Ola I Ka Wai - The Barriers of Implementing a One Water Approach on O‘ahu

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I certify that I have read this thesis and that, in my opinion, it is satisfactory in scope and quality as a thesis for the degree of Bachelor of Science in Global Environmental Science.

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MOTIVATION

Throughout my years in the GES program, I have learned about a multitude of ways in which human activities affect the natural environment. Climate change drives large-scale changes to the hydrological cycle, especially in Hawai‘i whereas water resources have a unique value. Water is an essential resource that has become undervalued in our communities.Water resources are becoming increasingly scarce, urging efforts to conserve the water we have left in a sustainable and equitable way. As research identifies the ways water can be impacted from global warming and other factors, the next step is to actively integrate climate science to water resources management. In conclusion, environmental science and planning needs to go hand-in-hand to solve our future challenges to natural resources, and this thesis research is a contribution towards that specific effort and ultimate goal.

ABSTRACT

The Hawaiian Islands are on course for a water crisis. Currently, water supplies face challenges deriving from overconsumption of water and a growing world population increasing the demand. Furthermore, climate change causes detrimental impacts to water resources by reducing water quality and quantity, urging planning efforts to integrate climate science within water management practices. In 2020, the City and County of Honolulu stated their intention to adopt a One Water (OW) approach, which aims to manage water resources in Hawai‘i in a holistic and collaborative way. Through this research, we will identify the barriers of implementing the OW framework on O‘ahu to encourage strategies in effectively integrating the framework to O‘ahu's water management practices. The research follows a qualitative research design collecting data through conducting interviews with key stakeholders and professionals in the field of water resources management. We found the main barriers posing the implementation of the One Water framework to be; (1) siloed systems (2) funding and budget constraints, (3) political and social-buy in, and (4) socio-cultural understanding. Strategic action to overcome the addressed barriers will be key towards effectively implementing a One Water approach in the process of preserving Hawai‘i’s waters for the benefit of the people.

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1.0 INTRODUCTION

1.1 Ola I Ka Wai - Water is Life

Water has a unique value in the Hawaiian Islands. "Ola I Ka Wai" is a Native Hawaiian saying, exemplifying the importance of water in the Island chain, meaning "water is life." In Hawai‘i, Water has a long history of traditional agricultural practices that rely on water flowing freely from the mountains, mauka, to the shoreline, makai. The Hawaiian Islands have always been abundant in waters due to strong trade winds, mountains, and tropical climate driving precipitation patterns in Hawai‘i. However, western influence changed water management practice, whereas economic incentives controlled water resource decision-making. The Great Mahele of 1848 embarked on the beginning of land privatization and ownership (Stover, 1997). In many ways, the mahele welcomed a western economy in the Hawaiian Islands by re-designating the land management system.

Overall, western influence has caused many challenges to Hawai‘i and its resources, including water. There are many challenges to water resources today deriving from social, cultural, economic, and environmental factors. All the stressors culminate into a disequilibrium between water access and demand in the Hawaiian Islands. The water supply is becoming scarce, while the water demand is projected to increase by 40% over the next two decades (Haddout, 2021). O‘ahu and the Hawaiian Islands are on course for an emerging water crisis.

1.2 Thesis Roadmap - Study Focus and Objectives

The thesis work involves diving into water management on Oʻahu with the vision of sustaining Hawaii's water resources. Climate change, population rise, and other socio-economic factors drive Oʻahu towards a water crisis. As a response, decision-makers and critical water management agencies aim to solve problems through improving water management practices. The City and County of Honolulu are actively attempting to integrate a One Water (OW) framework to deal with the future water challenges on Oʻahu. OW takes a holistic approach to water management by encouraging collaboration across sectors and agencies. Currently, there are gaps and disconnections in the water sector rooted in the design of institutional and bureaucratic water governance structures. As a result, integrating One Water can prove difficult to provide efficient water management and improve the pre-existing water management system. Therefore, identifying the barriers to adopting a One Water approach on Oʻahu can provide value towards successfully implementing the plan and developing climate resiliency to water resources.

The project's main objective is to identify the barriers associated with the implementation of One Water on Oʻahu. Through engaging with key stakeholders from the public and private sector at a local, county, and state level, the goal is to explore how stakeholders perceive One Water. Central questions that the thesis work aims to answer include; how do stakeholders learn to recognize the value of One Water? How does a One Water approach fit into the pre-existing water management infrastructure? Lastly, what are the main barriers to implementing One Water on Oʻahu? Through a qualitative research design, the thesis can generate new knowledge on how to overcome the barriers

posing One Water and locate efficiencies in the water management field to ultimately sustain Hawaii's water resources.

1.3 The Ahupuaʻa System

The ahupuaʻa is the traditional term for understanding land division for watersheds in Hawaiʻi. Natural streams from valleys laid the foundation for the ahupuaʻa system that divided land from streams and watersheds in Hawaiʻi. The ahupuaʻa system emphasizes the interconnectedness between abiotic and biotic factors within the watershed from mauka (mountain) to makai (sea) (Mueller-Dombois, 2007). Similarly, the ahupuaʻa recognizes the responsibility that the kānakā, the people, have over the land and its resources, water being the most important. The Moku integrates several ahupuaʻa systems to form the conventional land division on the island. There are six Moku systems on Oʻahu, as shown in figure 1. However, the ahupuaʻa system was disbanded after western influence on water resources management reflected economic incentives and increasing privatization of Water in Hawaiʻi.

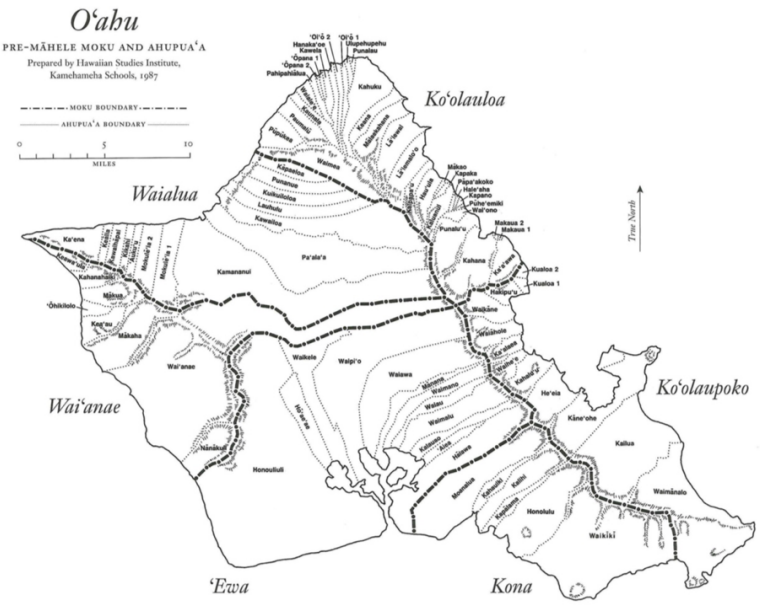

Figure 1. Overview of the ahupuaʻa division as a part of the Moku system, the traditional form of Hawaiian land division. The main Moku's on Oʻahu are; Kona, 'Ewa, Ko'olaupoko, Ko'olau Loa, Waialua, and Wai'anae. (AvaKonohiki, n.d.)

1.4 Climate Change Impacts on Water Resources in Hawaiʻi

Climate change means water change. Many studies have made it clear that climate change has detrimental implications for water systems (Leta et al., 2017; Timm et al., 2015; Church et al., 2013; Yang and Francis, 2019). There are a multitude of ways in which climate change will impact the Hawaiian Islands, including (1) sea-level rise level, (2)flooding, (3) extreme weather events, and (4) changing weather patterns. The listed effects have significant impacts on the hydrological cycle by causing imbalances in the supply and demand of water across the islands. Due to global warming, the global average temperature will rise, altering evapotranspiration rates and controlling water

budgets in the Hawaiian Islands (Leta et al., 2017). Furthermore, the amount of rainfall in Hawai‘i is declining (Timm et al., 2015). There are many challenges to water resources in Hawai‘i driven by climate change, altogether urging the need for redevelopment in the water management infrastructure.

1.4.1 Sea Level Rise

Sea-level rise (SLR) is a widespread impact of global warming threatening water resources in Hawai‘i. The melting of glaciers and ice sheets in Greenland and Antarctica is the primary cause of rising sea levels. Scientific research and studies show that the majority of countries all around the world can expect to experience SLR, including Hawai‘i (NOAA, 2021). The IPCC projects the global sea level to increase by 0.6 - 1.1 meters by 2100, given a 'business as usual scenario (Church et al., 2013). Similar to the rest of the world, the sea level in Hawai‘i will continue to increase in the future. Figure 2 shows the SLR exposure area on O‘ahu under mild (1m) and extreme scenarios (3m) in 2100. There is a clear pattern that areas near the coastline will experience significant impacts of SLR. Figure 3 illustrates the rate at which SLR increases on O‘ahu through time-series trend analysis from various data sources at the MOKU (Kāne'ohe)and HONO (Honolulu) stations (Yang and Francis, 2019). From the figure, the clear trend is that SLR is increasing. While each figure implies that SLR will occur at different rates, it is a valid interpretation to conclude that SLR will cause adverse impacts on all Islands of Hawai‘i.

