ELEGY FOR THE SALT RIVER

Successional Tales of a Southwestern Social-Ecological System

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"The few perennial streams and rivers in Arizona were highways for the early American explorers and pioneers. These streams and their riparian forests were linear oases in an arid land, a haven for man and wildlife. The region's few natural wetlands and watering holes were of an importance to wildlife far out of proportion to their geographical extent" (Davis 1982 176).

"In the morning of the 1st of February, we began to ascend [Salt River]. We found it to abound with beavers. It is a most beautiful stream, bounded on each side with high and rich bottoms. We traveled up this stream to the point where it forks in the mountains; that is to say, about 80 miles from its mouth" 1826 expedition (James Ohio Pattie 1833 qtd. in Davis 19)

"The [Salt] river we found to be from 80 to 120 feet wide, from two to three feet deep, and both rapid and clear…The water is perfectly sweet …We saw from the banks many fish in its clear waters, and….along the immediate margins of the stream large cotton-wood trees grow" 1852 expedition (John Bartlett July 3 1854 qtd. in Davis 70)

"…[the beaver] is found abundantly on all streams of the Territory….Particularly upon the Rios Salado and San Francisco [Verde] it is very abundant; and its dams occur, in some places, every few hundred yards. The almost unbroken seclusion of these retreats gives the animals such a sense of security, that they are less strictly nocturnal…than in most localities…I have frequently seen them swimming about in broad daylight" (Coues 1867 362).

"Salt River is at this season of the year at least a large stream. Nor do I think it ever entirely dry…I consider this valley from 6 to 10 miles wide and extending from its mouth upwards to the mountains about forty miles – as some of the best agricultural land I have yet seen in the Territory and would recommend that it be subdivided at an early day" (Wm. H. Pierce 1867 qtd. in Zarbin 6).

"By the mid-1940's the completion of six upstream dams on the Salt and Verde Rivers prevented all flows in the channel in the agricultural and urban reaches except for unusual floods or local runoff. […] . the desiccated river lost its riparian vegetation, becoming an unstable, forgotten landscape of derelict uses…(Graf 2000 322).

How did we get to this point?

ABSTRACT

Desiccation of the Salt River is one local, yet fairly extreme example of human alteration to an ecological system. Extreme, but unfortunately not unique. On a world wide basis these alterations are "substantial and growing." In order to understand how humans effect such profound changes in their environment, there has been a growing awareness of the need to study social and ecological processes as part of one large integrated social-ecological system (SES). This thesis can be viewed as a first iteration in a larger attempt to integrate the social and ecological processes that have resulted in massive surface, and more recently subsurface, hydrological alterations in this southwestern urban region.

The current study, focusing on the early settlement of the Salt River Valley (1867-1902), integrates the social and ecological components using Holling's complex adaptive system metaphor in conjunction with Elinor Ostrom's Institutional Analysis and Development (IAD) framework, in order to analyze the interactions that occurred between the early inhabitants and the Salt River as they tried to govern their common pool resource (CPR). The focus of the study was to determine the nature of the common pool resource situation at the turn of the century and to identify the feedbacks that had occurred between the social and ecological components of the system. The study has found that the settlers were not able to restructure their institutional setting in order to avoid an open access situation. Instead, extensive physical restructuring occurred as the CPR became crowded, demand for water increased, and users intensified efforts to capture and control increasingly scarce resource units.

CONCEPTUAL BACKGROUND

Social-Ecological System

- The Salt River Valley viewed as an integrated system
  - -Ecological or natural resource component – the Salt River - also viewed as a Common Pool Resource (CPR)
  - -Social Component – institutions (laws, customs) and built infrastructure (water diversion structures, dams)
- Behavior of system over time depends on
  - -The interactions and feedbacks within the system
  - -The emergence of novelty and innovation
  - -Shocks or disturbance

Common Pool Resources

- Rival and Non-exclusive

Holling's Metaphorical Complex Adaptive Cycle

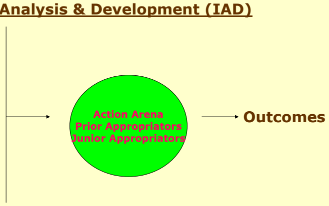
- α Phase – Organization/reorganization
- r Phase – Exploitation
- K phase – Accumulation/conservation
- Ω Phase - Release

