Institutional Analysis of the Colorado River Delta

1. Part I: System Structure

The case covers the evolution of the Colorado River Delta to its current degraded state. The Colorado River Compact of 1922 specified the amount of water to be allocated to all the basin states based on measurements taken at Lee's Ferry during very wet years. This has resulted in allotments to the Basin states and to Mexico based on 18 million acre-feet of water when the average flow is 13 million acre-feet of water. The 1928 Boulder Canyon Project Act authorized the construction of the Hoover Dam and the All-American Canal. The 1944 Mexican Water Treaty guaranteed the delivery of 1.5 maf per year to Mexico. The apportionment of the Colorado River is based on the prior appropriation doctrine which states that the first in line to take a defined quantity of water for beneficial use has the right to continue to use that quantity of water for that purpose.

1.1 The Commons Dilemma

Potential Appropriation Problem or Poor Coordination of Appropriation

The commons dilemma here is one of gross over-appropriation of water at multiple scales. On the Basin level, the amount of water allocated to States is based on exaggerated estimates of the average annual river flow. On use scales, agricultural use for water is allocated seniority of rights, though growing demand from urban sectors is increasing water stress.

Potential Under-Provisioning of Public Infrastructure

This does not seem to be an issue on the basin scale, though it is observed on the scale of irrigation districts and at individual user level.

1.2 Biophysical Context (IAD)

The Colorado River has numerous nodal infrastructure systems as well as linear conveyance infrastructure. The nodal systems are mainly water storage units and dams for hydro power generation including the following the Glen Canyon dam, Morelos and Laguna Dams, Hoover Dam, Parker and Davis Dams among others as well as numerous reservoirs, lakes and storage systems. The main owner and operator of the dams is the Bureau of Reclamation, though some of the dams, such as Morelos, is owned by the International Boundary and Water Commission (a body created to manage boundary and resource issues between the US and Mexico) and a couple of the smaller dams are owned and managed by other entities. Because of the over-abundance of dams and storage facilities, the amount of water reaching the delta has drastically reduced, with the result that the Colorado River no longer drains into the Gulf of California and significant parts of the Lower Basin and large parts of the delta are degraded.

1.3 Attributes of the Community

At the constitutional level are federal agencies such as the Bureau of Reclamation that provide water delivery and infrastructure provision for a multitude of uses. At the collective choice level are state agencies, energy and water companies and irrigation districts that manage allocation of water

and energy to users within their domain. At the operational level are the various users and the rights each of these users hold to use water.

1.4 Rules in Use (IAD)

Position Rules:

There are a number of positions in this system:

(1) Federal agencies such as the Bureau of Reclamation who own and manage water delivery to various users along the river, the National Park Service that maintains protected habitat along the river and so on.
(2) State agencies who review water rights of users in state to ensure third parties are not injured, such as, Arizona Department of Water Resources, Arizona Game and Fish Department, California Water Commission, Colorado River Commission of Nevada and so on.
(3) Irrigation districts, water supply organizations, mutual drainage and ditch companies that are government constituted entities and political subdivisions of the state to regulate water distribution within the state.
(4) Power companies that use dams and reservoirs to generate electricity or transport water to cities.
(5) Water users in urban areas, conservation agencies and NGOs who buy water rights for environmental purposes.

Boundary Rules

These are extremely difficult to specify due to the macro-scale nature of the system and the various tele-connections that affect system performance.

Choice Rules

At a macro-scale the choice rules are fuzzy. Water allocations and senior rights determine the limits water users and water providers have to navigate around.

Aggregation Rules

Though the Bureau of Reclamation is the owner and provider of water to States, the states have absolute authority over the water allocated, and can enable trading of water rights in state.

Scope Rules

Different for different scales of analysis of the system and therefore very difficult to define.

Information Rules

A wide variety of information is available on water allocation depending on the specific infrastructure, use, location or context in question.