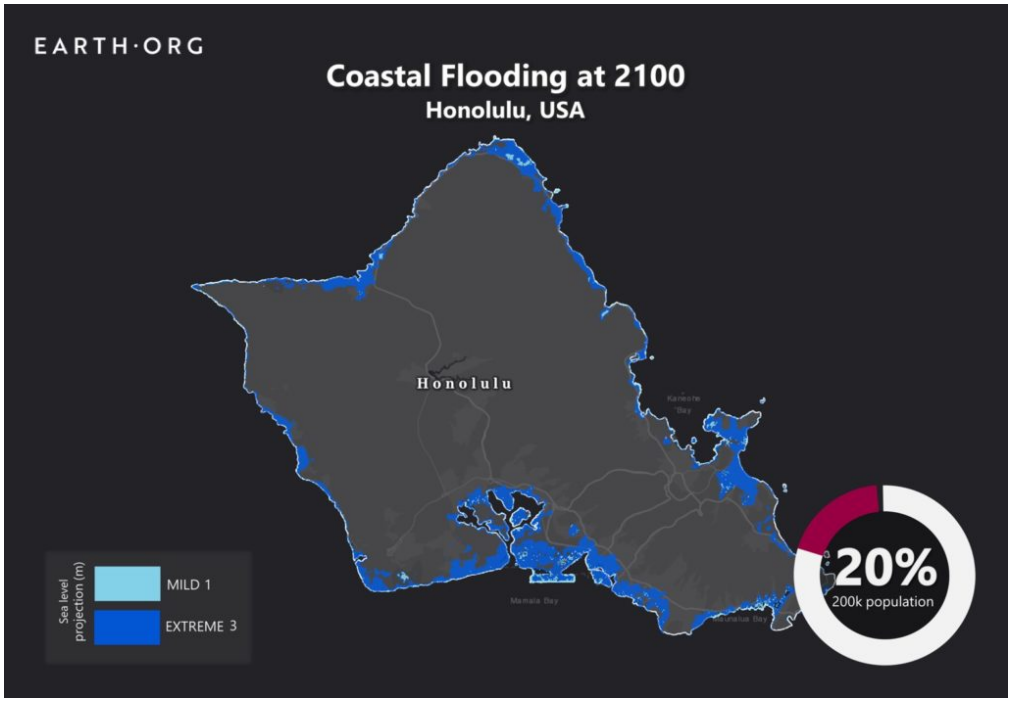

Figure 2. Map of SLR exposure area on O‘ahu under mild and extreme scenarios in 2100. The blue color indicated regions that will experience flooding. Coastal areas around the island are likely to be impacted to various degrees (Earth.org, 2020).

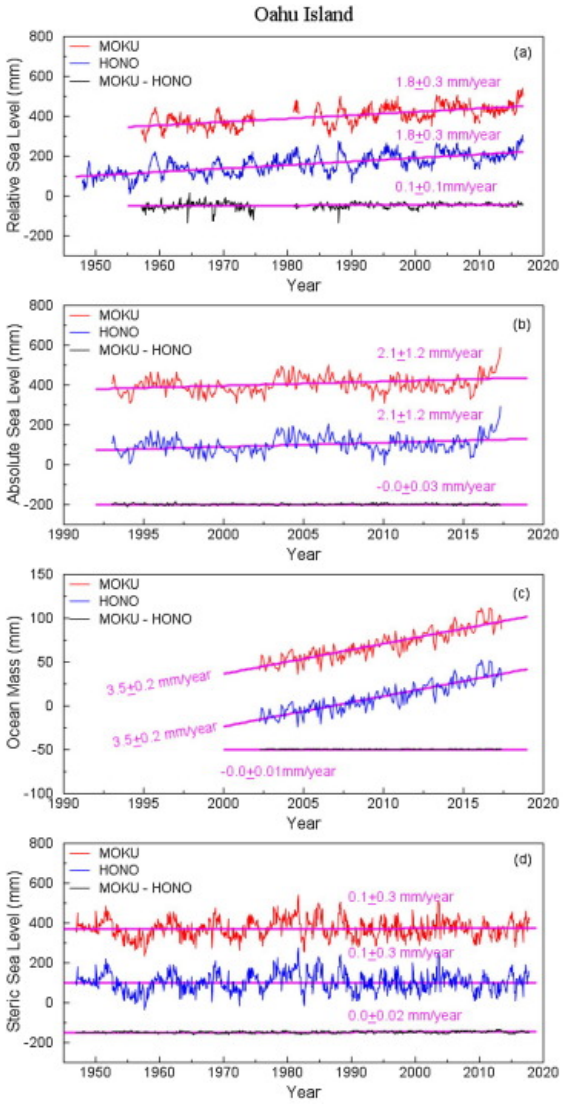

Figure 3. Representation of SLR trends on O‘ahu from (1) the MOKU station, (2) the HONO station, and (3) the difference between the stations. a) shows sea-level trends from tide-gauge data, b) from satellite altimetry, c) ocean mass from GRACE, and d) trends from salinity and temperature data (Yang and Francis, 2019).

The direct effects of SLR on water resources in Hawai‘i are mainly through saltwater intrusion caused by an increase in the groundwater table. Saltwater intrusion

involves contamination of potable groundwater in aquifers that results in decreased freshwater storage (Rotzoll and Fletcher, 2013). Ultimately, saltwater intrusion decreases water quality while reducing freshwater availability in the aquifers (USGS, 2019). On the other hand, increasing sea levels increase the groundwater table. The water table level depends majorly on precipitation. However, SLR can cause a natural increase in the water table beyond the natural fluctuations. As a result, areas become more easily flooded during heavy precipitation events and damage low-lying areas and infrastructure.

1.4.2 Flooding

Flooding is another effect of climate change that involves water overflow to submerge land and cause excessive water pollution. Flooding is a common phenomenon occurring during heavy rainfall events. However, flooding can more easily happen under high water table conditions. Hawai‘i experiences frequent flooding events, causing streets, houses, and excessive infrastructure to submerge. Flooding beyond natural levels has several adverse effects on people, such as destruction of property, the risk of drowning, and ecosystem degradation. Flooding causes excessive stormwater to contaminate bodies of water, impede runoff, and destroy crops, among others. Wells and other water supply infrastructure can be damaged during flooding events and decrease water quality through contamination. Overall, flooding can have several health impacts and cause issues to water resources.

1.4.3 Extreme Weather Events

Extreme weather events pose significant threats to water resources in Hawai‘i. Extreme weather events are the primary driver of flooding, harming social, economic, and environmental conditions. The formation of storms and hurricanes is directly linked to air temperature. Increasing temperatures warm ocean waters and contribute to a more unstable atmosphere, creating favorable conditions for hurricane formation. Defforge and Merlis found that sea surface temperatures (SST) have increased in areas of tropical cyclone genesis, suggesting a connection with strengthened storminess (2017).

Furthermore, changes in tropical cyclone intensity over the past 40 years have accelerated on a global scale (Kossin et al., 2020). During El Niño conditions, SST increases in the eastern Pacific contribute to more intense and frequent hurricanes and storms (Bell and Chelliah, 2006; Murakami, 2013). More frequent and extreme weather events drive the overflow of water in streams and runoff that pollutes large bodies of water, harming marine wildlife. Eutrophication and algal growth are two direct results of extreme weather events creating anoxic conditions in marine environments, overall reducing water quality.

1.4.4 Changing Weather Patterns

Changing weather patterns due to climate change leads to decreased rainfall in the Hawaiian Islands. Weather patterns in Hawai‘i are mainly controlled by the equatorial trade winds and mountains that create a windward and leeward side. On O‘ahu, the windward side of Kailua and Kaneohe receives significantly more rainfall compared to the leeward side of Kapolei and Waianae. ENSO circulation also affects weather patterns,

with more precipitation during cooling events in the mid-eastern equatorial (La Niña) than warming events (El Niño). On average, future rainfall changes in the Hawaiian Islands show a negative precipitation trend (Power et al., 2012). The contrast between the wet and dry regions in the Hawaiian Islands will increase (Timm et al., 2015). Figure 4 illustrates the changes in rainfall in the Hawaiian Islands, comparing models from representative concentration pathways (RCP) 4.5 and RCP 8.5 scenarios during wet and dry seasons. The simulations reveal that the wet seasons will have lower precipitation. On the other hand, the models suggest a more significant drying trend during dry seasons on the leeward sides of the islands.

