Optimizing for Water Equity in the Colorado River Basin

(Technical Paper)

The Technopolitics of Israeli Water Management

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Water resources management, adequate and efficient water distribution and reliable water sources are pillars of modern infrastructure. Water management's technical function provides different groups of people with an adequate water supply while meeting domestic, economic and industrial hydrological needs of society. Due to the functional nature of a water resources system, water management is inherently political, executing a political agenda via a technical solution. By design, constructing water resources systems calls the political process into action, requiring stakeholder collaboration, trust in government and the norms of the policy making process. Failing to study the social and political factors influencing water management and planning results in the ignorance of oppressive power dynamics embedded in infrastructure and engineered technology. I seek to understand the hydropolitics of water management from an applied, technical standpoint as well as an additional pure, socio technical perspective.

A technical research project will be conducted, examining the Colorado River Basin's reservoir operating rules and redesigning the regional water management system for optimum water allocation. Selecting critical variables for water allocation optimization, integrating environmental flows, and balancing water needs across varying industries and communities, I will gain technical experience in water planning and water resource allocation. My applied research will use a coupled river systems model and multi objective evolutionary algorithms to investigate different water use and allocation rules, with a final deliverable including recommendations for improving the Colorado River Basin's operating rules.

To study the social and political aspects of water management, I have opted to study the development of Israeli water management systems and water injustices faced by Palestinians as a result of Israeli water policies. These water distribution networks are currently understood to

provide Israelis and Palestinians with an appropriate water supply in a supposedly water scarce environment, yet water allocation inequality and racial segregation for Palestinians integrates political complexity to a technical problem. Using an STS framework known as technological politics (Winner, 1980), I will craft an argument about the political dynamics between the state of Israel and the Palestinian people embedded in Israeli water management systems. I will explore narratives about supposed water scarcity in the region and the context in which Israel's centralized water system was created, arguing that Israeli water management systems function as tools of oppresion in an apartheid system. Both through its centralized water management system, segregative water policy and disproportionate allocation of water for Israeli settlers and Palestinians, Israel's utilization water distribution systems and lack thereof impose consequences on the Palestinian people.

Together, my technical research on water allocation optimization and my STS research on the political nature of Israeli water management systems, I will gain a more thorough understanding of how water distribution infrastructure executes a technical function while shaping power relations between an oppressor and an oppressed group of people.

Technical Topic

The Colorado River Basin (pictured in Figure 1), through climate change and excessive usage, is experiencing water shortages of increasing severity and regularity. Supply-demand relationships within the Colorado River Basin have become increasingly complex as demand continues to soar for agriculture and municipal services at the expense of environmental flows. Increased evapotranspiration losses throughout the basin due to reduced seasonal snowpack from climate change-induced irregularities in precipitation and temperature patterns have already begun making the region drier and more vulnerable (Milly & Dunne, 2020). Due to the economic

and environmental importance of this watershed, the impacts of a sustained water shortage would have a far-reaching, detrimental impact. The Colorado River accounts for over 50% of the gross economic product in the states of California, Arizona, Nevada, Utah, Colorado, New Mexico, and Wyoming (Hawes, n.d.). If 10% of the water were unavailable, there would be a predicted loss of $143 million and 1.6 million jobs (Hawes, n.d.). The current water shortage and potentially greater losses barring proactive changes would have an enormous economic impact on the Colorado River Basin region and the United States economy in general.

To address this problem, this research project aims to redesign reservoir operating rules and water allocation techniques using optimization models and water resources modelling tools to better serve its socioeconomic and environmental objectives in the face of drought and climate change. My team seeks to balance industrial water use, ecological impacts, economics and equity of allocation to redress water justice inequalities in the region. In optimizing flow and water allocation systems, the project is entirely bound by the hydrological budget of the river systems. For simplification, this project will be bound to current infrastructure and water distribution infrastructure. There will be no consideration of alternative dam systems, aqueduct/canal designs, stormwater management systems, or additional infrastructural water management. Since this project will assess alternatives to existing water allocation rules, it is not necessarily bound by existing water compacts and treaties. However, judicial rulings - particularly federal rulings on water disputes between user entities, is a system boundary.

The primary decision variables are the quantity of water which will be allocated collectively to the stakeholders (including the environment) and the specific water allocation that each stakeholder will receive. These decisions are influenced by reservoir operating rules, which will be explicitly optimized in our study. Fundamentally, the quantity of water which can be

allocated is bounded by the amount of water which flows through the Colorado River Basin and is impacted by elements such as climate change. The final quantities and allocations of water will also be informed by human and environmental needs to ensure that the economics of the Colorado River Basin can remain relatively unharmed while protecting sustainability and regional ecosystems. Historical and existing environmental justice issues, specifically relating to water resources on Native American reservations will also be used to inform decision making.