Payoff Rules

These are generally applicable at the level of individual farmers within an irrigation district. There are cases at inter-state level where payoff rules have been applied, for instance in the Lower

Colorado Multi-Species Conservation Program, where a multitude of stakeholders have an agreement on habitat restoration along the river as a mitigation measure in compliance with the Endangered Species Act (ESA).

1.5 Summary

It can be concluded that the rules-in-use have not adapted to changing biophysical contexts of the river. Because of fuzzy property rights surrounding water due to boundary definition issues, complex governance challenges need to be overcome. The governance needs multi-jurisdictional actors at and across different scales to achieve increased system performance.

2. Part II: Dynamic Analysis – Robustness

The update is based on the state of the river delta currently as opposed to prior to the Compact and prior to the dam-building phase starting from the 1920s.

2.1 Update on the Commons Dilemma

The Colorado River, for large stretches, functions as a water conveyance system rather than a river. The problem remains one of over-appropriation of water.

2.2 Shocks, Capacities, Vulnerabilities

…..to and of the Resource (Link 7 to R)

The abundance of public infrastructure as well as subsidies and price incentives for agriculture has resulted in rent-seeking behavior and inefficient use of water for irrigation resulting in massive water lost due to runoffs as well as degraded water quality available to downstream users. Salinization of the water as well as the floodplains has also resulted in restriction in the type of crops grown.

…..Between Resource and Resource Users (Link 1 between R and RU)

Because of the prior appropriations doctrine, users who have senior rights are assured water first. In cases of drought, junior rights holders stand to lose their allotments due to this prioritization. Because those who hold water rights can lose their allotted share if they do not utilize the full amount allotted, they typically tend to use water they don't need. There are absolutely no incentives for enabling users to achieve water conservation or greater efficiency of water use. In fact the system is rigged to penalize these measures instead.

…..to and of the Resource Users (Link 8 to RU)

Water users can trade water rights either through sales or lease transfers. However, due to the nature of property rights on water (fuzzy boundary issue) water markets tend to be invariably localized and limited. Agriculture has been, traditionally, very heavily subsidized and market conditions encourage the growth of water-intensive crops for export. However, increasing urbanization in the West as well as restrictions on agriculture in some states such as Arizona is leading to a gradual shift in water use toward more urban use and away from irrigation.

…..Between Public Infrastructure and Resource Users (Link 6 between RU and PI)

The numerous dams, storage reservoirs, canals and diversions constructed over the past decades has resulted in massive reduction in river flooding in the floodplain and more rigorous control over river flows to intended users downstream. This tendency to use built infrastructure to drastically reduce variation in river flow has led to increased system robustness in the short-term, but has also led to increase in the fragility of the system to external shocks over larger time-scales.

2.3 Robustness Summary

The trend over the past decades has been one of increasing water shortages due to extreme water stress. That agriculture is prioritized, that crops grown are highly water-intensive as well as the fact that increasing urbanization is putting additional pressure on an already taxed system has meant that serious reform is needed in governance of the river in order to achieve a more efficient allocation that leads to robust system performance over a longer time scale. Because rivers are so vital to human well-being, this last is most important. Therefore, future approaches to managing the Colorado River need to take into account how best to achieve robust system performance as well as reduce the pressure on the system due to numerous demands and associated infrastructure to fulfil those demands, thereby also reducing system fragility to shocks.

In a rare and successful example of polycentric governance of a river as a resource (and not merely as a water supply source), the Lower Colorado Multi-Species Conservation Program (LCR MSCP) was conceived in the early 2000s after long negotiations between a variety of stakeholders, including the Bureau of Reclamation, the National Park Service and other federal entities, State Water Commissions for Arizona, California and Nevada as well as water and power companies, irrigation districts and conservation groups. There is considerable cohesion and trust within the group as they share the common goal of habitat building as a mitigation measure in accordance with the Endangered Species Act (ESA). This is the first step toward regulating river health by putting water back into the system to support natural infrastructure and maintain long-term system performance.

3. Part III: Case Contributors

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References

CRWUA (N.A.). *Law of the River*. Colorado River Water Users Association. Accessed at < http://www.crwua.org/colorado-river/uses/law-of-the-river>