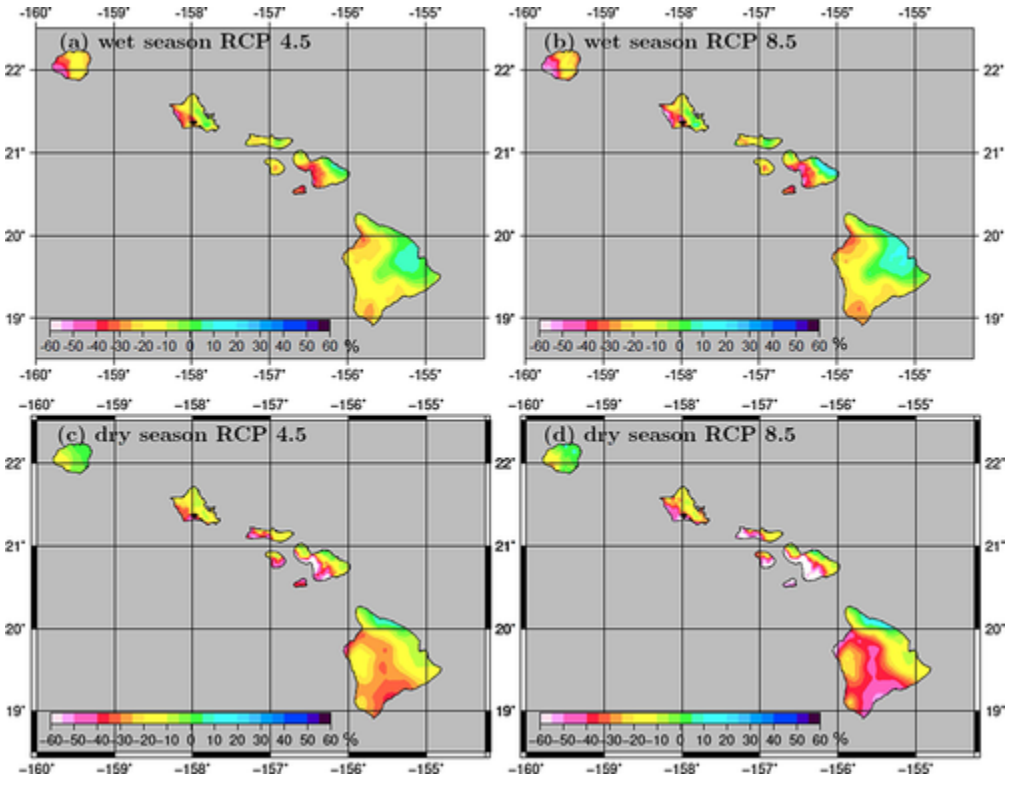

Figure 4. Model simulations RCP 4.5 and 8.5 scenarios predicting future rainfall patterns in the Hawaiian Islands from 2041 to 2071. The figure compares the wet and dry season trends to convey precipitation anomalies in each scenario. In both projections, the RCP 8.5 shows more significant anomalies in the wet and dry seasons than RCP 4.5. The model also suggests that the leeward sides of each island will become drier while precipitation slightly increases on the windward side (Timm et al., 2015).

Decreased rainfall in Hawai‘i is strongly correlated to a reduction in stream discharge and flow (Leta et al., 2017). Changing weather patterns causes the Hawaiian Islands to become drier. Drier conditions will increase water demand while limiting water supply through reduced streamflow and discharge. Aquifer recharge rates decline under drought conditions, increasing the likelihood of water shortages (Leta et al., 2017). During wet seasons, precipitation levels will increase recharge rates. However, the overall trend emphasizes that water scarcity will become a reality in the future.

1.5 Water Consumption on O‘ahu

A significant driver of the evolving water crisis on O‘ahu is rooted in the overconsumption of water. Water scarcity describes the level at which water supply cannot meet the demand, which is a common public health crisis in many places worldwide. Water shortages stem from both a disequilibrium between water supply and demand. The Hawai‘i economy relies on tourism, constituting 21% of the state's economy (Kiprop, 2020). Despite efforts to diversify the economy, tourism will continue to be the primary source of income in the future. Simultaneously, the tourism industry is

among the most significant water users. The largest water consumers in Honolulu in 2021 are listed in figure 5.

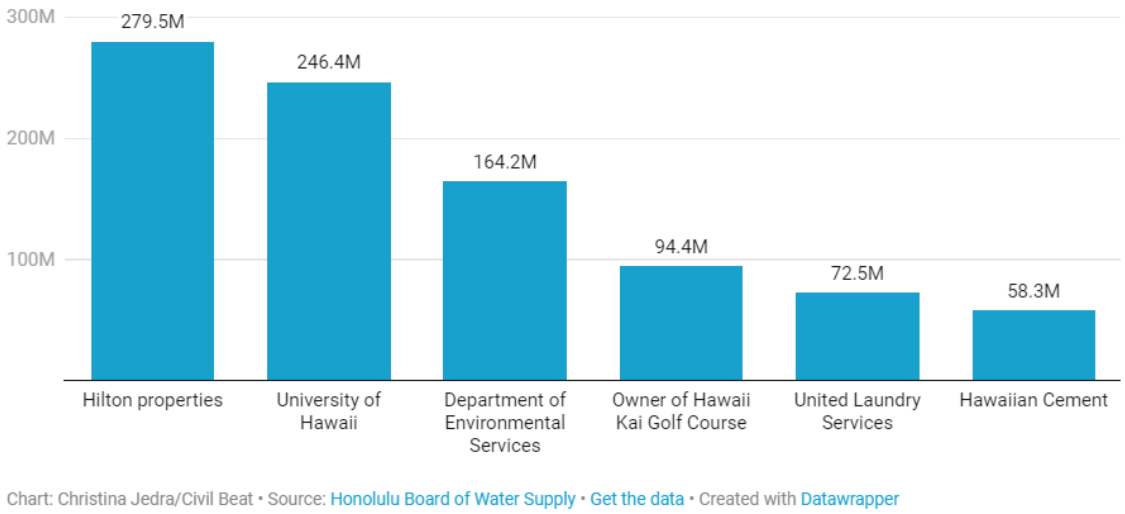

Figure 5. The figure shows the most prominent water consumers in Honolulu in 2021. Hilton properties use the most water, closely followed by the University of Hawaii at Manoa. Overall, the tourism industry uses the most water on O‘ahu (Jedra, 2022).

Hilton properties were the largest consumer of water in 2021, using over 280 million gallons of Water (Jedra, 2022). Interestingly, the University of Hawaii at Manoa followed closely, consuming about 240 million gallons of water throughout the same year (Jedra, 2022). The extensive water usage among industry and institutions show that water shortages are emerging. In March 2022, the Board of Water Supply (BWS) asked water customers to reduce their consumption by 10% due to the fear of water shortages driven by low precipitation and the shutdown of the Halawa shaft from water contamination (Jedra, 2022). The current trend of water usage stresses Hawaii's water resources (majorly by tourism) and urges finding efficient ways to promote the use of recycled water. By

providing insights into how water is consumed on Oʻahu, statistics on water supply and demand reveal the weaknesses in the water system.

1.6 Oʻahu's Current Water Infrastructure

In 1978, the State of Hawaiʻi passed legislation towards protecting and preserving water resources across the island chain. The State Water Code states: "the waters of the State are held for the benefit of the citizens of the State who have a right to have protected waters for their use" (HRS Chapter 174C). Through the State Water Code, the State of Hawaiʻi recognizes the need for implementing a statewide program addressing the issues and challenges facing water resources.

Conventional water management in the Hawaiian Islands is, by design, disjointed and complex. Water is managed through an extensive network of agencies that follow local, state, and federal regulations, as illustrated in figure 6. There are many entities affiliated with water management at a City and County level. Boards and departments play a pivotal role in controlling water fluxes in the system to comply with public health standards and deliver quality service to the community. For instance, the Honolulu BWS manages municipal water resources and functions as a distributional power providing residents with drinking water. Another key agency is the Commission on Water Resource Management (CWRM), which administers the Stater Water Code through planning, regulating, and monitoring water resources in Hawaiʻi. (DLNR, n.d). Overall, the infrastructure is structurally intertwined with overarching responsibilities among key agencies, boards, and departments to manage Hawaiʻi's waters ultimately.

