
Irrigation Institutions in Nepal

- Water allocation and maintenance of irrigation systems complicated by asymmetry between “headenders” and “tailenders”
 - Mutually beneficial tradeoffs possible: tailenders work more, get more water—total flow increases
 - Agreements are embodied in some type of rotation rule; e.g., headenders and tailenders alternate water days, share labor
 - Tradeoff decreases the difference in water allocation between head and tail
 - Hypothesis: Farmer managed irrigation systems should be more productive
-

Empirical Evidence from Nepal

- Examines productivity for 108 irrigation systems (86 farmer, 22 agency)
 - Farmer systems produce more, have higher crop intensity
 - Farmer systems more likely to get adequate water to tailend of system
 - Regression analysis shows farmer managed systems have more equal allocations
 - Allocation also affected by irrigation practices, e.g. canal lining
 - Possibility that permanent irrigation headworks provided through international aid reduce productivity, providing political advantage to larger headenders
 - *Comparative institutional analysis*: Look how rules vary across systems
-

Southern California Groundwater Institutions

- Groundwater very valuable; usually cheaper than imported surface water
 - Conjunctive management: Using groundwater and surface water simultaneously; groundwater as storage for meeting peak demand
 - Early structure of groundwater rights led to overextraction (IF the court was called upon to adjudicate):
 - 1) Correlative riparian rights (overlying landowners allowed to withdraw water for beneficial uses; proportional reductions)
 - 2) Prior appropriation rights (rights to surplus water not put to beneficial use by riparians)
 - 3) Prescriptive rights (a right earned by taking non-surplus water for 5 years in row; e.g., without legal action from adversely affected riparians)
-

Adjudication of Groundwater Rights

- Uncertainty about the amount of “surplus water” and subsequent perfection of prescriptive rights
 - Too early: If you go to court before all surplus water is appropriated, then appropriators have right to surplus water
 - Too late: If you got to court after 5 years of non-surplus water is taken, then appropriators have earned prescriptive rights
 - LA water users used litigation to reform water rights; courts issue a “stipulated judgment” that defines basin boundaries and rights
 - These are “adjudicated groundwater basins”, one of several institutional structure for governing groundwater in CA
-

Raymond Basin Game

- Small number of users, with Pasadena dominant
 - Settlement agreement leads to “mutual prescription agreement”, proportional reduction by all water rights holders; exchanges allowed
 - Department of Water Resources as watermaster
 - Watermasters are assigned by court to implement stipulated judgments
-

