance was unconstitutional, the Karnataka government showed no inclination to implement the tribunal's interim order, until a compromise was reached through political negotiations behind closed doors. The Sarkaria Commission was of the view that in order to make tribunal

awards binding and effectively enforceable, the ISWD Act should be amended to give these awards the same sanction as an order or decree of the Supreme Court. However, as noted in section 6, tribunals seem to have this force in theory: the problem is of penalties to be imposed for noncompliance. We suggested that the solution would require decoupling water disputes from more general problems of Indian federalism and center-state relations. This brings us to a discussion of alternative institutions.

Institutions

Current institutions do not do a good job of resolving inter-state water disputes. To some extent, the problems of lack of well-defined procedures, delay and enforcement, are all linked to a deficiency in the design of the relevant institutions. A key feature of this deficiency is the subsuming of inter-state water disputes into the general political process. In India, federalism, and perhaps the political economy in general, has been characterized by an over-reliance on discretionary allocation, and high influence costs as a result. The pattern of inter-state water disputes is a prime example of this problem. The solution we propose is the creation of specialized permanent institutions to regulate the allocation of water across states, including the resolution of water disputes. These institutions would themselves respect the federal structure of the country, as we will elaborate below, but will have a greater degree of independence and transparency than the current situation. The idea of such institutions is not far-fetched. The Finance Commission has done a relatively good job of handling central-state financial transfers, including making allocations across states according to public and rational criteria. This mechanism is in the process of being extended to the level of state-local transfers[50]. Other examples of such sideways delegation are the creation of an independent body to regulate financial markets, and the operation of a relatively independent central bank. In such cases, the government gives up some of its direct powers as a way of precommitting itself, and insulating certain types of decisions from political pressures. While these examples all involve financial issues, whereas water is a physical resource, water is also an economic asset that can be allocated according to rational principles. Our analysis in sections 4 through 6 suggests that the process of resolving inter-state water disputes, and of allocating water more generally, has been made inefficient by being entangled in more general political issues, including the nature of Indian federalism in general. This inefficiency is the central concern.

The kind of institutions we propose would incorporate the specific recommendations to clarify and streamline procedures, reduce delays, and improve enforcement that have been made above and by numerous others. However, they would be quite different from the NWRC, which is very much a political creature. A possible guide for specifics of organization is the Murray River Commission (MRC) in Australia, where the states and the central government have equal representation, and each state typically has drawn its representative from a major rural water management authority, while the central representative

[50] See Singh (1996) for a discussion of these developments.

is a senior civil servant[51]. This is not to suggest that the MRC is a perfect model. However, a permanent institution, with rotating membership weighted towards technically knowledgeable administrators, seems a feasible improvement over the current situation.

It is, of course, important to keep in mind that the MRC is a single river basin management authority. We are proposing at the national level an institution that will provide an umbrella for actual river boards or river basin authorities. The legislative framework for such bodies exists, of course, but, as discussed in chapters 2 and 3, it has not been effectively used: even when such entities have been proposed or created, they have not functioned well. The problem, again, has been the concern of state governments that they would be ceding too much power to such bodies, and, indirectly, ceding control of their water resources to the center. The solution we propose would uniformly remove a set of decisions with respect to water sharing and use outside the general political orbit, without tilting power towards the center, and ought to be easier for states to accept. Thus, we envisage a hierarchy of water management institutions, with river basin authorities being the next step down from the national commission. One can then think of membership at the national level being drawn from experienced members of individual river board authorities.

The idea of developing a hierarchy of specialized water management associations is not new, but the main discussion of this has come in the context of local water user associations, and federations of such associations. Several different models of such federations exist[52]. We can think of state and national level institutions as linking up and continuing this kind of hierarchical, federated structure. Ultimately, water allocation will be efficient only if decision-making is responsive to the end users. Furthermore, it is important to emphasize that detailed central planning will not succeed for water allocation any more than for other goods: the role of the institutions at the national and river basin levels is to provide mechanisms for dealing with conflicts associated with externalities, and lack of well-defined property rights, not to allocate water at the micro level. Finally, in any kind of hierarchy, the potential for influence activities and associated costs will exist: we are suggesting that these can be reduced by the creation of specialized institutions, with clearly defined limits of authority.

We envisage a national level water institution as incorporating the tasks of dispute resolution, perspective planning, and information gathering and maintenance. These tasks are currently scattered among tribunals, the NWRC and the NWDA. The last of these organizations seems to be particularly isolated and relatively unsupported. The advantages of

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[51] See the articles by David Constable and John Paterson in Eaton (1992).

[52] See, in particular, Meinzen-Dick *et al* (1994), pp. 25-27. It is interesting to note that a recent study for the United States by Foster and Rogers (1988) makes somewhat similar institutional recommendations to the ones proposed here, including a national and regional councils for water resources policy.

integrating information collection and storage with long range planning and dispute resolution seem manifest. One stumbling block will, of course, be the reluctance of ministries, including politicians and bureaucrats, to give up power over decision-making[53]. It is here, perhaps, that ultimately goodwill, emphasized by several analysts of Indian river water disputes, will have to come into play. The possibility of significant, potentially positive institutional change in India is illustrated by recent legislation strengthening local governments. The allocation of water is another aspect of India's federal institutions that can be improved.

Conclusion

In summary, current Indian water-dispute settlement mechanisms are ambiguous and opaque. A cooperative bargaining framework (section 4) suggests that water can be shared efficiently, with compensating transfers as necessary, if initial water rights are well-defined, and if institutions to facilitate and implement cooperative agreements are in place. Our analysis also emphasizes the role of complementary investments, and the need to expand the scope of bargaining to include these where feasible. Furthermore, delay in the dimension of agreement over water can encourage inefficient, non-cooperative investments in dams, irrigation, etc. Additionally, we draw the distinction between situations where cooperation is possible, and situations where the initial allocation of rights is at stake (section 5), where there is pure conflict rather than potential gains from trade. In the pure conflict situation, which seems very relevant for Indian inter-state disputes, a search for a negotiated solution may be futile, and quick movement to arbitration or adjudication may be more efficient. However, in the Indian case, not only is this process slow, but, effectively, binding arbitration does not exist. The threat point of no agreement has been the outcome in several major disputes (e.g., Cauvery; Ravi-Beas). This can result in inefficient levels of investment by the individual, non-agreeing states, generating a diversion of scarce investment resources, as well as inefficient use of the water itself. This in turn can have negative impacts on economic growth. The problems are compounded by the entanglement of inter-state water disputes with more general center-state conflicts, and with everyday political issues. We would argue that these impacts can be reduced by a more efficient design of mechanisms for negotiating inter-state water disputes. In this section, we have presented some of the possibilities, including a

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[53] Currently, the Ministry of Water Resources is responsible for "overall planning, policy formulation, coordination and guidance in respect of the water resources sector as a whole", according to the National Water Policy of 1987 (quoted in Frederiksen, *et al*, 1993, p. 39). However, this Ministry is essentially the old Ministry of Irrigation, and it tends to focus on irrigation and flood control only. Other important functions are not directly under its control. An important organization, the Central Water Commission, has a Chairman with a rank equivalent to the seniormost bureaucrat in the Ministry, and acts directly as a technical adviser to the planning commission. Other organizations include the Central Groundwater Board, and the National Institute of Hydrology. Overall, there are competing voices, and sometimes ambiguous lines of authority (Frederiksen, *et al*, 1993; Chitale, 1992; Rogers, 1992).

national water commission independent of daily political pressures, a federated structure incorporating river basin authorities and water user associations, and fixed time periods for negotiation and adjudication.

Figure 1

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