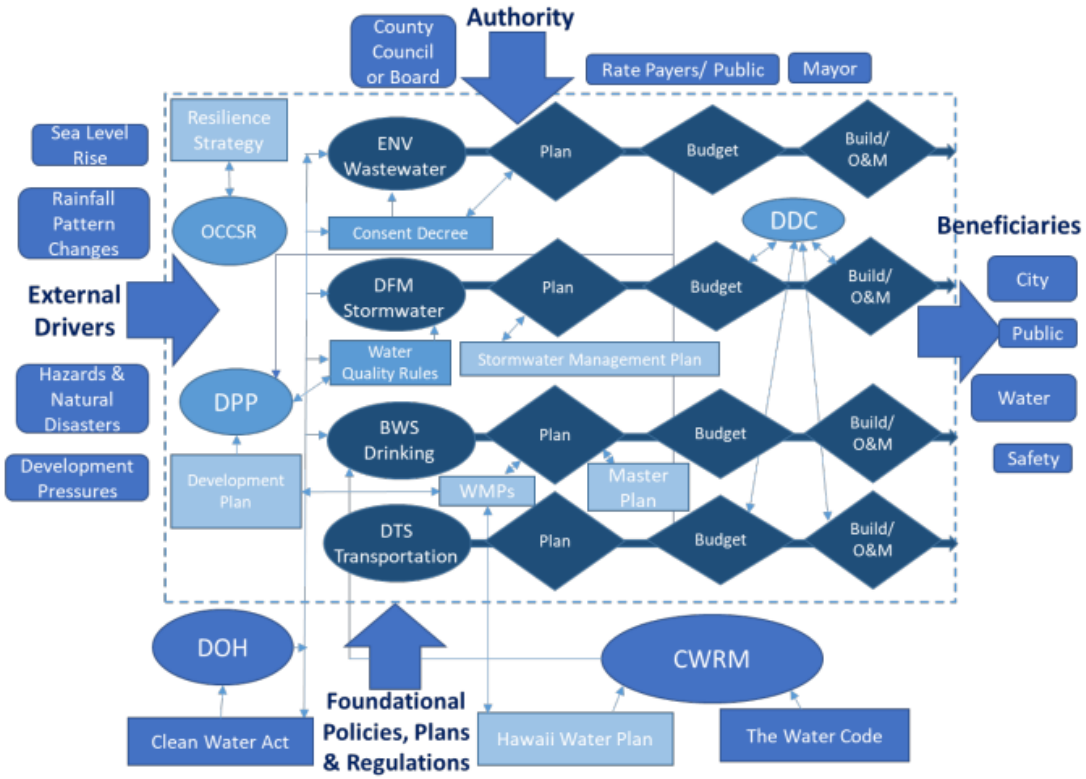

Figure 6. Network Diagram of Honolulu's water management system. The figure shows the responsibilities, functions, and roles each agency controls (One World One Water, 2020).

1.7 The One Water Approach

The One Water approach is a proposed planning framework within the field of water management designed to meet the future challenges posing water resources. OW takes a holistic approach to water resources management, integrating all types of water, including stormwater, groundwater, greywater, freshwater, seawater, and recycled water (US Water Alliance, n.d.). In developing One Water, planners redefined water sustainability by attempting to integrate the management of the overall water sector within one planning framework. Policymakers and planners recognize the

socio-economic and environmental need for improved water planning that addresses climatic and non-climatic drivers of water resources while efficiently managing the public's water sustainability goals (Egan, 2020). The management plan seeks to manage finite water resources while considering long-term resilience, reliability, and the needs of both the community and the environment (US Water Alliance, n.d.). The approach is meant to serve as a more inclusive and collaborative approach to water resources management by bursting through institutional tunnel-vision management, known as silos. The goal of One Water is to encourage collaboration across sectors and agencies to achieve multiple benefits from planning, programs, and projects that emphasize that all water has value.

1.8 One Water O‘ahu

In 2020, former Mayor of Honolulu, Kirk Caldwell, proclaimed to position Honolulu to build climate resiliency through establishing a One Water ordinance. One World One Water prepared a white paper stating the need for implementing One Water in the face of climate change for the City and County of Honolulu climate change in June 2020. As discussed, climate change presents significant threats to water resources by SLR, extreme weather, flooding, and changing weather patterns leading to decreased precipitation, etc. To combat the challenges to water quantity and quality deriving from climate change, limited budgets, and aging infrastructure, a One Water framework may help reach water security. The OW framework will be structurally integrated into Honolulu's current water management system, as illustrated in figure 7. While its integration point is uncertain, it is clear that One Water requires systemic change for

adoption purposes. Pushing for a One Water framework entails collaboration at the planning, program, and project development levels. Ultimately, realizing the benefits of the One Water approach demands structural change at the bureaucratic levels for implementation.

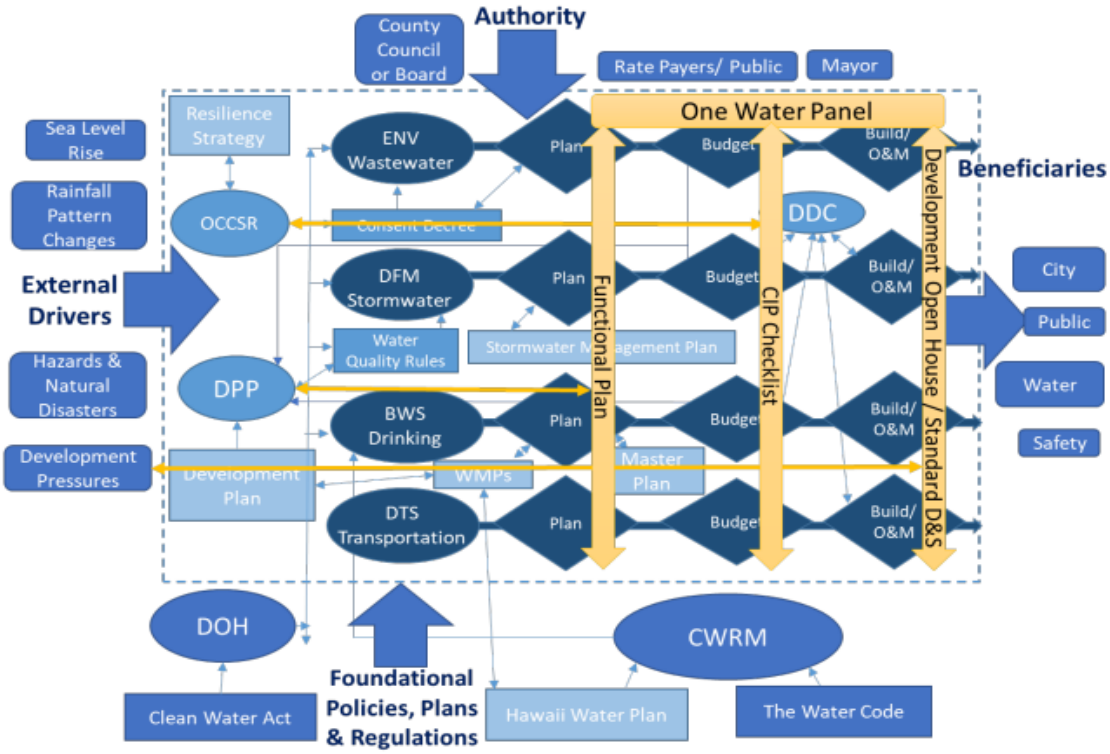

Figure 7. The proposed adoption of One Water to Honolulu's water management infrastructure. A-One Water Panel will be integrated into the system, functioning as an arena for overlapping responsibilities through collaborative planning, budgeting, and building operation and maintenance (One World One Water, 2020).

O‘ahu's One Water collaboration framework is designed to explore efficiencies in the water management system across sectors and disciplines. There are many overarching responsibilities in the bureaucratic structures to manage water, and OW O‘ahu seeks to

simplify the currently complex water management infrastructure and develop climate resiliency. The goals and objectives of OW O‘ahu are described in table 5. All goals and objectives emphasize a need for increased investments in the water sector, similar to integrated water resources management (IWRM). Especially projects involving using recycled water, stormwater, and wastewater for multiple purposes, such as the Freshwater Initiative launched in 2013. For current progress, a One Water Panel has been established to move forward with implementation efforts and build collective capacity toward climate change adaptation (One World, One Water, 2020).

Goals:	**1.** Fit for purpose use: value all water in the natural and built environment, utilize fresh, wastewater and stormwater resources for their best use, and preserve water's quality and quantity.
	2. Increase climate resilience and adaptation for freshwater, stormwater, and wastewater systems including the delivery and collection systems involved.
	3. Find efficiencies to partner on projects for the tax payer/rate-payer benefit, taking advantage of co-benefits, overlapping goals, and limited funding.
Objectives:	**1.** Establish the authority and develop processes that help enable collaboration on the goals listed above.
	2. Identify pilot projects to demonstrate the multiple benefits of 'one water' practices.
	3. Consistent messaging with the pubic and developers around stormwater, wastewater, and fresh water.

Table 1. The table shows O‘ahu's goals and objectives for a One Water framework. The goals aim to identify how water can be managed more effectively through recycling Water, developing climate resiliency, and the responsibilities for stakeholders. The objectives illustrate the proposed actions toward integrating One Water (One World, One Water, 2020).

As the One Water approach aims to be adopted in several states nationwide, including O‘ahu, barriers can be linked to its implementation. Previous research suggests clear institutional barriers to shifting towards a One Water approach (Mukheibir et al.,

2014). Several challenges pose the implementation of One Water on a national scale. For instance, a lack of systems thinking, political will & leadership, and siloed systems are challenges to One Water (Mukheibir et al., 2014). Similarly, efforts to adopt IWRM have preceding barriers that are closely related to One Water, such as a lack of clear direction, funding, and complexity (Yusof and Haad, 2020).