Raymond Basin Bargaining

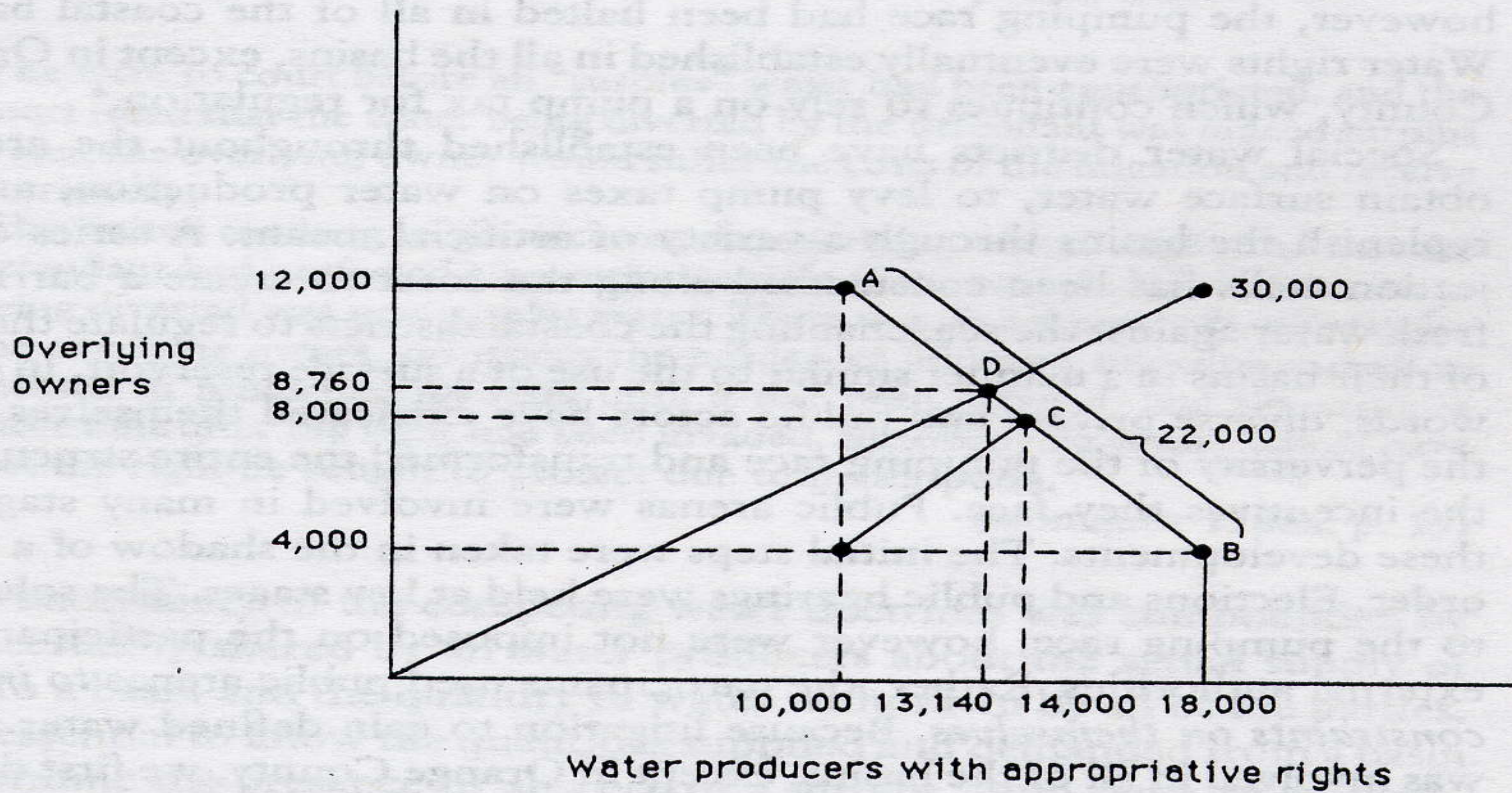


Figure 4.2. The bargaining situation faced by overlying owners and appropriators.

West and Central Basin Games

- More users, and less concentrated users; overdraft very severe (curtailment of 60 thousand acre feet needed!)
 - Asymmetry with coastal users in more trouble
 - Formed a West Basin Water Association to study and communicate
 - Starts out with interim “mutual prescription agreement”, signed by 82% of water users
 - Conflict with refusing parties (Hawthorne): 18 years later and approximately \$3 million later, agreement accepted by court to define rights
 - Central Basin settlement was faster and cheaper, because of lessons learned from other basins
-

