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Fill Mead First: What is Glen Canyon Dam's value and should it be decommissioned?

"Glen Canyon was built on the assumption that is was necessary- period," concludes attorney Scott Miller in his analysis of undamming Glen Canyon and draining Lake Powell (Miller, 2007). Sixty one years after the dam was approved by Congress, critics continue to question the initial justifications of, and the continuing need for, Glen Canyon Dam (GCD) and the colossal lake it holds back. The Bureau of Reclamation and dam proponents claim that the storage and power created by the dam was and remains absolutely vital to the West (Bureau of Reclamation, 2008). GCD critics believe that constructing the dam came at too great a cost to the natural environment and it would be beneficial, economically and ecologically, to decommission the dam as soon as possible (Glen Canyon Institute). It is difficult to compare the merits of these opposing stances, especially when considering existence values and criteria that do not have clear costs and benefit value. It is easier to analyze the economic effect of decommissioning GCD, often presented under the option "Fill Mead First". One the United States' greatest engineering feats is a story of value tradeoffs and economic uncertainty – pitting water storage, clean power and recreation against ecological health and Glen Canyon's existence.

Benefits

Glen Canyon Dam was built to provide water storage, cheap hydroelectric power and recreational opportunities for lake-starved Westerners. The department that built the dam, the Bureau of Reclamation, fought for Glen Canyon because of a politically pressing need for water storage (Reisner, 1993). While it is difficult to quantitatively measure the benefit of water storage, it is easier to measure the benefits from hydropower and recreation because they are valued goods.

The water storage at Lake Powell is the "bank account" of the Upper Basin (UB) states. This Upper Basin includes all areas that drain into the Colorado River above Lee's Ferry (Colorado River Compact, 1922). Every year, at least 7.5 million acre feet of water is required to pass to the Lower Basin (LB) states regardless of the Colorado's flow (unless reservoir levels mandate cuts) (Colorado Compact 1922). Lake Powell can hold 24.3 million acre feet (maf) of water, though it currently holds just 11.2 maf and has not been near full since the late 1990s (Bureau of Reclamation, 2017b). While Lake Powell water storage helps the UB avoid shortages in long-term droughts, the original push for more storage was to make sure that the LB states did not jeopardize future water needs of the Upper Basin with their skyrocketing urban populations and growing agricultural areas (Miller, 2007).

In the event of a low annual flow for the Colorado, the UB may have to reduce its water use in order to meet its required release to the LB and Mexico. Because the Colorado Compact has promised more water to states than the Colorado River annually provides, this problem could become a reality if multiple years of flow could not be captured in Lake Powell (Colorado River Compact, 1922). In the UB states 1,360,000 acres were irrigated with Colorado River water in 2008 (Cohen et al., 2013). Most of the acreage is devoted to livestock feed crops and pasture, while the LB grows more varied crops and generates more revenue per acre (Cohen et al., 2013). There has been no recent evaluation of the value of UB livestock and feedstocks grown with Colorado River water, though Paul Douglas, an Illinois senator, bemoaned in 1956 that the high cost of "reclaiming" pasture lands with Colorado River projects (about $2000/acre) was painfully

higher than the actual market value of the lands ($150/acre) (Reisner,1993). Immense political pressure had an important role in building GCD and providing UB water security, even though the value of the upper basin irrigated cropland is much less than the Lower Basin.

Electricity generated from hydropower is another benefit to utility customers in the Colorado Basin, though GCD electricity generation is becoming increasingly insignificant and expensive for the government to maintain (Power et al., 2015). Glen Canyon Dam is the largest single source of power in the Colorado River Storage Project (CRSP) and provides base and peak electric power to publicly-owned electric utilities, Native American tribes, federal agencies and rural electric cooperatives at a cost-based rate (not market prices). The average annual revenue from GCD electricity is $153.3 million dollars, of which $47.8 million dollars comes from peak electrical generation (Power et al., 2015). Most of the 3.2 million customers using GCD electricity also get power from other non-CRSP sources provided at market prices, but some groups like sovereign Indian nations, governments or government-owned or run enterprises get all their electricity from the CRSP (Power et al., 2015).