Furthermore, fragmentation in urban water systems through isolation can create disconnections that enhance the nature of siloed systems (Mukheibir et al., 2014). Other studies found a strict investment gap in water infrastructure at $81 billion in annual investments compared to its needs (IMS, 2020). While the benefits of investing in water infrastructure are enormous, the actual investments from decision-makers to realize projects reflect an undermining mindset towards water resources. Overall, a One Water approach faces challenges related to costs and institutional barriers within the water sector to be implemented. Breaking down the barriers will be necessary for One Water to be integrated on Oʻahu to ultimately sustain Oʻahu's water resources.

The research involved actively intervening in the planning process of the OW implementation on Oʻahu. The thesis project aims to explore the value of an OW approach on the island to water resources management and identify barriers that limit the planning implementation. The methods involved engaging with stakeholders to learn how professionals within water management recognize and understand One Water. Researching One Water in Honolulu can provide value to develop further planning efforts to overcome them and successfully shift to a One Water approach locally and statewide. Ultimately, the research contributes to facilitating planning as an effective tool to combat

the future challenges to water resources driven by environmental, social, and economic stressors.

1.9 Stakeholder Brief

In adopting newly developed water management plans, stakeholders play a crucial role in ensuring a successful implementation (Focht and Trachtenberg, 2005; Brooks, 2002; Lane, 2005). Stakeholders represent community and business leaders, policymakers, agencies, institutions in the public and private sectors, and NGOs. Stakeholders greatly influence the foundation of planning frameworks by how they are designed, adopted, and monitored (Focht and Trachtenberg, 2005). In the planning process, stakeholders provide input to planning efforts that can be poorly understood and accounted for in decision-making (Handmaker et al., 2021).

Exploring value information among stakeholders across different sectors can provide essential insights and knowledge to develop effective planning frameworks (Taylor et al., 2015). By examining the acceptance of planning efforts among stakeholders, data can be utilized l in decision-making processes toward full-scale implementation (Handmaker et al., 2021). Ultimately, recognizing stakeholder value information in planning efforts allows decision-makers and planning practitioners to design frameworks that reflect socio-economic and environmental concerns more collaboratively.

2.0 METHODS

2.1 Study Site and Scope

The thesis work followed a qualitative research design.The selected research study site was O‘ahu and the City and County of Honolulu. In 2020, the City and County of Honolulu expressed their intent to integrate a OW approach into their water management system. Therefore, data collection involved interviewing key stakeholders who had professional experience working with water resources management on the island. The selected study group was limited to professional water managers from the public, private, and NGO sectors, including planning practitioners, engineers, project directors, etc.The rationale for the selected study population was to collect information and insights on the OW from multiple perspectives contributing to the project's scope. Despite OW becoming a nationwide approach to water resources management, maintaining and developing a local perspective on implementing the plan within the state boundaries was an integral part of the data collection process.

2.2 Data Collection - Qualitative Interviews with Key Stakeholders

Qualitative interviews were the primary source of data contributing to the research. We collected data through qualitative interviews with key stakeholders from the study site's public, private, and NGO sectors. The stakeholders represent their respective agencies and entities from the local, county, and state levels. Interviews were held upon completing the IRB protocol from January till March of 2022. We approached interviewees through formal invitations over email. Once the interviewees agreed to participate, we obtained consent, and video conferences through Zoom were scheduled

for an interview of 30-50 minutes. Overall a total of 10 interviews were conducted to maintain a qualitative research style. The study group was not deliberately limited to 10 practitioners; however, it represented many O‘ahu's current water management practitioners. A complete stakeholder interview list is disclosed in Appendix A. The list gives an overview of the local, county, and state agencies we interviewed for the research.

A standardized set of questions was intended to guide a semi-structured interview with the allowance of follow-up questions. All questions were related to the interviewees' professional practice. The questionnaire consisted of four sections, including (1) an introduction, (2) open-ended background questions, (3) a set of questions directly related to One Water, and (4) follow-up questions. A talk-story guide was designed to provide a roadmap for the interview procedure. The talk-story guide includes desired outcomes and objectives that we tracked across the interviews and a list of questions in the interview. The complete stakeholder list is enclosed in Appendix B. The purpose of the talk story guide is to provide insight into the data collection and interview process.We asked the same questions to all the interviewees independent of their professional background in managing water resources in Hawai‘i. Lastly, the researchers followed the interview protocol to ensure the interviews were conducted professionally. All interviews were audio-recorded through Otter.ai, an open-access live transcription software.

2.3 Data Analysis

The data analysis involved conducting a qualitative textual interpretation of the collected data in stages. The first step was to do a close reading of each interview

transcript independently, summarize them, and draft key points expressed momentarily upon the completion of the interview. Reviewing interviews was done in the online application Otter.ai and quality-proofed to ensure the validity of the data source for the research.The recordings were destroyed after the transcripts were coded correctly. The anonymized transcripts were analyzed to answer the research questions and draft preliminary results.

We analyzed information and insights carefully to contribute to the results and discussion portion of the study. After completing a sufficient number of interviews representing the baseline data collection, results were drafted and organized. In the second step of the analysis section, interviews were compared and contrasted. The goal of the preliminary results drafting was to draw similarities and differences in the knowledge delivered by stakeholders related to the One Water approach and water resources management within the study site. Similar ideas across interview transcripts were grouped according to the topic and ideas. Furthermore, we inductively drew common themes across all interviews to develop qualitative characterizations of the discussions. Ultimately, the barriers to the OW approach expressed by the stakeholder groups within each sector were identified, drafted, and discussed.

3.0 RESULTS

Evidence from the interviews suggests that several barriers are linked to the implementation of One Water on O‘ahu. The identified barriers are inductive, meaning they derive strictly from the interviews. The findings are illustrated in figure 8. We found that there are four underlying barriers to the implementation of One Water on O‘ahu: (1)

Siloed systems, (2) funding and budget constraints, (3) political and social buy-in, and (4) socio-cultural understanding. Altogether, the identified barriers of One Water are unique to the research study and were drawn from the various responses from the interviews. Additionally, the results are unique to the setting of O‘ahu and the Hawaiian islands and can be different in comparison to other states in the US.

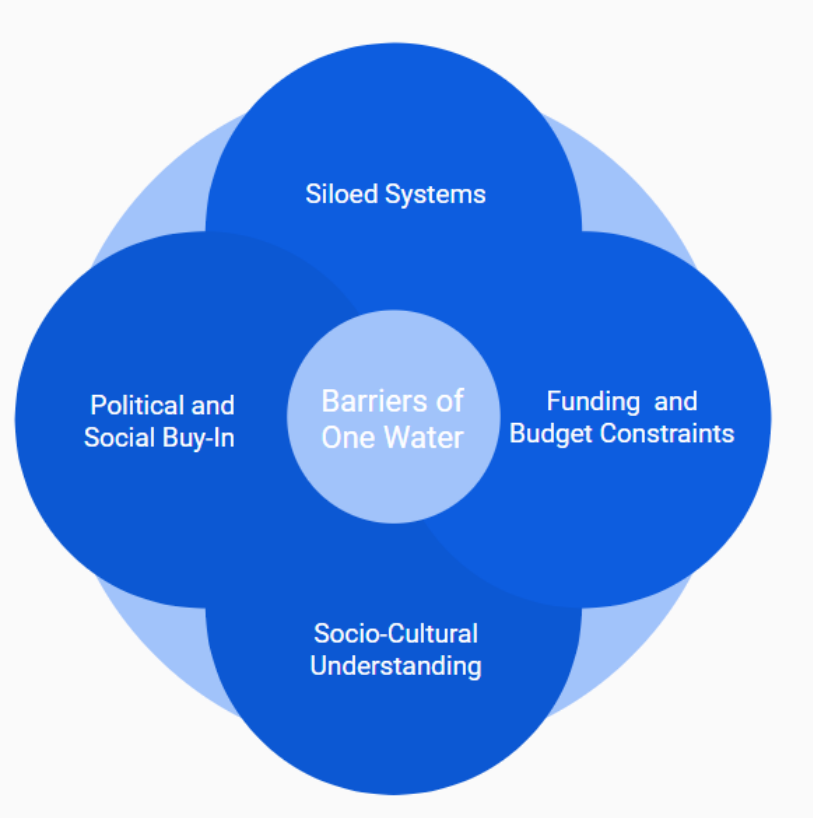

Figure 8. The barriers to implementing One Water on O‘ahu. By analyzing the collected data, there were four consistent across all the interviews.