Analysis of Institutional Supply

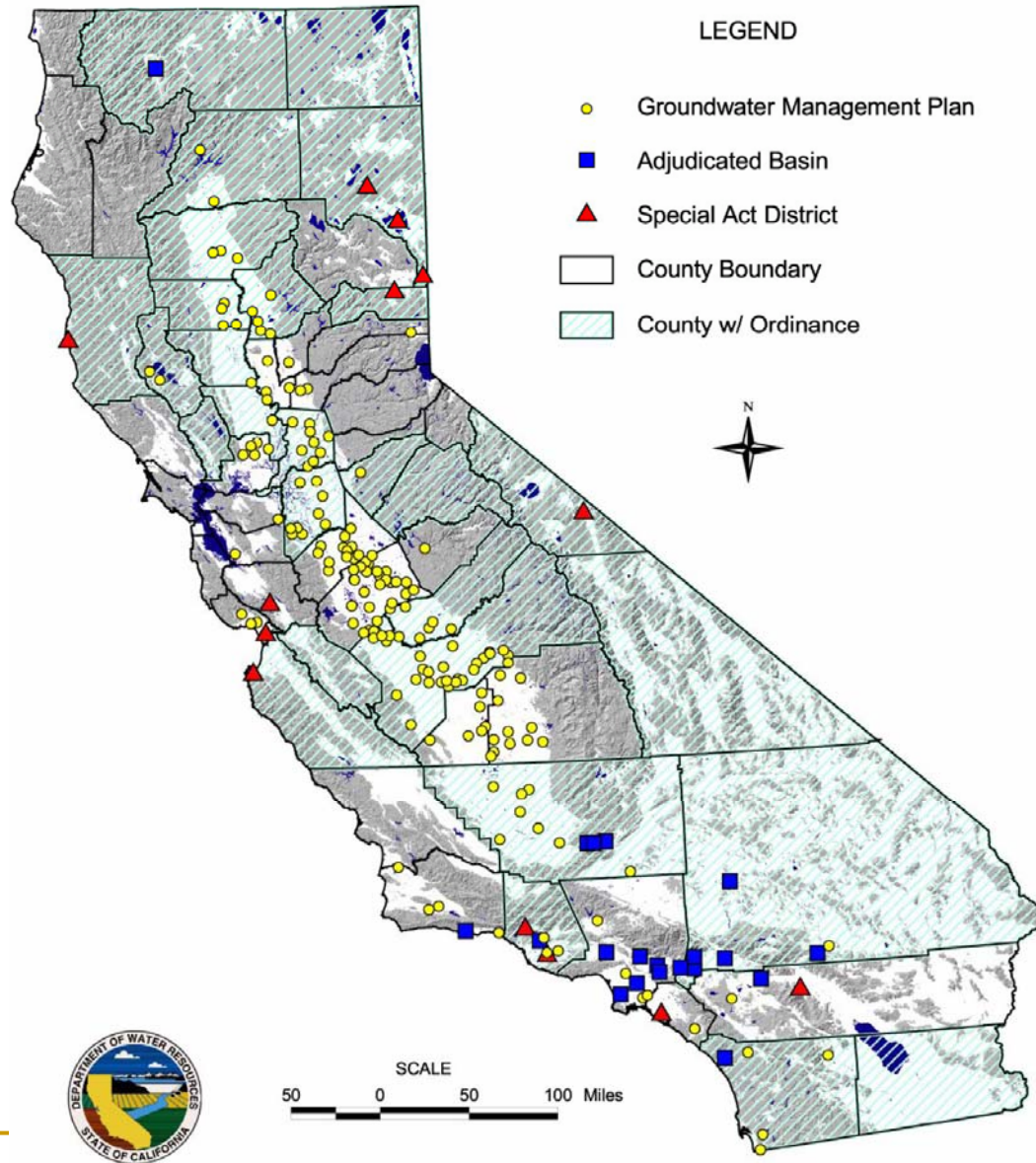
Compliance

- Watermasters have significant monitoring authority
- Users report annual pumping data
- Watermaster calibrates meters
- Non-compliance punished by litigation from other users (self-enforcement)

Reasons for Institutional Supply

- Incremental steps; series of successful changes
 - Use of scientific studies to understand hydrological processes
 - Overlap between basins allows policy learning
 - Formation of voluntary water associations for negotiation
 - Institutional support from CA legal system and watermaster concept
 - In West and Central Basin, local settlements became launching pad for larger regional institution (Central and West Basin Water Replenishment District)
-

Status of Groundwater Management in California



Status of Groundwater Management in California
(as of December 2004)

Covenants With and Without Swords

Overview

- Covenant: A bargain made to take certain actions
 - Sword: A coercive power used to punish non-compliance
 - Experimental subjects given a choice of how much to invest in a CPR and investing in another activity; if everybody invests in CPR, the outcome is inefficient
 - Equilibrium prediction is overinvestment in CPR, just like Prisoner's Dilemma
-

Experimental Design

Basic Game

- 8-person groups
- Each person allowed to invest experimental tokens in a private market or a CPR market
- Initial endowments of either 10 tokens or 25 tokens; higher initial endowments allow free rider to do more damage
- 36 tokens invested in CPR lead to optimal yield (each subject invests 4.5); Nash equilibrium is 8 tokens

Experimental Conditions

- Communication only
 - Punishment only; there is a cost to punishing another player
 - Punishment and communication, with punishment mechanism either imposed or selected by subjects
-

Results Table

TABLE 2

Summary Results: Average Yield as a Percentage of Maximum

EXPERIMENTAL DESIGN	ROUND					
	1-5	6-10	11-15	16-20	21-25	26+
Baseline						
10TK ^a	51.5	34.7	34.4	35.6	37.1	29.6
25TK	-42.5	-12.4	10.3	32.0	—	—
One-shot communication 25TK	-40.9	-12.7	74.1	45.4	42.5	58.6
Repeated communication						
10TK	32.6	27.3	97.2	98.4	100.0	—
25TK	32.5	-14.4	74.1	75.0	68.9	—
Sanction 25TK	-35.7	-39.6	40.1	38.8	28.7	—
One-shot communication sanction 25TK	-.7	-27.0	86.8	86.3	82.5	77.8
One-shot communication 25TK						
No sanction chosen ^b	46.4	41.2	91.7	61.9	14.7	—
Sanction chosen ^b	-16.9	-5.1	92.5	91.6	89.9	93.8
Sanction chosen ^c	—	—	96.8	97.0	96.7	90.4

^aTK corresponds to tokens per subject.

^bCommunication and sanctioning choice occurred after round 10.

^cCommunication and sanctioning choice occurred after round 1; the table displays this data beginning in round 11 for comparison purposes.

Note: Average yield as percentage of max= (CPR return-opportunity costs of tokens invested)/(Optimal CPR return-Opportunity cost of tokens invested)

Summary of Results

- Single shot communication game: Increases return to about 50% of max. efficiency.
 - Repeated communication: Almost 73% of max. efficiency; allows discussion of defections
 - Sanctioning only: Yields increase to about 40%, but once cost of sanctions included, only 9% (frequency of sanctioning inversely related to cost of imposing, but positively related to size of fine)
 - Explanation: No clear contribution rule; sanctions overused including mistakes and blind revenge
 - Sanctioning and communication: If subjects can figure out optimal solution in communication phase, then they receive highest payoff
 - Thought exercise: What are similarities/differences between real world and experimental settings?
-