Ostrom's Institutional Analysis & Development (IAD) Framework

Physical Attributes
good soil
highly variable water supply
knowledge deficit

Community Attributes
rapid population growth
heterogeneous population
markets

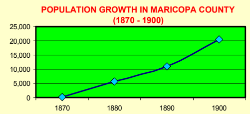
Rules
acequia laws
prior appropriation



QUESTIONS

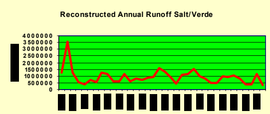
- What was the nature of the CPR situation at the turn of the Century?
- What factors enabled or inhibited the ability of the early settlers to organize and govern their common pool resource base?
- What were the interactions between the social and ecological components of the SES?
- What was the role of feedback within the system?

RAPID POPULATION GROWTH



YEAR	POPULATION	CHANGE
1870	340 ±	---
1880	5689	32.50%
1890	10986	6.80%
1900	20457	6.40%
1910	34488	5.40%
1920	89576	10%
1930	150970	5.40%
1940	186193	2.10%
1950	331770	5.90%
1960	663510	7.20%
1970	971228	3.90%
1980	1509175	4.50%
1990	2122101	3.50%

VARIABLE WATER SUPPLY



(From Graybill 1982)

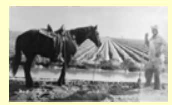
RULES

ACEQUIA LAWS

"Notwithstanding the existence of our Public Acequia Law, there has never been, so far as we can recall, any ditches or canals constructed or operated under it, in this valley. The system of canals, if it may be called a system, is the result of more spontaneous growth without any preconceived plan and without uniformity, either of theory or practice." (Clark 1936)

PRIOR APPROPRIATION

"during years when a scarcity of water shall exist, owners of fields shall have precedence of the water for irrigation, according to the dates of their respective title…the oldest titles shall have the precedence always" (Howell Code 1865). Importantly "no provision was made for declaring or recording the claims to the water of the Territory, nor for preventing the diversion of water previously appropriated" (McClatchie 1902).



BASIC CANAL ORGANIZATION

- Canal shares based on initial investment
- Canal Co. had board of directors elected by shareholders
- Zanjeros or overseers elected or appointed
- Canal maintenance and operation paid for by water delivery rates (cash or labor)
- Special assessments – more extensive flood damage
- Water rights tied to canal ownership

BY 1900

- Collective, self-governed system still used by Tempe, Mesa and Utah Canal Companies
- Hispanic influence most clearly seen in Tempe system
- Mesa and Utah systems – Mormons with some input from Native Americans

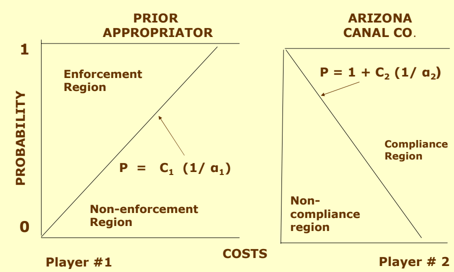
IN STARK CONSTRAST

By 1900

- North side system was owned/operated by eastern investors
- Outside capital used to finance/construct larger, more 'efficient' irrigation works
- Canals built primarily for land development
- Water rights not tied to land or canal ownership

PRIOR APPROPRIATOR'S GAME

	Don't Enforce	Enforce Prior Appropriation
Not Comply w/prior Appropriation	B_2^+ (Open access) B_1^-	$B_2^+ - C_2 + P(B_2 - B_2^+)$ $B_1^- - C_1 + P(B_1 - B_1^-)$
Comply w/Prior Appropriation	B_2 B_1	B_2 $B_1 - B_1^-$



Reaction Functions

LOW PROBABILITY OF SUCCESSFUL ENFORCEMENT

- **Physical Attributes** – variable water supply, transmissive sediments exacerbated by ↑↑ water diversion
- **Community Attributes** – land/ water markets, rapid growth, Heterogeneous population → unable to maintain unity
- **Accumulation of resources** → ↑↑ connectivity and rigidity

FEEDBACKS

- System increasingly dominated by positive feedback
  - Hydrological modifications intensified drought/flood vulnerabilities which exacerbated variable resource flows
  - Without ability to limit # of appropriators water supply was inadequate (demand too high) → ↑↑ conflict and intensified resource extraction
  - ↑↑ Conflict made it more difficult to establish effective rules

