Taking Down Hetch Hetchy

Tecali Aguilar, Edward Chan, Leigh Hiura, and Christine Mateo Grade: 10/10

Abstract

The Hetch Hetchy Valley, located in Yosemite National park, extends across a 1,200-square acre area and is approximately 1,800 feet in depth. The reservoir provides water to the majority of the Bay Area and is made of multiple dams along the Tuolumne River. The O'Shaughnessy Dam is the second largest dam along the Tuolumne with a height of approximately 430 feet, width of 308 feet, and length of 900 feet. Recently, there has been much debate over the removal of the dam but before any decisions are made, there are many variables that must be taken into account. The O'Shaughnessy's removal will cause economic and environmental impacts such as a decline of water quality and an increased water cost. Some of the challenges related to performing a cost benefit analysis of removing the dam are defining an appropriate scale and finding the stakeholders' willingness to pay. Since this project is so large, it is difficult for us to take into consideration all of the project's components. Also, removing the dam is expensive and part of that cost will fall upon the stakeholders. We are unsure of how much of the cost they will be willing to bear.

Our project compares the costs and benefits of removing the O'Shaughnessy Dam with leaving Hetch Hetchy as it currently is. We examined past studies and used the data we found to construct a cost benefit analysis in present day values. We then used the values found to predict future net benefits. Furthermore, we looked at the economic and environmental impacts of removing or keeping the dam and created models of the future based on those various aspects.

While still highly debated, we calculated the net benefits of removing the dam to be greater than simply maintaining the existing infrastructure only under certain circumstances. This project includes removing the O'Shaughnessy Dam, restoring the Hetch Hetchy Valley, and developing recreational areas. Although a change in the water management infrastructure is likely to cause changes in water quality in addition to the reallocation of its source and replacement of the hydroelectric benefits of the O'Shaughnessy Dam, the removal of the Dam is beneficial by 2050 if costs are minimized. However, if costs and benefits are maximized we wont see a positive net benefit within the examined time period.

Some limitations we faced while undertaking our project were finding enough data to draw accurate conclusions, being able to take every variable of the project into consideration, and predicting unforeseeable costs. We were only able to find data from 2005 and 2009 because the previous years were not conclusive and there have been very few studies more recent than 2009. Also, while performing our cost benefit analysis, we would find more variables that should be taken into consideration and would need to add them into our analysis. In addition, there are many costs that may arise as this project continues such as unplanned construction costs, the need for more water treatment plants, or environmental conservation needs. Overall, we advise that this project be undertaken if costs can be minimized because it will be beneficial under that circumstance.

Introduction

The O'Shaughnessy Dam is the second largest dam in the Hetch Hetchy water system. Our project will compare the costs and benefits of removing the O'Shaughnessy Dam. The Hetch Hetchy water system is the main provider of water to the Bay Area. Most of the stakeholders reside in this area, and any changes to the water supply will have some effect on this population. After hearing about the recent debate over removing the dam, we decided to research the net benefits of removing the O'Shaughnessy Dam to relocate the water to the upgraded Don Pedro dam. This project is interesting because the majority of us are from the Bay Area, and we felt that it was important to know where our water comes from and how we might be affected by changes to our water management infrastructure.

Objective

The main objective is to determine whether the removal of the O'Shaughnessy Dam and restoration of Hetch Hetchy Valley has a larger net benefit than the status quo. In order to evaluate this, we performed two cost benefit analyses. Due to the uncertainty of the future we used assumptions and modeling to create a visual guide until 2050. With such a large scale we had to address multiple variables, one being visitor population growth within Yosemite Valley. In hopes of gaining an optimal point, we chose to evaluate the maximum benefits against the maximum costs and the minimum costs against the minimum benefits. By doing so we obtained a decision, and a perspective on the potential costs a project this large can have. We also need

researched the restoration measures needed to bring the valley back to its original state, along with the cost and benefits of doing so. After we collected and analyzed the two separate options we were able to choose the scenario that had the highest net benefits.

Hypothesis

In terms of optimizing water management in California, we believe the removal of the O'Shaughnessy Dam is more favorable, in the long run, than maintaining the Hetch Hetchy Reservoir.

The removal of the O'Shaughnessy Dam will cause significant impacts to the Bay Area Water Supply. Our projection is the cost to supply water will go up due to change in infrastructure, along with the increased cost for water quality. This cost imposed on producers will cause in increase in prices due to the shift of costs to the consumers. The eventual decision will be dependent on the value of Hetch Hetchy in restored state, and whether this value offsets the costs to implement this supply change.