3.1 Siloed Systems

Siloed water management systems are a clear barrier to the implementation of a One Water approach. Siloed systems refer to how the various elements of the governance

landscape are disconnected due to the individual management of water, strictly limiting cross-sector collaboration. Interviewees reflected on siloed systems in the current water management regime and noted how they would make it difficult for One Water to be implemented. For example, one respondent noted:

> "Departments tend not to work with each other... they're all very busy with whatever they're doing".

This tendency reduces the amount of cross-sector and inter-agency collaboration. Agencies, institutions, and organizations work specifically towards their tasks, goals, and objectives. While there is an incentive to collaborate and share knowledge across skills and disciplines, this tends to be overlooked. The question is, why is that the case? Interviewees suggested three answers to this question. First, a root cause of the development of siloed systems for water management can be related to costs and accounting. To highlight this issue, a respondent said:

> "Water branches are separate…have separate priorities, and those priorities do not always align well…and they are all operating and competing against each other for dollars for their individual and separate projects".

Secondly, while water access through permits is gained, competing for funding induces barriers that enhance the nature of siloed systems. A market-driven approach where branches compete for their projects tends to create water management separations by limiting collaboration.

> "To help leverage these projects where for the government or private sector...they just can't quite fund it..even though the overall benefit to society would be very beneficial."

Third, stakeholders explained how the emergence of siloed systems is induced by the education system, in which we are trained and educated to work individually. A respondent discussed the occurrence of silos:

> "Agencies do not grow in siloed forms...at a university level, we train them to be siloed."

Several interviewees related siloed systems to systems-thinking. According to the respondents, students at the university level were educated to become knowledgeable within their significant and specific field of interest, enhancing tunnel-vision towards future work. Tunnel-vision is another way to view silos by extensively overlooking the broader picture. Training to understand water systems reveals water infrastructure vulnerability, especially for professional areas where water concerns face integration. To emphasize the issue, a respondent said the following:

> "At the city level..to a certain degree... wastewater, freshwater, and other agencies operate in separate silos and do not think of themselves as integrated."

Disconnections within the design of bureaucratic infrastructure in the form of silos are related to skills and expertise, similar to academic disciplines. There may be more subtle practical motivations to this picture as well. Working in silos encourages individual decision-making that embraces the political power of entities. For instance, an interviewee noted:

"Politically, people enjoy their silos and freedoms."

Silos are a form of political space for water management with a lot of institutional inertia. Institutional silos create loopholes for coordination and knowledge sharing internally and between agencies. As one respondent noted:

> "What I'm seeing…is that at the state, county, and federal levels…everyone wants to create their own little spaces to share knowledge..but there is no line for how we are coordinating across agencies and across sectors to share data and information to use it collectively".

In addition to financial incentives, silos also create spaces in which practitioners become comfortable. The silos are tight spaces that have worked for practitioners, so why bother changing them? However, within the One Water framework, the plan is to eliminate silos to facilitate cross-sector and inter-agency collaboration, which will require water practitioners to rework or rewire institutional relationships, or as one interviewee put it:

> "If we are going to take this One Water approach…and be one integrated unit related to water…then if we are to keep our silos or keep our organizations…there need to be really tight ways that we relate and rely on one another for decision-making".

If the existing water management infrastructure can successfully integrate a One Water approach will stand as unknown in the equation. Despite this, some participants saw One Water to evaluate the current system and explore efficiencies in water management.

> "One Water may be helpful to evaluate whether the existing system is as sufficient as it should be....or can we create a new system via that evaluation...that is more efficient and beneficial to the collective society?"

Simultaneously, there were opposing views in which the implementation of OW might introduce itself. The fundamental question multiple interviewees revolve their points around is related to the degree of fitness in the current system.

> "Where I see a lot of pushback… it's like the system does not want to incorporate the new framework...and so then you have to create a new system so that we framework can thrive holistically as its intention".

A OW approach might function as a double-edged sword. While the already existing water management system is designed to be siloed, OW can help alleviate the problem, but it can also disrupt the current water management practice.

> "You are going to sacrifice some of the altruistic values of One Water approach in order to meet and fit into a system that's already existing… that's where I see the tension playing out in the One Water framework approach."

Successfully implementing a OW approach on O‘ahu requires that key water management professionals and decision-making bodies are willing to step out of their silos and work in a more collective-oriented manner. Interviewees brought up the importance of OW to facilitate collaboration and bridging of skills and expertise. Innovative ideas and projects can be more easily designed, implemented, monitored, and evaluated under a OW framework. For instance, a respondent said:

> "I think the benefit of the One Water framework is coming up with new solutions to water management that you would not think of within your individual silos.'"

Stakeholders expressed their interest in seeing how OW can be integrated into local and statewide water projects. For instance, the Red Hill case highlights the fragility of current water management. Identifying ways OW can actively solve local water challenges can help build public trust and understanding of One Water's intention. "Red Hill demonstrates the strength and weakness of our water governing bodies...and we're seeing a lot of disconnect... it's a challenge…but also an opportunity".

Overall, the siloed nature of current water management poses challenges to the implementation of OW on O'ahu. OW can be a practical approach to burst through the silos, or it can, as expressed by stakeholders, create further disconnections in the water system. Interviewees reflect on OW to present itself as an opportunity in which bureaucratic structures are forced to work collaboratively within their projects and roles towards water governance. The majority of respondents view siloed systems as the main barrier facing the implementation of One Water, and this is the common theme around which the following barriers consider.

3.2 Funding and Budget Constraints

Stakeholders reported funding to be a core barrier to implementing One Water on O'ahu. Funding is a necessity in realizing plans and projects in the community. Projects from the public and private sectors require substantial funding and sufficient resources.

> "To help leverage these projects for the government or private sector...they just can't quite fund it..even though the overall benefit to society would be very beneficial".

Interviewees expressed funding to be a significant barrier to implementing plans, programs, and projects in the state of Hawai‘i. A lack of financial resources for current water management poses challenges to One Water to be implemented as it can be viewed as an additional entity and initiative to support the water management infrastructure. How decision-makers will prioritize funding under a One Water framework is another question several stakeholders report. For instance, a participant said:

> "Under a One Water Approach….do we invest in those communities that are most vulnerable?.... And put the money there to create a more holistic water space for them?"

Equity is a repeated theme throughout the interviews and something stakeholders believe One Water should explicitly strive to seek. Ensuring that everyone in the community is given equal opportunity and benefit under a OW approach is essential to several respondents and needs to be addressed under a potential OW adoption at a broader range than the county level.

> "How you pay for implementing One Water will be critical...and how do you ensure that it is equitable?".

With the pre-existing silos in the sphere of water management, silos may enhance this issue. As agencies and organizations push for their individual projects to receive funding already in a system that receives minimal grants, a respondent addressed the following:

> "We don't have as much time as other places to implement One Water… so I think environmentally with climate, the climate crisis, sea level rise, etc... it's going to be challenging to do it, and a lot of it will be money-driven, cost-driven."

Where the funds will come from is a leading question, and how agencies operate to integrate a OW approach becomes a question mark in the context of water resources management. In Hawai‘i, most funding for water is provided by ratepayers and not from federal grants.

Decision-making is primarily controlled at a higher state or governmental level but can be encouraged from lower community levels. The majority of the interviewees mention funding to limit One Water from being implemented and as a statewide concern to water resources management. Furthermore, several stakeholders expressed the various questions about the financing of One Water by questioning:

> "How will funding be prioritized in a One Water approach? What will the budget look like? How will projects be implemented and directed?".

Stakeholders reported the presence of several questions that remain unanswered from an economic point of view, given their knowledge of One Water. Budget constraints are a barrier that needs to be overcome to implement OW on O‘ahu successfully. Altogether, identifying the costs of One Water to be integrated into water management practices can help alleviate the issue of financing the planning framework, as communicated by relevant stakeholders.

3.3 Political and Social Buy-in

Respondents described the budget constraints of implementing OW to be aligned with the degree of political buy-in to water resources. The degree to which decision-makers are on-board with stepping towards investing in water resources management and the OW approach is lacking. A respondent reflected on political will and leadership to limit the plan implementation of OW by asking:

> "Are we prepared to take that funding for One Water once (or if) given…and use it in the best possible way?"

While a OW framework in the City and County of Honolulu to proactively address climate change impacts on water resources, decision-makers need to be aware of the scale of impact. Learning how an OW approach can help solve climate change by building resilience and adaptation in the community is a common theme expressed throughout interviews, asking; "What is the value of a One Water Approach?".

Furthermore, respondents described the political buy-in of implementing OW as related to mindsets and ways of thinking. In many interviews, stakeholders reported that decision-makers may be aware but are not actively integrating climate science.

> "It (water management) has limited resources…and the way people think about climate change reflects that it's a mindset issue of tomorrow's problem."

The common theme is a lack of urgency toward managing water in response to climate change. Several interviewees pointed out the City and County of Honolulu to be a leader in addressing these issues; however, on a statewide scale, it's not happening. Multiple stakeholders emphasized that to implement OW; there has to be a shared

awareness and understanding of what the future looks like to tackle water challenges in a holistic approach. Building leadership in the higher political decision-making bodies and the lower community levels is a barrier and an opportunity that stakeholders frequently expressed in the interviews.