Glen Canyon Dam's creation, Lake Powell, also brings economic benefit because it is a major recreation destination that has provided jobs and revenue to surrounding communities and government. The Glen Canyon Dam National Recreation Area (NRA) was established by the National Park Service in 1972 with the goal of combining "scarce open spaces with the preservation of significant historic resources and important natural areas in location that can provide outdoor recreation for large numbers of people" (National Park Service, 2017a). Over 2.5 million people visited the area in 2015 and spent $167 million dollars that supported 2,375 full-time jobs (Cullinane Thomas & Koontz, 2016). The economic output, the sum of all business to business sales and business to consumer sales, totaled $190 million dollars for the year (Cullinane Thomas & Koontz, 2016).

Popular recreation activities at Lake Powell include boating, hiking, camping and fishing. Most fishing is for bass, crappie, catfish, and blue gill, with trout fishing being more common in the river below the dam (National Park Service, 2017c). There are four marinas and countless companies offering houseboat rentals, fishing guides and aquatic gear to satiate the outdoor appetite of visitors (National Park Service, 2017c). Towns like Page and Marble Canyon, Arizona have economies dependent on Glen Canyon tourism and the influx of money from their service industries (Jonas, 1991).

Costs

Despite the major economic and political benefits from water storage, electricity generation and recreation, some Americans believe the costs of the dam are too great. The ecological costs have always been high, but in recent years, even the returns from the dam are decreasing (Lustgarten, 2016). But calculating some of the non-economic costs of the dam is a challenge that has been attempted only in piecemeal. Besides operational costs, one must consider the value of ecological damage, lost recreation opportunities and the value of Glen Canyon's existence.

The operational costs of Glen Canyon Dam remain consistent as the revenue from hydropower decreases (Lustgarten, 2016). The dam cost $35 million dollars a year to operate, which breaks down into general operations ($22 million), compliance with the Department of Fish & Wildlife and the Endangered Species Act ($2 million) and the coordination of the Glen

Canyon Dam Adaptive Management Program ($10.5 million) (Power et al., 2015). In recent years, the Department of the Interior had to purchase power to offset reduced hydroelectric generation. The government bought $62 million dollars of extra power in 2014 and $22 million dollars in 2015 to fulfill its contractual obligations (Lustgarten, 2016).

Another major cost of Glen Canyon Dam is the ecological damage caused by the effects on downstream habitat, native species and water quality. Upstream of GCD most of the riparian ecosystem has been drowned for about 186 miles, while the reduced flows below the dam have caused a decline in the number of sandbars, an increase in nonnative/invasive plant and animal species and a loss of native species. In economics, the "cost" of these degraded habitats and endangered species is society's willingness to pay to restore them (Keohane & Olmstead, 2007). Tens of millions of dollars have been spent to stabilize species and eradicate invasives that capitalize on steady river flows (Reese, 2008). Many of these problems are a result of the dam along with other human influences. For example, trout were introduced into the Colorado River and now thrive in the cold, consistent flows provided by GDC while predating on endemic fish (Bureau of Reclamation & National Park Service, 2016). Because of competing interests, complications often arise while evaluating these problems. Though trout are bad for endemic river species, trout fishing is popular on the river and now provides a recreational benefit. The effect of GCD on the Colorado River ecosystem becomes even more complex when managing the various groups with a stake in the region.

Like the rise of the trout fishing industry, the dam has changed other forms of recreation. While Lake Powell generates significant revenue from water sports and recreation, it is a tradeoff for the economic benefits it may have derived from river rafting in Glen Canyon. River running in the Grand Canyon made $21 million dollars in revenue in 2001 (Hjerpe & Kim, 2007). Given Glen Canyon's similarities to the Grand Canyon, the rafting industry may have looked similar. Unfortunately, rafting produces mainly seasonal, low-wage jobs and only 50% of rafting-related expenditures were captured by the regional economy in 2001 (Hjerpe & Kim, 2007). Also, the Grand Canyon rafting industry actually benefits from GCD because it provides consistent flows, without which trips would be riskier and the season shorter due to high flow periods (Bureau of Reclamation & National Park Service, 2016).