Figure 1. Map of Colorado River Basin and Water-Supply Districts.(Colorado River Districts, 2018)

Sociotechnical Research Topic

Israeli apartheid[1] and the government's systematic domination is codified in Israeli law and physically transpired into the built environment. Oppression manifests itself in Israeli infrastructure design; its highways, electrical grid, bridges, tunnels, and water management practices. Between 1948 and 1959, British and Israeli hydrologists and civil engineers held the belief that Israeli water resources were abundant, later shifting to a narrative of water scarcity (Alatout, 2001). In 1967 and 1968, Israeli military orders declared water resources an Israeli state property, prohibiting Palestinians from using or installing water installations without a permit, orders that are still upheld today and exacerbate the water crisis in Palestine (Alatout, 2001). Now, the Jordan River basin, which primarily flows through the Palestinian West Bank, is almost completely controlled by Israel's water supply company, Mekorot (Alatout, 2001).

From a purely scientific perspective, water management in Israel and Palestine is understood to perform the technical function of delivering adequate amounts of water efficiently to both Israelis and Palestinians. Israeli water management systems serve an additional function- to maintain a system of apartheid and racial segregation. As water resource inequality has been thoroughly documented by international human rights organizations on Palestinian land, the story of water scarcity in Israel, the construction of a centralized Israeli water management system and the Israeli control on Palestinian water resources will be central to my STS research.

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[1] The United Nations' Economic and Social Commission for Western Asia released a resolute report in 2017 describing Israel as an apartheid regime (United Nations, 2017), and in April of 2021, the Human Rights Watch, an international NGO, published a breakthrough report detailing Israel's human rights violations on the Palestinian people and its institutionalized apartheid (Shakir, 2021). The Human Rights Watch report details how Israel's control over the Palestinian people meets the 1973 Apartheid Convention and 1998 Rome Statute of the International Criminal Court (United Nations, 2001) definition of apartheid on the basis of 3 key elements; domination of one racial group over another, systematic oppression of one racial group over another, and one or more inhumane acts as a part of that oppression.

Without comprehending the history of the Israeli occupation and the political context in which water management systems in the region were developed, engineers will misunderstand the power dynamics and oppressive design embedded in the water distribution network.

Technology and science are commonly seen in a positive light, as they are deemed neutral and apolitical. The supposed dichotomy between technology and politics is deconstructed in Langdon Winner's landmark piece "Do artifacts have politics?" as Winner argues that "certain technologies in themselves have political properties"(Winner, 1980). Using this sociotechnical framework, my research will study how Israeli water management privileges Israelis and marginalizes the Palestinian people. Winner makes the claim that artifacts can contain political properties through two ways; first, that "the invention, design, or arrangement of a specific technical device or system becomes a way of settling an issue in the affairs of a particular community" or what are called "political technologies, man made systems that appear to require political relationships". I seek to understand the power dynamics between an oppressor and the oppressed and how this is manifested in the design of Israeli water management systems and Israeli regulation and surveillance on Palestinian water resources. My research will address Palestinian and Israeli hydropolitics from the time of the British Mandate in the early 1920s, the Nakba ("catastrophe") of 1948 to present day in occupied Palestine. Using Winner's technological politics and socio technical framework, I will assess the historical and political context through which Israeli water management was designed and justified, and argue that Israeli water management works as a tool of oppression in an apartheid system . I plan on drawing from the original water management division plans of 1948 as primary sources of evidence (Hays, 1948) which provide technical descriptions and reasoning behind the technical water distribution plan.

Conclusion

My team's investigation of the Colorado River Basin's water allocation rules and optimization model will inform policymakers, hydrologists, government officials and the watershed's residents of improved regulatory practices. The development of multi-objective evolutionary algorithms allows our team to quantify multiple decision variables including environmental flows, economic benefits, industrial uses and environmental injustices with different levels of strength into our model within our defined geographic boundaries. Through this project, I will better my comprehension of the scientific considerations made by water resource engineers and the resulting social compromises of a water management system.

My sociotechnical research of hydropolitics and the inherent political qualities of water management systems will frame Israeli water management systems as tools of the Israeli government. I will explore the politics of water abundance versus scarcity, Israeli water infrastructure, the context in which it was designed and its consequences on the Palestinian people.

Together, my team's technical and my individual socio-technical research will deepen my grasp on water management as a system that performs a scientific, technical task and executes a political agenda. Water is the basis for the function of society; an increased understanding of hydropolitics and the technical nature of water management molds me into a stronger water resources engineer for my future career.

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