Respondents talked about the importance of having community leaders advocate for holistic water management practices such as One Water and for people to understand what a OW approach means for them.

> "We need just to get people more engaged and understand how they are part of that integrated (water) system…. what is the role that you individually play you and your family play your family and your community play…. in this larger framework of water resources management and One Water?"

Stakeholders also reported the undervalue of water in the community and legislative bodies to be the main challenge. While Hawai‘i has established water as a public trust, few resources are allocated to bridge skills and expertise within the silos and the community. For instance, a respondent said:

> "Building trust….is really about educating others about what it means like what is One Water and in a very clear, succinct way, right..finding ways to make it relevant to people".

The political and social buy-in to implementing a One Water framework presents itself as a challenge, driven by the silos that the bureaucratic structures in water management are designed today. Finally, a respondent discussed how:

"Making sure that the board and commission members of the key decision-making bodies actually have somebody on it with water expertise."

3.4 Socio-Cultural Understanding

A final barrier to the implementation of a OW approach on Oʻahu deriving from siloed systems is related to the socio-cultural understanding of water in Hawaiʻi. Stakeholders to water resources reported how:

> "There is a history in Hawaiʻi of water being taken away from people..and native uses...and move to support the economic benefit of the few...that is an elephant in the room that is still there."

Combating the socio-cultural barriers to OW implies integrating Native Hawaiian knowledge of water management. The ahupuaʻa was the traditional form of water management that emphasizes the system's interconnectedness from ecological, social, and cultural values. Connecting this to One Water, some stakeholders emphasized the potential conflict with local values by introducing a western framework to water management.

> "A One Water approach might be new across the country….however, in Hawaiʻi…traditionally, a holistic approach to water management has been a part of Hawaiʻi's identity and relationship with water..through the ahupuaʻa".

Therefore, stakeholders reported the issues that One Water may induce arise from a socio-cultural landscape. Trying to implement a new framework for water resources management without understanding the place of Hawaiʻi is a primary concern of some

respondents. Ultimately, a One Water framework will have to find its way around these barriers to be effectively implemented.

4.0 DISCUSSION

4.1 Bursting Through the Silos

Based on the interviews with stakeholders to water management on O‘ahu, there are clear barriers to implementing One Water. The nature of the current water management infrastructure in Hawai‘i appears to be the dominant barrier to implementing OW. Knowledge sharing and communication at different levels, from local to county, state, and federal levels, are limited due to the nature of silos within water management. A suggested implication of the finding of siloed systems is how siloed systems can create further disconnections in the institutional landscape to water management. As reported in many interviews, integrating a One Water approach entails incorporating another entity into the water management, serving common goals with theoretical and practical implications. The reason why OW can enhance disconnections is by how the work of professional water managers can potentially change under the framework. Presented in the results section, water managers often work on their projects within their organization. Under a One Water approach, water management practitioners can have additional overarching roles and responsibilities to ensure that a collaborative framework is maintained. Therefore, the added tasks in the professional workspace resulting from One Water integration can be overwhelming for the practitioners and reduce efforts and motivation for their role in managing waters collectively.

As presented in the results section, a lack of system-thinking among decision-makers and water managers is the primary driver of the current silos. People operating within their silos represent an institutional barrier that most professionals are unaware of. The pre-existing silos cause conflict with what One Water attempts to achieve, which is to burst through the silos. It remains a challenge to force people across disciplines and sectors to step out of their silos and work as a collective unit. A lack of systems thinking stems from the educational system, in which people are trained to become experts within their field and become tunnel-visioned by training. Understanding water's ecological, environmental, social, political, ethical, and technological dimensions become crucial to creating an open-minded environment for people to work together successfully.

Rooted from the bureaucratic silos, funding and budget constraints show to be another significant barrier to implementing One Water. Gaining funding and federal grants for managing water resources have been a common issue for decades, and shifting to a One Water approach does not make it any easier. The problem is that water is undervalued, thereby receiving less attention in grants and financial support. A known barrier to implementing IWRM is related to the pricing of water (Yusof and Saad, 2020). In Hawai‘i, people are generally unaware of the actual cost of capturing, treating, and delivering clean water for their uses (HawaiiCommunityFoundation.org, n.d.). A lack of investments in the water sector and the ability to hold and prioritize funds in departments have left infrastructure in despair (HawaiiCommunityFoundation.org, n.d.). This finding agrees clearly with the significant investment gap in the water sector to support improvements in the infrastructure. In 2019, there was an 81$ billion investment gap in

the water sector, implying imbalances in government spending on water projects and infrastructure (IMS, 2020).

In the light of the evident gaps in gaining funding and grants within the water sector, pushing for a One Water approach becomes tough as several agencies already compete for financing for their projects. Prioritizing funding is an existing challenge to IWRM (Yusof and Saad, 2020: Mukheibir et al., 2014). As reported in the results section, stakeholders asked themselves several questions about how the state will prioritize funding under a OW framework and how it can be equitable. The government factors into the water resources management through regulation and policy actions. The finding of funding and budget constraints to implementing One Water is related to how ratepayers are the dominant financial structure of water management. The fixed fee determined by the government provides an economical system for water infrastructure services and maintenance costs.There is no clear answer to why the government does not subsidize the water sector to a greater extent; however, water users, meaning the general public, should understand the importance of preserving water resources and be encouraged by higher legislative structures to support the transition towards OW as they represent the main economic structures.

Furthermore, to gain funding for One Water, educating people about the value of One Water can have a positive impact. While intuitively, an integrated approach to water management sounds great, people need to understand how they are a part of their system to create relationships with One Water. Without engaging with the community on this matter, One Water will remain unknown to the broader community. The Hawai‘i Community Foundation emphasizes the importance of education to implement the Fresh

Water Initiative to improve consumer awareness of the need to conserve the resource (n.d.). Education can break several barriers to implementing IWRM, such as system resilience. In an aging water infrastructure, education can ensure that future generations understand the value of water and how climate change alters the water cycle to upgrade facilities and expand infrastructure. Overall, as One Water Honolulu wants to establish itself as a solution to water security, raising awareness of climate change in the community can provide value to implementing the plan. Therefore, political and social buy-in can be tailored to this picture.

For most plans and programs to thrive, there needs to be leadership. As for One Water, there is a call for community and political leadership to advocate for the approach. Building climate resiliency and water security through One Water requires coordination from key stakeholders and agencies (Mukheibir et al., 2014). To promote systemic change in a system, leadership needs to be present. A preceding barrier to IWRM frameworks, similar to One Water, using the EU's Water framework example, was a lack of direction (Yusuf and Saad, 2020) The authors also discuss how introduced frameworks often involve innovative ideas meant to improve the system and can be misunderstood (Yusuf and Saad, 2020). In adopting complex water frameworks, leadership can help involved groups gain clarity on which paths to implementation of which the plan will take. Therefore, clear guidelines and action plans for a OW framework demand spearheading by a leading agency. Ultimately, finding leaders in the community and higher decision-making bodies must successfully implement an OW approach and other IRWM frameworks.

Insights gained on the implementation of OW in Hawai‘i illustrate the importance of understanding the socio-cultural landscape of the environment. Traditionally, holistic approaches to water management are not new in Hawai‘i, and attempting to introduce a more western framework can create conflict in the community. Equity is a fundamental objective of the planning process, and while water is public trust in Hawai‘i, there are gaps in how OW can be equitable outside the City and County of Honolulu. Public trust entails how the people have the right to have water protected for their uses, including access to enough water and clean water. Efforts such as the Fresh Water Initiative recognize water's socio-cultural value to its users by promoting watershed (ahupua‘a) protection (HawaiiCommunityFoundation.org, n.d.). The people of Hawai‘i are engaging on local water issues, as seen through the Red Hill conflict. Developing ways in which OW can overcome the socio-cultural barriers will be key to its implementation. Ultimately, ensuring that local voices are heard and accounted for through participatory planning and stakeholder engagement should be integrated into the OW framework.

4.2 Theoretical and Practical Implications

Adopting a One Water approach calls for structural reforms in water resources management. The study confirms how institutional barriers constitute a significant challenge for One Water. Given how siloed systems occur to be a common theme in water management and the issues of inter-agency and cross-sector collaboration this induces, systematic change is required. The theoretical implications of One Water revolve around the structural changes that need to happen in the water governance bodies. Several participants affirmed the challenges to One Water by how, structurally, One Water is likely to be unfit for the current system due to complexity. Similar to One Water,

complexity has been identified to be a significant barrier to implementing IWRM. Yusof and Haad discuss how overstated frameworks lead to the inability to understand water resource issues' technical and management complexity (2020). As a result, the complexity can contribute to poor management and monitoring of the framework. One Water aligns with this initial finding to IWRM. The OW approach represents an overstated framework that faces acceptance issues among stakeholders due to its complex structure. As discussed, One Water can provide means to evaluate the current system to promote holistic approaches to managing water resources. In conclusion, One Water can challenge the current water management system by leading a structural reform in the landscape of institutional governance of water resources.