When considering recreation value it's important to account for the associated costs and economic impacts on local communities. The infrastructure supporting Glen Canyon NRA includes four marinas and multiple hotels and restaurants inside the recreation area and in nearby Page, Arizona (National Park Service, 2017b). The Park Service and local governments must provide basic services like sewage and trash while local residents deal with the increased cost of living, congestion and crime. Environmental degradation from tourists is perhaps the most visible side effect of recreation, mobilizing the Park Service to recruit volunteers to clean graffiti and pick up trash (Hjerpe & Kim, 2007). Of course there are benefits to being a tourist hub, like more local jobs, a retained local population, better infrastructure and a stronger community identity (Hjerpe & Kim, 2007). Recreation would likely be a major industry in the area without the dam, though it is impossible to know what the infrastructure and local impact of tourism might be like for this alternative. One could compare it to the fairly extensive infrastructure of the Grand Canyon area; which suffers many of the same costs and benefits.

In addition to ecological and recreational tradeoffs, a more symbolic cost is the value of Glen Canyon's existence. Existence is different than maintaining the region to enjoy it for

recreation, but instead is the idea that "consumption, even as economists think about it, should extend to include the simple fact of knowing that a wilderness, endangered species, or other object in nature exists" (Nelson, 1997, p. 500). Many advocate for the conservation of Western landscapes because of their inherent value to us and future generations (bequest) because "There are values involved that simply cannot be balanced with dollars or any other economic valuation" (Miller, 2007, p. 204).

There is still a lively debate about the use of existence value in environmental economics. Some economists argue that existence value is theoretically incorrect and borders on religious theology while others worrying that decisions made without accounting for existence value would be inadequate (Miller, 2007). The United Nations Food and Agriculture Organization provides guiding documents about existence value and the difficulties in making estimations of it. Perhaps the most obvious difficulty is that economic and socio-cultural factors influence people's valuation, and that "there is no single option or existence value" (UN FAO, 1994).

David Brower, Wallace Stegner, and Edward Abbey are some of the well-known writers and activists who have written about Glen Canyon's existence value. Brower, the Sierra Club founder, said in the forward for *The Place No One Knew* that, "Glen Canyon died in 1963… Neither you nor I, nor anyone else, knew it well enough to insist that at all costs it should endure" (Brower, 1963). In Page, Arizona in 1981, Edward Abbey spoke at an Earth First! event and expressed his thought that "Glen Canyon Dam is an insult to God's Creation, and if there is a God he will destroy it. And if there isn't we will take care of it, one way or another, and if we don't then Mother Nature most certainly will" (Philippon, 2004). One-time professor of Abbey and famous Western author Wallace Stegner also wrote about the necessity of wilderness and echoed the importance of existence value in *The Sound of Mountain Water*, "We simply need that wild country available to use, even if we never do more than drive to its edge and look in" (Stegner, 1969).

Fill Mead First

In response to the high ecological, recreational and non-use costs of Glen Canyon Dam is the proposal to "Fill Mead First". It was an idea first developed by the Sierra Club and subsequently adopted by conservation and advocacy organizations. The proposal suggests decommissioning Glen Canyon Dam and draining Lake Powell to increase the amount of water in Lake Mead near Las Vegas. The perceived benefits of this plan include increased hydroelectric generation at Hoover Dam, a restored riparian ecosystem in Glen Canyon, a more natural stream flow to the Colorado and reduced water losses from evaporation and ground-water seepage (Glen Canyon Institute). While this proposal is technically feasible, the costs would also be significant (Schmidt et al., 2016). Implementation would curtail the current benefits of the dam as well as have unknown economic and ecological effects.

Carrying out the plan to drain Lake Powell, although technically feasible, would likely be very expensive. Water can only drain to dead pool elevation through the penstocks, after which water would only flow through the dam's river outlets. The river outlets can only accommodate flows of up to 15,000 cfs and would impede the river's natural flow during flooding periods (Schmidt et al., 2016). It would be necessary to drill new bypass tunnels, which Bureau of Reclamation director Floyd Dominy said "would be an expensive, difficult engineering feat. Nothing like this has ever been done before, but… it will work. You can drain it" (Barcott, 1999).

