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 (overlaying 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
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

LEGEND
- Groundwater Management Plan
- Adjudicated Basin
- Special Act District
- County Boundary
- County w/ Ordinance

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
### Summary Results: Average Yield as a Percentage of Maximum

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**Note:** Average yield as percentage of max = \( \frac{\text{CPR return-opportunity costs of tokens invested}}{\text{Optimal CPR return-Opportunity cost of tokens invested}} \)

*TK corresponds to tokens per subject.

¹Communication and sanctioning choice occurred after round 10.

²Communication and sanctioning choice occurred after round 1; the table displays this data beginning in round 11 for comparison purposes.
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?