Data Sources

(1) State of California Resources Agency, Department of Water Resources, and Department of Parks and Recreation, 2006, "Hetch Hetchy Restoration Study," http://www.water.ca.gov/pubs/environment/hetch_hetchy_restoration_study/hetch_hetchy_restoration_study_report.pdf

(2) National Parks Service, 2013. "Park Statistics." http://www.nps.gov/yose/parkmgmt/statistics.htm

Methods and Assumption

There are several steps necessary in order to determine the future revenues generated by the removal of the O'Shaughnessy Dam with low and high development of the Hetch Hetchy Valley.

Initially, we had to determine Yosemite's amount of visitors in the future through 2050 by graphing the amount of visitors of Yosemite from 2006-2012 from data provided by the National Park Service (Figure 1).

A power regression trend line of y=8E-222x^68.919 with an r-squared value of 0.9523 was determined. By plugging in the year as the x-value, we can generate the amount of visitors in the future without dam removal and with dam removal for low and high recreational development of the Hetch Hetchy Valley (Figure 2) and compare these populations (Figure 3).

Low development would generate an additional 400,000 visitors per year while 1,000,000 visitors with high development (State of California Resources Agency: Department of Water Resources & Department of Parks and Recreation, 2006). These additional amounts are added to the amount of visitors from 2025 through 2050.

To create a cost benefit model we began by obtaining as much data as we could. First we used the cost analysis in the 2006,Hetch Hetchy Restoration Study. These values were all in 2005 so we had to convert them to the future value using the interest rate formula FT = A [((1+i)^T-1)/i]. The variable "FT" is the future value, while "i" is the interest rate and T is the amount of time. Since we assumed the project wouldn't start for another 2 years we moved the values into the year 2015. Our benefits were from 2005 as well so we used the same equation again to get to them in 2015.

Now that we have the annual benefits, we calculated the total benefit over the given time period. To create a much more accurate chart, we added the annual values Hetchy Hetchy would generate. In the Hetch Hetchy Restoration study there was a projected benefit based on level of development. We assumed that there would be no annual benefit until the project is completed and set this time to be an estimate of 10 years from the start of the project. Therefore, the first annual benefit from Hetch Hetchy appears in 2025. The annual benefits were calculated in 2025 then returned back to the present using the present value interest rate formula, P = FT/(1+i)^T. The variable "P" represents the present value, while "i" is the interest rate and "T" is the amount of time.

Once this was completed, we decided to combine efforts and try and account for the change in population. We calculated the marginal increase each year. Using the population in 2009 and the revenue produced that year, we were able to calculate that each person spends

approximately $90. This amount became our constant to multiply to each change in population. Then, the values were summed and averaged to find the mean. This is may not be the most accurate way to account for population, but it is an important variable that must be taken into consideration. With the calculated mean, we used it to calculate another annual benefit starting from 2015. These were all the benefits we took into account. Once they were all in present value we summed them to compare that value to the total costs. We repeated this process to get the maximum benefit and costs. We did this in hopes of finding the equilibrium point within this spread.