Also, though the lost power generation from Glen Canyon hydropower can be easily replaced with other sources, alternatives would likely emit pollution, reduce flexibility to meet peak loads and would be significantly more expensive for some customers[1]. Substituting fossil fuel sources for the maximum generation capacity at GCD would take 11 million barrels of oil or 2.5 million tons of coal (Bureau of Reclamation, 2008). Also, hydropower is very flexible and managers can increase power generation in periods of peak demand, while many other power sources can't meet rapid changes in power use and meet mostly base load demand. In addition, while the increase in customer prices would be minimal when spread over 3.2 million customers ($1/yr residential and $7/yr commercial), the groups that rely heavily on CRSP (sovereign nations, etc.) would experience two to threefold energy price increases (Power et al., 2015).

Besides the environmental cost of decommissioning a clean energy source, draining Lake Powell may have significant ecological effects from sediment releases. A common concern is that the sediment behind GCD has toxic materials that would imperil wildlife downstream (Hart et al., 2001). A 2001 study by the National Park Service did find environmental contaminants in Lake Powell, like arsenic, copper, lead, mercury and pesticides, which increased in concentration with depth and from upstream to downstream sites (Hart et al., 2001). Though potentially toxic, these soil cores "did not show unusual concentrations for typical delta sediments" (Hart et al. 2001, p.31). Even without toxic sediments, the sheer amount of sediment displaced would still have a tremendous effect downstream. In the last stage of draining Lake Powell "fine-sediment delivery into the Grand Canyon would probably be very large and would cause significant ecosystem adjustments associated with the sudden change from relatively clear water to a very turbid river" (Schmidt et al., 2016). Also, new sediment beds would form within Glen Canyon closer to the dam and could affect river drainage through the river outlets (Schmidt et al., 2016).

A major argument of Fill Mead First supporters is that the plan will save water. Advocates say that the losses from Lake Powell evaporation (2-3% of the lake each year) and seepage (124 billion gallons of water into groundwater) would decrease because of reduced surface area and a "less leaky" Lake Mead (Glen Canyon Institute & Myers, 2013). Though this water is not "lost", it is not available to downstream users. The Bureau of Reclamation argues that water seeping into Glen Canyon eventually returns to the river and combining the two reservoirs would save only a small amount of water (Lustgarten, 2016). In contrast to Fill Mead First claims, a recent study from Utah State concluded that draining Powell would not significantly reduce evaporative losses and the totaling water savings of combining the reservoirs would be less than 50,000 acre feet/year (Schmidt et al., 2016).

Perhaps the most challenging aspect of this proposal would be the essential renegotiation of the Colorado Compact. Because GCD is the delivery point for the UB's required releases, the UB does not support the Fill Mead First proposal. During drought years, "the negative benefit would fall disproportionately on the Upper Basin" (Miller, 2007, p. 181). One suggestion to appease the UB states is to move their delivery point to Hoover Dam, thus making Lake Mead the storage basin for the UB (Miller, 2007). Still the costs of negotiating a new compact, which

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[1] The loss of power generation would also dry up a major source of funding for the Glen Canyon Adaptive Management Plan, which supports many research projects studying the effects of the dam (Miller 2007).

would likely include adjusting the total allocations of the Colorado River to reflect its true annual flow, could be immense, and more importantly, could politically stifle the proposal.

Conclusion

The environmental costs of Glen Canyon Dam and the costs and benefits of the Fill Mead First proposal are complicated, as they are often stakeholder-value dependent. Though many are offended by the dam and "Lake Foul" (as Abbey called it), decommissioning Glen Canyon may lead to unintended ecological consequences that further imperil the fragile habitats downstream. Even though, some believe that Fill Mead First must be given a chance, simply because Glen Canyon was never given one – no environmental impact studies were conducted before the dam was approved (Miller, 2007). One might ask, "If Glen Canyon Dam would not have been built had we known then what we know today, then doesn't the proposal deserve careful consideration?"(Miller, 2007, p. 206). The increasing urban population and water needs of the Western states and the declining annual flows of the Colorado may be the strongest motivation for studying this proposal. Perhaps at a future date, the seemingly small amount of water saved by draining Powell will be enough to call for a serious consideration of Fill Mead First, but likely not before then.

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