1867 - 1870 ORGANIZATION (α) PHASE

- ↑↑ Agricultural profits "dividends from a bonanza mine" (Mead 1903)
- At *least* 6 ditches by 1870
- 1870 "*GREAT SALE OF LOTS AT PHOENIX, ARIZONA*" (Mawn 1979)
- High river flows 1868 and 1869 washed away dam/headgates
- Time of innovation and opportunity

THE 1870's EXPLOITATION (r) PHASE

- ~32% annual population growth

By 1872 @ least 10 canals including Tempe Canal

- Existing canals enlarged and extended
- 1877 Desert Lands Act
- 1879 ↑↑ Conflict
- Increased diversions/Highly transmissive sediments → Decreasing stream flows
- Irrigators intensify water capturing activities

THE 1880'S Accumulation (r to k)

- 1882 Arizona Canal Co ~ 40 miles long
  - -Arizona Improvement Co. (Comstock Mines, J. P. Morgan, Newlands)
  - -Building canals, water and land sales
- 1885 Az Canal Co controls 20,000,– 40,000 acres
  - - accumulation and transformation of political and economic resources
- 1887 New water rights system accelerated land speculation
- ↑↑Connectivity and rigidity
- Canal companies file suit against Arizona Canal Co
  - -3 months later Az Canal Co buys north systems
- 1887-1889 Lawsuit amended 4 times
  - -Final suit *Wormser et al, v Salt River Valley Canal Co et al.*
- Lawsuit → 'Prior Appropriators Vs Junior Appropriators' attempt to define the boundaries of resource system and close access to new arrivals

THE 1990'S RELEASE (Ω) PHASE

- 1891 Floods -worst in recorded history
  - Chandler consolidates south side system (Consolidated Canal)
    - - Almost *all* water now diverted from river
    - - ↑↑ water diversion → loss of riparian integrity and ↑↑ vulnerability to flood/drought
- 'Extralegal' agreement between canal companies renders 'Kibbey' ineffective
  - - watering new lands ongoing
- Arizona Canal Co. defaults
- Hostilities mount ↑↑ lawsuits, gate breaking,
- 1898 water dispute ends in fatal shooting
  - - ↑↑conflict → social instabilities
- 1899 /1900 drought
- Reclamation – the final triggering event
  - - represents significant and irreversible turning point for both ecological and social components

OUTCOMES

BASED ON A.J. MCCLATCHIE'S 1902 REPORT

EFFICIENCY

- ~ 275,000 acres served by canals
- By his calculations - only enough water on *average for* ~ 110,000 acres
- Canals built in excess of water supply
- Inefficiencies
  - - Small quantities of water carried long distances through large canals and many small canals
  - -Duplication of canals and head gates
  - -Attempt to irrigate more acreage than possible resulted in ↑↑ losses to evaporation and seepage
- Efficiencies
  - -Almost all water diverted via 2 large dams

EQUITY

- Many farmers not getting enough water, often receive only a small proportion of water actually contracted and paid for
- 1901 average flow year - example
  - -Experiment Station contracted for 685 acre-ft – received only 170 acre-ft
- Prior Appropriators bearing burden of over appropriation
- Settlers leaving valley

LONG-TERM SUSTENANCE OF SYSTEM

- ↑↑ conflict - ?? Socially sustainable
- Overextension of physical system - ?? Technically sustainable
- Extensive hydrological modification - ?? Ecological sustenance

RECLAMATION AS A TRIGGERING EVENT

- Progressive Program used scientific / technological solutions to social problems
- Stewardship of watersheds – save for future generations
- New way to ↑ land values
- Drafted model 'water user's association agreements
- Represents significant and irreversible turning point for both ecological and social components

DIRECTIONS FOR FUTURE WORK

- Analysis at the intracanal level to compare and contrast the three main systems
  - - All 3 shared similar climate, territorial laws etc.
  - - Hypothesis: Tempe and Mesa systems relatively more stable; Phoenix systems less stable – perhaps the source of system wide instability?
- Link intracanal organization and institutional structure to early growth patterns of three settlements
- Evaluation of 'robustness' of SRV-SES from early settlement up to and including the present time
  - -

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