Calculation/Results

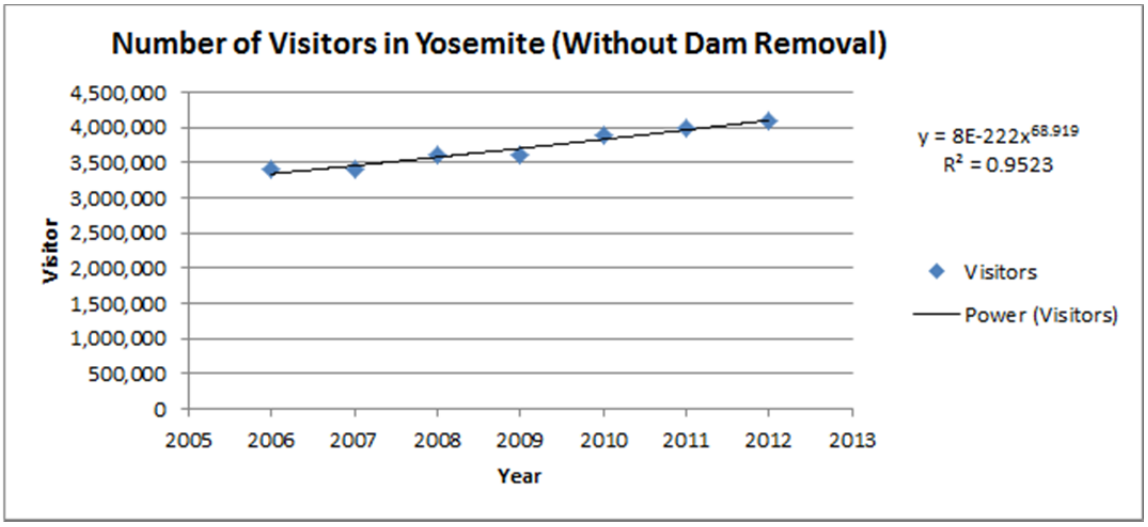


Figure 1

Without Dam Removal		With Dam Removal and Low Development		With Dam Removal and High Development	
Years	Visitors	Years	Visitors	Years	Visitors
2006	3,400,000	2006	3,400,000	2006	3,400,000
2007	3,400,000	2007	3,400,000	2007	3,400,000
2008	3,600,000	2008	3,600,000	2008	3,600,000
2009	3,600,000	2009	3,600,000	2009	3,600,000
2010	3,880,000	2010	3,880,000	2010	3,880,000
2011	4,000,000	2011	4,000,000	2011	4,000,000
2012	4,098,648	2012	4,098,648	2012	4,098,648
2013	3,987,485	2013	3,987,485	2013	3,987,485
2014	4,126,334	2014	4,126,334	2014	4,126,334
2015	4,269,944	2015	4,269,944	2015	4,269,944
2020	5,065,252	2020	5,065,252	2020	5,065,252
2025	6,006,154	2025	6,406,154	2025	7,006,154
2030	7,118,843	2030	7,518,843	2030	8,118,843
2040	9,988,298	2040	10,388,298	2040	10,988,298
2050	13,991,180	2050	14,391,180	2050	14,991,180

Figure 2

Example of without dam removal: y = 8*10^-222x^68.919

= 8*10^-222(2050)^68.919

= 13,991,180 visitors

Example of with dam removal and low development: y = 8*10^-222x^68.919+400,000

= 8*10^-222(2050)^68.919+400,000

= 14,391,180 visitors

Example of with dam removal and high development: y = 8*10^-222x^68.919+1,000,000

= 8*10^-222(2050)^68.919+1,000,000

= 14,991,180 visitors

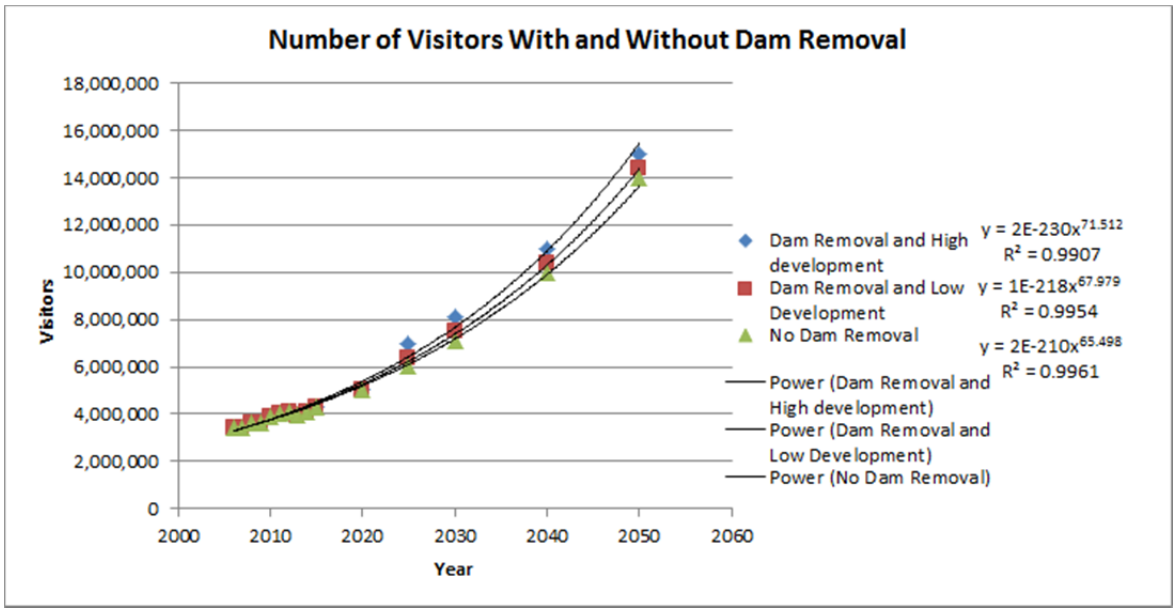

Number of Visitors With and Without Dam Removal
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Visitors
2000
2010
2020
2030
2040
2050
2060
Year
Dam Removal and High development
Dam Removal and Low Development
No Dam Removal
Power (Dam Removal and High development)
Power (Dam Removal and Low Development)
Power (No Dam Removal)
y = 2E-230x^71.512
R² = 0.9907
y = 1E-218x^67.979
R² = 0.9954
y = 2E-210x^65.498
R² = 0.9961