The practical implications dig into the behavior and habits of water management practitioners and decision-makers. As One Water calls for a systematic change of the bureaucratic structures, professionals within the water management field simultaneously have to adjust to a One Water framework. The most apparent practical implication will be through willingness and commitment to work more collaboratively. In the One Water framework, stakeholders have to work across sectors and agencies, sharing innovative ideas, information, and knowledge to emphasize the values of One Water. With this, practitioners have to see themselves dedicating time to collaborate, coordinate daily/weekly/monthly meetings, and find ways to do One Water effectively. Given the constraints to the One Water approach and how difficult it is to re-organize workspaces in the field, the practical implications must be further explored and factored into the OW framework. However, what is clear is that both the addressed theoretical and practical implications are likely to impact the full implementation of One Water.

4.3 Study Limitations

Qualitative interviews with stakeholders on water management provided significant insights into the barriers to a OW approach. However, there are some clear limitations of the study worth to be noted. Analyzing interview data required qualitative interpretation, and it was challenging to draw patterns across interviews in a descriptive and organized manner. Within the data analysis framework, the quality of data varied significantly among the interviews. Maintaining and collecting objective observations and insights to a OW approach could potentially limit the quality of the study. For instance, short answers can lead to a lack of complete understanding, and a lengthy explanation can lead to missing the main point of the response and reduce the quality of the qualitative interpretation.

Furthermore, the study included a smaller sample size than may be required to make a thoughtful conclusion for the scope of the study. However, 10 interviewees represented a large quantity of practitioners, emphasizing the minimal resources in the field of water management. While the goal was to conduct 30-minute interviews, some interviews went as far as 20 minutes longer than anticipated, which made the transcription and analysis time-consuming. Another limitation of the study is the nature of conducting interviews, which requires coordination and scheduling over email, which was a process that extended the duration of data collection. Therefore, successfully scheduling interviews could take weeks to accomplish.

4.4 Further Research

Engaging with stakeholders to identify the current and predicted barriers to a One Water approach can significantly benefit its implementation. Overcoming the discussed challenges can allow a smoother transition to a One Water framework at the local level and state-wide. Gaining insights into how stakeholders learn to recognize the value of a One Water approach shows how far the planning implementation has come, its challenges, and what needs to be done to operate as desired.

There is potential to expand the study on One Water and conduct further research. For the scope of the research study, we focused on the OW implementation in O‘ahu and the City and County of Honolulu specifically. However, it could bring value to exploring the statewide understanding of OW in the potential case of statewide implementation. As OW seeks to manage water holistically and encourage cross-discipline-and-sector collaboration, many agencies operate on a broader picture than the County level that would be meaningful to engage. While the goal of OW is to develop water management practices that actively address climate change and tackle future water challenges, it could be beneficial to engage with stakeholders beyond water management and even across islands. Ultimately, the plan is to adopt a OW approach across the state, so head-starting the planning process to understand the setting for a OW implementation on Maui, Hawai‘i Island, Kaua'i, etc., would be the desired objective for future studies.

4.5 The Path Forward for One Water

The current silos aligned with funding, political & social buy-in, and socio-cultural knowledge are the main barriers to One Water. While the goal of OW is to

break through the silos to support a holistic approach to water management, the found barriers limit the implementation and must be overcome for One Water to be adopted. The challenges are rooted in how people think about water in the community. In many ways, the way water is undervalued in society results from the education system itself. As discussed, silos are forged in the educational system by training skills and disciplines.

Additionally, the climate change impacts on water resources have to be communicated effectively to water users, i.e., the general public. Communicating the significance of climate change and its adverse effects on water resources can ensure that future generations understand the system they are a part of. Developing a unified vision among stakeholders entails that resources have to be prioritized to train students to be systems-thinkers and understand their roles and responsibility in the community. The idea of kuleana, a Native Hawaiian term used to describe one's responsibility in the community they live in, has to be established for One Water to function as intended but can take decades to achieve.The implementation of One Water follows the same lines. Shifting towards One Water requires better education on water systems and raising awareness of what One Water means for the public, private, NGOs, and the general public. Overcoming the barriers to a One Water approach entails bridging the gaps in skills and expertise within disciplines and agreeing to a unified vision to combat future water challenges. Climate change poses significant stressors to water systems in Hawai‘i, and without recognizing how One Water attempts to address these issues, it will be challenging to integrate the approach.

Ultimately, shifting to a One Water approach encourages a mindset change in how state, county, and local entities manage water resources. Siloed systems present

themselves as the main barrier to implementing One Water. However, the benefits of a One Water by collaborating can have immense value towards sustainable water management. One Water faces challenges related to the social, technological, ecological, economic, and political dimensions. Even though the path to achieving systemic change through integrating a One Water approach is a challenge. However, by theory, it is not impossible.

5.0 CONCLUSION

Climate change has detrimental impacts on Hawai‘i's water resources. Through SLR, extreme weather events, and decreased rainfall, it is unequivocal that there will be changes both in water quantity and quality. In the planning process toward a One Water framework, the study attempts to gain insights into how stakeholders understand OW and identify the barriers to its implementation. Overall, the study successfully identified four key barriers to the implementation of One Water through qualitative interviews with stakeholders.

The nature of siloed systems, derived from gaps between skills and expertise in water management, is the dominant barrier expressed by stakeholders. Siloed systems create disconnections that limit cross-sector-and-discipline collaboration and are already a challenge in water management. One Water presents itself to be a silo-bursting initiative promoting communication, knowledge sharing, and collaboration between local, state, and federal entities. However, we also found that OW can enhance the pre-exisitng silos by how it can be viewed as another initiative that ineffectively develops climate resiliency and the current water practice of water management.

Furthermore, funding and budget constraints are other key barriers to One Water. A lack of federal grants and financial support to shift to a One Water approach can delay the plan's implementation time, reduce its efficiency, or lead to decision-makers neglecting One Water. Communicating the value of a One Water approach with the public and key decision-makers can solve many challenges posed from the political and social buy-in. Also, ensuring that One Water aligns with the socio-cultural importance of water in Hawai‘i must also be overcome. Water is public trust in the Hawaiian Islands and has a unique meaning to the traditional way of watershed management in the form of the ahupua‘a. Reintroducing holistic water management through One Water requires people in the community to engage in its value and purpose, which poses challenges.

Shifting to a One Water approach can be the step in the right direction towards water security and proactively address climate change impacts on Hawai‘i's water resources. Overcoming the barriers facing One Water on O‘ahu should be a key emphasis in the future planning work of the program towards its implementation. One Water can be a pioneer effort to address climate change impacts on water resources in sustaining Hawai‘i's water resources.

Another discussed aspect of One Water is how it challenges the current water management system and promotes systematic change in the field of water resources management on O‘ahu. Taking a holistic approach to water management through One Water can prove to be the solution to solve water challenges if implemented and operated successfully in the face of climate change. Ultimately, OW can unlock the potential to develop climate and water resiliency. However, if One Water is the solution to achieve water security in Hawai‘i remains to be seen.

Overall, the thesis research study confirms how there are clear barriers to the implementation of a One Water approach on O‘ahu and provides a brief roadmap on how to approach the identified challenges. Ultimately, through further planning, the barriers have to be overcome for One Water to succeed and achieve its goals in sustaining Hawai‘i's waters.

APPENDIX

Appendix A. Stakeholder List

Stakeholder	Sector
DLNR: Commision of Water Resource Management	Public - State
Hawai‘i Community Foundation	Public - Non-profit
Hawai‘i State Land Use Commission	Public - State
Sea Grant College Program (University of Hawai‘i)	Public- Education
Honolulu Board of Water Supply	Public - County
One World One Water	Private

Appendix B. Talk-Story Guide

Stakeholder Talk-Story Guide
Desired Outcomes:
1. Learn how stakeholders come to understand the value of One Water towards climate resiliency on O‘ahu
2. Explore the ways in which climate science can work hand-in-hand with planning and policy design
3. Identify the main barriers towards the implementation of the One Water Approach on O‘ahu and propose actions to overcome the challenges
Questions:
1. In regards to your professional experience in managing water resources, what are some challenges you have faced through cross-sector and interdisciplinary collaboration?
2. How well do you think current water management integrates climate change impacts to water resources?
3. Thinking about water management on O‘ahu, how might water resources planning and management be improved by using a ‘’One Water” approach?
4. What challenges or barriers do you think might exist for implementing a ‘’One Water” approach on O‘ahu?
5. How would you like to see organizations and agencies work differently under a ‘’One Water” approach?
Recommendations:

- *Do you have any suggestions for who we should contact for the purpose of the study?*

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