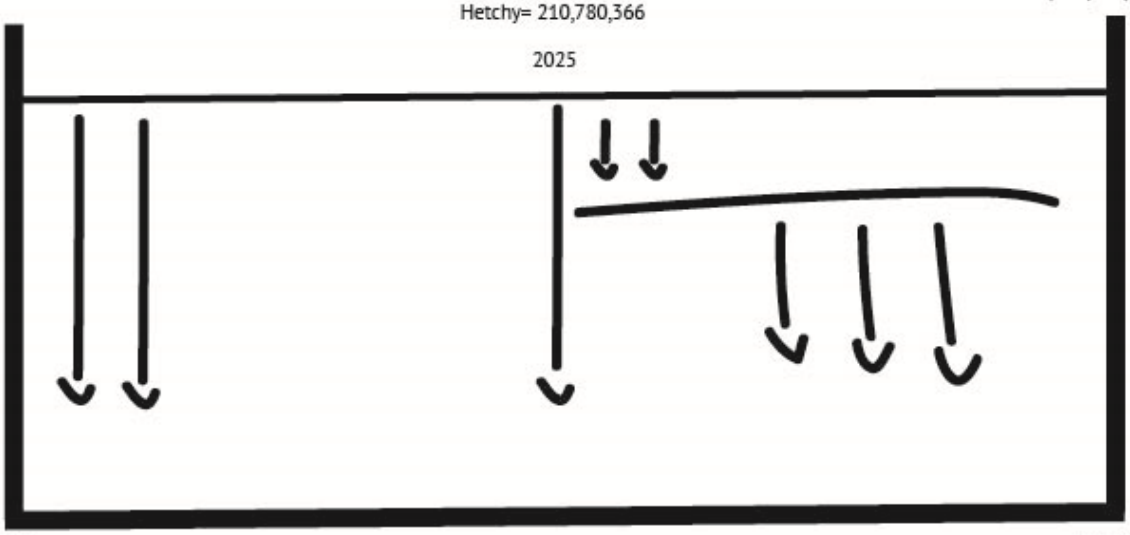
Figure 3

Total Addition of Benefit For Population Change=1,663,738,813

Annual Benefit w/o P Growth=7,718,884,391

Minimum Total Annual Benefit With Increased Revenue From Hetch Hetchy= 210,780,366

Initial+Added+Population. In 2015 = 6,192,519,179



Cost =4,318000000

An interesting finding is that the expansion of space value is relatively low. The park could mitigate the costs with population growth and their original revenue alone. The amount of change required for this project seems extremeley high for such a small contribution, but this number will grow over time as it is now infinitily accessible.

NB>0 Should conduct project.

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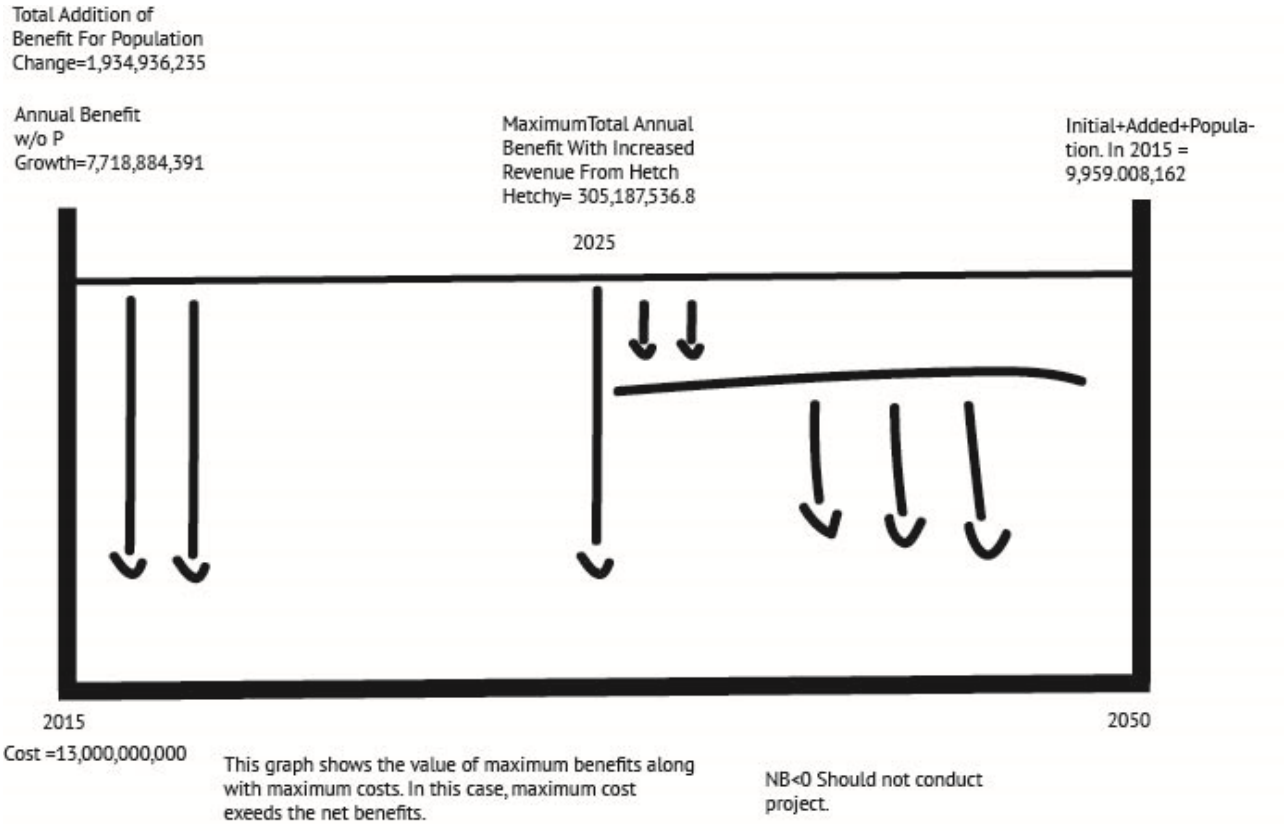
Minimum Costs and Benefits(Figure 4)



Maximum Costs and Benefits(Figure 5)

Conclusions

After plotting data of the amount of visitors and generating a power trend line, we were able to determine the yearly number of visitors to Yosemite by 2050. The 3 different amounts of visitors by 2050 calculated were fairly similar to each other as they all increased. Furthermore, the number of visitors after the removal of the O'Shaughnessy Dam and high recreational development was the largest at 14,991,180 visitors.

The cost benefit analysis provided two contrasting results. If the benefits and costs are minimized the Net Benefit is positive. If the maximum costs are compared to the maximum benefits, the net benefits would be negative. This is only in the constraints of our model. You must take into account the compounding and infinite return on the space, and the ability of Yosemite's originally large income to offset the costs. The unfortunate part about this scenario is

the money Yosemite gains may not go to the stakeholders affected by the change in infrastructure even though the cost is offset by the benefit to society. In the short run, these large costs might cause serious market changes and affect the water supply for the Bay Area immensely.

Recommendation/Limitations

We recommend that the government proceed with the project if the costs can be minimized. Another condition to this acceptance is a government intervention that will protect the people from a large increase in price. Since the costs are unknown right now, it would be a good place to start. Once the costs are clearly defined, utilities and other stakeholders involved can voice their concerns. The stakeholders must come to a majority and agree that this will benefit everyone in the long run. While proceeding with our project, we came across a few limitations. First, we were unable to find enough current data necessary for determining our net benefits calculation. Although our goal was to compare the benefits to the costs of restoring the Hetch Hetchy Valley, we did not find any statistics on how much the development would cost. Aside from the data on the number of visitors in Yosemite collected in 2013, all the values we used were from 2005 and 2009. This is because the previous years do not have thorough calculations or estimates and there are very few studies conducted after 2009. There are countless aspects of tearing down the O'Shaughnessy dam and restoring the Hetch Hetchy Valley that can be taken into account. Although we included a numerous amount of variables, there may be more that we did not consider. If this project is taken up, unexpected costs may arise while being completed. For example, unanticipated infrastructure costs such as additional water quality treatment plants may be needed.

References

(1) State of California Resources Agency: Department of Water Resources & Department of Parks and Recreation, 2006, "Hetch Hetchy Restoration Study," <http://www.water.ca.gov/pubs/environment/hetch_hetchy_restoration_study/hetch_hetchy_restoration_study_report.pdf>, November 17, 2013

(2) National Parks Services, 2013, "Park Statistics," <http://www.nps.gov/yose/parkmg mt/statistics.htm>, November 25, 2013